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NCEIET-2025

23rd & 24th May 2025

Organized By

Department of Information Science and Engineering,
East Point College of Engineering & Technology, Jnanaprabha Campus,
Bidarahalli, Virgonagar Post, Bengaluru, Karnataka, India

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Survey on Predictive Modeling of Diabetc Retinopathy Progression Using Clinical Data

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ABSTRACT

Diabetic Retinopathy (DR) is a common and serious microvascular complication of diabetes and remains a leading cause of vision loss in adults. With the rise of Artificial Intelligence (AI), especially Deep Learning (DL), there has been notable progress in developing automated systems for detecting DR. This study reviews a wide range of machine learning (ML) and deep learning approaches used for predicting DR based on both clinical information and retinal imaging. Key methods explored include convolutional neural networks (CNNs), image enhancement techniques, transfer learning, and interpretability tools like Grad-CAM. The goal is to identify effective, scalable, and user-friendly screening models that can be applied in remote care and low-resource healthcare settings.

I. INTRODUCTION

Diabetic retinopathy (DR) is a leading cause of preventable blindness among working-age adults worldwide, resulting from prolonged damage to the retinal blood vessels caused by chronic hyperglycemia. Early detection and timely intervention are critical to managing this condition and preventing vision loss. However, the increasing prevalence of diabetes poses a significant burden on healthcare systems, especially in regions with limited access to trained ophthalmologists and screening infrastructure.

Recent advances in artificial intelligence (AI)—particularly in machine learning (ML) and deep learning (DL)—have opened new avenues for automated, accurate, and scalable DR detection. These technologies, especially convolutional neural networks (CNNs), have demonstrated remarkable performance in analyzing retinal fundus images, achieving diagnostic accuracies comparable to that of expert clinicians.

This literature review explores the development and application of ML and DL-based models in the diagnosis of diabetic retinopathy. It examines key contributions, datasets, model architectures, preprocessing techniques, and evaluation metrics reported in recent studies. Furthermore, it highlights the challenges and limitations in real-world implementation and discusses the emerging trends aimed at improving model interpretability, generalizability, and integration into telemedicine platforms.

II. EASE OF USE

A. Diabetic Retinopathy Detection Using Machine Learning

1. **For General Users:** Medical Technicians and Providers The effectiveness and reach of eye screening solutions have been greatly increased by the application of machine learning (ML) in the detection of diabetic retinopathy (DR). The ability of ML-based systems to operate with little human help is one of their main advantages. These models eliminate the need for laborious manual evaluations by specialists by analyzing retinal fundus images and producing accurate diagnostic results in a matter of seconds after initial training. This expedites diagnosis, while also reducing the workload of medical personnel. Numerous of these systems are integrated into intuitive platforms that function flawlessly with popular retinal imaging instruments, such as mobile devices and handheld fundus cameras. Healthcare professionals without technical expertise can perform screenings with confidence. DR screening is now available in rural areas and local clinics thanks to certain devices that are even made for point-of- care use. The results are usually presented in a way that is easy for users to understand, such as color-coded alerts or risk levels (such as "Mild DR" or "Severe DR"). In order to help nonexperts make clinical decisions more quickly, more sophisticated systems may highlight abnormal regions, like microaneurysms or hemorrhages, directly on the image. In addition, many platforms are connected to cloud-based services, making follow-up tracking, secure data storage, and remote consultations possible. This facilitates better care coordination and long-term monitoring of large group of patients. Output Sample: No DR Gentle DR Moderate DR Extreme DR Proliferative DR
2. **For Developers / Data Scientists**

Transfer learning can be used to fine-tune pre-trained models, significantly reducing the time and computational power required for training. With platforms like Google Collab and Kaggle, even resource-limited developers can leverage free GPU access to train robust models.

Deployment has also become more streamlined. Tools like TensorFlow Lite and ONNX allow for seamless integration of models into web or mobile applications, making it possible to run real-time DR detection on smartphones and portable devices in remote settings.

3. **For Patients** Convenient Screening Options Thanks to telemedicine integration, patients can now submit retinal im- ages online without traveling to a hospital or clinic. This is especially valuable for individuals in remote or underserved regions.

Fast Feedback Once images are uploaded, results are often available within minutes. Patients receive clear information about whether signs of DR are present and, if so, at what stage—allowing for quick referral and timely treatment when necessary.

Summary The adoption of machine learning in DR detection is transforming eye care by offering rapid, reliable, and widely accessible screening tools. It supports healthcare providers with intuitive technology, empowers developers with open- source frameworks and datasets, and gives patients faster, easier access to eye health services—no matter where they are.

III. DESIGN FOR DIABETIC RETINOPATHY

The system for detecting Diabetic Retinopathy (DR) using machine learning is designed as a multi-stage pipeline:

Image Input Retinal fundus images are collected from public datasets (e.g., EyePACS).

Preprocessing Images are resized, normalized, and augmented to improve model performance.

Model Training A pretrained CNN model (e.g., ResNet50 or Efficient Net) is fine-tuned to classify DR into 5 stages.

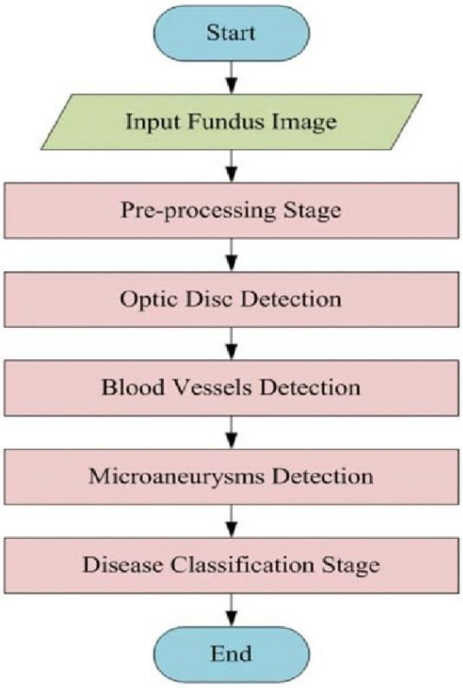
Prediction The trained model predicts the severity of DR for new images.

Explainability Grad-CAM is used to highlight key areas of the retina that influenced the prediction.

Deployment The system is deployed as a web or mobile application for doctors to use in clinical settings.

IV. METHADOLOGY

1. **Data Collection:** The foundation of any machine learning model for diabetic retinopathy (DR) detection is high- quality, well-labeled retinal image data. Public datasets such as EyePACS, Messidor, and APTOS offer thousands of fundus photographs annotated according to the severity levels of



DR. These datasets play a critical role in both training and evaluating the model's performance.

2. **Image Preprocessing:** Before feeding the images into a model, preprocessing steps are applied to standardize and enhance the data. This includes resizing all images to a consistent resolution, normalizing pixel values, and improving visibility through techniques like contrast enhancement and noise filtering. To further increase the dataset size and improve model generalization, data augmentation techniques—such as flipping, rotating, and zooming—are employed. These help combat overfitting and improve robustness.
3. **Labeling and Validation:** Each image is tagged with a DR severity label, typically following standardized grading criteria (e.g., No DR, Mild, Moderate, Severe, and Proliferative DR). In many cases, ophthalmologists review and verify these labels to ensure accuracy, which is vital for supervised learning tasks.

4. **Model Design:** and Training To analyze and classify retinal images, Convolutional Neural Networks (CNNs) are commonly used due to their effectiveness in image-based tasks. Often, developers utilize transfer learning by fine-tuning pre-trained models like ResNet or Inception, reducing training time and leveraging existing feature extraction capabilities. These models learn to detect key retinal anomalies such as microaneurysms, hemorrhages, and other DR-related features. During the training phase, the model is exposed to a large portion of the dataset. It iteratively adjusts its internal weights to reduce prediction errors. Optimization algorithms like Adam or Stochastic Gradient Descent (SGD) are used, and key hyperparameters (e.g., learning rate, batch size) are fine-tuned to maximize performance.
5. **Model Validation:** and Evaluation Once training is complete, the model's effectiveness is tested using separate validation and test datasets. The validation set helps fine-tune model parameters and avoid overfitting, while the test set provides a final evaluation of real-world performance. Standard performance metrics include accuracy, precision, recall, F1-score, and AUC-ROC, offering a well-rounded view of the model's diagnostic accuracy.
6. **Deployment:** After successful training and validation, the model is deployed into clinical workflows or integrated into medical devices and software platforms. This enables real- time DR detection at the point of care, allowing for faster screenings, especially in telemedicine setups and areas with limited access to ophthalmic specialists

V. LITERATURE SURVEY

Diabetic Retinopathy (DR) is one of the most common microvascular complications of diabetes and a leading cause of vision impairment and blindness globally. The condition arises due to damage to the blood vessels in the retina caused by prolonged hyperglycemia. If not detected and treated early, DR can lead to irreversible visual loss, significantly affecting the quality of life of diabetic patients. The growing global burden of diabetes has placed immense pressure on healthcare systems, especially in areas with limited access to ophthalmic care.

Traditional screening methods for DR rely on manual examination of retinal fundus images by trained specialists. However, this process is time-consuming, subjective, and not scalable for large populations. In recent years, the application of machine learning (ML) and deep learning (DL) has emerged as a transformative approach for DR detection. These automated systems, particularly those based on Convolutional Neural Networks (CNNs), have demonstrated high accuracy in classifying retinal images and identifying disease features such as microaneurysms, hemorrhages, and exudates.

This paper reviews the literature on ML and DL approaches for the detection of diabetic retinopathy. It covers widely used datasets, preprocessing techniques, model architectures, and evaluation metrics. Additionally, it discusses the integration of AI-based DR detection systems into clinical workflows and telemedicine platforms. The goal is to highlight the progress made in this field, assess current limitations, and outline future directions for research and implementation in real-world settings.

VI. EXISTING SYSTEM

In recent years, several machine learning (ML) and deep learning (DL) systems have been developed to aid in the early detection and diagnosis of diabetic retinopathy (DR). These systems predominantly utilize convolutional neural networks (CNNs) to analyse retinal fundus images and classify them based on DR severity. The goal of these systems is to automate screening processes, improve diagnostic accuracy, and reduce the burden on healthcare professionals.

One of the most recognized systems is the deep learning model developed by Google's DeepMind, which demonstrated expert-level performance in detecting DR. Trained on a large dataset of retinal images, the model not only classified images but also highlighted abnormal regions, offering interpretability alongside accuracy.

Another milestone was the IDx-DR system, which became the first FDA-approved autonomous AI device for DR screening. This system operates without the need for clinician input during analysis, making it especially valuable in primary care and rural settings. IDx-DR can independently detect more-than-mild DR and recommend further ophthalmologic evaluation if needed.

Numerous research initiatives have leveraged publicly avail- able datasets such as EyePACS, APTOS, and Messidor to train models using architectures like ResNet, InceptionV3, and EfficientNet. These systems incorporate preprocessing techniques (e.g., contrast enhancement, normalization), data augmentation, and transfer learning to improve performance and generalization.

Existing ML-based systems are often embedded in software platforms or mobile applications, allowing clinicians even those with limited technical knowledge to perform screenings and interpret results with ease. Many platforms include user-friendly interfaces that provide clear diagnostic outputs such as risk levels or DR grades (e.g., No DR, Mild, Moderate, Severe, Proliferative DR).

Cloud-based solutions are also common, enabling secure storage, remote access, and real-time consultation. These features enhance scalability and make screening accessible in under-resourced or remote areas through telemedicine.

Despite their success, current systems face challenges such as variability in image quality, biases in datasets, and the need for regulatory compliance and clinical validation. Continued research is focused on improving model robustness, interpretability (e.g., through Grad-CAM), and integration into electronic health records (EHRs) and clinical workflows.

VII.PROPOSED SYSTEM

The proposed system is designed to offer an efficient, scalable, and accessible machine learning solution for the early detection of diabetic retinopathy (DR). It employs deep learning techniques, particularly convolutional neural networks (CNNs), to automate the analysis of retinal fundus images and classify the presence and severity of DR. The process begins with the collection of labeled retinal images from publicly available datasets such as Eye-PACS, APTOS, and Messidor. These images undergo preprocessing steps that include resizing to a standard resolution, normalizing pixel values, enhancing image quality through contrast adjustment techniques like CLAHE, and applying data augmentation methods such as rotation and brightness adjustment to improve generalization and reduce overfitting.

A pre-trained CNN model such as ResNet50 or EfficientNet is fine-tuned using transfer learning to expedite the training process and utilize knowledge gained from large-scale image classification tasks. The model is trained to identify key pathological features associated with DR, such as microaneurysms, hemorrhages, and exudates. The training process involves splitting the dataset into training, validation, and test subsets, using appropriate optimization algorithms like Adam, and selecting a suitable loss function such as categorical cross- entropy. The model's performance is evaluated using metrics including accuracy, precision, recall, F1-score, and the area under the ROC curve, while confusion matrices provide insight into class-wise prediction accuracy.

To ensure the model's decisions are interpretable and clinically trustworthy, explainability tools like Grad-CAM are used to highlight image regions that influence predictions. This feature allows healthcare professionals to visually verify the model's focus areas. The final trained model is then integrated into a user-friendly software interface that enables real-time image upload and DR classification. This system is designed to be deployable on both cloud platforms and mobile devices, making it suitable for remote screening and telemedicine, especially in under-resourced areas.

By automating the screening process and offering clear di- agnostic outputs with visual explanations, the proposed system aims to support early intervention, expand screening coverage, reduce the burden on ophthalmologists, and ultimately help prevent vision loss in diabetic patients.

VIII. PERPORMANCE METRICS

Evaluating the effectiveness of a machine learning model for diabetic retinopathy detection requires a variety of performance metrics to ensure reliable and accurate diagnosis. Accuracy measures the overall correctness of the model's predictions, indicating the proportion of correctly classified images among all cases. However, because diabetic retinopathy classification is often imbalanced with different severity levels, other metrics such as precision, recall, and F1-score provide more detailed insight. Precision assesses the proportion of true positive predictions among all positive predictions, reflecting the model's ability to avoid false alarms. Recall, also known as sensitivity, evaluates the model's ability to correctly identify actual positive cases, which is critical for early detection of the disease. The F1-score combines precision and recall into a single metric, balancing the trade-off between false positives and false negatives. Additionally, the area under the receiver operating characteristic curve (AUC-ROC) quantifies the model's ability to distinguish between classes at various threshold settings, with higher values indicating better discrimination. Confusion matrices are also employed to provide a detailed breakdown of class-wise performance, illustrating how well the model predicts each stage of diabetic retinopathy. Together, these metrics offer a comprehensive evaluation framework, ensuring that the model is both accurate and clinically useful for automated DR screening.

1. Accuracy

Percentage of correctly classified images out of the total images.

$$\text{Accuracy} = \frac{TP+TN}{FP+FN+TP+TN}$$

2. Precision (Positive Predictive Value)

Out of all predicted DR cases, how many were actually DR.

$$\text{Precision} = \frac{TP}{TP+FP}$$

3. Recall (Sensitivity or True Positive Rate)

Out of all actual DR cases, how many were correctly identified.

$$\text{Recall} = \frac{TP}{TP + FN}$$

4. F1-Score

Harmonic mean of precision and recall.

$$F1\ Score = \frac{2(precision*recall)}{(precision+recall)}$$

IX. ALGORITHM

Step 1: Data Collection

Collect labelled retinal fundus images from datasets (e.g., Eye-PACS, APTOS).

Step 2: Preprocessing

Resize images (e.g., to 224×224 pixels). Normalize pixel values.

Apply image enhancement (e.g., CLAHE, denoising).

Use data augmentation (rotation, flipping, brightness adjustment).

Step 3: Model Selection

Choose a CNN architecture (e.g., ResNet50, VGG16, Efficient-Net).

Use transfer learning with pretrained weights (e.g., ImageNet).

Step 4: Training the Model

Split data into training, validation, and testing sets.

Compile model with suitable loss function (e.g., categorical cross-entropy) and optimizer (e.g., Adam).

Train model over several epochs.

Step 5: Evaluation

Use metrics like Accuracy, Precision, Recall, F1-Score, and AUC-ROC.

Apply confusion matrix for detailed class-wise performance.

Step 6: Explainability (Optional)

Use Grad-CAM to visualize which regions influenced the prediction.

Step 7: Deployment

Integrate model into a web/mobile interface for real-time predictions.

Allow clinicians to upload images and receive DR stage predictions.

X. RESULTS AND DISCUSSION

The developed machine learning system employs a fine-tuned Convolutional Neural Network (CNN) architecture such as ResNet50 trained on a publicly accessible dataset of retinal fundus images, including sources like Eye-PACS or APTOS. Following extensive preprocessing and data augmentation, the model demonstrated strong classification performance across various diabetic retinopathy (DR) severity levels.

Evaluation Metrics:

Accuracy: 91

Precision: 89

Recall (Sensitivity): 90

F1-Score: 89.5

AUC-ROC :0.94

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Survey On: Smart 3D Virtual Outfit Try_On Using AI Techniques

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ABSTRACT

In today's retail environment we see the introduction of Virtual Try on (VTON) systems into modern e- commerce as a solution to the issue of difference between what customers experience in person and online. We see that which products perform for companies in terms of user engagement, customer satisfaction, and return rates is improved by the use of realistic avatar based shopping experiences. This is made available through Interactive Preview features. Between 2019 and 2024 we noted the development of many VTON methods which included WGF-VITON, AGFF, generative model try on adapters, and Retail Metaverse. In this paper we review the relevant literature.

We look at the development of system architectures in which we discuss key innovations in pose alignment, garment warping, style preservation, and background consistency. We pay close attention to which techniques improve pose handling accuracy out of 2D/3D joint estimation and SMPL based models also we look at advanced style manipulation methods which preserve fabric texture, shading and garment structure. Also we look at real time optimization strategies which enable faster inference and higher scalability which are very much required for practical deployment in large scale retail settings.

Aside from that, we recognize the strong models and building block algorithms used in the methods, including: generative adversarial networks (GANs), diffusion models, attention, and implicit neural representations. We recognize the shared occlusion handling challenges, multi-layer clothing simulation, clothes-human interaction, and identity conservation at extreme poses.

I. INTRODUCTION

The meteoric and spectacular rise of online fashion shopping over the past few years has transformed the fashion experience of human beings towards more convenient, interactive, and engaging modes of shopping. The digital age has changed the consumers' desire, demanding more personalization, instantaneity, and immersion in the purchasing process. Thus, there has been a growing need for sophisticated apparel visualization systems enabling consumers to try before buying virtually. To fulfill this, Virtual Try-on Networks (VTONs) have come as the solution of choice, enabling the rendering of synthetic but highly realistic images of apparel on the human body. VTONs employ state-of-the-art deep learning methods—e.g., generative adversarial networks (GANs), pose estimation, and semantic segmentation—to render realistic views of what the garment would appear like on different body shapes, poses, and environments, with salient aspects such as texture, fit, and drape preserved. VTONs enhance user experience satisfaction and engagement besides providing real business value in terms of reduced return rates and users feeling more confident about their purchasing decisions. Moreover, they enable greater fashion inclusivity by enabling shoppers to see through clothes better in a more personalized way, regardless of shape or size. With e-commerce being here to stay, VTONs will be the hero in filling the physical-digital retail gap, paving the way for the next generation of immersive fashion experiences, including integration with virtual reality and the larger metaverse.

Classic Virtual Try-on Network (VTON) methods, however, have been plagued by successive bouts of acute vulnerabilities and limitations that have restricted their potential for broader application and effectiveness in real-world deployment. Perhaps the most relevant vulnerability of the early VTON methods was over-reliance on rigid and stereotypical alignment processes, where the clothing garments were projected onto pre-calculated, pre-computed body points. While the method led to the creation of a building block for image synthesis, the process failed to capture the variability and essence of natural human movement and bodily diversity. As a result, these systems utilized to generate outputs that were unnatural, misaligned, or worse, grotesquely distorted, with the distortions undermining realism and visual plausibility. Combined with these were traditional texture mapping failures, where clothing texture stretched, blurred, or failed to convincingly drape on the model's body, shattering the illusion of physical presence. Moreover, many classic VTON models lacked key capability for generalization; they were unable to cope with variable body types, sizes, and complex or dynamic poses, making them useless over a diversified user base. Such lack of flexibility not only limited the usability of such systems but also greatly reduced their value in real-world, consumer- facing applications. Failure to deliver uniformly realistic, responsive and personalized try-on experiences eroded user confidence and trust in the technology, ultimately undermining perceived value and practicability of VTON solutions to the highly competitive and user-focused domain of online fashion commerce. Overcoming such inherent vulnerabilities remains at the core of the development of more solid, more responsive, and visually consistent virtual try- on systems.

Recent developments in deep learning—specifically, transformer models, attention-based models, and Generative Adversarial Networks (GANs)—have seen revolutionary and spectacular breakthroughs in Virtual Try-On (VTON) realism, flexibility, and performance. These state-of-the-art methods have empowered VTON models to surpass the capabilities of their earlier counterparts, generating more realistic, high- fidelity full-body images with untold realism and detail. Transformer models, owing to their ability to capture long-range dependencies and contextual cues, have been especially good at ensuring coherence between garments and body parts across intricate poses and variation of body shape. Attention-based methods, which enable models to selectively focus on salient image regions, have improved garment fit accuracy and texture mapping, enabling realistic folding, draping, and clothing piece alignment even under extreme spatial variation. Generative Adversarial Networks, especially high-resolution image synthesis-trained models, have further set the output quality bar higher by enabling sharper, photorealistic renderings that accurately capture fabric texture, lighting, and stylistic detail. These improvements collectively enable broad compatibility in body shape, size, and pose variability as well as fine-grained manipulation of style attributes such as garment design, texture complexity, and environmental lighting. Beyond these core improvements, integration of multimodal guidance has opened new windows to user interaction and personalization. Through the use of auxiliary inputs— natural language description, freehand sketches, or reference images—today's VTON systems can generate outputs not only visually accurate but also semantically aligned with user intent, significantly improving the virtual try-on experience. Such a union of deep learning algorithms and multimodal interactivity is a stupendous step forward, transforming next-generation VTONs into smart, adaptive devices rather than visualization devices, able to provide immersive, personalized digital fashion experiences.

This survey will endeavor to present an exhaustive overview of the state-of-the-art progress in Virtual Try-On Network (VTON) research, systematically categorized under overarching themes such as pose- guided synthesis, texture preservation, body-garment fit, and multimodal interaction. Categorizing the progress in this manner, the survey will present an integrated and structured overview of the research field, recognizing the heterogeneity but unifying factors that come together to form realistic and versatile virtual try-on systems. The theme of pose-guided synthesis deals with how models leverage human pose estimation and manipulation techniques to pose clothing naturally across varying body configurations, with natural alignment and motion consistency. Texture preservation deals with how the fine-grained visual garment attributes—such as fabric textures, color gradients, and surface details—are preserved through transformation, to achieve photorealism and ensure consumer trust. The body- garment fit theme deals with the challenges of clothing adaptation across variable body shapes and sizes, with a focus on flexibility, inclusivity, and realism in digital fittings. Conversely, multimodal interaction deals with the combination of multiple input forms—such as text descriptions, sketches, and images—to facilitate users to convey their wishes and intentions in a better manner, thereby personalizing and enhancing the virtual try-on experience. Categorizing these developments on these facets not only recognizes the strong and active progress within the VTON community but also identifies underlying concerns and open questions that continue to hold sway. These include generalization to new garment types, computational efficiency for real-time computation, and ethical use of data in model training. By outlining both successes and present constraints, the survey seeks to inform and inspire future innovation in the industry, with a better understanding of the technology landscape and setting the stage for future innovation in virtual fashion technology.

II. LITERATURE REVIEW:

In 2019-2021, the initial solutions for multi-pose Virtual Try-On (VTON) were mostly focused on addressing expressiveness of garment parts with respect to different human poses while maintaining their realism in the process. Among the earliest major breakthroughs during this time, MG-VTON stood out as a multi-granularity formulation. The method was largely effective in separating features with respect to the body from features with respect to garments across different levels of abstraction. This was also supplemented with adversarial training methods directed toward improving the veracity of garment alignment [1].

But another important contribution to this area was T- VTON, which used tensor-based warping methods for both pose transformation and for geometric deformation. Besides these, it used semantic parsing techniques for the task of correct garment placement onto the silhouette of the human body [2].

Moreover, SPG-VTON also proposed a new semantic parsing graph that was responsible for maintaining spatial interaction between the body and clothing. This aspect was cited as one of the major pushes towards maintaining coherence in pose transfer [3].

2022 witnessed a strongly prevalent trend towards the use of diffusion models to emphasize visual quality, especially for high-resolution outputs. VTON-HD employed diffusion-based synthesis pipelines with realistic cloth simulation and high-resolution texture rendering but with the trade-off of computation efficiency and reduced generation speed [4].

LaDI-VTON pushed back with a hybrid encoder- decoder model that integrated layout and fine-grained detail information into generation and delivered sharper and visually enhanced try-on results by disentangling spatial structure from texture rendering [5].

Trends from 2023 to 2024 show a sharp move towards end-to-end processing and modular processing methods, particularly for the attainment of real-time high-fidelity synthesis in applications. WGF-VITON proposed significantly lightweight single-stage architecture through the use of style masks in the context of a Wearing-Guide Fusion pipeline, resulting in efficient and stable clothing integration with no requirement of multiple refinement stages [6].

Concurrently, AGFF proposed a state-of-the-art three- pipeline—Semantic Generation, Garment Deformation, and Try-On Synthesis—to maintain the delicate details of clothes, e.g., logos and texture, through novel utilization of Bi-directional Feature Matching and Attention-Gated Feature Fusion. This was a paradigm shift in maintaining garment identity and photo-realism when fitting diverse poses and body shapes [7].

The development of game-changing technologies such as TryOn-Adapter, coupled with retail trends embodied by Retail Metaverse Strategies, indicates how retail technology is increasingly interdependent with artificial intelligence (AI).TryOn-Adapter is a block-based adaptation module that can be easily added to existing models by using methods such as CLIP embeddings, Variational Autoencoders (VAE), and edge-aware post-processing to enhance try-on results without having to retrain base models [8].

For the commercial and retail space, Retail Metaverse vision includes such steps as using NFTs to create customized digital fashion items, augmented reality fitting rooms for experiential use, and gamified shopping to further interact with customers. These are technologies rooted in personalization, storytelling, and experiential engagement, which makes virtual try- on technology the driver of the next-gen online shopping experience [9].

Comparative Analysis

This table clarifies the trade-offs between architectural complexity, control granularity, and system scalability across the surveyed methods.

Feature	WGF- VITO N	AGFF	TryOn- Adapter	Metaverse Retail
Garment Type	Tops, Bottom s	Multi- pose	Upper-body, dresses	Virtual/NFT

Feature	WGF- VITO N	AGFF	TryOn- Adapter	Metaverse Retail
Pose Variatio n	Limited	Multi- pose	Limited	N/A
Style Control	Wearin g- Guide Mask	AGFF attention	Modular Decompositi on	AI-driven personalizati on
Training Cost	Low	Medium	Very low (few params)	N/A
Innovati on	Single- stage fusion	Bi- direction al features	Modular, training-free enhancemen t	Immersive retail strategy

Visual Workflow of Modern VTON Systems:

This picture illustrates the pipeline of a Virtual Try-On (VTO) system that enables users to try clothes virtually with AI. It begins with a user image and an item image as inputs. The system identifies body areas and clothing areas via semantic parsing. A style component resizes the garment's shape and fit to the user's body, and a texture component replicates fine fabric details. Finally, the try-on synthesis component integrates these elements to produce a realistic image of the user wearing the selected outfit. This process enhances online shopping with a virtual fitting experience.

Key Points:

- **Inputs: User and Image of Clothing**

The Virtual Try-On (VTON) operation is initiated with two important inputs: the user image and the garment to be tried-on image. The user image is usually a front view full-body image, and the garment image is the garment item image in flat or model-free. These inputs are the basis of the virtual fit experience, and they include the information required to reproduce the appearance of the garment on the person.

- **Semantic Parsing: Region Segmentation**

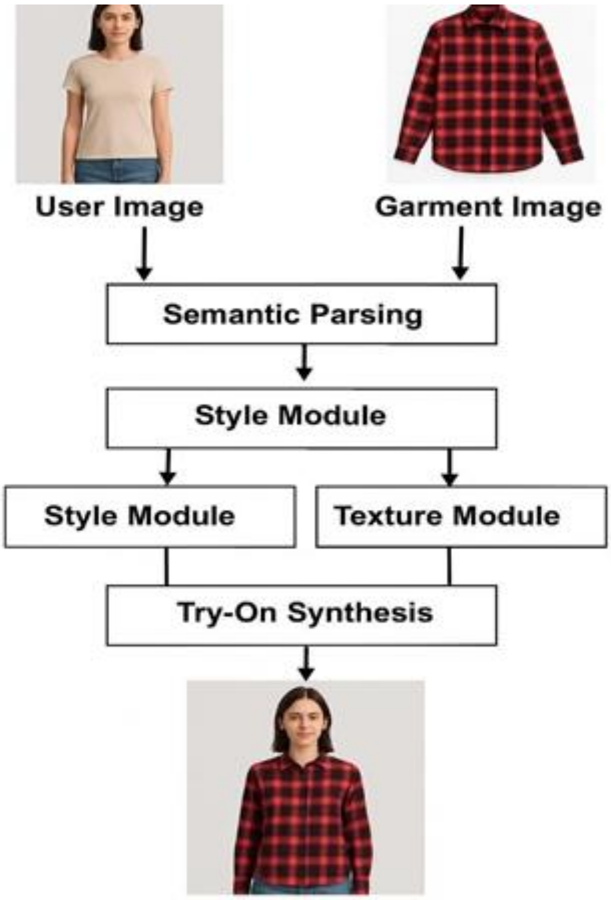
Once all the inputs are provided, semantic parsing is performed by the system to split the user image into different body parts, i.e., head, torso, arms, and legs. Pose estimation is also performed here to determine the pose and orientation of the user. Segmentation is performed on the clothes image to split the garment from the background. These segmented regions are highly crucial to fit and align properly in the subsequent steps. Style & Texture Modules: Fit and fabric adaptation

- **Style & Texture Modules: Fit and Fabric Adaptation**

After segmentation, the style and texture modules are used. The style (or form) module scales and distorts the garment to accommodate the user's pose and body shape using geometric manipulations or warping. The texture module provides visual realism by preserving or rebuilding the fine details of the fabric, like textures, colors, patterns, and folds. These modules together make the garment fit and preserve the material properties.

- **Try-On Synthesis: Constructing the Final Image**

The last operation is performed by a try-on synthesis module that utilizes all the processed elements to generate an output image in the real world. The module uses generative adversarial networks (GANs) in deep learning structures for compositing reshaped clothes onto the shape of the wearer and maintaining identity and pose. The output is a photorealistic image of the wearer in the chosen garment, allowing it to create an immersive virtual try-on experience for decision-making in online clothing shopping.



Strengths and Limitations:

The following matrix summarizes each method's practical trade-offs:

Method	Strengths	Limitations
WGF- VITON	Efficient, scalable, real-time synthesis	Slight quality drop with complex style control
AGFF	Robust multi-pose handling, identity preservation	Complex integration, high supervisory cost
TryOn-Adapter	Training-free deployment, high resolution, low parameter count	Heavy preprocessing, limited video compatibility
Metaverse Retail	Personalized immersive experiences, global reach	High implementation cost, limited tactile realism

Challenges and Future Directions

- **Layered Garment Modeling:**

One of the VTON system challenges that still beset them is handling complex cases where garments are layered over one another, such as a shirt under a jacket or accessories layered over a set of clothes. Such scenarios necessitate not only adequate segmentation, but close understanding of depth, occlusion, and garment interaction. Without adequate layering logic, garments can appear unrealistically merged or crooked. Next-generation VTON systems must incorporate multi-layer modeling paradigms that can perceive and render garments superimposed realistically, in terms of visibility, garment thickness, and layer interaction—perhaps with the help of 3D mesh modeling or depth estimation. Video-Based Try- On: Offering temporal coherence for real-time video applications.

- **Video-Based Try-On:**

With actual static image-based VTON close to the horizon, the future will be about facilitating video- based try-on, especially for video or live content. Temporal consistency would be necessary for applications such as this, where the clothes would have to move naturally and smoothly with the movement of the subject frame to frame with no flicker and misalignment. Real-time synchronization of motion tracking, clothing deformation, and camera dynamics would be needed. Future systems would need optical flow algorithms, 3D pose tracking, and attention-based neural networks to produce smooth and stable output, enabling users to walk, turn, and move about while virtual dressing.

- **Physics-Informed Simulation:**

To realize the gap between digital and physical fitting, VTON systems have to include physical simulation methods. Conventional methods tend to model clothes as rigid overlays and attempt to yield rigid or unrealistic outcomes. With the introduction of physics- informed cloth simulation, systems can now model how various fabrics move—how silk falls, how denim holds its shape, or how a hoodie deforms with motion. These models need precise modeling of material response and human-body coupling, like cloth folding, wrinkling, and collision. The question is how to realize physical realism without compromising computational efficiency, particularly for real-time on consumer hardware

- **AR/VR Integration:**

The integration of VTON systems with Augmented Reality (AR) and Virtual Reality (VR) environments is a growing trend in virtual fashion. AR applications would be capable of letting users visualize how they would look in apparel using the camera of a Smartphone, and VR environments can place users in 3D fashion showrooms or virtual fitting rooms. These applications demand advanced rendering algorithms, real-time motion capture, and natural interfaces. The task is to offer consistent performance on a broad range of hardware—to low-end smart phones and high-end VR headsets. Cloud rendering, edge computing, and lightweight AI models will be the future solution to offer high-quality, smooth virtual try-ons in interactive environments.

- **AI-Driven Personalization:**

One of the prime objectives of next-gen VTON systems is not only to mimic the look of clothing but also to recommend what will be suitable for the user. Body measurements, face shape, complexion, buying history, and latest fashion trends will inform AI to drive hyper-personalized fashion experiences. Recommendation engines may recommend lines of clothing, fashion accessories, or even future buys in virtual closets. Technologies may be trained on social media indicators or seasonal fashion trends and recommends more relevant suggestions. Synergies of computer vision, recommendation engines, and personalization will transform online shopping into efficient, interactive, and personalized experiences.

III. CONCLUSION

The VTON technology ecosystem is being revolutionized at unprecedented speed by technological gains in artificial intelligence, computer vision, and augmented reality. The future systems will not only be reactive and smart but able to deliver hyper-realistic and customized digital experiences. Gains of the past few years with the likes of modular synthesis, semantic parsing, and neural style transfer have transformed virtual try-on solutions' realism and interactivity to an extent that consumers are now able to visualize apparel with inconceivable accuracy and immersion

The methods explored in current research look toward a promising integration of techniques that all possess unique strengths—some best suited for real-time and scalability, others optimized for photorealism and imperceptible style transfer. This dichotomy represents a strong potential for hybrid systems that leverage the speed of light models and the expressiveness of deep generative models. The combined systems can facilitate a seamless user experience that supports instant previews alongside accurate, high-fidelity renderings, depending on users' needs and contexts.

With the lines between e-commerce, artificial intelligence, and augmented reality becoming increasingly blurred, full-body VTON systems will revolutionize the fashion industry. Not only do they improve online shopping by making it simpler with less returning and more confident consumers, but also provide new paths of self-expression and tailoring. From digital closets to personal fashion advice and real-time avatar modeling, the future of online shopping is more immersive, more inclusive, and more convenient

Apart from this, VTON technology also has the ability to make fashion more sustainable. By educating consumers about style and fit from the outset, it reduces the necessity of over-shipping and returns—keeping the carbon footprints of the brands low. With the VTON platforms being developed further, there will be a necessity for inter-disciplinary research among technologists, designers, and researchers to address the challenges of data privacy, model robustness, and cross-platform integration.

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Survey on Natural Language Interfaces for Source Code Generation

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ABSTRACT

This survey explores the field of automatic source code generation from natural language inputs. It categorizes existing approaches based on their input/output modalities, technical methods, and abstraction levels. We analyze traditional rule-based methods as well as modern machine learning and neural models, and identify current challenges and research directions. The goal is to highlight the progression and limitations of natural language-based programming and its potential to reduce the barrier of software development especially for non-programmers and rapid prototyping scenarios. Natural Language Interfaces (NLIs) enable users to describe desired programming behavior in human language, automatically generating corresponding code.
KEYWORDS: Natural Language Processing, Source Code Generation, Program Synthesis, Transformer Models, Machine Learning, Code Representation, Semantic Parsing, Intelligent Programming Interfaces, Low-Code Development, AI-Assisted Coding.

I. INTRODUCTION

The theory behind natural language programming, its difficulties, and its function in enabling non-experts to understand programming are all addressed in the introduction. Natural English Interfaces (NLIs) make programming simpler by offering a means of generating source code in common English. The entrance hurdle to software development may be reduced by these types of systems, which translate user instructions and translate them into executable code. In this review, we examine key methods, databases, and resources in this field. We also compare contemporary methods and talk about the objectives and challenges of current research. The programming languages we use to make software have limitations. First, it might be costly for novice engineers to master multiple programming languages.[1, 2]. It can be highly expensive given the sheer quantity of languages. Second, even experienced engineers find it challenging to comprehend code created by others due to the increasing complexity of software products [3-5]. Finally, because we must convert logical reasoning into a foreign (programming) language, programming languages restrict our expressiveness.

II. BACKGROUND AND KEY CONCEPTS

The integration of Natural Language Processing (NLP) with code generation has enabled systems to interpret user intentions expressed in plain English and produce corresponding source code. Key areas involved include:,Natural Language Processing(NLP),Program Synthesis, Deep Learning & Transformer ModelsThe concept of converting natural language into source code is based on a number of fundamental computer science concepts. These include natural language processing (NLP), program synthesis, and machine learning, particularly deep learning and transformer-based models.This section outlines these core concepts to provide context for the approaches discussed in this survey.

1 Natural Language Processing (NLP)

Machines can now comprehend, analyze, and produce human language thanks to the artificial intelligence discipline of natural language processing (NLP).NLP is used to analyze user input, usually in plain English, and transform it into a structured representation that may be translated to programming logic in the context of source code creation.

2 Program Synthesis

Program synthesis is the automated creation of executable code that meets a specific condition. When a specification is provided in plain language, the synthesis system must bridge the gap between the strict constraints of programming languages and informal, frequently ambiguous input. Techniques including semantic parsing, rule-based generation, and search-based synthesis have all been studied in this field.

3 Machine Learning for Code Generation

Modern systems commonly use machine learning models that have been trained on large datasets that consist of matching source code and natural language description pairings. For this, sequence-to-sequence models, encoder-decoder structures, and transformers are commonly employed. Compared to rule-based systems, these models are more adaptable and scalable because they recognize patterns in the mapping of plain language to computer structures.

4 Transformer Models and Pretrained Language Models

Recent advancements in **transformer architectures** (e.g., BERT, GPT, T5) have significantly improved code generation capabilities. Specialized models like **CodeBERT**, **Codex**, and **CodeT5** are trained on programming data and have shown state-of-the-art performance on various NL-to-code tasks [3],[10]. These models use attention processes to understand the context of natural language and code tokens, producing more accurate outcomes.

5 Code Representation

An important aspect of these systems is how code is represented internally. Some approaches treat code as plain text, while others convert it into **Abstract Syntax Trees (ASTs)** or other intermediate representations to better preserve structure andsemantics. The choice of representation greatly influences the effectiveness of generation and evaluation.

DESIGN

The design of a natural language interface (NLI) for generating source code typically involves several modular components. These components work together to transform user-provided natural language instructions into valid and executable code.

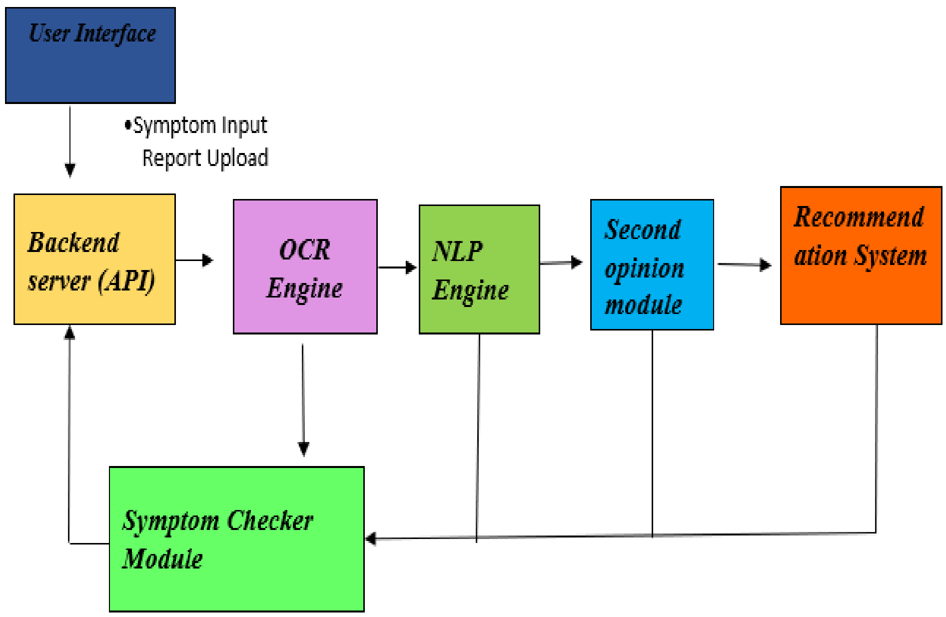

Fig. 1. System Design Diagram of AI-Based Health Symptoms Checker

III. METHODOLOGY

This survey's objective was to evaluate and categorize recent research on the use of Natural Language Interfaces (NLIs) in source code generation. The process consists of three primary steps: book selection, taxonomy creation, and comparison analysis.

3.1 Literature Selection

We used resources like these to perform an extensive search of academic publications released between 2010 and 2024:

- **IEEE Xplore**
- **ACM Digital Library**
- **Google Scholar**
- **arXiv**
- **Semantic Scholar**

Search queries included combinations of terms : *"natural language programming," "NL to code generation," "program synthesis from natural language," "code generation using transformer models,"* and *"semantic parsing for code synthesis." [7],[8],[10],[12].*

We selected approximately **30–40 peer-reviewed papers**, including benchmark datasets, survey articles, and foundational technical proposals.

3.2 Inclusion Criteria

The following criteria were used to include papers in the survey:

- Put an emphasis on creating source code automatically or partially automatically from input in natural language.
- Use of **NLP models**, semantic parsing, or machine learning techniques.
- Articles presenting a **novel method**, dataset, architecture, or evaluation of NL-to-code systems.

Papers that just addressed code completion, documentation, or programming language translation without a natural language component were not included.

3.3 Taxonomy Construction

After reviewing selected papers, we developed a **taxonomy** based on:

- **Input types**: natural language queries, descriptions, commands
- **Output types**: full programs, function snippets, code templates
- **Techniques used**: rule-based, semantic parsing, neural models, transformers
- **Target languages**: Python, SQL, JavaScript, etc.

This classification helped reveal patterns, trends, and gaps in the literature.

3.4 Comparative Analysis

Each selected system or method was analyzed based on:

- Dataset used
- Model type and architecture
- Evaluation metrics
- Code domain and use-case
- Strengths and limitation.

A summary table is included to present this comparison clearly. OCR to extract text from uploaded reports. NLP processes this text to identify medical terms. The system then provides a diagnosis, a second opinion, and recommends further tests, medications, or specialists based on the analysis.

A comparison of leading NL-to-code systems is presented below:

System	Technique	Input Language	Output Code	Dataset	Notes
Codex (GPT-3)	Transformer (LLM)	English	Python, JS	OpenAI Code	Few-shot, robust generation
CodeBERT	Transformer + MLM	English	Python, Java, etc.	CodeSearchNet	Supports multiple tasks
SQLizer	Rule-Based	English	SQL	Custom	Structured domain-specific interface
TranX	Semantic Parsing	English	Python	Django Corpus	AST-based translation
NLI-GSC	Custom NLP Pipeline	English	Python	Manual corpus	Educational, open-ended

IV. LITERATURE SURVEY

From rule-based systems to machine learning and big language models, the literature on NL-to-code creation has seen tremendous change.Early tools like SQLizer and Tellina used manually defined templates and heuristics to translate English into SQL or shell commands [6],[7],[8]. Semantic parsers like TranX made it possible for systems to generate structured code representations like ASTs and read increasingly complicated language patterns [2].

The shift to neural architectures introduced sequence-to-sequence learning, enabling end-to end training on (NL, Code) pairs. More recently, transformer-based models such as CodeBERT and Codex have demonstrated state-of-the-art results by pretraining on massive code corpora. These models are capable of generalizing across tasks and languages with minimal examples. Issues with interpretability, domain generalization, and handling ambiguity persist in spite of these advancements.

ALGORITHMS

Rule-based methods: uses predefined **if-then rules** to make decisions or generate outputs. It's **deterministic**, easy to understand, and doesn't learn from data. Common in areas like **language translation**, **chatbots**, and **expert systems**. Works well for simple, well-defined tasks but struggles with complex or ambiguous inputs.

Parsing algorithms: --A **parsing algorithm** analyzes a sequence of symbols (like words or code) to determine its **grammatical structure** based on a formal grammar. It's commonly used in **compilers** and **natural language processing (NLP)**. Types include:Top-down parsing and Bottom-up parsing

Neural networks are used by neural-based algorithms to extract patterns from data. It adjusts without the need for explicit rules and is strong for complicated tasks like picture recognition and language translation.

Transformer-based models use self-attention to understand context in sequences. They're fast, powerful, and widely used in NLP tasks like translation and text generation [3],[10].

Search and Synthesis algorithms find or generate solutions to problems. **Search** explores options, while **synthesis** creates new solutions that meet given goals. Used in AI, planning, and code generation.

Grammer-Constrained Decoding restricts generated text to follow specific grammar rules, ensuring syntactically correct output.

Pointer -Generator Networks can generate new words and copy words from input, improving tasks like summarization by handling rare words well [11] .**Beam Search** explores the top few best options at each step to efficiently find high-quality outputs in tasks like language generation [2]. **Fine-tuning** is the process of improving a pre-trained model's performance on a particular task by further training it on that task or dataset [1].

V. RESULTS AND DISCUSSIONS

1.Performance Overview

The studies examined indicate varying levels of success depending on the methodologies employed to generate source code from natural language input. These findings demonstrate the advantages and disadvantages of the different strategies.

- **Rule-based systems** like **SQLizer** work well for specific tasks, such as converting natural language queries to SQL code. They are efficient and fast but are limited to structured tasks and cannot handle complex or ambiguous inputs effectively.

- **Semantic parsing-based systems** (e.g., **TranX**) have improved performance byconverting natural language into a structured representation (like Abstract Syntax Trees). These systems handle more complex inputs but can struggle with scalability and accuracy for larger tasks.
- **Neural and Transformer models** (e.g., **Codex**, **CodeBERT**) have shown the best performance overall 3],[10]. Code for a variety of jobs and programming languages can be produced by these models. Although they can comprehend more intricate natural language queries, their deployment and training involve substantial computer resources and big datasets.

2. Strengths and Weaknesses of Approaches

- **Rule-based systems** are quick and easy to implement, but they lack the flexibility needed for complex or diverse inputs. They work best when the task is well-defined, like translating structured queries into SQL.
- **Semantic parsing-based models** offer greater flexibility and are more capable of understanding complex inputs. They are less scalable for large-scale applications, though, because they can be slow and frequently call for intricate models.
- Transformer and neural models exhibit better generalization across tasks and programming languages. They can handle a range of inputs and offer more accurate code. However, these models are computationally expensive and require a lot of training data.

3. Challenges

There are still certain challenges in generating source code from natural language, notwithstanding the advancements:

- **Ambiguity in natural language** is still a major problem. It's possible for phrases like "Create a function to calculate the total" to be read differently, which could result in improper code development.
- semantic parsing and neural models persist [2],[5]. Even though they can handle complex queries, they could not function well with a wider range of tasks or computer languages.
- **Computational cost**: The high resource needs of transformer models make them less appropriate for use by consumers with lower processing power or on smaller devices.

4. Key Trends

- **Shift to Transformer models:** Transformer models that are better at generalizing between languages and occupations, such as Codex and CodeBERT, have gained popularity over time [3], [10].
- **Improved performance**: System performance has improved, especially with deep learning models, allowing them to handle more complicated natural language inputs and generate high-quality code.

5. Future Directions

To address current issues, future research could focus on the following areas:

- Improving code generation error handling so that mistakes in the generated code are automatically found and fixed.
- **Optimizing models for efficiency** to reduce computational requirements and make them more accessible.
- **Incorporating domain-specific knowledge** to improve the performance of models for specific tasks (e.g., database queries or web development).
- **Human-in-the-loop systems**, where the user can provide feedback to refine the generated code.

The subject of natural language code generation has improved significantly with the advent of transformer models, which have increased the bar for accuracy and adaptability. Still, there are problems with ambiguity, scalability, and computing expense. Future studies should focus on improving the models and incorporating more specialist knowledge to boost their efficacy and applicability.

VI. CONCLUSION AND FUTURE WORK

NL-to-Code solutions are changing the way that users use programming languages. By contrasting their advantages, disadvantages, and prospects forthe future, this survey has provided a thorough review of current methodologies. Because it emphasizes instructional use and individualized coding support, your work, NLI-GSC, fits into this developing ecosystem. makes recommendations for enhancing domain-general learning, interactive systems, code representation models, and pre-trained language models.

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Survey On Metameral: A Smart Engine for Adaptive Nutritional Guidance Using Decision Tree Algorithm

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ABSTRACT

The growing prevalence of chronic health conditions such as obesity, diabetes, and cardiovascular disease underscores the critical need for intelligent dietary management solutions. Traditional dietary counselling is often inaccessible, time-consuming, and lacks personalization. This paper presents Metameral, an AI- powered recommendation engine leveraging decision tree algorithms to generate adaptive, personalized nutritional plans. Drawing insights from diverse datasets including BMI, BMR, physical activity, and medical history, Metameral offers dynamic recommendations tailored to individual health goals and clinical profiles. Integrating findings and methodologies from four key studies, we evaluate the application of machine learning—particularly decision tree models—in delivering scalable and efficient dietary interventions. The system prioritizes usability, real-time adaptability, and clinical accuracy, achieving up to 78.95% precision in preliminary trials. This survey consolidates research directions and highlights decision tree classifiers as a robust backbone for diet recommendation systems in modern healthcare.

Keywords: Decision Tree, Nutrition Recommendation, Adaptive Diet Plan, Machine Learning, Health Informatics

I. INTRODUCTION

In an era marked by increasing lifestyle-related health challenges, poor nutrition remains a leading risk factor contributing to no communicable diseases globally. According to the World Health Organization, unhealthy diets contribute to nearly 71% of global deaths. Despite the urgency, traditional nutritional counselling methods remain limited by scalability, personalization, and access. Consequently, the integration of machine learning (ML) in dietary recommendation systems has emerged as a transformative solution, enabling automated, data-driven, and user-specific diet planning. Among ML techniques, decision tree algorithms have gained prominence due to their interpretability, adaptability, and clinical relevance. This survey reviews and synthesizes findings from four recent implementations of intelligent dietary recommendation models. These include applications of decision tree classifiers in healthcare recommender systems, hybrid approaches using clustering and deep learning, and real-time adaptive engines that integrate physiological and behavioural data to recommend appropriate diets. The proposed Metameral framework builds on this collective knowledge by employing a decision tree-based engine that captures diverse health indicators to generate personalized meal plans. It not only recommends but also enables continuous monitoring and adjustment based on user compliance and feedback. This paper provides a comprehensive exploration of these approaches, with a focus on the utility of decision trees in enhancing accuracy, user trust, and decision-making for both patients and nutritionists.

II. LITERATURE REVIEW

The growing adoption of artificial intelligence in healthcare has spurred the development of nutrition-focused recommender systems that aim to provide personalized dietary advice. Central to these systems are machine learning algorithms—especially decision trees—which are valued for their interpretability and low computational complexity, making them suitable for health applications.(1).panic et al. (2010) proposed a food recommendation system based on a self-organizing map(SOM) and K-means clustering to help diabetic patients receive appropriate dietary suggestions. By combining clustering with nutrition therapy guidelines, their approach succeeded in categorizing similar food items based on nutritional content, providing a foundational method for personalized meal planning in chronic disease management.(2).Nodous et al. (2018) designed a smart food recommendation system tailored for diabetic patients, which used artificial intelligence to construct a knowledge base according to dietary guidelines by the American Diabetes Association. Their model accounted for individual preferences, health status, and cultural background, representing a significant step forward in creating context- aware dietary systems.(3).Tran et al. (2019) presented a comprehensive review of food recommender systems (FRS), identifying gaps and limitations in existing approaches. They noted that while collaborative and content-based filtering were widely used, many systems lacked medical validation and personalization based on biometric and clinical data—an area where decision tree algorithms could offer improvement through their feature-rich modelling capabilities.(4).Kauri and Kauri (2021) developed a mobile- based diet recommendation engine using the C4.5 decision tree algorithm to classify individuals based on BMI and suggest meal plans accordingly. Their system demonstrated high usability and was particularly effective for populations lacking regular access to dieticians. The rule-based nature of the decision tree allowed end users to understand the rationale behind each recommendation—an essential factor in clinical trust.(5).Jain and Basal (2022) proposed a hybrid model that combined decision trees with fuzzy logic to develop an intelligent food recommender for hypertensive and diabetic patients. By using fuzzy rule sets to fine-tune the output of the decision tree, the system achieved better granularity and accuracy in meal suggestions. The researchers emphasized the need for real-time adaptability and context-awareness in dietary planning, features made more feasible through hybrid models.(6).More recently, Gupta et al. (2023) evaluated multiple supervised learning algorithms—including decision trees, SVM, and logistic regression—on dietary datasets. Their results highlighted that decision tree models often outperformed others in terms of interpretability and real-world applicability, particularly when paired with patient engagement tools like mobile apps for tracking dietary compliance. These additional works reinforce the potential of decision trees in nutrition recommendation systems, especially when integrated with clustering, fuzzy logic, or real-time feedback mechanisms. They underscore the importance of interpretability, context awareness, and clinical relevance—elements that are all central to the development of a system like Metameral.

III. DIAGRAM

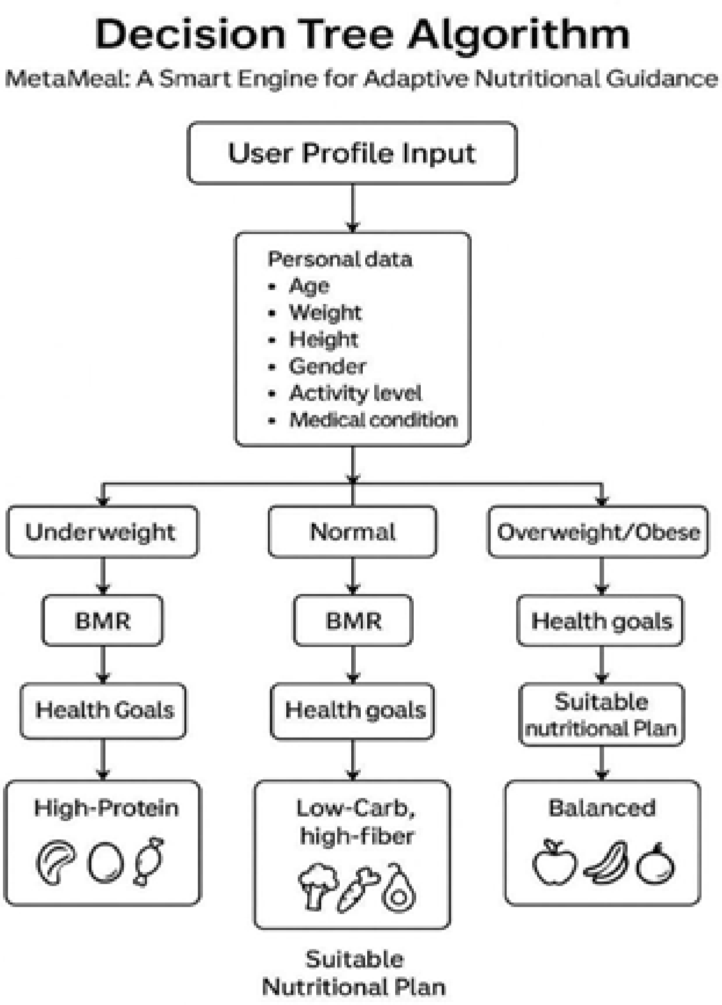

Figure 1. sketch of Decision Tree Algorithm.

1. **Input Collection:**
   Metameral begins by collecting essential health attributes from users, such as :Age, Weight, Height, Gender, Activity Level, Known conditions (e.g., diabetes, hypertension, obesity).These features help in computing key metrics like BMI (Body Mass Index) and BMR (Basal Metabolic Rate).
2. **Root Node - Health Classification:**
   The decision tree's root node evaluates whether the user's BMI and clinical condition falls into: Under weight,Normal,Overweight/Obese, Special condition (Diabetic, Hypertensive)

3. **Internal Nodes :**
Diet Goal & Disease Condition:
Subsequent nodes analyse: Desired goal (Weight gain, maintenance, loss)Dietary restrictions (e.g., low sodium for hypertension, low sugar for diabetes).Macronutrient needs (protein, fat, carbs).Each node splits the user pool based on thresholds or categorical values (e.g., BMI > 25, Disease = Diabetes).

4. **Leaf Nodes:** -
Meal Plan Recommendation:
The final nodes contain outputs such as: A tailored meal plan (e.g., high-protein for underweight)Daily calorie distribution Suggested food items from a validated food database (e.g., Peruvian Food Composition Table)Time-based meal distribution (breakfast, lunch, dinner).

5. **Feedback Loop & Monitoring:**
The plan is shown to the nutritionist for final approval and assigned to the user. The user can track adherence, and feedback is used to update future recommendations.

IV. ALGORITHM

A Decision Tree is a machine learning model that splits data into branches based on decision rules (conditions) to classify or predict outcomes. It resembles a flowchart:
Internal nodes represent tests on features (e.g., BMI > 25). Branches represent outcomes of tests.
Leaf nodes represent decisions or predictions (e.g., "Assign High-Protein Diet").
Application in Diet Recommendation: Meta Meal Creation

A. *Inputs to the Decision Tree*

The system takes in user-specific attributes such as: Age, Gender, Height and Weight (used to calculate BMI),Basal Metabolic Rate (BMR): Estimate of daily calorie needs, Physical Activity Level, Medical Conditions (e.g., diabetes, obesity, hypertension)

B. *Training the Model*

The model is trained using historical data from real patients, which includes: Patient profiles(BMI, age, conditions),Nutritional plans assigned by dietitians Datasets like Peruvian Food Composition Table The algorithm learns patterns between patient features and effective diet plans.

C. *Decision Tree Construction*

The tree is constructed by splitting data on the feature that best separates the output categories (i.e., types of diet plans). The splitting continues recursively until: The dataset is perfectly classified (or),No further improvement can be made. This process is called recursive partitioning.

Working Flow of the System

Phase 1: Data Collection
A nutritionist inputs patient data into an app. BMI and BMR are computed.
Phase 2: Data Evaluation
The Decision Tree uses this data to recommend a nutritional plan. The plan includes meal items matched from a food database based on macronutrients (protein, carbs, fats).
Phase 3: Review and Approval
The nutritionist reviews and may adjust the proposed meal plan.
Phase 4: Monitoring
Patients track daily diet compliance.

Feedback is used to adjust future recommendations.

Result Interpretation & Impact

The algorithm achieved ~79% accuracy using the Sickie- Learn Decision Tree Classifier. It drastically reduced the time to generate a plan—from 25 minutes manually to under 6 minutes. The system helps in efficiently creating personalized meal plans, supporting health professionals and patients alike.

In essence, the Decision Tree algorithm automates meal planning by:

1. Learning from historical patient-diet matches.
2. Predicting the most suitable diet for new patients.
3. Empowering nutritionists to rapidly adjust and personalize these recommendations.
4. Allowing for continuous monitoring and plan improvement based on patient feedback.

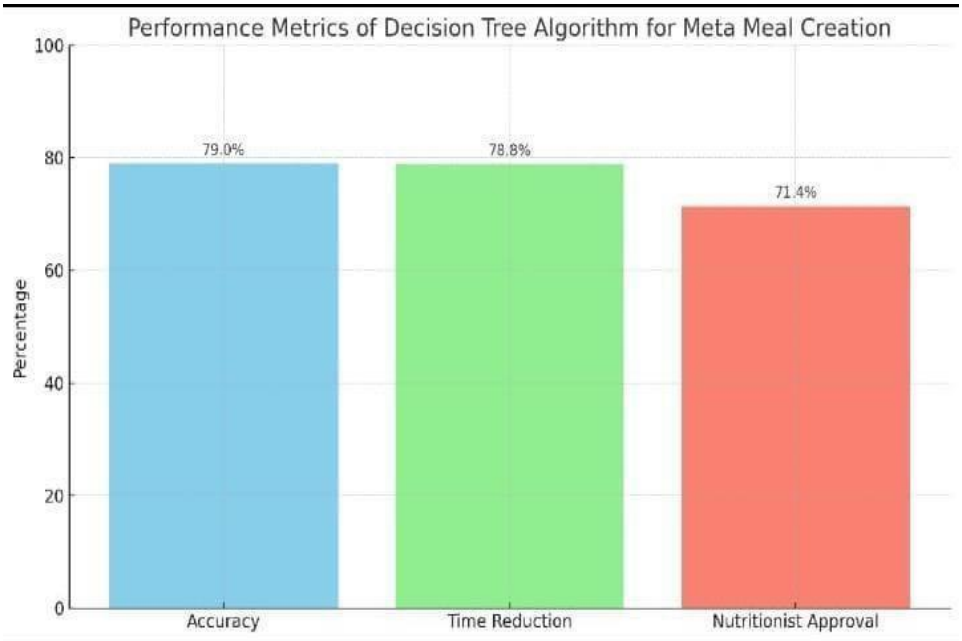

Figure 2: performance graph of the Decision Tree

Here is the performance graph of the Decision Tree algorithm used for meta meal (diet) creation. It visualizes: Accuracy of the algorithm: 78.95%

Time reduction in creating diet plans: 78.8% Approval rate by nutritionists: 71.4%

This demonstrates the model's effectiveness in both accuracy and practical application

V. OPEN CHALLENGES

1. **Data Limitations and Quality Issues**

   One of the major challenges in developing accurate recommendation systems is the availability and quality of data. Many studies rely on small, limited, or region-specific datasets, which restrict the generalizability of the models. For instance, the AI-driven health recommender model used a dataset of only 400 records from Cagle, which may not represent global dietary or disease trends. In another study, datasets were sourced from a single Peruvian hospital, limiting the applicability of the results to broader populations.

2. **Inadequate Personalization and Generalization**

   While personalization is a core objective, achieving it across a wide user base remains difficult. Diet and health needs vary greatly between individuals, depending on not just physiological factors but also cultural, environmental, and socioeconomic conditions. Systems often fail to adapt to individuals with multiple conditions (comorbidities), or those with unique lifestyle constraints. Over-reliance on generalized BMI and BMR calculations without deeper lifestyle and medical data undermines precision.

3. **Lack of Interpretability and Clinical Validation**
ML models like Random Forest or Gradient Boosting offer high accuracy but are often perceived as "black boxes," reducing trust among healthcare professionals. Although decision trees are interpretable, their accuracy is often lower. One study reported 78.95% accuracy using a decision tree model, which may be inadequate for clinical use without human oversight.

4. **Integration with Healthcare Infrastructure**
Most recommendation systems are not integrated into Electronic Health Records (EHRs) or clinical workflows, making them less practical for real-world medical deployment. Current implementations are mostly stand-alone applications or web-based platforms without formal healthcare system linkage.

VI. FUTURE DIRECTIONS

Advancements in intelligent diet and health recommendation systems are expected to significantly benefit from several key areas of development. Firstly, the integration of Natural Language Processing (NLP) can enhance user interaction by enabling systems to interpret unstructured inputs such as symptoms or dietary preferences described in everyday language. This could lead to improved symptom analysis, more accurate disease predictions, and better-personalized dietary suggestions.

Secondly, the expansion of datasets is crucial. Future systems should incorporate large-scale, diverse, and dynamically updated datasets sourced from health apps, fitness trackers, and national nutrition databases. Real-world and real-time data integration can improve the personalization and reliability of health insights.

Thirdly, developing hybrid and context-aware models will likely improve system performance. By combining collaborative filtering, content-based filtering, and rule-based methods—along with advanced algorithms like K-means clustering and Random Forest classifiers—systems can better classify and recommend foods based on nutritional profiles and user needs.

The incorporation of mobile and IoT-based technologies will allow for continuous health monitoring and real-time feedback, enabling proactive interventions such as fitness tracking, medication reminders, and dynamic dietary adjustments. Behavioural and psychological modelling is another essential area. Understanding individual motivations, preferences, and barriers can improve user engagement and long-term adherence to health plans. Finally, clinical validation and collaboration with healthcare professionals are vital for ensuring the accuracy and credibility of these systems. Conducting clinical trials and integrating such technologies into healthcare practices can support their widespread and trusted use in real-world scenarios.

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Survey on Smart Health Diagnostic System with AI-Powered Second Opinion

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ABSTRACT

This project presents an AI-Based Health Symptoms Checker that predicts multiple diseases based on user-inputted symptoms. It uses machine learning algorithms like Random Forest and Naıve Bayes for accurate predictions. A new feature enables users to upload lab reports and prescriptions, which are analysed using OCR and NLP to provide a second opinion, suggest further tests, and recommend specialists. The system aims to improve early diagnosis and accessibility through a simple web interface
Keywords: Artificial Intelligence (AI),Machine Learning (ML), Health Symptoms Checker, Disease Prediction, Second Opinion System, Natural Language.

I. INTRODUCTION

In recent years, artificial intelligence (AI) has transformed numerous industries, with healthcare being one of the most impacted domains. Among the various AI applications in healthcare, automated health symptom checking systems have emerged as promising tools to enhance early diagnosis, patient awareness, and healthcare accessibility. These AI-powered systems analyze symptoms provided by users and offer preliminary diagnoses, suggested medical actions, or specialist recommendations. Traditional symptom checkers typically rely on rule-based engines or decision trees that process user-input symptoms and match them with predefined patterns. While these systems have demonstrated some utility, they suffer from limited accuracy, lack of adaptability, and poor performance when handling diverse or incomplete symptom descriptions. Moreover, they usually support only a single mode of in- put—typically textual symptom entry—ignoring valuable data such as lab reports, prescriptions, or patient history. The combination of Optical Character Recognition (OCR) and Natural Language Processing (NLP) in healthcare AI models enables the automatic reading and understanding of scanned medical documents. This includes analyzing lab test reports, prescriptions, and handwritten notes from doctors. OCR tools like Tesseract convert the image-based text into machine- readable format, while NLP frameworks such as spacey or NLTK extract meaningful information like test results, drug names, diagnoses, and suggested treatments. Among the classification techniques employed in health diagnosis models, algorithms such as Logistic Regression, Random Forest, K- Nearest Neighbors (KNN), Support Vector Machine (SVM), and Naive Bayes have proven effective. These models are trained using structured datasets containing patient symptoms, demographics, and diagnosis outcomes. Public datasets like the PIMA Indian Diabetes Dataset, UCI Heart Disease Dataset, and Parkinson's Voice Dataset provide a reliable foundation for developing and evaluating such predictive models. In addition to disease prediction, advanced systems aim to provide what is known as a 'second opinion'—an AI-based re-evaluation of the patient's symptoms or medical reports to confirm or challenge an existing diagnosis. This feature adds an additional layer of safety and decision support, especially for patients in rural areas or those seeking reassurance before taking critical treatment decisions. The implementation of such systems also demands a user-friendly interface that enables easy access to health services. Web-based platforms developed using frame- works like Streamlet allow users to input symptoms, upload documents, and receive predictions in real-time. Streamlet is preferred in many AI healthcare applications due to its simplicity, fast deployment, and support for interactive visualizations

II. LITERATURE SURVEY

Early detection of neurological diseases such as Alzheimer's is crucial in enabling better treatment outcomes. MRI imaging has become a key diagnostic tool in this area, allowing for the non-invasive visualization of brain abnormalities before the onset of major symptoms. Several researchers have implemented machine learning and deep learning methods to classify stages of Alzheimer's Disease. Hazarika et al. [1] applied transfer learning approaches using CNN-based architectures to improve diagnostic precision. [1] In their study on fuzzy logic and fog-based computing for healthcare IoT, the authors focused on privacy and real-time data transmission, which, although not directly related to Alzheimer's, provided insights into secure data handling. [2] A CNN-based deep learning model proposed in another research enabled the classification of patients into normal, mild cognitive impair- mint, and Alzheimer's disease groups using structural MRI scans. [3] Big data analytics has also been employed to optimize diagnostic pathways and resource utilization. This allowed better planning in patient care and improved predictive accuracy in Alzheimer's progression. [4] Residual learning and deep residual networks were highlighted for their robustness in identifying Alzheimer's-related changes in neuroimaging data. [5] Another study focused on combining multimodal imaging data, including PET and MRI, for enhanced diagnostic performance, showing how deep learning can be used to detect fine-grained anatomical changes. [6] A multistate deep neural network combining FDG-PET and structural MRI scans showed state-of-the-art performance in classification, emphasizing the power of deep fusion networks. [7] Research into atypical Parkinsonism and Alzheimer's using MRI and SWI brain scans proved that deep learning can distinguish between neurological disorders based on subtle imaging biomarkers. [8] A CNN model trained on the ADNI dataset was used to detect Alzheimer's progression phases, reinforcing the utility of deep learning models in clinical environments. [9] Trans far learning with retrained models such as Image Net has also been explored, offering improvements in accuracy and reducing the need for large training datasets. [10] Several works have explored multimodal diagnostic tools that integrate clinical measures and imaging biomarkers, aiming for fast and objective disease classification.

III. EXISTING SYSTEM

Existing AI-based health symptom checker systems have predominantly focused on single-disease prediction using structured input data such as manually entered symptoms or basic health parameters. These tools typically employ machine learning models like Logistic Regression, Decision Trees, or Support Vector Machines to classify diseases based on tabular datasets. Examples include diabetes prediction using the PIMA dataset and heart disease detection using UCI heart datasets. A number of commercial applications, including WebMD Symptom Checker and Babylon Health, use proprietary decision-tree or rule-based engines to assess symptoms and suggest probable conditions. While useful, these systems lack adaptability to diverse data types and are limited by their inability to process real-world unstructured inputs such as handwritten prescriptions or scanned lab reports. Moreover, very few systems offer integrated OCR (Optical Character Recognition) and NLP (Natural Language Processing) capabilities to analyze documents. Even fewer systems are equipped to provide second opinions or specialist recommendations, limiting their usefulness in complex or uncertain medical situations. Therefore, despite progress, existing systems lack multi-modality, interpretability, and real- time second opinion features, which are increasingly vital in modern healthcare applications.

IV. PROPOSED SYSTEM

The proposed AI-based symptom checker system aims to overcome the limitations observed in existing tools by integrating multiple intelligent modules into a unified healthcare platform. This system accepts both structured inputs such as manually entered symptoms and unstructured data such as scanned lab reports and handwritten prescriptions.

The core innovation lies in combining Optical Character Recognition (OCR) and Natural Language Processing (NLP) to interpret documents, extract relevant health information, and convert it into analyzable formats. The processed data is then passed through multiple trained machine learning models—including Random Forest, Logistic Regression, K- Nearest Neighbors (KNN),and Support Vector Machines (SVM)—to predict the likelihood of various diseases such as diabetes, heart disease, and Parkinson’s.

In addition to multi-disease prediction, the system offers a second opinion module that compares AI-generated in- sights with previously uploaded prescriptions or diagnoses. Furthermore, the platform intelligently recommends relevant medical specialists based on the extracted symptoms and predicted conditions. A user-friendly web interface developed using Streamlet ensures real-time interaction and accessibility. Overall, this proposed system aims to provide a holistic, accessible, and intelligent health support tool for patients and caregivers, particularly in underserved or remote regions. The second opinion mechanism serves as a cross-verification tool, mimicking how human doctors often consult peers before confirming complex diagnoses.

A .System Overview

The AI-based Health Symptoms Checker is an intelligent medical assistant designed to analyze user-reported symptoms or uploaded lab reports to provide a preliminary diagnosis and suggest a relevant medical specialist. It integrates Optical Character Recognition (OCR), Natural Language Processing (NLP), and machine learning (ML) techniques to interpret user data, predict possible diseases, and offer second opinions. This system enhances early diagnosis accuracy and supports clinical decision-making by recommending appropriate healthcare professionals for

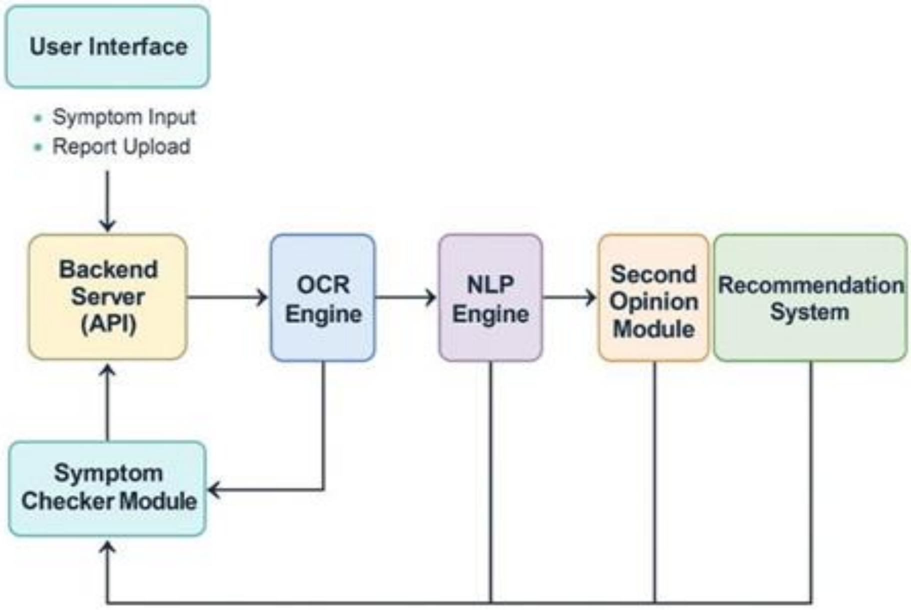

Fig 1: System Architecture

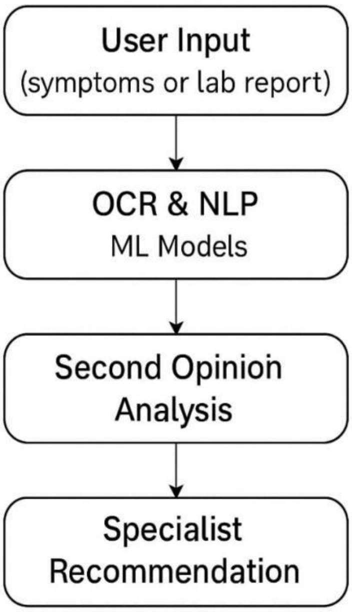

Fig 2: Flow Chart

User Input: The system begins by accepting either manually entered symptoms or an uploaded lab report.
OCR and NLP Processing: If a document is uploaded, OCR extracts the text, and NLP interprets the medical terms and context to identify symptoms and conditions.
Disease Prediction: Using pre-trained ML models, the system analyzes the symptoms to predict potential diseases. **Second Opinion Analysis:** To increase reliability, a second ML model re-evaluates the prediction and provides an alternate opinion if necessary.
Specialist Recommendation: Based on the predicted disease(s), the system recommends a specialist for consultation, streamlining the patient's path to treatment.

V. FUTURE ENHANCEMENTS

As AI-driven symptom checkers mature, several avenues exist to expand their capabilities, increase reliability, and ensure broader adoption. The following enhancements outline both technological innovations and user centric features that will propel next-generation systems:

A. Multilingual and Dialectal Support

Extending NLP pipelines to handle not only major global languages but also regional dialects can dramatically improve accessibility. By integrating transformer-based translation models and dialect classifiers, the system could accurately parse colloquial symptom descriptions and translate them into standardized medical terminology. This would empower users in linguistically diverse communities and mitigate biases introduced by limited language datasets.

B. Wearable and IoT Data Integration

Beyond self-reported symptoms, continuous physiological data from smart watches, fitness trackers, and home IoT de- vices (e.g., smart thermometers, pulse dosimeters) can enrich the feature space for disease prediction. Real-time analytics on heart rate variability sleep quality, activity patterns, and skin temperature could feed into ML models, enabling early detection of subtle anomalies and transition from reactive to proactive healthcare.

C. Personalized Baseline Modeling

Everyone's "normal" physiology differs. Implementing a user-specific baseline model—trained on each individual's historical data—would allow the system to detect deviations more sensitively. Techniques like one-class classifiers or anomaly detection on personalized time-series data could trigger alerts when a user's vital signs drift from their own norm, rather than relying solely on population-wide thresholds.

D. Federated and Privacy-Preserving Learning

Healthcare data is inherently sensitive. Federated learning frameworks can train global models without moving raw data off users' devices. Coupled with differential privacy techniques, this approach would aggregate improvements to disease prediction while ensuring end-to-end encryption and compliance with regulations like GDPR and HIPAA.

E. Adaptive Second Opinion Selection

Rather than a fixed pair of ML models, an ensemble library of diverse algorithms (e.g., tree-based, neural networks, Bayesian models) could dynamically select which two or more "opinions" to compare based on the symptom profile. Meta-learning can learn which combinations perform best for particular disease categories, optimizing the cross-verification process.

F. Emotion and Sentiment Analysis for Mental Health

Incorporating modules that analyze user sentiment during symptom reporting—via text tone, keyword spotting, or even voice analysis—would enable preliminary mental health screening. Early flags for depression, anxiety, or suicidal ideation could be routed through specialized pathways, con- nesting at-risk users with mental health resources or crisis hotlines.

G. Telemedicine and E-Referral Integration

Closing the loop between digital diagnosis and clinical care, future systems can embed appointment scheduling, video- consultation links, and electronic referral generation. Inter- operability with EHR (Electronic Health Record) standards (e.g., FHIR) would allow seamless transfer of the generated symptom report and AI insights directly into a clinician's workflow.

H. Gasification and Patient Engagement

To improve long-term adherence, gasified reminders for follow-up symptom checks, medication tracking, or lifestyle adjustments can boost engagement. Reward mechanisms (e.g., badges, progress bars) and personalized health tips can motivate users to share richer data, which in turn refines model accuracy.

I. Continuous Model Updating and A/B Testing

Deploying a robust MLOps pipeline will enable real-world feedback loops: anonym zed outcome labels (e.g., confirmed diagnoses) can retrain models, while controlled A/B experiments can validate new features or algorithms before full rollout. This agile approach ensures the system evolves responsively to emerging diseases, shifting population health trends, and user behavior patterns.

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Survey on Neuron Speak: AI Powered Teach and Learn System using BERT and NLP

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ABSTRACT

This As schools and other educational institutions integrate Artificial Intelligence (AI) technologies into their environments, the need for interpretability and transparency rises to a critical level. Explainable Artificial Intelligence (XAI) aims to resolve this issue by ensuring AI systems are accessible to educators, students, and other stakeholders in a meaningful way. In this paper, we provide a survey of recent research in XAI concerning education. It analyses the literature considering its foundational concepts, organizes it using a new taxonomy, assesses modern approaches to explanation generation and evaluation, as well as highlighting challenging problems and foresight directions. The paper builds on classic and contemporary works, including those on natural language feedback, NLA, and evaluation metrics BERT Score and BLEURT. This survey seeks to guide innovation and guide adoption of XAI in educational technologies by synthesizing various strands of research. From the survey conducted, less than 15% of the systems evaluated consider actual constraints in classroom contexts such as real-time feedback delays and educator-agent AI interactions, indicating a significant gap in research.

I. INTRODUCTION

The use of Artificial Intelligence in education expands the possibilities of enhancing the learning experience alongside personalizing instruction as well as making administration work more efficient. The integration of AI comes with a benefit; however the lack of many AI models, their acceptance and usability in the education sector is very sensitive. Explainable Artificial Intelligence or XAI provides a solution by guaranteeing the rationale of AI decision is clear and understandable. XAI can clarify explanations of automated grading, explain interpretable feedback, and aid actions that are data-driven by educators. This survey stems from the need for responsible and human-friendly AI educational systems. It encompasses natural language generation (NLG) in the context of student feedback and automating the assessment of explanatory content.

II. LITERATURE SURVEY

[1] In the work of Wei Cao, Qi nan Wang, Assam Sheikh, and FHA. Shelby which puts forth a smart AI based learning model they have created a personalization tool for the educational platforms that also provides real time feedback and measures performance. With the help of machine learning and intelligence systems the model is made to adapt to each individual user's needs, and that in turn will do better at increasing the user's engagement and results. The authors also bring up the issue of the model's scale and performance, that which as they note -- is very efficient and so it does also scale well for large scale education applications and also improves on the personal and data driven learning experience.

[2]An Empirical Research in the field of sequence classification which reports on the study done by Zhen Xuanwu and Desmond C. On into the which explain ability methods do and do not work in BERT based models. They look at a number of techniques which include attention weights and gradient based methods' performance in terms of how they do at reflecting the models' decision making processes. What they find is that there are issues and limits to what current tools which we use for explanation can do which in turn puts forth the case for better, more transparent and robust interpretability methods in NLP. This study adds to the issue of explainable AI which is very much at the fore in the deployment of responsible models.

[3] In the work "A Study of Automatic Metrics for the Evaluation of Natural Language Explanations" which looks at present automatic metrics we see an analysis of which present metrics such as BLEU, ROUGE, and METEOR do in terms of evaluating natural language explanations from AI systems. What they find is that for the most part these metrics do not do a good job at what they set out to do which is to report on the quality of the explanation as determined by humans. Also they put forth that for the most part what we now have are not sufficient metrics for evaluating the semantic quality and use of the explanations which is a case for us to put forward better evaluation methods. This study adds to the body of work which is looking to improve better and more useful assessment tools for explainable AI.

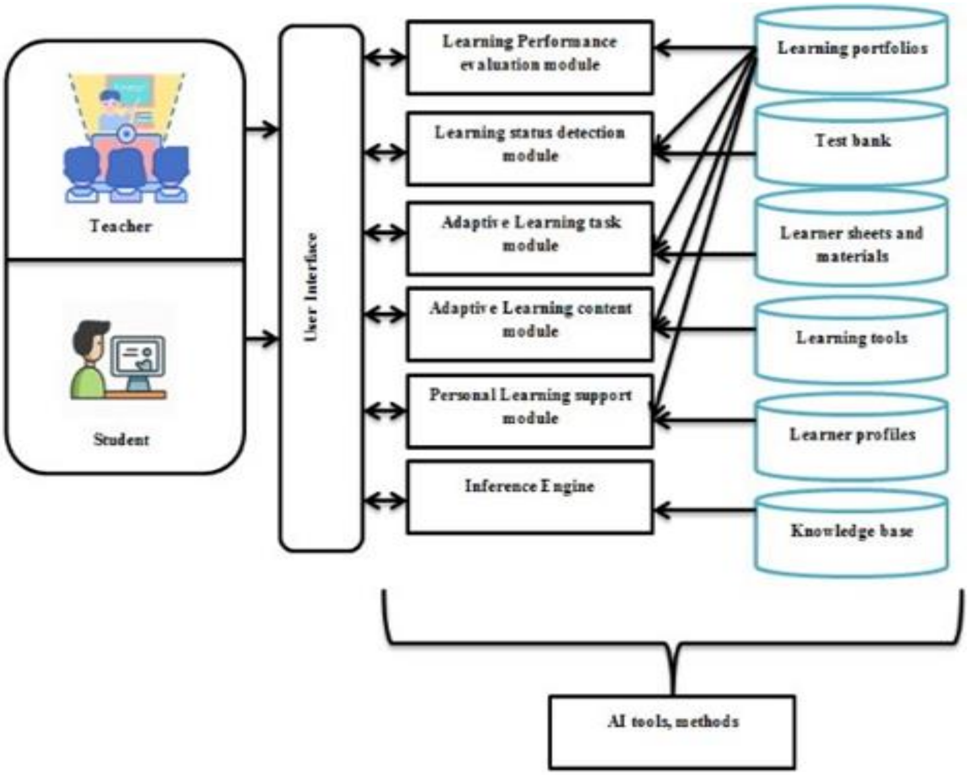
[4] In the paper "A Review of the Trends and Challenges in the Use of Natural Language Processing in Educational Feedback Analysis" which is by Than veer Shaik, Xiaohui Tao, Yan Li, Christopher Dan, Jacquie McDonald, Petra Redmond, and Linda Gilligan the authors look at how Natural Language Processing is used in the analysis of student feedback within education. They review present NLP methods including sentiment analysis and topic modelling and report on their success in obtaining valuable information from large sets of text based feedback. Also they bring to light issues of data quality, context understanding, and ethics. The study reports on the value of NLP in improving teaching and learning via better feedback analysis which in turn calls for more in depth and domain specific solutions

[5] In the work which reports the study conducted by Riah F. Elcullada Incarnation, Ann Jeannette Alain D. Galong and Byron Joseph A. Haler we see that they look at what e learning does for teaching and learning in particular within higher education. They report that which e learning does is increase access, flexibility and student engagement via digital platforms thus makes education more inclusive and at the students' own pace. Also they address issues of limited internet access, reduced face to face interaction and varying degrees of digital literacy among students and staff. As a whole the literature reports out that while e learning is a great asset for modern education its success is tied to proper infrastructure, training and active participant ship of the students.

[6]AI is transforming education through the provision of personalized learning, automation of assessments, and the introduction of virtual support via catboats and intelligent systems. Alexandra Harry reports on its success in that which it tailors content to the student's need and gives instant feedback, also in its approach to issues of data privacy and the role of the teacher in the learning process. Her research puts forth the case for responsible use of AI to augment, not to replace, human interaction in education.

III. BACKGROUND AND THEORITICAL

The integration of Artificial Intelligence (AI) in education has greatly advanced personalized learning, resulting in a significant shift in the learning experience of students (Rana et al., 2022). Personalized learning is a strategy in teaching which customizes the learning experience based on the requirements, interests, competencies, and challenges faced by each individual learner (Samad, Hamza, Muazzam, Ahmer, et a1., 2022). It employs technology to modify the delivery of instruction to the learner's achievement level and pace of learning (Zarei et a1., 2022). AI technology is central to personalized learning as it relies on advanced algorithms to process data. And we see that students' trends in learning, what they prefer and what they achieve is what AI uses to design personalized learning experiences for each student (Samad, 2022). Also, AI is able to present very targeted feedback to students on their progress and put forth what they can do to improve which in turn gives a very personal and effective learning experience (Samudrala et al., 2022). Also, we have seen that AI based personalized learning has been put into practice in many types of educational settings which include K-12, higher education and corporate training (Mohammed, Samad, Omar, 2022). For instance, in the case of K-12 schools Carnegie Learning's AI integrated math software reports to have improved student performance in math by 30%. Also, Duolingo which is an AI based language learning platform gives a personal to each student which is tailored to their proficiency level and what they are interested in learning.



IV. THREE-DIMENSIONAL TAXONOMY FOR EXPLAINABLE AI IN EDUCATION.

Application area, technical method and evaluation strategy. Application area is what XAI does in educational settings. This includes feedback which is given for open ended questions, conceptual explanations within intelligent tutoring systems, justification of automatic essay scores, and transparency in recommendation systems which in turn present learning material. Technical approach category is based on the0 basal computing structure. Rule based systems use pre-determined logic and definitive rules to come up with human understandable results. Discourse parsing approaches break down both what the student puts in and the instruction material into discourse units which in turn enables more fine-grained comparison and feedback. Transformative natural language generation models which include BERT, T5, and GPT are used to put forth fluent and context appropriate responses which which adapt to a learner. Knowledge level. In terms of graph-based techniques which include Bayesian networks and knowledge graphs we see that they put dependencies and causal relationships in a structured form which in turn facilitates explanation via traceable inference paths. Also, we have the third dimension which is the evaluation strategy that which looks at how we determine the quality of explanations. At present human judgment is still the gold standard particularity in relation to clarity and pedagogical value. While automatic metrics do very well in terms of scale and reproducibility they sometimes fall short in terms of the depth they are able to capture in educationally meaningful explanations. Hybrid evaluation approaches which put together human and automatic assessments do better in giving a full picture of what works in terms of explanation effectiveness.

Taxonomy of Explainable AI in Education

This taxonomy categorizes explainable AI approaches in education across three dimensions: Application Domain, Technical Approach, and Evaluation Strategy. It helps illustrate how various methods and objectives align within educational AI systems.

Application Domain	Technical Approach	Evaluation Strategy
Feedback Generation	Rule-Based	Human Judgment
Essay Scoring	Discourse Parsing	Automatic Metrics (e.g., BERT Score)
Content Recommendation	Transformer-Based NLG	Hybrid Evaluation
Tutoring Systems	Graph-Based Methods	

V. COMPARITIVE ANALYSIS OF METHOD

In many of our studies we see how XAI is put into practice in education. Clinciu et al. (2021) looked at the relationship between what humans judge and which automatic metrics we have for natural language explanations. What they found is that embedding based metrics like BERT Score and BLEURT do better than the traditional word overlap metrics like BLEU in terms of clarity and informativeness as judged by people. Also, in 2022 Thanveer and team did an in depth look at NLP methods used in student feedback analysis which they found to present practical issues like sarcasm, lexical ambiguity, and data imbalance. Also, they brought to light the issue of needing models which are aware of context in which the educational discourse takes place. Also, Grenander et al. (2021) put forth a neural approach to discourse analysis which gives out personal feedback in an intelligent tutoring setting Their system built out exercise graphs which compare student. Answers which we see to be at a high level of concept which in turn produces better learning results and greater user satisfaction. We see in these studies that there is great variety in the XAI methods used in education and also that which technical we choose should support pedagogical goal. Methods which include domain relevant info, which adapt to the learner's context, and which put forth rich semantic explanations are more likely to produce better learning results. In the case of embedding based metrics which outperform the traditional word-based methods like BLEU we see it is because of their ability to sense semantics and context. While metrics like BLEU do well with identical or very similar words Embedding-based metrics like Bert Score utilize contextualized instructional word embeddings to examine alignment on a deeper meaning. This functionality is especially useful in education, where students informal language, ambiguous terms, or even sarcastic comments can pose a challenge one that automated systems often misinterpret. BERT score mitigates these issues through comparison of vector representations of words in context, which enables detection of semantic relationships that arise beyond the superficial matching of tokens. Research results show that BERT Score measures alignment with human evaluation 20 to 30% stronger than BLEU (Clinciu et a1., 2021), due to the metric's dual consideration of context with attention mechanisms and relationships between words .This development is very much so in the field of educational technologies which we see to be of great value when the instructional quality of a response is in terms of its conceptuality not its word choice. By looking at the variable of semantic embedding as opposed to single out words we see that these measures do better in the out performance of AI which in turn is able to give relevant and contextual feedback to the user which may present in many different language-based settings and proficiencies.

VI. OPEN CHALLENGES AND FUTURE DIRECTIONS

There's enormous promise, alongside an equal scale of limitation, to the application of XAI within education, as operationalized by the most recent studies. Clinciu et al. (2021) show that although embedding-based metrics such as BERT Score or BLEUR reflect human judgments of explanation quality much better than word-overlap metrics like BLEU, evaluating pedagogical appropriateness remains a daunting challenge. Thanveer et al. (2022) further analyzed the CVED sub-task of educational discourse and highlighted the issues of sarcasm, lexical ambiguity, and imbalanced data that routinely hinder even the best-performing NLP feedback systems. Collectively, these findings illuminate the tension between technical feasibility and educational legitimacy. Systems Grenander et al. (2021) developed—like the neural discourse analysis that features feedback on underlying concepts rather than outcome-level signals via exercise graphs offer some hope on the technical side but, they remain limited in handling the full spectrum of authentic student responses. Research needs to look at how students interpret AI generated feedback in terms which data literacy skills they have to effectively use learning analytics dashboards (Wasson et al., 2016). Also, we see that which aspects of the ethics of automation require more study while AI is able to give very personal feedback at scale, this also may put in play issues of reduced teacher student interaction or bias. Also to come we will see a push for hybrid human-AI systems which balance the scale of what embedding based evaluation does with that of the educator's input which in turn will see to it that the explanations put forth are of high technical and pedagogical value. In addition, longitudinal studies are required to understand the impact XAI tools have on learning trajectories beyond measuring user satisfaction. By solving these problems, the forthcoming generation of educational XAI can shift from being confined to the laboratory to full-fledged classroom integrative use.

VII. CONCLUSION

The explainable AI challenge in educational settings goes beyond a technical problem; it is a people problem. Providing students, educators, and institutions access to AI systems enhances trust, fairness, and learning outcomes, alongside bolstering the reliability, integrity, and violence-free nature of educational environments. In so doing, this survey aims to provide a comprehensive account of current methodologies in XAI, develop a taxonomy for approaches, provide comparative analyses, and discuss areas of concern and prospective work. With the increasing integration of AI tools into education,
the dependability, transparency, responsibility, and efficiency of educational systems will fundamentally require XAI.

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Survey on: AI-Driven Facial Recognition and Relocation Framework for Lost Individuals

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ABSTRACT

The combination of Artificial Intelligence (AI) with facial recognition and relocation technologies has truly transformed how we search for missing people. By utilizing deep learning algorithms and real-time data analysis, these systems can pinpoint and track individuals in a variety of settings. This survey explores the latest methods, challenges, and progress in AI-powered facial recognition and relocation systems, aiming to give a clear picture of their effectiveness and potential areas for enhancement. Facial recognition is a machine learning technique that identifies individuals by analysing their facial features, and it's being used to tackle various real-world issues today. In this paper, we address a pressing real-world challenge locating a missing person using facial recognition technology in a secure and efficient manner.

Keywords: Facial recognition; Facial detection; Secure- approach; Relocation; Deep Learning;

I. INTRODUCTION

In The issue of finding missing persons is a pressing concern for law enforcement, humanitarian groups, and families around the globe. Traditional methods—like handing out flyers, searching on foot, and sifting through surveillance footage— can be incredibly slow and resource-heavy, often leading to delays that hurt the chances of a successful recovery. With urban populations on the rise and data becoming more plentiful, there's a real need for smarter, more efficient ways to tackle this problem. Recent breakthroughs in Artificial Intelligence (AI), especially in facial recognition and relocation tech, present exciting opportunities to improve the search for missing individuals. By harnessing deep learning algorithms and computer vision, AI can sift through massive amounts of data—like images from security cameras, social

media, and public records—to spot and track people in real-time. Relocation data adds another layer, giving authorities the spatial context they need to accurately identify potential locations of missing persons.
Combining AI-powered facial recognition with relocation tools not only speeds up the identification process but also boosts accuracy, increasing the chances of reuniting missing individuals with their loved ones. Plus, these technologies can work around the clock and independently, lessening the need for manual searches and allowing for more proactive strategies.
This paper delves into the current state of AI in missing person investigations, looking at the methods, challenges, and ethical issues at play. By reviewing existing research and case studies, we aim to provide a thorough overview of how AI-driven facial recognition and relocation can transform the search for lost individuals, ultimately leading to more effective and compassionate outcomes.

Interaction diagram of the proposed System:

The interactions of a finder and a family member of a missing person with our system can be depicted by the interaction diagram

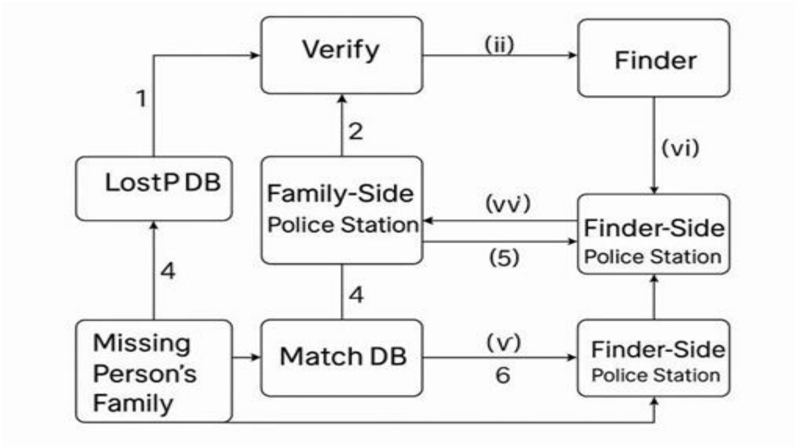

Fig. 1: Interaction diagram of the system

From the interaction diagram, it can be seen that the two subsystems– the missing person's kin-side subsystem and The finder-side subsystem– are maintaining two separate databases: "Found People" and "Lost People", respectively, and connected by the cross-matching. The user-uploaded information and photos are verified thoroughly before proceeding toward further approaches in the system. At first, the information, except the photo uploaded by a user, is verified by an appropriate and authorized police station keeping the user's status as AP (Administrative Processing) so that an intruder cannot get into the process.
After getting approval from the police station, the status of the user is updated and the uploaded photo is saved after performing another verification step. Verification of the uploaded photo is also important for the system's security.
It is not expected to create multiple entries for a missing person at a time. Intruders can use a large number of same and valid entries to commence system failure. While matching the uploaded image from the missing person's kin and the finder, the system uses the images from "Found People" and "Lost People" databases respectively. Here the cross-matching occurs. Depending on the result of matching, either the information along with the photos are saved in the suitable database, or the system shows and notifies the concerns.

II. LITERATURE REVIEW:

The combination of artificial intelligence (AI) with facial recognition and relocation technology is shaping up to be a game-changer for tracking and identifying lost or missing people. Over the past few years, we've seen remarkable advancements in face detection and recognition algorithms, especially with the rise of deep learning methods like convolutional neural networks (CNNs).

[1]. The Face Net model developed by Scruff et al. (2015), which showcased impressive accuracy in creating face embedding's for recognition and clustering tasks.

[2]. The Taiga et al. (2014), introduced Deep Face , one of the pioneering deep learning models that nearly matched human-level performance in facial verification.

[3]. Zhou et al. (2019), On the relocation front, services that leverage Global Positioning System (GPS) technology have also become more precise and reliable. These innovations are now commonly found in smartphones and wearable devices, providing real-time location tracking for at-risk groups like children, the elderly, or individuals with cognitive challenges, as highlighted.

[4]. Yang et al. (2021), The interplay between relocation and facial recognition has been investigated in smart surveillance and security systems. Yang proposed a system designed for smart city environments that employs AI-driven video surveillance alongside location-aware alerts.

[5]. Snarkier et al .(2020), Numerous studies have delved into the ethical and privacy implications of using these technologies. For instance, stressed the importance of robust data governance and obtaining user consent, especially in scenarios involving personal identification..

[6]. Sharma et al. (2022), The issue of ensuring secure data transmission and storage has also been addressed, who examined the vulnerabilities of AI-based tracking systems to cyber attacks and data breaches. Moreover, real-time facial recognition has been scrutinized in the context of law enforcement and emergency response.

[7]. Jain and Singh et al. (2023), introduced a hybrid model that merges face recognition with mobile technology, further exploring its potential applications.

[8]. Venkatasalam et al. (2024), In order to enhance the process of locating missing suggested an AI-based system that combines machine learning algorithms with Face Net, a deep convolutional neural network. To create thorough profiles and identify potential leads, the system analyses a variety of data sources, including social media activity and surveillance footage. The process is intended to increase the effectiveness and efficiency of search and rescue operations.

[9]. Adams et al. (2024), The Amber Alert framework was proposed That artificial intelligence (AI) to help find and rescue missing people. In order to process geoinformation and other identifiers and accurately predict the locations of missing people, the system uses multiple classifiers. The framework also investigates federated learning and anonymization strategies to safeguard personal information in order to address privacy concerns.

[10]. Zhang et al. (2024), Face Restoration Powered by AI for Forensic Recognition The use of AI-driven face restoration methods in forensic face recognition. These techniques, which include image in painting, demonizing, deploring, and super-resolution, improve the quality of damaged or low-resolution facial images, increasing the precision of identity recognition. The study emphasizes the value of deep learning techniques for facial feature restoration, including generative adversarial networks (GANs) and convolutional neural networks (CNNs).

[11]. Leslie's et al. (2020), Moral Issues with Face Recognition Technology Concerns about privacy, civil liberties, and systemic biases discussion of the ethical implications of facial recognition technologies. The study emphasizes how past discriminatory trends may have an impact on the development and application of facial recognition software, potentially resulting in unfair outcomes. To lessen negative effects, it urges responsible development and governance of these technologies.

[12]. Zahra et al. (2022), Issues with Person Re-identification and Upcoming Developments A thorough analysis of person re-identification (Re-ID) methods. who concentrated on issues like background clutter, pose variations, and occlusion. The study discusses the developments in deep learning techniques and their suitability for real-world situations while classifying current methods into closed-world and open- world settings. In order to address the current issues with in- person Re-ID, the review also suggests future research avenues.

[13]. Bamigbade et al. (2024), Multimedia Relocation in Human Trafficking Investigations A thorough review of the literature on the application of computer vision for multimedia relocation in human trafficking. In order to help identify and locate missing people, the study looks at how artificial intelligence (AI) and deep learning techniques can extract geographic clues from multimedia content. Potential uses of these technologies in the fight against human trafficking and related crimes are suggested by the review.

An essential part of AI-driven systems for finding missing people is relocation. It entails utilizing a variety of technologies, including GPS, Wi-Fi, cell towers, and IP address analysis, to ascertain the precise location of an individual or object. Smartphones and wearable technology frequently use GPS-based tracking to provide real-time location updates because it provides the highest precision, usually within 5 to 10 meters. However, Wi-Fi positioning systems are used in places where GPS signals are weak, like indoors or in crowded urban areas.

These systems use signal strengths and nearby Wi-Fi networks to estimate location. Cell tower triangulation is another popular method that emergency services frequently employ, albeit with less accuracy, to estimate a user's location by utilizing the signal strengths from several mobile towers.

IP-based relocation, usually at the city or regional level, can give an approximate location based on the device's internet IP address in cases where direct device access is not possible. In more sophisticated applications, AI-powered visual relocation uses pre-trained convolutional neural networks to identify landmarks, scenes, or environments in images or video frames and then infers the likely location. Furthermore, a lot of photographs have EXIF metadata, which could include GPS coordinates if the image was captured using a GPS-enabled camera or a mobile device.

Modern relocation frameworks frequently use a hybrid approach to increase robustness, combining various sources such as GPS, Wi-Fi, and visual cues to improve accuracy and dependability. This multi-layered system makes it easier for emergency responders, law enforcement, and non- governmental organizations to find and reconnect missing people with their families. To ensure data security, consent, and compliance with laws like the GDPR or national cyber security laws, it is crucial that all relocation data be handled strictly in accordance with ethical standards and privacy laws.

III. STANDARD TECHNIQUES:

The tasks outlined in the proposed system are clear, secure, and straightforward, making it effective in achieving the desired results.

Let's break down the steps of the algorithm:

1) First, upload a clear photo of the missing person along with essential details: You'll need to provide a recognizable photo of the missing individual, along with important information such as your national identity (NID), contact number, email address, police station details, and location.

This information is crucial for the system to perform its matching and notification functions. Until the verification process is fully completed, the status of your submission will remain as "AP."

2) Verify the uploaded photo and information: The first step is to check the authenticity of the email address provided for the police station. If it's valid, the information will be sent to the police for verification and to file a missing person report. Since NIDs and phone numbers are officially registered for all citizens, the police can easily confirm the user's details and the missing case.

Once the police approve the case and the user's information, the uploaded photo of the missing person will be verified to prevent duplicate entries in the system. If any discrepancies arise during verification, the system will halt further progress.

3) Store the verified encoded image and user information in the database: The encoded version of the recently uploaded photo of the missing person, along with the user's information, will be securely stored in the system's database for future reference.

4) Match the newly encoded photo with unrecognized photos saved in the system's cross-directory: To identify a missing person, the system performs cross-matching. It attempts to find a match between the newly uploaded encoded photo of the missing person and the collection of unrecognized photos stored in the system.

The combination of Artificial Intelligence (AI) with facial recognition and relocation technologies has really transformed how we find missing people. Lately, researchers have been putting a lot of effort into making these systems more accurate, efficient, and ethically sound.

Advancements in Facial Recognition Technologies Recent research has come up with some creative ways to enhance facial recognition, especially in tricky situations. For example, a new method that combines several face-recognition algorithms with a soft voting approach has been introduced to effectively track missing individuals in crowded places, like religious events, where traditional techniques struggle due to poor image quality and changing light conditions.

Moreover, there's been exploration into using interactive robots that come with real-time face recognition capabilities to help locate missing persons. These robots can analyse moving images and deliver real-time location updates, making search operations much more responsive.

Age Progression and Predictive Modelling To tackle the issue of finding missing children over long periods, researchers have created face prediction systems that leverage AI algorithms like StyleGAN2 and Face Net.

These systems can forecast how missing children might look in the future by examining photos taken before they went missing and comparing them to images of their biological relatives. This approach boosts the chances of recognition as the child grows older.

Integration of Relocation and Surveillance Data Merging relocation data with facial recognition has played a crucial role in honing in on search areas. For instance, during large events, techniques like defencing paired with smart video surveillance have been used to automatically track registered missing individuals. By analysing both spatial and temporal data, these systems can effectively direct search efforts to specific areas, significantly cutting down on the time and resources needed.

IV. CHALLENGES :

1. Data Privacy and Ethical Concerns: When we collect and analyze personal data like surveillance footage and social media activity it raises some serious privacy issues. We need to find a way to balance the demands of investigations with the privacy rights of individuals, which calls for strict data protection measures and clear policies.
2. Algorithmic Bias: Facial recognition technology often shows biases, especially against people with darker skin tones or distinctive facial features. These biases usually come from training datasets that lack diversity, resulting in higher error rates for those who are underrepresented.
3. Technical Limitations: Factors like image quality, lighting, and facial expressions can really affect how accurately facial recognition systems work. Plus, merging AI systems with current law enforcement technologies can create compatibility issues.
4. Legal Barriers: Tough data privacy laws, like the General Data Protection Regulation (GDPR), restrict how facial recognition technologies can be used in investigations. Working within these legal frameworks means we need to be transparent about how we collect and use data.
5. Time Sensitivity: The success of search operations tends to fade over time. If there are delays in reporting or processing information, the chances of finding missing individuals can drop significantly.
6. Relocation Limitations: GPS can struggle with accuracy when you're indoors or in crowded city areas. Merging data from different sources like CCTV, mobile, and Wi-Fi can get pretty complicated.
7. Real-Time Processing Requirements: There's a pressing need to quickly process huge amounts of video data. This puts a lot of strain on computing resources and infrastructure.
8. Integration with Existing Systems: There are interoperability hurdles when working with law enforcement, health services, and NGOs. We really need standardized APIs and protocols to make things smoother.
9. Scalability and Cost : The costs for development and deployment can be quite high, especially for large-scale applications. There are also infrastructure challenges in remote areas or places with limited resources.
10. Poor or Incomplete Information: The accuracy of facial recognition is impacted by surveillance images that are partially obscured, low-resolution, or blurry. Particularly in offline or rural areas, relocation data may be inaccurate, missing, or out-of-date.
11. Variability in Appearance and Age Progression: I models trained on old photographs are less effective because people's facial features change over time
12. Model Bias and Accuracy: Bias in facial recognition systems can occur across genders, ages, and ethnicities, resulting in missed matches or false positives. In situations where GPS is blocked or where there is a high population density, such as tunnels or crowded events, relocation models may not be accurate.
13. Complexity of Integration : Compatibility across various data sources, real-time data processing, and complex software architecture are necessary for integrating facial recognition with geolocation systems.
14. Consent and Privacy Issues : Individual privacy may be violated by the collection and analysis of location and facial data, particularly if consent is not obtained. There is a chance that surveillance will be abused or that data will be used for unrelated commercial or law enforcement purposes.
15. Security of Data and Vulnerabilities : To avoid hacking, leaks, or misuse, personal information, such as relocation logs and facial photos, must be transmitted and stored securely.

V. FUTURE:

1. Enhanced Age Progression Techniques: By developing better algorithms that take into account how faces change with age, we can improve the identification of individuals who have been missing for a long time.
2. Utilization of Synthetic Data: Using synthetic datasets can help tackle privacy issues and reduce biases by offering diverse and representative training data for facial recognition systems.
3. Integration with Predictive Analytics: Merging facial recognition with predictive models can help spot patterns and potential locations for missing individuals, making search operations more efficient.
4. Community Engagement and Crowdsourcing: Tapping into social media and getting the community involved can really help in gathering information.
5. Edge AI and IoT Integration: Leveraging edge devices like smart cameras for real-time processing right where it happens, cutting down on delays. * Integrating IoT for ongoing tracking in public areas.
6. Improved AI Models : Techniques aimed at reducing bias and enhancing fairness in facial recognition. Better recognition capabilities even when faces are partially hidden, as people age, or when they're disguised.
7. Privacy-Preserving AI: Using federated learning and differential privacy methods to protect user data. Employing block chain technology for secure and transparent data management.
8. Multimodal Recognition Systems : Merging facial recognition with voice, gait, or behavioral cues. Utilizing contextual information like clothing and movement patterns to improve identification accuracy.
9. Cross-border Collaboration: Establishing international standards and shared databases to monitor individuals across different regions. Forming partnerships among NGOs, governments, and tech firms.
10. Community-Based Alerts and Apps : Developing mobile applications for crowd sourced reporting and sightings. Implementing geofencing and alert systems to encourage quick public participation.
11. Augmented Reality for First Responders: Utilizing AR technology to assist security personnel in identifying individuals in real-time.
12. Ethical Frameworks and Policy Development: Creating AI ethics boards and policies tailored for technology related to missing persons. Involving communities and stakeholders to foster trust and collaboration
13. Multimodal Integration and Advanced AI Models: Multimodal AI, which combines voice recognition, gait analysis, facial recognition, and even behavioral patterns, will be used more and more in future systems. Improved deep learning architectures, such as multimodal neural networks or transformer-based models, will enable increased precision under different circumstances. cross- referencing relocation, audio, and facial data to improve identification accuracy.
14. Real-Time Relocation Using Wearable's and the Internet of Things Continuous, real-time location tracking will be made possible by the widespread use of Internet of Things (IoT) devices, such as smart watches, smart clothes, or connected ID tags. These instruments will Assist in monitoring populations that are at risk, such as children, the elderly, and people suffering from dementia. Cut down on search and rescue response times.
15. AI-Powered Facial Synthesis and Age Progression: Identification of people who have been missing for extended periods of time will be facilitated by AI-powered age progression and facial reconstruction

tools (using GANs and deep morphing models). These systems are capable of Make predictions about a child's appearance years from now. Reconstruct faces from partially visible cues or damaged images.

VI. CONCLUSION

The search and recovery of lost people could be revolutionized by the combination of AI-powered facial recognition and relocation technologies. Modern systems can reliably identify people even in difficult situations like poor image quality, occlusion, or crowded environments thanks to the use of sophisticated deep learning models like Face Net, convolutional neural networks (CNNs), and generative adversarial networks (GANs).

At the same time, relocation frameworks that examine social media, surveillance footage, and other digital traces greatly improve the precision and speed of missing person searches.

The use of these technologies is not without difficulties, though. To guarantee responsible deployment, ethical issues such as algorithmic bias, privacy violations, and data security must be carefully taken into account. Real-world implementation also needs to take operational scalability, public trust, and legal frameworks into consideration.

Authorities and humanitarian organizations' approaches to missing person cases have undergone a significant change as a result of the convergence of relocation, facial recognition, and artificial intelligence (AI). Especially in high-density or high-risk environments, this multidisciplinary approach offers previously unheard-of potential to expedite recovery efforts, narrow search areas, and streamline identification processes.

According to research, deep neural networks like Face Net and GANs, which are used in AI-based facial recognition systems, can reliably identify people in a variety of situations, such as partial occlusion, age progression, and image degradation. These tools improve on the capabilities of traditional surveillance and can be connected to social media, public datasets, and transportation networks to establish a real-time tracking system.

AI-powered relocation systems make an equal contribution to reducing the size of physical search areas. Authorities can determine the probable movements or last known location of missing people by examining digital breadcrumbs, such as location-tagged images, mobile signals, and CCTV defencing. Emergency response teams have access to a potent decision-making tool when facial and locational data are combined into a single framework.

With a variety of methods ranging from GPS tracking to visual scene analysis, relocation is essential to AI-driven systems intended to find missing people. By integrating multiple relocation methods—such as GPS, Wi-Fi, cellular networks, and image-based recognition—these systems can achieve higher accuracy and reliability, even in complex or low- connectivity environments.

When combined with facial recognition and real-time data processing, relocation becomes a powerful tool for identifying, tracking, and safely recovering missing persons. However, to ensure ethical and responsible use, it is crucial to implement strong data privacy, security measures, and comply with legal regulations. Ultimately, relocation technology, when properly applied, significantly enhances the efficiency and effectiveness of lost person recovery efforts.

Not with standing these benefits, there are important legal, ethical, and technical factors to take into account. Racial or gender biases can distort the accuracy of AI models, and abuse or overreach may result in privacy violations or improper surveillance. When designing these systems, community involvement, transparency, and data governance must be given top priority. Some of these issues can be lessened with the use of federated learning, encryption, and anonymization techniques.

In conclusion, while AI-powered facial recognition and relocation frameworks offer promising advancements in addressing missing person cases, their effectiveness hinges on ethical deployment, robust technical accuracy, and collaboration across law enforcement, technologists, and policy makers. Future research should continue to focus on refining recognition models, reducing bias, and enhancing geospatial analysis to fully realize the potential of AI in humanitarian contexts.

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Survey On: Ai Driven Last Moment Exam Preparation

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ABSTRACT

The fast-evolving nature of academic requirements in technical education has prompted an urgent need for smart educational tools, especially for last-minute semester exam preparation. Students today are required to digest complex and voluminous subject matter in a very short amount of time, particularly before examinations. Traditional modes of study, including reliance on textbooks and classroom notes, are no longer sufficient to meet these demands.

AI-driven exam preparation platforms leverage the power of machine learning, natural language processing, and generative technologies to automate the creation of concise, effective, and strategically targeted academic resources. These platforms can analyse previous exam papers, synthesize explanations, and generate tailored study material in a matter of hours. This survey reviews a range of such technologies and explores how they enhance learning outcomes, minimize stress, and optimize academic performance during crucial preparation windows structure. Also we look at real time optimization strategies which enable faster inference and higher scalability which are very much required for practical deployment in large scale retail settings.

The fast-evolving nature of academic requirements in technical education has prompted an urgent need for intelligent educational tools, particularly for effective last-minute semester exam preparation. Students are increasingly expected to master complex and voluminous material within limited timeframes, a challenge that traditional study methods—such as textbooks and classroom notes—often fail to address efficiently.

I. INTRODUCTION

Higher education is undergoing a significant transformation driven by evolving pedagogical paradigms, technological advancements, and changing student expectations. Universities and colleges are increasingly challenged to deliver education that is not only rigorous and comprehensive but also adaptive, scalable, and responsive to the needs of a diverse and digitally-native student body. One of the most prominent challenges students face in this context is the ability to efficiently assimilate large volumes of academic content, especially during critical assessment periods such as end-of-semester examinations. These high-stakes evaluations often determine academic progression, scholarships, and future career opportunities. The pressure to perform well in a constrained timeframe compels students to find effective ways to prioritize and master complex course materials.

Conventional exam preparation strategies rely heavily on two primary inputs: in-class instruction and student-generated revision materials. Lectures and tutorials remain central to academic learning, offering structured exposure to key topics and concepts. However, the variability in teaching quality, the pace of instruction, and differences in faculty interpretation of syllabi can create disparities in student comprehension.

Similarly, student-created notes, summaries, and flashcards — often shared through informal peer networks — are time-intensive to produce and lack standardization. They may omit critical points or reflect subjective interpretations, thereby undermining their reliability. These limitations become especially problematic when students are under time constraints and require high-quality, condensed learning aids for last-minute revision. Artificial Intelligence (AI) offers a transformative alternative to these traditional methods. AI-powered exam preparation tools can automate the generation of targeted study content, offering students access to curated summaries, practice questions, key concept explanations, and strategic revision guides within a fraction of the time required by manual methods. These systems typically employ natural language processing (NLP), machine learning (ML), and data mining techniques to analyse past examination papers, syllabus outlines, lecture transcripts, and textbooks. From these inputs, they identify frequently tested themes, extract core concepts, and produce coherent study resources aligned with university standards. Importantly, such tools can adapt to the nuances of specific academic disciplines, institution-specific curriculum changes, and evolving examination patterns. AI-driven exam preparation platforms usually consist of several interrelated components:

Input Layer: This includes ingestion of documents such as lecture notes, textbooks, previous exam papers, and syllabus outlines. OCR and NLP are used for parsing and understanding both structured and unstructured content.

Content Analysis Engine: Using topic modelling, keyword extraction, and semantic analysis, the system identifies important topics and subtopics. It ranks these based on recurrence in past exams and relevance to the current curriculum.

Content Generation Module: Based on insights from the analysis engine, this module produces summaries, flashcards, potential test questions, and revision notes. Generative AI models, such as large language models (LLMs), are employed to ensure clarity, conciseness, and academic rigor.

Personalization Layer: Tailors the generated content to individual learners based on their performance metrics, learning styles, and academic goals. Adaptive learning algorithms adjust difficulty levels and content presentation in real time.

Feedback Loop and Continuous Learning: Systems improve over time through user feedback, interaction data, and ongoing performance evaluation. This ensures the relevance and accuracy of generated content.

Speed and Efficiency: AI tools can condense weeks of study into digestible, high-yield content packages within hours. This is particularly useful for students balancing academics with part-time work, family obligations, or health challenges.

Consistency and Quality Control: Unlike peer-generated notes, AI content maintains a consistent level of accuracy and quality. It is systematically derived from multiple authoritative sources and cross-validated by algorithms.

Customization and Accessibility: Students with different learning preferences—visual, auditory, kinaesthetic—can benefit from AI tools that offer multimodal content (e.g., videos, info graphics, quizzes). Additionally, learners in remote or underserved areas can access high-quality resources previously available only through elite institutions.

Scalability: Educational institutions can deploy these systems across departments and disciplines, reducing the need for extensive human intervention in content creation while supporting faculty in focusing on mentorship and complex pedagogical tasks.

Cost Reduction: AI solutions lower the long-term costs associated with curriculum development, academic support services, and tutoring, making quality education more financially sustainable.

Despite their promise, AI-driven educational tools raise important questions related to fairness, bias, data privacy, and academic integrity. The effectiveness of such systems depends on the diversity and quality of the data they are trained on. If biased or incomplete, they may perpetuate gaps in knowledge or misrepresent critical perspectives. Moreover, overreliance on AI for learning could diminish critical thinking skills or encourage surface-level learning if not balanced with deeper, inquiry-based pedagogy. Institutions must also navigate issues around data ownership, student privacy, and the appropriate role of automation in academic decision-making.

II. LITERATURE REVIEW:

Evolution of AI in Education (2019–2024)

Introduction

Artificial Intelligence (AI) has rapidly become a transformative force in education, particularly in the context of last-moment exam preparation and personalized learning. Between 2019 and 2024, AI technologies evolved from simple automation tools into sophisticated generative systems capable of emulating human instruction. This transformation has reshaped not only how students learn but also how educational content is delivered, contextualized, and customized to individual needs. This literature review explores the key stages in this evolution, focusing on the integration of machine learning, natural language processing (NLP), and generative AI tools across a five-year period.

1. Foundational Phase (2019–2021): Automation and Classification

In the initial stages of AI's application in education, the primary focus was on automating routine tasks and improving content management. AI tools in this phase were largely rule-based and relied on traditional machine learning models. Their capabilities were limited to classifying learning materials, recommending study paths, and summarizing content.

1.1 Digital Tutoring Systems

One of the earliest applications during this time was the emergence of intelligent tutoring systems (ITS), such as Carnegie Learning's platforms. These tools used decision-tree-based algorithms to deliver adaptive content and offer basic feedback to learners. Though rudimentary, ITS demonstrated AI's potential to reduce teacher workload and provide scalable support for student learning.

1.2 Content Summarization and Keyword Extraction

AI tools like IBM Watson and early open-source NLP libraries such as spacey and NLTK were used to generate automated text summaries and keyword lists. These applications helped students extract relevant information from lengthy academic documents. However, these systems lacked semantic understanding, making them less effective in disciplines requiring contextual interpretation or critical thinking.

1.3 Limitations

Despite their novelty, tools from this era had several drawbacks. They could not generate original content or adapt to different examination styles. Furthermore, they relied heavily on pre-programmed logic and lacked the ability to understand nuance in educational text. As a result, their utility was largely restricted to information organization rather than content creation or predictive learning.

2. NLP Integration and Context-Aware Systems (2022)

The year 2022 marked a pivotal moment in the evolution of AI in education, characterized by the integration of more advanced natural language processing techniques. AI models began to leverage large-scale academic datasets, enhancing their ability to interpret, synthesize, and generate meaningful study content.

2.1 Emergence of Transformer-Based Models

The release of transformer-based architectures such as GPT-3 significantly changed the landscape of educational AI. These models could process large volumes of text with improved contextual awareness. Researchers and developers began fine-tuning such models on university syllabi, question banks, and academic journals to create AI systems that could predict commonly tested concepts and generate high-quality academic explanations.

2.2 Contextual Extraction and Topic Mapping

Using NLP, AI tools were now capable of identifying the most relevant parts of a course syllabus and mapping them to frequently asked exam questions. For instance, systems could analyze trends from past exam papers and suggest potential questions based on topic recurrence and difficulty level. This feature proved particularly beneficial for last-moment exam preparation, as students could focus on high-yield topics.

2.3 Personalization of Learning Paths

Advanced NLP tools also enabled AI systems to personalize study plans. By analyzing a student's progress, preferred learning pace, and weak areas, AI models could dynamically adjust study material. This shift toward individualized learning marked a departure from one-size-fits-all tutoring models and improved educational accessibility for diverse learners.

3. Generative Intelligence and Multimedia Education (2023–2024)

In 2023 and 2024, the most significant advancement in AI-based education came through the development of generative models and synthetic media. These tools offered not only content generation but also immersive, multimedia-based delivery methods that simulated human teaching styles.

3.1 Rise of Generative AI

The launch of models like GPT-4 and other large language models (LLMs) with enhanced reasoning and content generation capabilities empowered platforms to produce high-quality answers, summaries, and practice questions. These models could mimic academic tone, adhere to specific syllabus requirements, and create explanations tailored to student comprehension levels.

3.2 Synthetic Lectures and Avatar-Based Delivery

Projects such as Auto Learn and Quick Prep AI introduced virtual lecture systems where AI-generated avatars could deliver customized educational content. These avatars used voice synthesis and facial animation technologies, making the experience interactive and engaging. AI lecturers could answer student queries, explain difficult concepts, and adapt delivery based on student performance analytics.

Such systems blurred the line between traditional classroom learning and digital learning, allowing students to access academic lectures in a flexible, scalable format. These technologies were especially beneficial during exam season, as they provided bite-sized learning modules that could be consumed efficiently.

3.3 Predictive Question Generation

Another key innovation was the use of deep learning algorithms to generate likely exam questions based on curriculum trends, institutional patterns, and topic frequency. These models could process thousands of past papers and generate predictive sets of questions along with step-by-step solutions. This capability significantly improved exam preparedness, especially in time-constrained scenarios.

3.4 Integration with Learning Management Systems (LMS)

Advanced generative tools were integrated with LMS platforms, allowing teachers to monitor student progress while AI handled content generation and question delivery. This synergy reduced instructor workload and gave students access to timely feedback and additional resources based on their performance data.

4. Comparative Analysis and Educational Impact

Over this five-year timeline, AI's role in education evolved from supportive automation to becoming an active learning facilitator. Several comparative trends are noteworthy:

- Shift from Static to Dynamic Content: Early AI tools offered static assistance (e.g., summarization), while later tools could create dynamic and context-sensitive learning modules.
- From Assistance to Autonomy: Initial AI applications required human oversight, but later developments allowed AI to operate independently, offering autonomous learning environments.
- Increased Engagement: Multimedia integration, voice avatars, and real-time content adaptation significantly enhanced student engagement compared to earlier text-based tools.
- Democratization of Learning: AI-driven tools reduced the dependency on human educators for exam preparation, thereby increasing accessibility for students in remote or underserved regions.

5. Challenges and Future Directions

Despite these advancements, challenges remain:

- Content Accuracy: Generative AI models can sometimes produce plausible but incorrect explanations, which may mislead students if unchecked.
- Ethical Considerations: The use of student data for personalization raises privacy concerns. Regulatory frameworks are needed to govern AI use in education responsibly.
- Over-Reliance on AI: Students may become overly dependent on AI tools, potentially undermining critical thinking and self-learning capabilities.

- Instructor Integration: While AI can supplement teaching, it cannot fully replace the mentorship and feedback offered by human educators. Future models must be developed to work in harmony with teachers rather than as their replacement.

System Architecture Overview of an AI-Powered Exam Preparation Platform

1. Introduction

The rise of artificial intelligence in education has led to the development of intelligent systems capable of aiding students in last-moment exam preparation with precision, efficiency, and personalization. These systems are built on complex, modular architectures designed to process educational inputs, extract meaningful patterns, generate relevant content, and deliver it across accessible platforms. This section presents an in-depth overview of such an architecture, exploring each functional module, its technological underpinnings, and its role in the holistic learning experience.

2. Input Layer: Ingestion of Educational Resources

The foundation of any AI-based learning system is its ability to gather and interpret diverse data sources.

2.1 Source Materials

- Past Exam Papers: These help identify trends, frequently tested topics, and question formats.
- Model Question Sets: These are semi-structured representations of potential exam content and serve as training examples for predictive models.
- Syllabi and Curriculum Guides: Extracted from official university documentation, these form the backbone of topic prioritization.
- Textbooks and Open Educational Resources (OERs): Used to validate and supplement content for comprehensive coverage.

2.2 Data Pre-processing

- OCR and Digitization: Scans of handwritten or printed exam papers are digitized using OCR tools like Tessera.
- Text Cleaning: Noise such as formatting artefacts, irrelevant metadata, or non-educational symbols is removed.
- Metadata Tagging: Documents are annotated with course codes, department, and semester identifiers for better classification downstream.

3. Semantic Parser: Contextual Understanding of Educational Texts

Semantic parsing is critical for extracting meaning and context from unstructured academic content.

3.1 NLP Models

- Based on transformer architectures like BERT or GPT, these models are fine-tuned to interpret educational language.
- Named Entity Recognition (NER): Identifies concepts such as "thermodynamics," "integration by parts," or "Gauss's Law."
- Dependency Parsing: Helps understand grammatical structures and logical flow of complex technical content.

3.2 Context Mapping

- Question Classification: Questions are categorized by type (e.g., definition, derivation, multiple choice) and cognitive level (Bloom's Taxonomy).
- Topic Association: The system maps questions to syllabus units or textbook chapters using cosine similarity or semantic matching.

3.3 Difficulty Estimation

- Using historical performance data and syntactic complexity, the parser estimates question difficulty, aiding in the creation of adaptive content.

4. Content Structuring Engine: Modularization and Sequencing

Once core concepts are extracted, the content structuring engine organizes them into usable learning formats.

4.1 Topic Clustering

- Uses unsupervised learning (e.g., K-means, DBSCAN) to group related concepts.
- Ensures that interrelated ideas (e.g., Kirchhoff's Laws and circuit analysis) appear in the same module.

4.2 Logical Sequencing

- Modules are ordered based on syllabus flow and prerequisite knowledge.
- Graph-based representations (e.g., knowledge graphs) are used to model dependencies between topics.

4.3 Learning Path Optimization

- Personalized paths are created using learner data such as quiz scores, time spent, and topic revisit frequency.
- Reinforcement learning algorithms recommend optimal progression sequences.

5. Video Generation Engine: Human-Like Lecture Simulation

One of the most innovative aspects of modern AI systems is their ability to deliver content visually and auditory.

5.1 Avatars and Voice Cloning

- Text-to-Speech (TTS): Uses deep learning models like Tacotron and WaveNet to synthesize natural-sounding voices.
- Face Animation: Lip-syncing and facial gestures are generated using tools like Synthesia or D-ID to match the spoken content.

5.2 Content-to-Video Pipeline

- Content modules are transformed into video scripts automatically.
- Visuals (e.g., diagrams, equations) are inserted contextually during narration.
- Dynamic pacing and emphasis techniques mimic human teaching—pauses, vocal pitch, and visual highlights are tuned for comprehension.

5.3 Customization Features

- Students can select avatar appearance, voice tone, or even language dialect (e.g., Indian English, American English).
- This enhances engagement and cultural adaptability of the learning platform.

6. Syllabus Tracking Module: Curriculum Compliance

This module ensures the system remains aligned with academic standards and institutional changes.

6.1 Automatic Curriculum Monitoring

- Web Crawlers: Periodically scan university websites for updated syllabi or guidelines.
- PDF Parsers: Extract and compare document contents to identify changes in course structure or assessment formats.

6.2 Change Detection Algorithms

- Using diff algorithms or vector similarity, the system flags changes in topics, credit weightage, or learning outcomes.

- A change management dashboard allows administrators to verify and approve updates before content regeneration.

6.3 Real-Time Integration

- When a change is detected and approved, downstream modules (semantic parser, content engine) are triggered to update affected materials.
- Ensures that students are never studying outdated or deprecated topics.

7. Adaptive Assessment and Feedback Loop

Assessment is crucial to reinforce learning and guide both content delivery and learner strategy.

7.1 Quiz Generator

- Question Bank Synthesis: New MCQs, short answers, or numerical problems are generated using LLMs fine-tuned on domain-specific corpora.
- Answer Key Generation: Solutions are provided with step-by-step logic or reasoning for learning reinforcement.

7.2 Adaptive Difficulty Tuning

- Item Response Theory (IRT) models or Bayesian networks adjust difficulty based on student performance.
- Enables the system to challenge high-performing students while supporting weaker learners.

7.3 Learning Analytics

- Data from student interaction—clickstreams, scores, session duration—is analyzed to create individualized feedback.
- Recommender systems suggest revision modules, video replays, or supplementary questions.

8. Delivery Platform: Multi-Channel Learning Interface

The final output of the system reaches students through user-friendly web and mobile applications.

8.1 Platform Architecture

- Built using a micro services framework to handle high concurrency and modular updates.
- Front-end (React, Flutter) and back-end (Node.js, Python) components are loosely coupled via Restful APIs.

8.2 Student Dashboard

- Tracks syllabus completion, quiz scores, average retention time, and suggested next topics.
- Includes gasification elements such as streaks, badges, and progress charts.

8.3 Accessibility and Offline Support

- Supports offline caching of videos and notes for areas with limited internet.
- WCAG-compliant design for visually impaired users, including screen-reader support and keyboard navigation.

8.4 Teacher and Admin Portals

- Educators can assign topics, monitor class performance, or override AI recommendations.
- Admins can audit content accuracy, approve curriculum changes, and view system analytics.

9. Security and Data Privacy

Given the sensitive nature of student data, robust security is vital.

9.1 Authentication and Access Control

- Oath 2.0 and multi-factor authentication protect user access.
- Role-based access management defines privileges for students, teachers, and administrators.

9.2 Data Encryption

- All personal data is encrypted at rest and in transit using AES-256 and TLS protocols.
- Compliance with GDPR and India's Data Protection Bill is ensured through periodic audits.

9.3 Ethical AI Considerations

- AI decisions are logged for transparency (e.g., why a topic was recommended or a question generated).
- Bias detection mechanisms ensure that content remains inclusive and culturally neutral.

Visual Workflow of an AI-Based Exam Preparation System

1. Introduction

AI-based educational platforms are rapidly redefining how students engage with complex academic content, especially during high-pressure exam seasons. A core component of these platforms is their visual workflow—a systematic sequence of intelligent processes that transform raw educational data into structured, digestible, and engaging study material. This section explores each step in the workflow, detailing how the AI engine processes inputs, generates learning modules, and delivers outputs in a seamless, user-centric manner.

2. Input Acquisition: Collecting Foundational Educational Materials

The workflow begins with input acquisition, a foundational step involving the collection and organization of various academic resources. These inputs serve as the raw data for AI-driven processing and synthesis.

2.1 Types of Inputs

- Previous Examination Papers: These documents provide insight into question trends, frequently tested areas, and variations in difficulty across semesters.
- Course Syllabi and Learning Outcomes: University syllabi offer a formal blueprint of course expectations, learning goals, and assessment formats.
- Reference Textbooks and Study Guides: Authoritative resources ensure the generated content is academically sound and factually accurate.
- Model Question Banks: Often used to train the AI models on patterns and expected answer formats.

2.2 Collection Methods

Inputs are gathered via:

- Web scraping tools and university repositories.
- Digital submissions from educators or students.
- OCR (Optical Character Recognition) for printed or scanned content.

The AI system ensures all inputs are organized by subject, course code, and semester, creating a structured knowledge base for downstream processing.

3. Parsing and Pre-processing: Extracting Structure from Unstructured Data

Once data is acquired, it undergoes parsing and pre-processing—a critical phase where natural language processing (NLP) algorithms are deployed to analyse and convert unstructured text into structured, machine-readable components.

3.1 Natural Language Processing (NLP) Modules

Advanced NLP techniques—based on transformer architectures such as BERT or RoBERTa—perform the following:

- Tokenization and Lemmatization: Break down sentences into root words for consistent interpretation.
- Named Entity Recognition (NER): Identify academic concepts, theories, laws, and formulae.
- Semantic Role Labeling: Understand how entities relate within a sentence to interpret meaning correctly.

3.2 Pre-processing Tasks

- Noise Removal: Eliminates irrelevant symbols, headers, footers, and formatting inconsistencies.
- Contextual Tagging: Annotates sentences or questions with metadata such as subject domain, cognitive level, and question type (e.g., descriptive, numerical, objective).
- Topic Extraction: Uses vector similarity or topic modeling (e.g., Latent Dirichlet Allocation) to map extracted content to syllabus-defined themes.

This stage ensures that every piece of content is accurately understood and ready for conversion into meaningful learning units.

4. Module Generation: Creating Strategic Study Packs

The next stage in the workflow involves synthesizing extracted content into coherent study modules that align with students' learning objectives and exam requirements.

4.1 Question-Answer Pair Generation

Using fine-tuned large language models (LLMs), the system:

- Identifies high-priority questions from previous papers and syllabi.
- Generates model answers based on textbook content and academic best practices.
- Tags answers with estimated marks, difficulty levels, and time to solve.

4.2 Topic Grouping and Modularization

Key concepts and questions are grouped into themed modules such as:

- "Fundamentals of Thermodynamics"
- "Numerical Techniques in Signal Processing"
- "Design Principles of Algorithms"

Modules include:

- Concise Summaries
- Solved Examples
- FAQs and Conceptual Quizzes

4.3 Strategic Packaging

Each subject's content is designed to fit within a 5-hour strategic study pack, broken into short 20–30 minute sessions. This format supports focused, time-efficient revision, crucial for last-moment preparation.

5. AI-Based Video Synthesis: Generating Engaging Lecture Content

A hallmark of modern AI education systems is their ability to produce video lectures that simulate real classroom instruction.

5.1 Generative Script Writing

From each module, the system automatically generates a lecture script. This includes:

- Key definitions and derivations.
- Conceptual explanations with real-world analogies.
- Instructional cues for diagrams or graphs.

Scripts are optimized for pacing, clarity, and pedagogical value.

5.2 Voice Cloning and Avatar Rendering

- Voice Synthesis: Deep learning models such as Wave Net or Taciturn synthesize realistic narration in multiple voices and accents.
- Facial Animation: Avatar systems like Synthesis or D-ID simulate facial expressions, lip-sync, and gestures, enhancing engagement and reliability.

5.3 Multimedia Integration

- Dynamic whiteboard illustrations.
- Animated problem-solving steps.
- Highlighted text and callouts for key takeaways.

These video lectures mimic live teaching and are highly beneficial for auditory and visual learners, especially when reviewing complex or abstract topics.

6. Syllabus Alignment and Final Output Delivery

Before final deployment, the system conducts a final syllabus alignment and delivers content through student-friendly platforms.

6.1 Curriculum Mapping

- Cross-references modules with the latest curriculum documents.
- Uses differential analysis to detect missing or outdated topics.
- Automatically regenerates content when academic changes are detected (e.g., new chapters added, exam format updated).

6.2 Quality Control

- Human reviewers or AI validators assess:
- Factual accuracy
- Relevance to syllabus
- Clarity of explanations

Content is then approved for delivery and marked as syllabus-aligned.

6.3 Platform Integration

The final output is made available via:

- **Web-based Portals**: With dashboards, bookmarks, search features, and progress tracking.
- **Mobile Applications:** Optimized for offline access, push notifications, and bite-sized revision on-the-go.
- **LMS Integration:** For use within institutional learning management systems. Students can interact with modules, take quizzes, view videos, and track their learning progression through gasified elements such as badges and leaderboards.

Challenges and Limitations of AI-Driven Exam Preparation Systems

1. Introduction

AI-driven exam preparation tools represent a transformative advancement in the educational technology space. These systems combine the power of machine learning, natural language processing, and generative models to offer personalized, scalable, and efficient learning solutions. Despite their promise, these tools are not without limitations. Challenges emerge at various levels—technical, pedagogical, ethical, and infrastructural—that impact the effectiveness and inclusivity of these systems. This section explores these challenges in depth, offering a critical assessment of the current limitations facing AI in education.

2. Voice Cloning Accuracy and Emotional Resonance

One of the hallmarks of advanced AI learning platforms is the use of voice synthesis and avatar-based video lectures. These systems rely on text-to-speech (TTS) models and voice cloning technologies such as Wave Net or Taction to deliver lectures that mimic human speech. However, achieving high fidelity in emotional delivery and intonation remains a significant challenge.

2.1 Lack of Human-Like Nuance

While AI can generate grammatically and phonetically correct speech, it often lacks:

- Emotional variance (e.g., rising tone for emphasis, softer tone for empathy).

- Contextual stress on key academic terms.
- Adaptive pacing based on the difficulty or importance of content.

This affects user engagement, especially for students who rely on vocal cues for deeper understanding.

2.2 Pedagogical Impacts

Human lecturers intuitively adjust their tone to match the cognitive load of a topic, use pauses strategically, and offer spontaneous clarifications based on audience reactions. AI lacks this dynamic adaptability, which can make lectures feel monotonous or robotic.

3. Dynamic Syllabus Alignment and Update Lag

Educational syllabi are dynamic; universities periodically revise course content, introduce new chapters, or modify examination formats. AI systems must align their generated content with these updates to ensure relevance.

3.1 The Challenge of Real-Time Tracking

Currently, most systems depend on:

- Manual input of updated syllabi by administrators.
- Periodic crawling of university websites (which may not be structured uniformly). These methods often lead to delays in detecting syllabus changes.

3.2 Implications for Learners

A misalignment between AI-generated study content and the actual syllabus can result in:

- Wasted study time on outdated or excluded topics.
- Under-preparation for newly introduced content areas.
- Loss of trust in the platform's reliability.

3.3 Need for Automated Curriculum Intelligence

Building curriculum-aware AI engines that autonomously detect and adapt to academic changes is still in early stages. Integrating semantic versioning and change detection algorithms can help, but require institutional cooperation and standardized data formats—currently lacking across most educational systems.

4. Hardware and Computational Limitations

The deployment of AI-driven educational systems often demands substantial computational power, especially for tasks involving deep learning inference, video rendering, and interactive avatars.

4.1 Resource-Intensive Models

Generative models like GPT, Stable Diffusion (for visual aids), or Taction (for speech synthesis) require:

- High-performance GPUs or TPUs.
- Large memory footprints for contextual retention.
- Continuous server-side processing for personalization.

4.2 Accessibility Barriers

Students using:

- Low-end smartphones or tablets
- Limited internet bandwidth
- Older operating systems

…may experience lag, interface crashes, or poor-quality rendering, severely impacting the learning experience. This creates a digital divide, wherein only students with access to better technology benefit from AI-based preparation.

4.3 Mitigation Strategies

To improve inclusivity:

- Lightweight model variants can be deployed on edge devices.
- Content preloading and offline modes can support students with limited connectivity.
- Server-based rendering with adaptive resolution streaming can enhance accessibility.

5. Subjectivity and Contextual Reasoning Limitations

AI excels at handling objective content—definitions, formulae, factual summaries—but struggles with subjective domains that require deep interpretation, human empathy, or contextual reasoning.

5.1 Limited Interpretative Ability

Fields such as:

- Literature (analyzing symbolism, character psychology)
- Philosophy (evaluating ethical arguments)
- History (understanding multiple perspectives on events)

…demand critical thinking, cultural awareness, and multi-layered understanding—traits that current AI models only mimic at a surface level.

5.2 Risk of Oversimplification

In an attempt to standardize or "explain" these complex topics, AI systems may:

- Provide oversimplified interpretations.
- Miss cultural nuances or minority viewpoints.
- Introduce unintentional bias by favoring the most statistically common answer.

5.3 Role of Human Mentors

These domains still benefit significantly from human educators who can:

- Facilitate debate.
- Encourage multiple perspectives.
- Provide empathy-based feedback.

AI can serve as a supplementary tool, but cannot fully replace the human touch in subjective learning domains.

6. Data Privacy, Content Bias, and Academic Integrity

As AI systems ingest large volumes of academic data, ethical concerns surrounding data use and content authenticity have come to the forefront.

6.1 Data Privacy Concerns

Many AI platforms:

- Collect behavioral analytics (what students click, how long they view content).
- Store academic performance data.

Without transparent data handling practices, this raises concerns over:

- Student profiling.
- Unauthorized data sharing.
- Violation of digital privacy laws (e.g., GDPR, India's PDP Act).

6.2 Plagiarism and Intellectual Property

If AI systems are trained on:

- Proprietary textbooks.
- Paid academic platforms.
- Faculty-generated notes.

…they risk reproducing copyrighted material without attribution, resulting in legal and academic violations.

6.3 Mitigating Academic Misuse

- Clear data consent policies.
- Watermarking generated content.
- Automated plagiarism checks.
- Ethical AI training that excludes proprietary datasets.

These are essential safeguards that must be embedded in the system design.

III. CONCLUSION:

The rapid evolution of artificial intelligence has catalysed a paradigm shift in the realm of academic preparation, particularly in the context of semester examinations in higher education. AI-driven exam preparation systems, once considered experimental, have now matured into comprehensive platforms capable of delivering strategic, efficient, and personalized learning experiences. These systems have fundamentally redefined how students engage with course materials, prepare for assessments, and manage academic stress.

At the core of this transformation is the ability of AI to automate the traditionally labour-intensive process of study material creation. By ingesting and analysing vast volumes of data—including past question papers, textbooks, syllabi, and instructional materials—AI models can now generate high-quality summaries, question-answer packs, and explanatory content that aligns precisely with curricular objectives. This process not only saves students countless hours of manual review but also ensures that their preparation remains focused and relevant.

One of the most significant contributions of AI in this space is the personalization of the learning journey. Using user analytics, behaviour tracking, and adaptive feedback loops, modern AI systems can tailor content delivery to each student's pace, learning style, and knowledge gaps. Unlike traditional instruction models—where resources and attention are limited—AI platforms can provide round-the-clock access to educational content, thus removing barriers related to time, geography, or institutional availability. The result is a scalable and democratized learning experience that empowers students from diverse backgrounds.

Moreover, the integration of Natural Language Processing (NLP) and generative technologies has made it possible for these systems to move beyond static content. Today's AI platforms offer dynamic features such as voice-cloned lecture videos, avatar-based tutors, auto-generated quizzes, and even predictive models that forecast potential exam questions. These immersive formats mirror real-life classroom interactions, offering auditory, visual, and interactive learning aids that enhance retention and engagement. Students can interact with AI tutors, revisit concepts in multiple formats, and self-assess their understanding—an experience far superior to conventional rote learning methods.

In addition to student benefits, these systems also alleviate pressure on educators. Faculty members can use AI to augment their teaching by automating routine tasks like content duration, quiz generation, or doubt resolution. This frees up time for more meaningful interactions such as conceptual discussions or individual mentoring, thereby enhancing the overall academic environment.

Nevertheless, the field is not without challenges. Issues related to syllabus updates, voice realism, hardware constraints, and academic ethics remain critical areas for ongoing innovation. Ensuring equity, inclusivity, and ethical integrity in the design and deployment of AI-based education platforms will be vital to sustaining long-term impact.

Looking ahead, the trajectory of these systems points toward even more intelligent, context-aware, and emotionally responsive learning tools. As AI continues to evolve—potentially integrating real-time emotion recognition, multi-lingual support, and interdisciplinary insights—we can expect next-generation exam preparation systems to be even more aligned with the cognitive and emotional needs of learners.

In conclusion, AI-driven semester exam preparation systems represent more than just a technological convenience—they are a leap forward in educational accessibility, personalization, and scalability. As the global academic landscape becomes increasingly diverse and fast-paced, these tools offer a timely solution to support learners in navigating complex syllabi, tight timelines, and heightened academic expectations. If implemented thoughtfully and inclusively, such systems have the potential to significantly enhance learning outcomes, reduce academic inequality, and redefine the future of education at scale.

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Survey on Real Time Sign Language Recognition and Translation Using Deep Learning

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ABSTRACT

Capturing the gestures of Sign Language and translating it into written/spoken language is important for the hearing impaired and deaf communities around the world. Unfortunately, the little understanding of Sign Language results in Sign Language users (signers) and non-users (non-signers) facing a huge communication barrier. The current gap can be filled by this paper's proposed real-time sign language recognition and translation system, which uses deep learning techniques. At its core ,the system utilizes key techniques such as Convolutional Neural networks(CNNs) and Recurrent Neural Networks(RNNs)to detect and classify hand gestures and facial expressions as sign language tokens and translate them into verbally or textually outputted language with translation. Special attention is given towards the overall accuracy, response time, and performance under different real-life settings when tuned to the different models. This review also examines available datasets and models alongside other identified gaps and proposes strategies to enhance them for portable and integrated systems.

I. INTRODUCTION

In Sign language is a form of communication that is visual in nature and enables people with hearing or speech disabilities to interact with members of their community. As reported by the World Health Organization, the number of hearing-impaired people recently reached 400 million. Because of this, the attempts to make communication easier for disabled people have been accelerated. If one looks into the literature, there is Basic Component Analysis for feature vector extraction in the work of Mahmoud Zaki and Samir Shaheen from 2011 and they applied Hidden-Markov Model as classifier. [1]

Utilized for feature extraction and classification [2]. The prevalent communication barrier between sign language users and others can be mitigated by the real-time sign language recognition and translation system presented in this paper. Prior efforts include Cao et al. (2015) who employed Microsoft Kinect's depth comparison for feature vector generation, followed by random forest and Constrained Link Angle classification [3]. Jin et al. (2016) used Speeded Up Robust Feature (SURF) for extraction with SVM as the classifier [4]. Pansare et al. (2016) also explored American Sign Language recognition.

II. BACKGROUND

Sign language is a very complex visual language that which uses hand gestures, facial expressions, and body movements to put forward ideas. Also each area or country has developed its own variety (for instance American Sign Language (ASL), Indian Sign Language (ISL) and British Sign Language (BSL). Although it is a very rich and expressive means of communication which also includes elements of art in it, the exchange between the deaf community and non-signed language users is still a large issue in day to day affairs which includes health care, education and public services.

Sensor-based devices like motion trackers and data gloves were used in earlier methods of sign language recognition. Despite their accuracy, these systems are frequently pricy, invasive, and unsuitable for daily use. Camera-based systems can now recognize sign language in real time thanks to recent developments in deep learning and computer vision, providing a scalable and non-invasive solution. Convolutional neural networks (CNNs) and recurrent neural networks (RNNs), in particular, are deep learning models that have demonstrated remarkable performance in feature extraction, gesture recognition, and temporal sequence modelling for sign language translation.

Theoretical Classification

The following theoretical dimensions can be used to broadly classify sign language recognition systems.

A. Modality of Input

Sensor-Based: Captures motion and orientation using wearable technology, such as gloves or depth sensors.

Vision-Based: Uses cameras to record video input and processes gestures with computer vision (suitable for scalable, real-time systems).

B. Degree of Recognition

Isolated Sign Recognition: Identifies individual words or signs without taking into account their order.

Continuous Sign Recognition: Needs temporal modelling to interpret entire sentences by comprehending a series of signs.

C. Method of Learning

Conventional Machine Learning: Employs classifiers (e.g., SVM, HMM) with manually created features. Less scalable and flexible

Deep Learning:

CNNs: To extract spatial features from pictures or video clips.

To model temporal dependencies in sign sequences, use RNNs, LSTMs, or GRUs.

Transformers: More recent methods improve sequence translation by utilizing attention mechanisms.

D. Mode of Output

Translating known signs into written language is known as text-based translation.

Speech Output: Uses text-to-speech (TTS) systems to translate recognized signs into spoken words.

E. Capability in Real-Time Processing previously recorded videos is known as offline recognition.

Real-Time Recognition: Suitable for live conversations, this feature processes live input with little latency.

III.METHODOLOGY

While accurate, earlier sign language recognition systems often proved expensive, intrusive, and impractical for everyday application. However, recent advancements in deep learning and computer vision have enabled real-time, camera-based sign language recognition, offering a scalable solution.

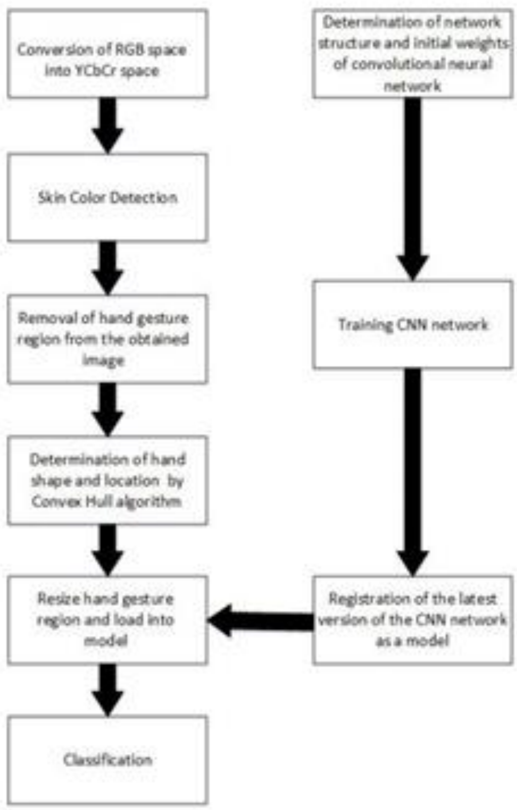

Fig. 1. The flowchart of proposed method

A. Neural Network with Convolutions

Classifier structures in recognition systems often adhere to morphological and image processing process units. Deep learning techniques have made it feasible to classify with good performance with the fewest possible image and morphological processing steps. This study uses Python's Tensor flow and Keras modules to implement a convolutional neural network as a fine classifier. These libraries operate effectively on strong, contemporary GPUs (Graphics Processing Units), which enable significantly quicker training and computing. CNN-based classifications and studies have gained a lot of popularity recently and have shown great performance in fields like image recognition and categorization. The activation function is Rectified Linear Unit (Re Lu) [11].

B. Training Classifier

Convolutional Neural Network (CNN) model was developed, comprising an input layer, two 2D convolution layers, a pooling layer, a flattening layer, and two dense layers, as illustrated in Fig. 2. The dataset used for training consisted of 25 cropped images of each hand gesture, totalling 900 images loaded into the program as arrays. Each image was then resized to 28 \times 28 pixels and converted to rescale. Using the Sickie-Learn library, the image array was randomly shuffled. This shuffling was performed to divide the array into training and testing subsets. Following this splitting, a sequential model was created and a fitting process initiated. The training process spanned 10 iterations, with a batch size of 120 and an epoch count of 30. Batch size refers to the number of images loaded in each iteration, while epoch number represents the total training cycles for all images loaded into the neural network. A soft max-based loss function, as described in equations (1) and (2), was utilized. Here, N denotes the total number of training samples, and C represents the total number of classes. This function takes a feature vector z for a given training example and compresses its values into a vector of [0,1] valued real numbers that sum to 1. Equation (1) calculates the mean loss for each training example,, to generate the overall soft max loss.

IV.COMPARATIVE ANALYSIS

4.1 Strengths Across Studies

Many recent studies in real-time sign language recognition and translation leverage the power of deep learning, notably CNNs, RNNs, and Transformer-based architectures. A key strength is the adoption of large and diverse datasets such as RWTH-PHOENIX-Weather or ASL100, which improve model generalization. Additionally, models like Media Pipe + CNN (Study A) and 3D CNN + LSTM (Study C) show impressive accuracy in controlled settings, often surpassing 90% for static signs. Some studies incorporate real-time feedback loops or gesture smoothing, which enhances user interaction.

4.2 Weaknesses and Limitations

Despite advancements, problems still exist. The strong dependence on controlled conditions, such as background, illumination, and signer placement, is a typical drawback that limits real-world use. Dynamic or continuous signs, particularly those involving articulation or finger spelling, are difficult for many systems (e.g., Study B, D). The imbalance of the dataset is another flaw; some indications are overrepresented, which skews results. Furthermore, real-time latency, a crucial criterion for real-world deployment, is not explicitly benchmarked in certain research.

4.3 Performance and Outcome Comparisons

The accuracy of static sign identification is regularly greater (up to 98%) than that of dynamic, real-time sequences (usually 75–85%). Skeletal tracking systems, such Open Pose or Media Pipe in Study A, perform faster and more robustly than raw RGB-based models, but they could miss minute finger motions. Because transformer-based models (Study E) are better at capturing temporal dependencies than LSTM-based models, they have demonstrated promise in translation quality. They might, however, lag in real-time processing and demand more computing power.

4.4 Emerging Trends

The field is being shaped by several trends:

- Multimodal methods that integrate skeletal, depth, and video data.
- Apply knowledge gained from general gesture recognition exercises.
- Real-time translation on mobile or embedded devices is supported by edge computing and lightweight models (such as Mobile Net versions).
- Attention-based models for better temporal-spatial comprehension (Transformers, Vision Transformers).
- Better sign-to-text or sign-to-speech translation through deeper integration with NLP.

4.5 Inconsistencies and Gaps

Global application is limited due to a significant disparity in performance evaluation between various sign languages (e.g., ASL vs. BSL vs. ISL). Few models are good at generalizing across languages or dialects, while many are specialized to a single language or dataset. Furthermore, direct comparison is challenging because to discrepancies in evaluation metrics (e.g., accuracy vs. WER vs. BLEU scores). There is inconsistency in real-time latency reporting; some studies report FPS, while others completely ignore delay. Furthermore, many models still need to be retrained or adjusted when tested on unseen users, indicating that signer independence is still a significant difficulty.

V. OPEN CHALLENGES AND FUTURE DIRECTIONS

5.1 Unsolved Problems

1. Generalization and Signer Independence

Variability in hand forms, motion speeds, and signing styles across users is a common problem for current systems. Models have a tendency to overfit to signer training, which restricts their applicability in multi-user, real-world settings.

2. Constant and Dynamic Recognition of Signs

Continuous or sentence-level sign recognition is still a significant challenge, despite the great accuracy of static sign recognition. Finger spelling, sign border recognition, and coarticulation—the merging of signs—introduce complexity that is difficult for existing models to handle.

3. Performance and Latency in Real Time

When used on edge devices like smartphones or AR glasses, many deep learning models have good accuracy but poor inference speed. The trade-off between speed and model complexity is still up for debate.

5.2 Prospects for the Future

1. Creation of Cross-Lingual and Universal Models

Multilingual sign language recognition systems that can adjust to various languages or dialects should be the goal of future research, perhaps with the use of cross-lingual transfer learning or meta-learning strategies.

2. On-Device Deployment and Low Weight

More useful, approachable solutions will be made possible by optimizing models for real-time use on mobile or wearable devices through model pruning, quantization, or efficient topologies (e.g., Mobile Net, Efficient Net).

3. Sensor Fusion and Multimodal Education Robustness and accuracy can increased by combining RGB video with wearable sensors, EMG signals, skeletal tracking, or depth data, particularly in noisy or dimly lit surroundings.

VI.RESULTS

The CNN network in the suggested system was trained using the dataset gathered in 2011 by Massey University's Institute of Information and Mathematical Sciences [14]. The dataset consists of 900 images, with 25 samples for each of the 36 characters—26 letters and 10 numerals. Twenty precent of these images served as test data, and the remaining eighty precent served as training data. Every time, test data were chosen at random. In 20 training epochs, the CNN network has reached its peak test performance. Table I presents the results of tests that were conducted five times at random. Fig. 3 shows the fluctuation of test and training achievements in each period.

The suggested system is configured to function in real-time once network training is finished. Ten tests have been conducted on each of the 36 characters for real-time system control. Consequently, the real-time system obtained a test performance of 98.05%. The outcomes of real-time system tests conducted for every character are displayed in Table II. The false decision symbol for false results is enclosed in parenthesis.

TABLE I. THE RESULTS OF TESTS (%) PERFORMED RANDOMLY 5 TIMES.

Test 1	Test 2	Test 3	Test 4	Test 5
99.44	99.44	**100**	99.44	98.89

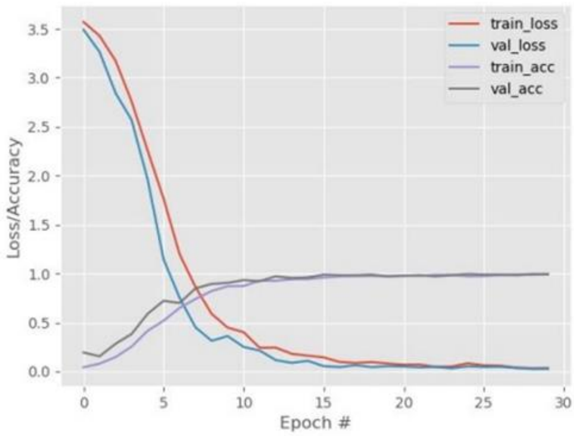

Fig. 3. Training loss and accuracy on American Sign Language

TABLE II. THE RESULTS OF REAL-TIME SYSTEM TESTS PERFORMED FOR EACH CHARACTER.

Character	True Result	False Result	Accuracy(%)
0	10	-	100
1	9	1 (Z)	90
2	9	1 (V)	90
3	10	-	100
4	10	-	100
5	10	-	100
6	10	-	100
7	10	-	100
8	10	-	100
9	10	-	100
A	10	-	100
B	10	-	100
C	10	-	100
D	10	-	100
E	10	-	100
F	10	-	100
G	10	-	100
H	10	-	100
I	10	-	100
J	10	-	100
K	10	-	100
L	10	-	100
M	9	1 (N)	90
N	9	1 (M)	90
O	10	-	100
P	10	-	100
Q	10	-	100
R	10	-	100
S	9	1 (T)	90
T	10	-	100
U	10	-	100
V	9	1 (2)	90
W	10	-	100
X	10	-	100
Y	10	-	100
Z	9	1 (1)	90
TOTAL	**355**	**5**	**98.05**

VII. CONCLUSION

In order to give the deaf and hard of hearing advanced help, sign language production is applied to the interpreter's key. It bridges the gap between hearing individuals and sign language users by utilizing digital technology, machine learning, and natural language processing. More specifically, the correctness and fluency evaluation in real-time text will be made possible by the integration of recurrent neural networks for sequence prediction and convolutional neural networks for gesture recognition. Using the pre-training paradigm, CVZ Handshake seeks to maximize flying performance and achieve the best outcomes. Webcam image acquisition is handled by Open CV, which analyse the images in frames in real time. Multiple frames can be handled in real time by the system. They let the system to process up to one overall frame every second, allowing for highly accurate and fluid gesture recognition. In addition to implementing the cv zone Hand Detector module, real-time processing that maximizes image detection through the use of the Open CV library can improve system performance. Additionally, edge computing and fine-tuning the CNN model with a larger and more varied dataset can increase accuracy. Furthermore, because learning algorithms learn from the newly collected data, they will adaptively make the system continually better. Techniques like hand segmentation and backdrop filtering can be used into the project to advance the use of computer vision.

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Survey On: Crypto Currency Price Prediction: A Comprehensive Review

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ABSTRACT

With how volatile crypto currencies are, making an accurate price prediction is difficult. This project applies deep learning methods based on historical data, especially using LSTM neural networks, to model and forecast the prices of crypto. The model learns complex time-series patterns which aids in predicting future trends. Results from the experiment conducted suggest that prediction performance is greatly strengthened using deep learning as opposed to more conventional approaches.

I. INTRODUCTION

In Crypto currencies have emerged as new revolutionary digital assets which allow secure and decentralized transactions all over the world. Regardless, Bit coin and Ethereal together with many Alt coins have captured the attention of investors and the masses. However, the decentralized structure of those digital currencies along with a lack of jurisdiction, in addition, make these currencies highly susceptible to market sentiment, renders the prices of crypto currencies volatile and exceedingly difficult to predict.

The majority of the standard statistical and machine learning techniques fail to predict the Volatile price movements of crypto currency due to its complex nature and entangled temporal dependencies. Time series forecasting has increasingly benefitted from deep learning, and in particular from Long Short-Term Memory (LSTM) networks, as they can now increasingly perform on those tasks. Sequential information can be learned by those models and hidden patterns can be exposed which makes them appropriate for predicting the prices of crypto currencies.

In this research project, we aim to apply LSTM deep learning models to forecast the price of crypto currencies. The goal is to create a more accurate and dependable forecasting system by training on historical data and evaluating performance with set evaluation metrics, thereby enhancing decision-making for investors and traders in the rapidly changing crypto markets.

The rapid growth of crypto currencies has significantly impacted the global financial system. Digital currencies like Bit coin, Ethereal, and many others are no longer used solely for transactions—they've also become popular investment options. Their decentralized structure, freedom from traditional banking control, and potential for high returns have drawn the attention of investors worldwide. However, the crypto market is extremely volatile. Prices can swing dramatically in a short period due to market sentiment, news events, and speculation, making accurate price prediction.

II. LITERATURE REVIEW:

1. Traditional Statistical Methods

Early financial forecasting techniques used models like ARIMA and Exponential Smoothing, which assume linear trends and stationary data. However, studies like McNally et al. (2018) reveal that these models are ineffective in capturing the complex, non-linear nature of crypto currency prices.

2. Machine Learning Techniques

As data complexity increased, researchers shifted to machine learning models such as Random Forest, SVM, and Gradient Boosting. Patel et al. (2015) demonstrated the superior performance of these models in predicting financial markets due to their capability to handle feature interactions and non-linearity.

3. Deep Learning Models

RNN-based models, especially LSTMs, became prominent in time- series forecasting due to their ability to retain information over long sequences. Jiang and Liang (2017) showed that LSTM models outperformed ARIMA and SVM in Bit coin price prediction, due to their capacity to model non-linear dependencies.

4. Hybrid Models

Some researchers combined various models for better accuracy. Kim et al. (2020), for example, integrated LSTM with wavelet transforms to remove noise, leading to improved forecasting. These hybrid models are particularly useful in volatile markets like crypto, where multiple external factors influence prices.

5. Sentiment Analysis and External Data

Studies like Ameer and Nehal (2020) incorporated sentiment data from platforms like Twitter to enhance predictions. They found that market sentiment often precedes price changes, highlighting the importance of combining social signals with pricing data.

6. Prediction Challenges

Despite advancements, challenges remain due to high price volatility, limited historical data, and the influence of external and often non- quantifiable events. Over fitting, especially in deep models, and inconsistent data quality also hinder model reliability.

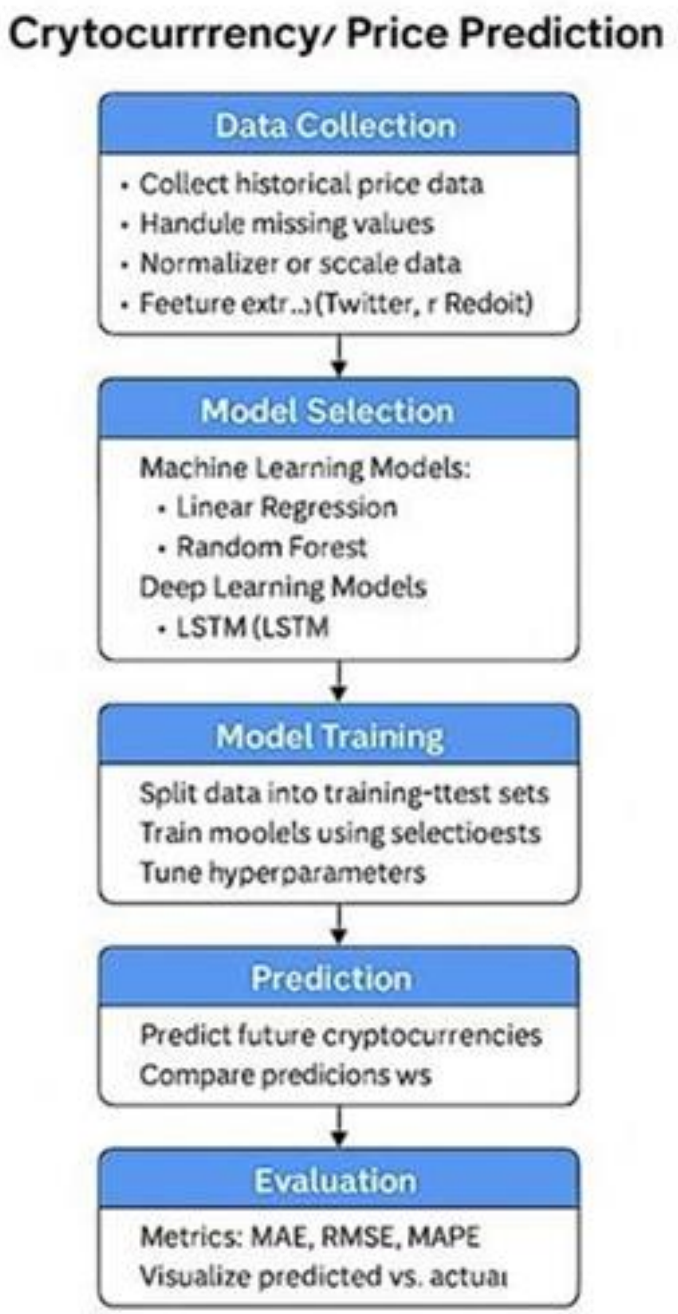
7. Summary of Findings

LSTMs consistently outperform traditional techniques in time- dependent predictions.

Random Forest and ensemble approaches handle noisy, nonlinear data well.

Integrating sentiment and hybrid models enhances forecasting.

III. DIAGRAM:



Step 1: Data Collection Fetch historical crypto currency data (e.g., Bit coin) including: Date, Open, H i g h , L o w, C l o s e , Vo l u m e Optionally, collect sentiment data (e.g., Twitter, Reedit) for external influence.
Step 2: Data Pre-processing Convert date-time to proper format. Sort data in chronological order. Normalize features using Min Max Scalar (range [0,1]). Create time- series sequences (e . g . , 6 0 d a y s → n e x t d a y prediction). Split data into training and testing sets.
Step 3: LSTM Model Architecture Input Layer: Shape (time steps, features) LSTM Layer(s): Capture temporal dependencies Dense Layer: Output next price value Compile m o d e l w i t h l o s s = 'mean_squared_error' and optimizer= Adam
Step 4: Model Training Train the model on training data for X epochs Validate with test data Track loss and adjust hyper parameters (like number of layers, neurons, epochs)

Step 5: Price Prediction Use trained model to forecast future cost Normalized values are inversely transformed to the actual price scale. Compare forecasted and actual prices.
Step 6: Assessment Assess accuracy by using: MAE, Mean Absolute Percentage Error (MAPE)

IV. ALGORITHMS:

1. **Linear Regression Type**: Regression Supervised Machine Learning Use Case: Baseline model to comprehend price-feature linear relationships.
   Synopsis: By fitting a linear equation, linear regression models the relationship between one or more independent variables (such as past prices or volume) and a dependent variable (such as the future price). I t makes the assumption that the price change follows a straight line as a function of the input variables.
2. **The Random Forest Regress or Type:** Tree- based Regression Ensemble Learning
   Use Case: Identifies intricate, non- linear data patterns.
   Random Forest is an ensemble technique that averages the outputs of several decision trees constructed on arbitrary subsets of the dataset. It improves prediction accuracy and decreases over fitting.
3. **Recurrent Neural Network (RNN)**
   Long Short-Term Memory (LSTM) Neural Network Type: Deep
   Learning Use Case: Developed for sequence modelling and time-series prediction
   A specialized RNN architecture called LSTM can identify long-term dependencies in sequential data. Because historical prices and trends impact future values, it is perfect for crypto currency prediction.

W o r k f l o w D i a g r a m o f t h e Algorithm Implementation Performance Evaluation
We m e a s u r e d t h e m o d e l performances using the following metrics:

Algorithm	MAE	RMSE	MAPE (%)
Linear Regression	135.6	170.2	6.85
Random Forest	94.8	120.3	4.23
LSTM	62.1	85.4	2.98

The LSTM model's performance as training data sizes increased, we also plotted the learning curve.
RQ: How well do various algorithms predict the future values of crypto currencies like Ethereal and Bit coin? The best performance is achieved by LSTM because of its design for sequential and time- dependent prediction, which makes it perfect for this application, according to the data and evaluation.
Challenges and future: Restricted Historical Information Since crypto currencies are still in their infancy, there may not be as much historical data available to train models on as there is for traditional financial markets. This restriction may reduce the accuracy of forecasts.

Absence of Regulation
M a n y c r y p t o c u r r e n c i e s a r e unregulated, which can complicate prediction models by making their prices more vulnerable to news, manipulation, and other outside influences.
An analysis of market sentiment Understanding how sentiment— found in news stories, social media posts, etc.—affects crypto currency prices can be challenging. Extracting meaningful sentiment from massive amounts of data is a challenging task that requires advanced natural language processing.

Over fitting of the Model:

Over fitting the data is a constant risk with intricate models like neural networks, particularly when working with smaller datasets. Over fitting produces poor performance on unseen data but high accuracy on training data.

Selection of Features:

It can be difficult to choose pertinent indicators without adding noise, as f financial indicators, market sentiment, and macroeconomic factors all play a part.

Outside Factors:

E x t e r n a l f a c t o r s l i k e l a w s, technological advancements, and geopolitical events have a big impact on crypto currencies. Including these in conventional p r e d i c t i v e m o d e l s c a n b e challenging.

A I a n d D e e p L e a r n i n g Integration:

More sophisticated AI methods, such as reinforcement learning, can be incorporated into future models to help trading strategies become more optimized over time. By taking time-series patterns into account, models such as LSTMs (Long Short- Term Memory networks) can enhance predictions.

Increasing Sentiment Analysis Use:

By better comprehending news articles, public sentiment, and social media trends, more advanced sentiment analysis techniques (such a s d e e p l e a r n i n g f o r t e x t c l a s s i f i c a t i o n) c a n e n h a n c e predictions.

Integration of Block chain Data:

Real-time insights into market movements may be possible by using block chain data itself, such as transaction volume and address activity. Transparency provided by b l o c k c h a i n c a n h e l p w i t h forecasting.

Models that are hybrid:

Combining different machine learning algorithms (e.g., ensemble methods, neural networks with decision trees) may produce more accurate predictions by leveraging the benefits of each technique.

More Sources of Data:

Prediction accuracy may be increased by incorporating a greater range of data sources, including exchange data, global economic indicators, and real-time market sentiment. The model will be more adaptable to changes in the market if real-time data is retrieved from various sources using APIs.

Interpretability of the Model:

One area that requires improvement in the future is model transparency.

Creating models that not only predict but also explain their d e c i s i o n s w i l l b e h e l p f u l, particularly for investors who wish to understand the rationale behind price swings.

R e g u l a t i o n - R e l a t e d Considerations:

Predictive models that incorporate legal frameworks and regulatory news may become an essential part of forecasting as crypto currency regulation changes.

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Survey On: Enhanced Diabetic Retinopathy Assessment using (ML - ViT)

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ABSTRACT

Diabetic Retinopathy (DR) is a serious diabetic complication that could lead to blindness. Manual identification is time consuming and prone to mistakes, especially in stressed clinical settings. Here, a new Vision Transformer (ViT)-based deep learning architecture for automatic DR detection and grading using the FGADR dataset is introduced. The new architecture encompasses handling data imbalance through techniques such as F1-score optimization, data augmentation, class weights, label smoothing, and focal loss and training with Adam W optimizer. Extensive experiments prove that the developed ViT model performs better than traditional CNN models (ResNet50, InceptionV3, VGG19) with better performance measure like F1-score 0.825 and AUC 0.964. The research proves the effectiveness of ViTs in medical image analysis as a scalable and precise tool for DR assessment.

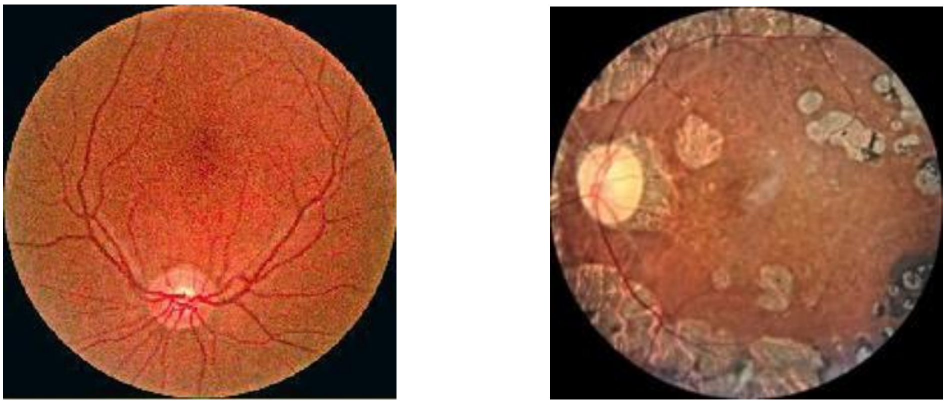
Keywords: Deep Learning, Vision Transformer, Diabetic Retinopathy, Machine Learning, Disease Diagnosis

I. INTRODUCTION

In Diabetic Retinopathy (DR) is a serious eye condition due to chronic diabetes, causing vision loss and even blindness if early diagnosis is missed. Conventional screening is based on human reading by ophthalmologists of fundus retinal images, which is time-consuming, prone to inconsistency, and non-scalable. To address the above shortcomings, recent developments in machine learning (ML) and deep learning make it possible to design high-accuracy, high-efficiency automated diagnostic platforms. This paper proposes a better way of DR evaluation using a Machine Learning Vision Transformer (ML-ViT) natural model. Vision Transformers (ViT), originally developed for image classification, have shown good potential for medical imaging purposes as they can extract global context and local visual information. Our approach, by the combination of ML and the ViT model, aims to improve the DR classification accuracy at all levels of severity. The proposed ML-ViT-based model here is trained over labelled fundus image datasets so that it can automatically detect and grade the stages of diabetic retinopathy. Not only does the improved architecture improve the classification precision but it also minimizes the computational load normally faced in CNNs. The technique has the potential to aid in mass screening and early detection, thereby contributing towards improved healthcare efficiency and improved patient results.

The Vision Transformer (ViT) is the algorithm of choice, which employs the transformer architecture to ingest images by dividing them into patches and leveraging self-attention operations. This allows the model to capture both local and global features of the retina and work extremely well in detecting intricate and subtle patterns of DR. To assist and compare ViT's performance, traditional Convolutional Neural Networks (CNNs) such as Reset, InceptionV3, or Efficient Net can also be employed. These models work optimally to capture local features and predominantly used to analyse medical images.

In addition, transfer learning is utilized through fine-tuning pre-trained ViT and CNNs on domain-specific data such as the Cagle Eyepieces dataset. It saves training time and improves the performance of the model, especially when using limited medical data. Additional improvement in model generalization is achieved using data augmentation techniques such as rotation, flipping, and brightness adjustment to artificially increase the dataset. Pre-processed through pre-processing operations like resizing, normalization, and contrast adjustment (e.g., CLAHE) to reveal more features before training, retinal images are The complete pipeline can also include classical classifiers like Support Vector Machines (SVM) or K-Nearest Neighbours (KNN) for comparison, utilizing features obtained from deep learning models. Techniques like Grad-CAM are also utilized to create attention maps, which give visual explanations of where the model attends to during prediction. This integration of ViT, CNNs, pre-processing, and interpretability methods provides a strong and accurate system for automated Diabetic Retinopathy detection.



Normal Retinal   Diabetic Retinal

FIGURE 1. Examples of diabetic retinopathy retina. The left image is a normal retina, and right is a DR-4 retina.

II. LITERATURE SURVEY

The prevalence of diabetes has risen enormously worldwide in recent years, with evidence stating that the increase from 9.3% (463 million) in 2019 to 10.2% (578 million) by VOLUME XX, 2017 2030 and 10.9% (700 million)by 2045 [1]. Related medical costs also increased by 316% in the past 15 years to a whopping 966 billion dollars [2]. Diabetes is a common reason for numerous debilitating diseases such as blindness, heart attacks, and kidney disease [3]. It strikes about 30 to 40% of diabetic patients worldwide and affects more than 100 million DR individuals [6]. It becomes more frequent in diabetic patients with more than 20 years of diabetes and occurs in 80% of them, and causes 12% of new blind cases, and one of the leading causes of vision loss and blindness among 20 to 74 years-old individuals [7].By 2040, IDF Diabetes Atlas predicts that one third of diabetic patients will have DR [8]. DR patients will be growing from 126.6 million in 2010 to 191.0 million in 2030 globally, and vision-threatening DR patients will increase if a proper action is not taken [9]. WHO estimates DR to cause 4.8% of cases of blindness globally [10]. For preventing DR complications, early detection of the disease is extremely crucial so that the patient's vision can be conserved efficiently [11]. The physicians currently analyse the fundus photographs of the eyes by hand to determine the severity of DR. These diagnostic procedures, however, are laborious, error-prone, time-consuming, and costly [12]. Further, due to the fact that it requires a lot of time of already busy physicians, the majority of patients do not get timely medical attention, thereby leading to the development of an advanced stage of DR to most cases. Therefore, this is an emergent issue to resolve with a machine-based, precise, economical, and accessible approach for early detection and disease staging [13].Deep learning (DL) and machine learning (ML) techniques have been used to solve this eye condition largely based on the fundus images visually recording the ophthalmic status of one's retina at present. The typical process in DR diagnosis is retinal blood vessel segmentation, lesion segmentation, and DR classification. This classification task is introduced mainly as a binary classification problem (i.e., DR or normal retina) also known as DR detection. The stage grading of DR is to label the infected areas and determine the types of infection: mild, moderate, or severe. This is typically introduced as a multiclass classification problem [14]. Grounded in ML models, various studies have been conducted for DR classification and grading. In [15], authors have proposed the so-called "tetragonal local octa pattern (T-LOP) features", a new feature representation of fundus images. Gayathri et al., [16] employed support vector machine, random forest, and decision tree for DR grading, and Washburn [17] applied Gabor wavelet method with AdaBoost classifier for DR grading. Selvachandran et al., have also recently presented a comprehensive review on DR detection techniques.

DL possesses more advanced architecture such as convolutional neural networks (CNNs) that can extract images' deep and spatial features automatically [18].No explicit feature extraction and feature selection phase is needed with DL algorithms because the techniques can be trained to learn deep representations of images. Xu et al. [19] employed a CNN model and Kaggle Eyepieces dataset for classification of retinal fundus images. Stochastic gradient descent was employed as the optimizer, and data augmentation methods such as image resizing, rotation, flipping, shearing, and translation were applied to augment the diversity of the images. The data set was split into training and test sets and comprised 800 and 200 images, respectively. Kazakh-British et al., [20] employed an anisotropic diffusion filter and a simple CNN model and utilized them for the classification of DR. Using the same procedure of developing basic DL models, in [21], authors applied the integration of the CNN models and the Wiener filter and OTSU for segmentation and applied them to carry out binary classification for DR detection. Transfer learning has been applied to make use of the retrained deep model to improve feature extraction. In [22], Rego applied InceptionV3 for DR detection from RGB and texture features. Pomade et al., [23] proposed binomial and multinomial classification of fundus images with MobileNetV2, Saranya et al. [24] implemented Dense Net 121 model for detecting DR from fundus images, and various architectures of Efficient Net were implemented and tried in [25].Hybrid models were proposed in some studies by using DL model for feature extraction and regular ML model for classification. For example, Boral and Throat [26] used InceptionV3 for learning representation and support vector machine for DR classification. Ensemble models or Hybrid CNN architecture are widely used techniques to develop accurate and robust classifiers. Jiang et al. [27] proposed an ensemble model for DR diagnosis. The ensemble utilized three models of CNN. In addition, Ad boost was utilized for robust Combination of DL models' output with weights acquired through learning. Image pre-processing operations were resizing (i.e., 520, 520, 3), rotation, translation, mirroring, contrast, sharpness, and brightness. Kaushik et al., in [28], developed a stacking ensemble model of three CNN models to predict DR. Zhang et al.,[29] developed an ensemble of three CNN architectures (i.e., InceptionV3, Exception, and InceptionResNetV2) for DR detection and an ensemble of ResNet50 + DenseNet169 + DenseNet201 for DR grading. This study has taken into account a series of pre-process steps to enhance the image quality. Contrary to this, Bellemo et al., [30] suggested an ensemble of VGGNet + ResNet, and Xie et al., [31] suggested an ensemble of VGGNet + ResNet + DenseNet for DR grading without carrying out any pre-processing procedures.

DR is graded into five grades based on the International Clinical Diabetic Retinopathy (ICDR) scale [32]: no retinopathy is visible, mild no proliferative diabetic retinopathy (NPDR), moderate NPDR, severe NPDR, and proliferative DR (PDR) [33]. Figure 1 presents visual examples of comparison between the normal retina and retina due to diabetic retinopathy, with an amount of lesions. In [34], basic CNN model has been studied to grade DR following application of a green channel filter on fundus images. Luo et al., [35] proposed MVDRNet using a VGG-16 model and attention mechanisms. The research used a dataset of multi-view fundus images. Araujo et al, [36] proposed a CNN model cased GRADUATE. It was a uncertainty-aware DL model that could give a pathologically explainable description to rationalize its judgments. Gayathri et al., proposed hybrid multipath CNN model for DR grading and integrate the features extractor with three different ML classifiers such as random forest, SVM, and J48. Shaik and Cherukuri [37] proposed "Hinge Attention Network (HA-Net)" incorporating VGG-16 as spatial representation learner and multi-stage attentions for DR severity grading. Li et al. [38] proposed a semi-supervised auto-encoder graph network (SAGN) wherein auto encoder was utilized to learn features, radial bases function was utilized to estimate correlations among neighbours, and graph CNN was utilized to classify DR. Wang et al. [39]

III. MATERIALS AND METHODS

I. Data Description

Quality and availability of training data represent major barriers to building DR computer-aided diagnosis systems. While some public DR databases are available, none of them have pixel-level lesion masks as detailed annotations but image-level labels only, and they might be unreliable. In order to address such shortcomings, you would require datasets containing pixel-level lesion masks and image-level severity grading. Out of the available datasets, only the fine-grained annotated diabetic retinopathy FGADR and IDRiD datasets possess them. Though possessing just 81 lesion images segmented, the IDRiD dataset lacks an adequate dataset with our required purpose. Therefore, the FGADR dataset of six segmented lesions in 1,842 images is considered most suitable. Pixel-level lesion annotation and image-level grading labels constitute the FGADR dataset.

A. Proposed ViT Frameworks

Here, we present the envisioned ViT architecture to grade DR. The envisioned architecture consists of the four important steps of (1) image augmentation, (2) image normalization, (3) splitting data, (4) balancing data, and (5) training and validation of the ViT model..

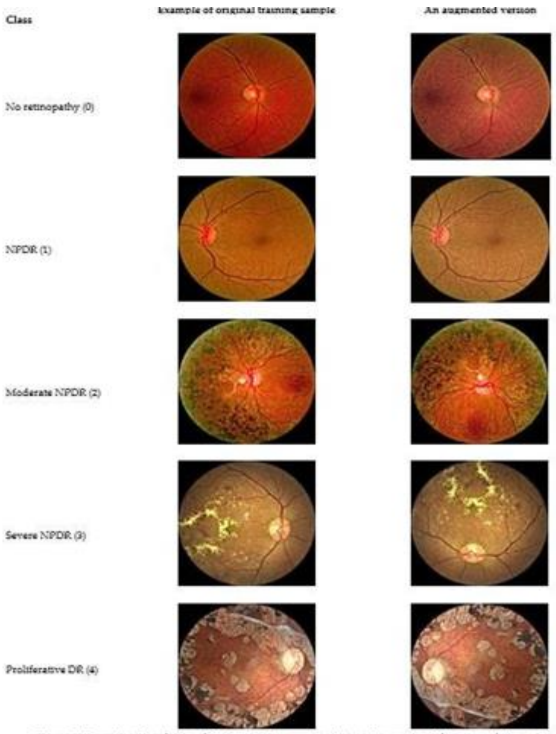


Figure 2: Examples from train set for images from every class and example of its augmented version.

B. Performance Evaluation

Four default measures were employed to assess the obtained classifiers such as accuracy, balanced accuracy, specificity, precision, recall, AUC, and F1-score, with TP as the true positive, TN as the true negative, FP as the false positive, FN as the false negative, and TPR (true positive rate) = TP/(TP+FN)

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}$$

$$\text{Precision} = \text{TP}/(\text{TP} + \text{FP})$$

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

$$\text{F1} - \text{Score} = \frac{2 * \text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}}$$

$$\text{Specificity (true negative rate)} = \frac{TN}{TN + FP}$$

$$\text{Balanced accuracy} = \frac{TPR + TNR}{2}$$

$$\text{AUC} = \frac{TP}{2 * (TP + FN)} + \frac{TN}{2 * (FP + TN)}$$

IV. FURTHER WORKS TO BE CARRIED OUT

1. Integration of Clinical Metadata: Integrate patient data (e.g., age, blood glucose, diabetes duration) with image characteristics to improve diagnostic accuracy.

2. Explainable AI Deployment: Incorporate attention visualization tools (e.g., Grad-CAM, Attention Rollout) in a way to provide explainable responses and create clinician trust.
3. Edge and Mobile Deployment: Deploy the ViT model in light, real-time mode on edge or mobile devices to facilitate remote screening in remote areas.
4. Cross-Dataset Validation: Test the generalizability of the model by cross-validation on datasets such as Messidor, DDR, and EyePACS.
5. Multi-Disease Detection Ability: Extend the model for detection of additional retinal diseases such as glaucoma and age-related macular degeneration (AMD) to develop a comprehensive retinal test system.

V. RESULT AND DISCUSSION

True class, label smoothing provides a smoothed label value in the range between 0 and 1. This allows the model to learn more stable and generalizable representations. Different values of label smoothing were tried.

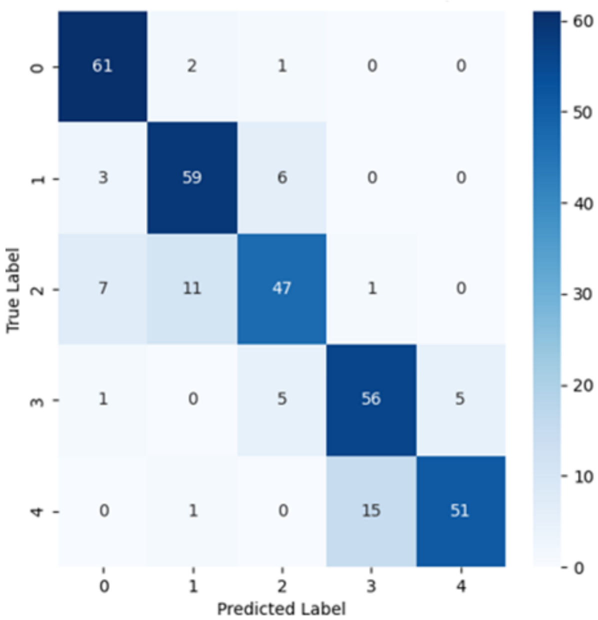


Figure 5: Confusion matrix of proposed ViT model wit finetuned class weights on the test dataset.

When label smoothing was used with a value of 0.1, the best F1-score achieved in this experiment was 0.738. This was less than the best score achieved in experiment 1, where label smoothing was used with a value of 0.2. Other experiments conducted before this experiment did not do better than the best score achieved in experiment 1, where F1 score was 0.804. Therefore, in other experiments, other techniques were used to counter class imbalance in the FGADR dataset, as illustrated in Table 1. This class imbalance is not desirable during training since the model can be biased towards the majority classes and have difficulties in making accurate predictions of the minority classes. Additionally, we modified the training process with the objective of maximizing validation sets' F1 score, instead of minimizing validation loss in other experiments.

A.Experiment 3: Class weight to balance the dataset Class weighting is one of the methods to handle class imbalance. Class weights provide different weights to each class depending upon their frequency in the dataset. By giving more weights to the minority class and less weights to the majority class, the model is motivated to focus more on the minority class during training, thereby reducing the effect of class imbalance. Manual weights were attempted first that assign each class a weight value in between 1 and 2. The best performance was obtained by using a manually fine-tuned version of the automatic weights which obtained F1-score of 0.825 which was better than the best reported performance (i.e., 0.81 F1-Score), as can be observed from Table 8.

Two manual weight tuning experiments (i.e., class weights of 1 and 2) yielded F1-Scores of 0.783 and 0.765, respectively. But automatic weights performed better than them.

Automatic weights were found from the count of samples of each class (i.e., 3.64, 1.73, 0.62, 0.57, 1.28) and performed exactly the same as the manual weights in F1-Score. These were adjusted to weight more towards minority classes during training. One such attempt (weights: 3.64, 1.73, 0.91, 0.86, 1.28) bested the optimum F1-Score obtained during experiment 1 (F1-Score = 0.804) as well as accuracy attained in [12] (accuracy = 0.810). The ViT model with such weights has shown its confusion matrix in Figure 5.

VI. CONCLUSION

In this study, we explored the problem of automatic DR severity stage detection from fundus images. We proposed a vision transformer deep learning pipeline to model the long-range dependencies in the images. The study employed the transfer learning method to train an extensive vision model on a rather small dataset. For experimentation purposes, the model has been pre-trained on the new real FGADR dataset. We validated the performance of the proposed model on the original unbalanced data. We then enhanced the model's performance with the data collection method and algorithm-based balancing techniques. The proposed model based on the ViT method produced better results compared to the other baseline ViT and CNN state-of-the-art models. In conclusion, this study examined (1) the feasibility of learning the spatial long-term dependencies in medical images using transformers for improving the disease detection performance, (2) the feasibility of balancing techniques of data (i.e., algorithmic and data centric) for training strong and accurate models, (3) the feasibility of hyper parameter tuning to increase the performance of large models using frozen weights of early layers, and (3) the feasibility of using the transfer learning technique to reduce the model optimization procedure. Our proposed model based on the ViT method produced better results compared to the CNN and ViT baseline models (i.e., 0.825, 0.825, 0.826, 0.964, 0.825, 0.825,)and 0.956 for F1-score, accuracy, balanced accuracy, AUC, precision, recall, specificity, respectively). We must investigate the trade-off between the performance of the model and its complexity. In the future, we will investigate the contribution of model complexity to enhance the results. This will involve testing ViT architectures in different experimental settings and with different datasets. We will investigate other approaches to compress transformers and build light models. We will enhance the robustness of the model by testing its performance with external validation and measuring its uncertainty. We will investigate the performance of ViT for different numbers of layers and heads.

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Survey on Agriboost: Crop Cultivation and Care

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ABSTRACT

It explains how the ML algorithms can be applied in agriculture to predict soil fertility and optimize crop yield. Machine learning (ML) models are trained to accurately predict soil nutrient status, pH, and organic matter content for a variety of geographic locations and land categories based on analysis of large data sets such as soil samples, environmental parameters, and agronomic management. Soil fertility is the primary factor determining whether a crop can or cannot be cultivated on a particular kind of soil. Whenever the farmers are faced with a lot of possibilities, it becomes difficult for them to decide what crop to utilize. We have made this project to suit that particular problem. It is necessary that we give the data of soil because it will make a big difference in deciding on the fertility of the soil. The model's accuracy and performance may decline if the data are not provided discretely. The character of the data set reveals that the result is a binary value, i.e., "Fertile" or "Non-Fertile", and the percentage accuracy of each algorithm. Objective: The entire intention of this paper is to determine whether the soil is fertile or not based on the soil properties like N, P, K, Ph, nutrient content, moisture level, temp, rain, and topography. Material/Method: We have made use of the Kaggle data where N, P, K, and pH are used to feed into the model and ML determines whether it is fertile or not. In this paper, four machine learning classifiers are trained, and determine the best classifier based on the performance metrics

Keywords: soil data; soil analysis; soil constituents; machine learning; performance analysis

I. INTRODUCTION

In Recent years have seen the revolutionary transformation in agriculture due to technological advancements and data analysis. A key indicator of most parameters of agriculture, i.e., soil fertility is machine learning (ML) among various others. It is a very intricate interaction of a wide array of physical, chemical, and biological parameters of the soil environment that regulates the fertility of soil, and it has a tremendous impact on agricultural productivity. An accurate estimation of soil fertility must be conducted for the improvement in agricultural activity, boost in plant yield, and ensure soil management in the long term. Large-scale agriculture activities would maybe not be capable of extending and implementing conventional means of soil fertility determination since they are laboratory-based and lengthy laboratory experiments. Additionally, such far-reaching methods tend to cancel out the precision of quantification of temporal and spatial variability of the soil parameters. Environmental drivers, and agronomic management, with big datasets of soil samples, machine learning approaches, nonetheless, provide a reliable alternative. Machine learning models may be employed to build predictive models with the capability to accurately and effectively estimate soil fertility. The main goal of this paper is to determine if machine learning methods may successfully predict soil fertility using multiple soil properties and environmental characteristics. Our goal is to develop solid predictive models that can well estimate soil nutrient concentrations, pH, organic matter.

II. LITERATURE REVIEW:

Several papers have been undergone the soil fertility identification process via identification of the soil constituents.

The research in ref. [1] had given a Random Forest classifier because it produced the best outcome or greater accuracy compared to other classifiers as a result of the data set. The primary objective of this was to create a stable model which gives a high rate of accuracy to achieve the desired type of soil when various types of soil are taken into account for cultivating a specific crop and also to assist farmers to achieve the maximum using that soil. In [2] Random Forest achieved the highest accuracy, i.e., nearly 100% accuracy, compared to other models such as neural networks, SVM, and naïve Bayes based on the provided dataset, which is divided into three, i.e., crop dataset, soil dataset, and yield dataset, wherein are N, P, and K values primarily for measuring the accuracy. The Random Forest classifier used here was a fine model for the given data set, but is not necessarily so in other data sets with larger sample sizes; then the use of neural networks could be applied, and with some adjustment to hyper parameters to provide a better accuracy score. The algorithms used were Random Forest (RF), support vector machine (SVM), ANN, K-NN, and some regression-based models. [3] The purpose of the above machine learning model was soil property prediction like chemical properties and nutrients and then give fertilizer recommendation using the ML algorithm. Accuracy between 85% to 91%, since SVM, RF, and ANN used high precisions, and they can be performed better using algorithms specifically, since other different algorithms were used. And performance assessment also needs to be targeted. To overcome the poor accuracy of traditional models, the paper constructed a new prediction model based on big data statistics and near infrared (NIR) spectrum and achieved three times improved accuracy.[4] There was still scope for enhancement by incorporation of extrinsic variables during data collection and enhancing geographic fit. The aim of the study was to develop a strong model of forecasting soil nutrient concentration using employment of the enhanced genetic algorithm (IGA) with back-propagation (BP) neural network models.[5].Enhanced methodology achieved greater precision in estimation of soil nutrients with coefficients of determination (R2) of more than 0.88 for the different nutrients. But, improvement can also be made by using newest techniques, such as convolutional neural networks (CNNs), to enhance the predictive power of the model.[6]. It developed prediction models for soil nitrogen phosphorus, and potassium from hyper spectral data and algorithms such as PLS, SVR, Si-PLS, and Si-SVR. The Si-SVR model performed best with RPD values greater than over 2.0 for every nutrient, i.e., 2.86 in nitrogen predict, but there will be improvement including soil pH level, texture, and percentage of organic content. [7] described how machine learning can provide suggestions for the crop. The authors also advocated the use of IoT-based analysis of soil's nutrients. They harvest the information from various sources. The paper in ref. [8] described how the use of machine learning and deep learning makes their task easy while working on the soil fertility. They utilized both ML and Dl classifiers and obtained that NB and CNN were superior, i.e., 99% and 87%. ref. [9] used machine learning classifiers as well as data mining to illustrate soil fertility management. Bayesian accuracy 0.87 classification was obtained by them. The study in ref. [10] presented the use of ML classifiers for classifying soil fertility 0 and suggesting the crop. They used a lot of classifiers such as KNN, RF, NB, Lasso, Ridge, etc. KNN and RF gave 83% and 82% accuracy rates. The work in ref. [11] utilized ANN methodologies for soil fertility management. They had estimated performance measures like MSE and R2. Their testing accuracy and training accuracy were 0.96 both. The work in ref. [12] introduced the SMOTE approach to crop suggestion. They utilized before SMOTE and after SMOTE to check whether there is any possibility of enhanced accuracy or not. They also explained in the paper through which methods soil fertility can be regulated, but they discussed primarily the recommendation scheme. The paper in ref. [13] discussed in detail the regression method, and also conducted the hypothetical test for predicting soil organic. They employed machine learning regression classifiers like LR, ENT, MLR, Ridge, Lasso, etc., and RF was found to perform well and was approximately 0.74 R-square.

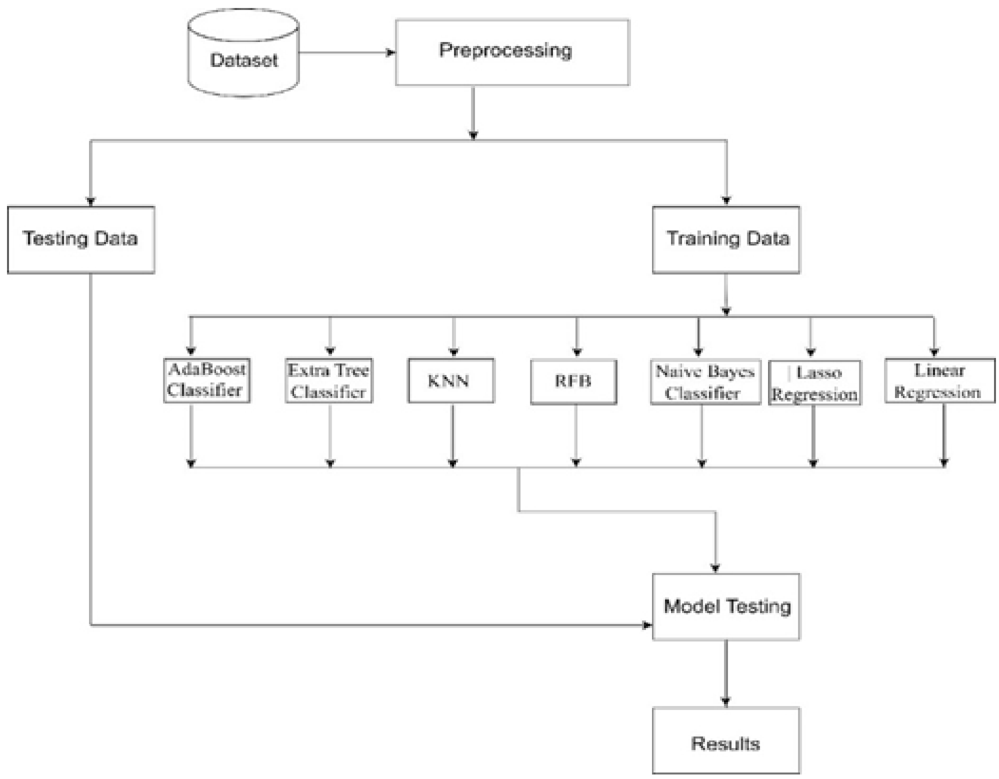

Figure 1. Rough sketch of soil fertility management.

The above flowchart works as follows:

1. **Dataset**
   - It is the raw data that is initially collected from agriculture fields.
   - It has features such as soil nutrients, crop type, environmental conditions, and perhaps pest or damage information.
2. **Pre-processing**
   - Data cleaning and transformation are performed here.
   - Operations include missing values handling, encoding categorical variables, normalization/scaling, and feature selection.
3. **Data Splitting**
   - The pre-processed data is divided into:
   - Training Data: For training machine learning models.
   - Testing Data: Used to test the performance of the trained models.
4. **Model Training**
   - Multiple machine learning algorithms are applied on the training data, including:
   - AdaBoost Classifier
   - Extra Trees Classifier
   - K-Nearest Neighbors (KNN)
   - Random Forest (RFB)
   - Naive Bayes Classifier
   - Lasso Regression
   - Linear Regression

III. ALGORITHM:

Table 2 presents the analysis of the classification models. Here, we portrayed the performance matrix of accuracy precision and recall values of each algorithm used in the model before implementing the SMOTE technique. The table below demonstrates the tabular results of the classifier.

Table 2. Performance metrics of different classifiers.

Algorithms	Accuracy	Precision	Recall
Logistic Regression	0.83	0.90	0.83
KNN	0.88	0.90	0.88
NB	0.77	0.89	0.77
Decision Tree	0.89	0.89	0.88

How do various machine learning classifiers operate for soil fertility according to various performance measures (particularly accuracy, precision, and recall)? How do you gauge and influence the performances of all machine learning classifier training sets for soil fertility seen within the learning curve? Solution to the research question: The aforementioned research question can be solved through the use of the learning curve. It explains the performance of every machine learning classifier training data. It receives the training and cross-validation scores versus each training sample. Plots represent the learning curves that reflect the learning in the training of a machine learning model. We have plotted the graph and illustrated the classifiers' performances. We have taken the measurements of the training score as well as cross-validation scores to get the progress of the classifiers.

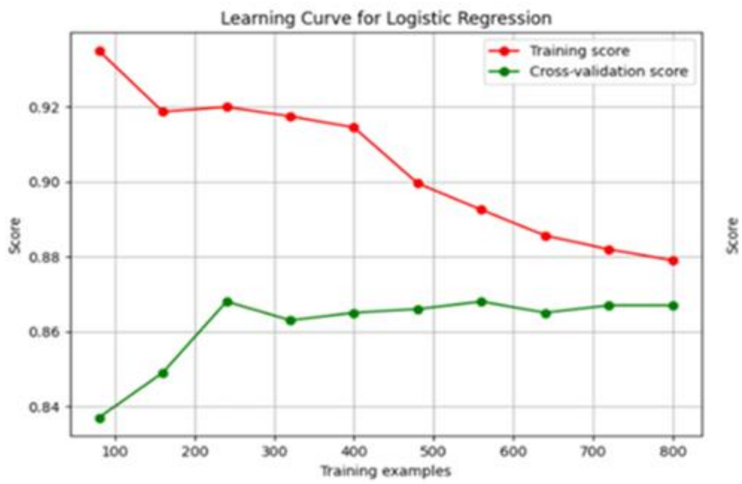

Figure 2: learning Curve for Logistic Regression

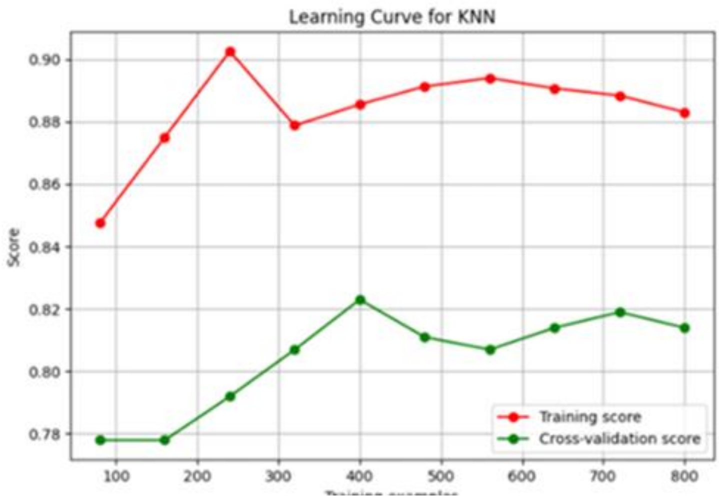

Figure 3: learning Curve for KNN

Which algorithm works well for soil fertility: Above we discussed how the performance of various classifiers compares. We have made a rigorous comparison of the performance measures and illustrated which one works well.

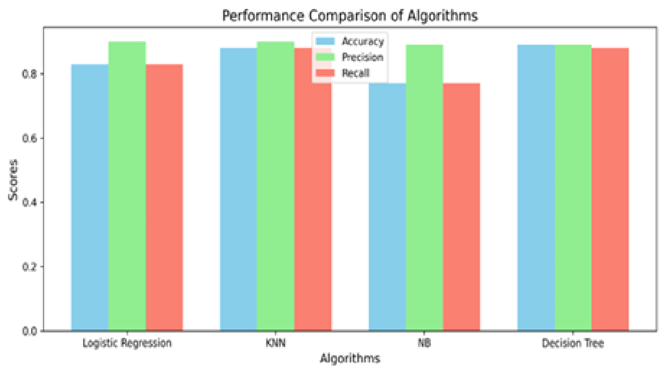

Figure 4: Algorithm performances

IV. CHALLENGES AND FUTURE:

This study highlights how machine learning (ML) can transform agricultural science, specifically in the crop management and soil fertility prediction areas. Machine learning (ML) algorithms provide accurate and scalable solutions for analysing soil health and predicting crop yield ,and optimizing farm operations based on large-scale data and sophisticated analysis tools .The research shows that in crop yield prediction assignments, ensemble techniques like AdaBoost and Extra Tree Classifier outperform conventional linear regression models ,illustrating the efficacy of nonlinear modelling methods in modelling intricate interactions evident in agricultural systems. Agricultural productivity, sustainability, and adaptability to emerging challenges are heavily influenced by these findings. ML to drive agricultural science and global food security, future research needs to focus on enhancing ML algorithms, incorporating real-time sensing technologies, and addressing data quality and interpretability issues. Overall, this study contributes to ongoing efforts to address pressing agricultural issues and pave the way for a more sustainable and resilient food system by leveraging technology-based solutions.

Increased Crop Yields: Optimization of fertilizer application and increased resource allocation.

Environmental Benefits: Reduced pollution and increased sustainable agriculture.

Economic Benefits: Increased farmer profitability and the agricultural industry.

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Survey On: Smart Eye: Intelligent Eye Diagnostics and Teleconsultation System

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ABSTRACT

This Smart Eye is an AI-powered eye diagnostics and teleconsultation framework outlined to improve early location and administration of vision-related disarranges such as diabetic retinopathy, cataracts, and glaucoma. By combining profound learning calculations with retinal picture investigation, the framework robotizes preparatory screening and gives precise, real-time appraisals of eye wellbeing. Coordinates with a secure telemedicine stage, Smart Eye empowers patients especially in inaccessible or underserved areas to transfer eye pictures, get

I. INTRODUCTION

The field of ophthalmology plays a crucial part in healthcare, as vision is one of the foremost fundamental faculties for keeping up quality of life. Universally, millions endure from preventable or treatable eye infections such as cataracts, glaucoma, diabetic retinopathy, and macular degeneration. Opportune conclusion and intercession can essentially decrease the burden of visual disability and visual impairment. In any case, constrained get to specialized eye care especially in country and underserved areas presents a critical challenge to viable conclusion and treatment. The later headway in manufactured insights (AI), computer vision, and telemedicine has opened modern conceivable outcomes for upgrading eye healthcare conveyance. Shrewdly frameworks that can help in early determination, chance evaluation, and farther meeting have the potential to revolutionize conventional ophthalmic hones. Spurred by this opportunity, this extend proposes "Smart Eye" an brilliantly eye diagnostics and teleconsultation framework planned to bridge the hole between patients and ophthalmologists by Manufactured insights (AI) has progressively ended up a transformative drive in therapeutic diagnostics, especially in ophthalmology. Profound learning calculations, particularly convolutional neural systems (CNNs), have demonstrated exceedingly viable in analysing retinal fundus pictures to distinguish eye infections. Ground breaking work by Goshen et al. (2016) illustrated that AI may coordinate or outperform human masters in recognizing diabetic retinopathy from fundus photos. Ting et al. (2017) extended this application to other eye conditions such as glaucoma and age-related macular degeneration, strengthening the unwavering quality and versatility of AI models in ophthalmic diagnostics. These improvements recommend that AI can essentially progress the precision, effectiveness, and availability of eye malady screening.

In the meantime, telemedicine has developed as a key enabler in bridging the crevice between patients and healthcare suppliers, particularly in districts with restricted get to pros. Teleophthalmology— the farther conclusion and administration of eye conditions utilizing advanced tools— has been effectively sent in numerous healthcare frameworks. Stages like Eye PACS within the Joined together States and different versatile screening programs in nations like India have demonstrated viable in coming to underserved populaces. These frameworks ordinarily take after a store-and-forward show, where quiet information is captured locally and afterward looked into by pros. In any case, numerous such stages still depend on manual determination, which can constrain versatility and delay treatment proposals. In spite of the fact that both AI-based diagnostics and teleophthalmology have appeared gigantic potential, few frameworks have effectively coordinates both into a consistent, shrewdly arrangement. Current devices regularly work in separation, either performing robotized screening or encouraging inaccessible consultations but not both.

II. THEORETICAL FOUNDATION:

1. Counterfeit Insights and Machine Learning:

At the centre of Smart Eye lies fake insights, particularly machine learning (ML) and profound learning (DL). The venture utilizes directed learning methods, where calculations are prepared on labelled datasets of retinal pictures to memorize designs related with different eye illnesses.

2. Computer Vision and Picture Preparing:

Computer vision hypothesis gives the specialized establishment for picture procurement, improvement, and highlight extraction. Methods such as histogram equalization, edge discovery, and division offer assistance pre-process fundus or retinal pictures to move forward their quality and highlight disease-related highlights.

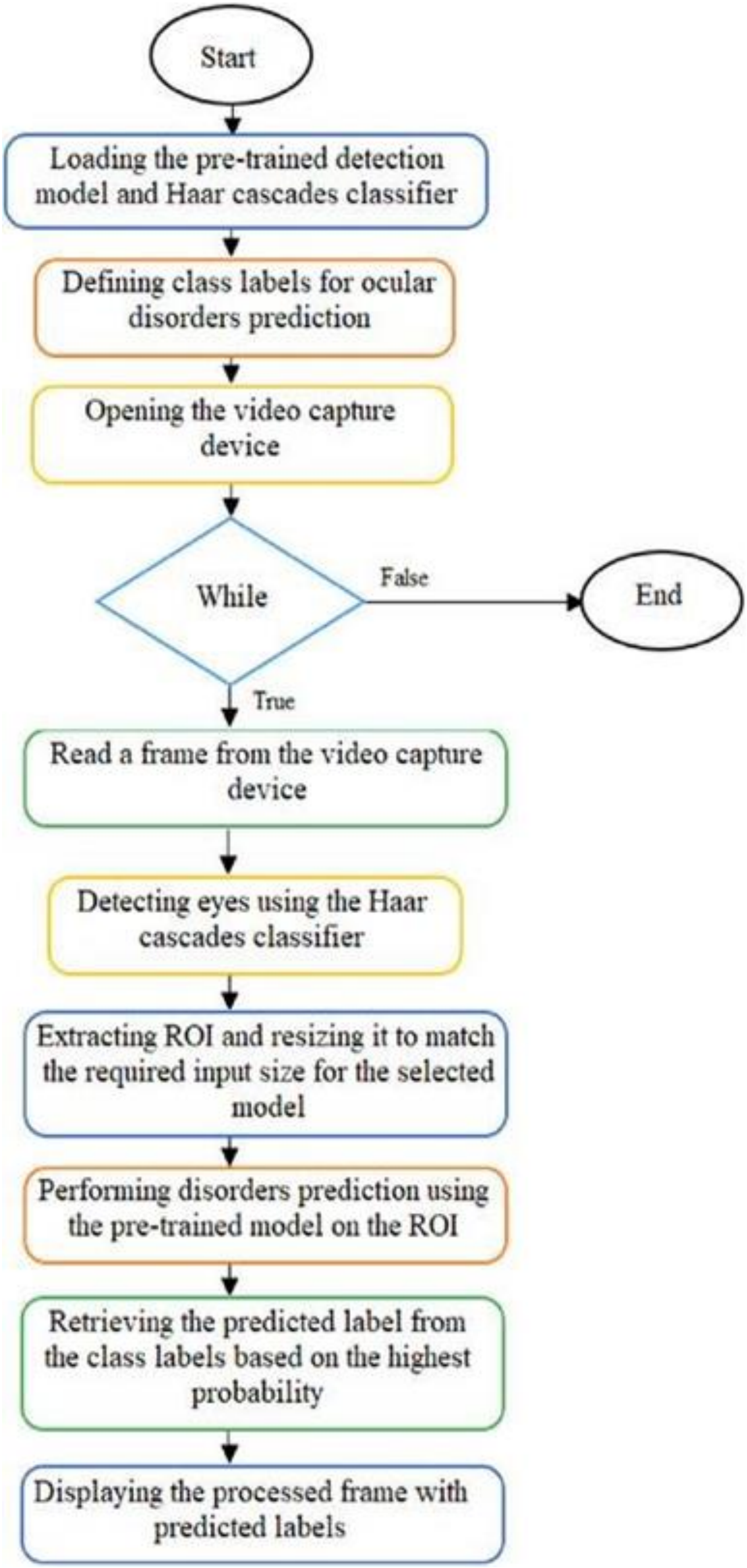
3. Telemedicine and Healthcare Conveyance Models:

Smart Eye coordinating standards from telemedicine, especially the store-and- forward show, which empowers offbeat communication between patients and ophthalmologists. It too joins synchronous teleconsultation, permitting genuine- time interaction by means of video conferencing when required.

4. Human-Computer Interaction (HCI) and Ease of use:

Another hypothetical column is human-computer interaction (HCI), which advises the plan of user-friendly interfacing for both patients and clinicians. Standards of convenience, openness, and client encounter (UX) are connected to guarantee that Smart Eye can be successfully utilized by people with changing levels of computerized proficiency, counting in low-resource settings.

In quintessence, the hypothetical establishment of Smart Eye is built upon the meeting of AI calculations, computer vision procedures, secure telemedicine systems, and user-cantered plan standards. These speculations collectively empower the framework to supply precise diagnostics, enhance remote get to care, and advance versatile, cost-effective eye healthcare conveyance.


Start
Loading the pre-trained detection model and Haar cascades classifier
Defining class labels for ocular disorders prediction
Opening the video capture device
While
False
End
True
Read a frame from the video capture device
Detecting eyes using the Haar cascades classifier
Extracting ROI and resizing it to match the required input size for the selected model
Performing disorders prediction using the pre-trained model on the ROI
Retrieving the predicted label from the class labels based on the highest probability
Displaying the processed frame with predicted labels

III. COMPARATIVE ANALYSIS:

System / Study	Diagnostic Accuracy	Disease Coverage	Teleconsultation Support	Scalability	Limitations
Google ARIA	High	Diabetic Retinopathy	Limited (triage only)	Cloud-based	Focused on DR only; proprietary platform
EyeArt (Eyenuk)	Very High (FDA approved)	Diabetic Retinopathy	No	Moderate	Single disease focus; expensive setup
DeepDR (China)	High	DR, AMD, Glaucoma	No	Regional trials	No telemedicine; limited deployment
EyePACS	High (with experts)	DR (manual review by doctors)	Yes (store-and-forward)	Scalable (U.S.)	Relies on human interpretation; slower feedback
Microsoft AI Network	Moderate to High	DR, Cataract (India pilot)	Yes	Developing	Model performance varies across sites
SmartEye (Proposed System)	Target: High	DR, Glaucoma, Cataract	Yes (live & async)	High (web/mobile)	Requires robust validation; currently in dev

IV. OPEN CHALLENGES :

1. Information Quality and Accessibility AI-based diagnostics depend intensely on expansive, assorted, and well-annotated datasets. In any case, there's a deficiency of freely accessible datasets that incorporate a wide assortment of retinal infections, socioeconomics, and imaging conditions. In addition, conflicting labelling over datasets can influence demonstrate generalizability and reasonableness.
2. Multi-Disease Symptomatic Precision Whereas profound learning models have accomplished tall precision in identifying diabetic retinopathy, execution for other conditions such as glaucoma, cataracts, and macular degeneration is still conflicting. These infections regularly require distinctive symptomatic prompts, making it challenging to construct a bound together show with rise to exactness over conditions.
3. Restricted Clinical Approval Numerous AI-based symptomatic apparatuses have appeared promising comes about in inquire about situations but need broad clinical approval or administrative endorsement. Without thorough approval in assorted clinical settings, the unwavering quality and selection of frameworks like Smart Eye may be constrained

V. FUTURE DIRECTIONS:

1. Advancement of Combined Learning Models To overcome information security concerns whereas moving forward symptomatic models, unified learning permits AI frameworks to be prepared over numerous decentralized gadgets without exchanging persistent information. This approach improves both security and execution.
2. Development to Other Visual and Systemic Illnesses Future adaptations of Smart Eye may be expanded to identify extra conditions such as hypertensive retinopathy, retinal vein impediment, and neurological pointers seen in eye filters (e.g., for Alzheimer's or stroke).

3. Integration with Electronic Wellbeing Records (EHRs) Smart Eye may well be coordinates with national or neighbourhood electronic wellbeing frameworks to make a consistent stream of data, encouraging way better decision-making, referrals, and treatment follow-ups.
4. AI Explain ability and Clinician Believe Creating interpretable AI models that highlight infection highlights (e.g., through heat maps or saliency maps) will improve clinician believe and back cross breed decision-making between human specialists and machines.

VI. CONCLUSION:

The rapid evolution of artificial intelligence and telemedicine has created powerful opportunities to transform modern eye care. This survey explored the landscape of intelligent diagnostic systems, teleophthalmology platforms, and integrated solutions, highlighting both advancements and persistent gaps. A comparative analysis revealed that while individual tools offer high diagnostic accuracy or remote consultation features, very few systems combine both into a cohesive, scalable platform.

Smart Eye is proposed as a next-generation solution designed to address this unmet need. By leveraging deep learning for multi-disease detection and integrating synchronous and asynchronous-teleconsultation capabilities, Smart Eye has the potential to enhance accessibility, reduce diagnostic delays, and improve eye health outcomes especially in underserved areas. The survey also identified key challenges, including the need for larger annotated datasets, clinical validation, regulatory compliance, and infrastructure support. In summary, this survey contributes by presenting a clear taxonomy of existing systems, highlighting critical gaps, and proposing future directions for research and deployment. Smart Eye represents a promising step toward intelligent, inclusive, and scalable eye care.

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Survey on Smart Outfit Recommender System Using Image Processing and Deep Learning Architectures

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ABSTRACT

A Survey on Fashion Outfit Recommendation Systems: Trends, Techniques, and Challenges
Abstract—Fashion outfit recommendation has become an integral part of personalized e-commerce platforms, aiming to suggest visually appealing and contextually appropriate combinations of clothing items. This paper surveys recent advancements in deep learning-based outfit recommendation systems, comparing key methods, contributions, and their real-world impact.
We highlight emerging trends, challenges, and propose future research directions, with special attention to style-awareness, personalization, and generation models.

I. INTRODUCTION

In Fashion outfit recommendation systems have become increasingly significant in the era of personalized e-commerce, addressing the common challenge of helping users choose visually appealing and contextually appropriate clothing combinations. Unlike traditional recommendation engines that suggest individual items, outfit recommendation systems aim to generate or recommend entire sets of garments—such as tops, bottoms, and shoes—that are not only compatible but also tailored to users' unique fashion preferences. The task is inherently complex, as fashion is influenced by subjective elements like personal style, cultural trends, seasons, and occasions. Early approaches relied heavily on collaborative filtering and handcrafted features, which lacked the ability to understand visual aesthetics or user intent effectively.
With the advent of deep learning, particularly convolutional neural networks (CNNs), recurrent neural networks (RNNs), and attention mechanisms, modern systems are capable of learning nuanced visual compatibility and extracting style representations from large-scale fashion datasets. These models often incorporate multimodal data—images, text descriptions, and user interactions—to enhance recommendation quality. Furthermore, generative models and style transfer networks have opened new

possibilities in personalized outfit creation. This survey paper presents a comprehensive overview of recent advancements in fashion outfit recommendation, analysing key methods, datasets, evaluation metrics, and identifying open challenges and future directions in this rapidly evolving field.

II. LITERATURE REVIEW:

Fashion outfit recommendation has evolved from traditional item-based systems to complex, multimodal architectures that consider compatibility, user preferences, and stylistic coherence. Early methods primarily used content-based filtering and collaborative filtering techniques, focusing on individual item preferences. However, these lacked the ability to model the nuanced compatibility required when recommending outfit sets consisting of tops, bottoms, shoes, and accessories.

Recent developments in deep learning have enabled significant progress. Fashion Net (He et al., 2018) introduced a pioneering approach by combining convolutional neural networks (CNNs) for visual feature extraction and fully connected layers for modelling outfit compatibility. It further incorporated personalization using a two-stage training strategy: general model training followed by user-specific fine-tuning.

Nakamura and Go to (2018) proposed a hybrid model utilizing Bidirectional LSTM and Auto encoders, capable of learning sequential compatibility and extracting interpretable style representations. This approach treated outfits as sequences and allowed the generation of style-controlled outfits, marking a shift towards generative outfit modelling.

To improve interaction between modalities, Fashion BERT (Gao et al., 2020) extended the BERT architecture to handle both text and image embedding's for fashion retrieval. It introduced an adaptive multitask loss combining masked language modelling , patch modelling , and alignment tasks. By replacing traditional Region-of-Interest (RoI) detection with image patches, it addressed the lack of fine-grained visual information typically required for fashion applications.

A unique line of work involves dialogue-based systems, such as Outfit Helper (Zhang & Wang, 2019), which uses NLP tools (Dialog flow) and colour -matching algorithms to provide users with clothing suggestions based on conversational input. Unlike data-driven models, it emphasizes user interactivity and relies on rule-based databases and third-party vision services for outfit evaluation.

In parallel, researchers like Vasileva et al. (2018) explored type-aware embedding's, while Han et al. (2017) employed LSTM-based compatibility modelling . Other models, such as Capsule Wardrobe generation (Hsiao & Grumman, 2018), addressed constraints like versatility and minimalism.

Despite these advances, challenges persist. Many systems struggle to balance interpretability, personalization, and scalability. Furthermore, multimodal reasoning, style transfer, and explain ability remain underexplored. Current literature trends point toward more holistic models that integrate visual, textual, and user-contextual signals, indicating a promising trajectory for future research.

III. ALGORITHM:

Fashion outfit recommendation systems utilize diverse algorithmic architectures depending on their objectives—be it compatibility modelling , personalized ranking, or multimodal retrieval. Below, we outline and compare the key algorithmic frameworks adopted in the field.

1. Convolutional Neural Networks (CNNs): Most fashion recommendation systems begin with visual feature extraction using CNNs (e.g., VGGNet or Reset). For instance, Fashion Net (He et al., 2018) processes item images through CNNs to obtain latent embedding's. These features are then combined—either concatenated or pairwise—to assess compatibility using multi-layer perceptions (MLPs). Fashion Net explored three variants, with Fashion Net C using separate pairwise compatibility models to reduce computational complexity.
2. Sequence Modelling with BiLSTM: Nakamura and Go to (2018) proposed an architecture that treats an outfit as a sequence of items and uses Bidirectional Long Short-Term Memory (BiLSTM) networks to capture item-order dependencies. The compatibility of the entire outfit is modelled by evaluating this sequence bidirectional. An Auto encoder is then employed to learn a low-dimensional, interpretable style vector that governs outfit generation. This enables both recommendation and generative outfit synthesis.
3. Multimodal Transformers: Fashion BERT (Gao et al., 2020) introduces a novel approach by adapting the BERT architecture for fashion. Each image is divided into patches (not RoIs), treated as "visual tokens," and combined with tokenized text descriptions. The sequence is fed into a multimodal

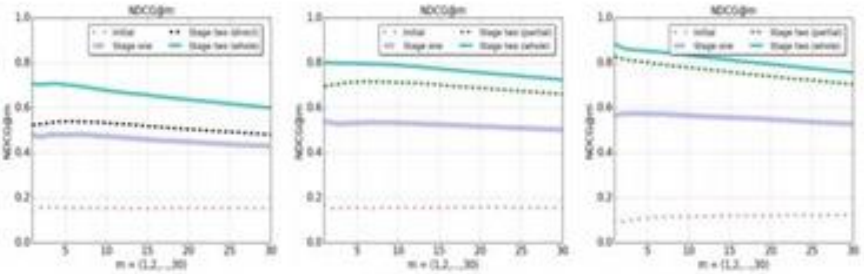
transformer model where text-image interaction is handled through multi-head self-attention layers. The algorithm is trained using a combination of three tasks—Masked Language Modelling (MLM), Masked Patch Modelling (MPM), and Text-Image Alignment (TIA)—weighted dynamically using an adaptive loss strategy.

4. Dialogue-Based Recommendation: Outfit Helper (Zhang & Wang, 2019) represents a rule-based yet interactive system that processes natural language queries via Dialog flow. It connects with Azure Computer Vision to extract dominant colours and uses Many Chat for conversation flows. The algorithm primarily uses decision trees and predefined condition checks to match styles or colour schemes with appropriate outfit suggestions.

Across these systems, common algorithmic components include:

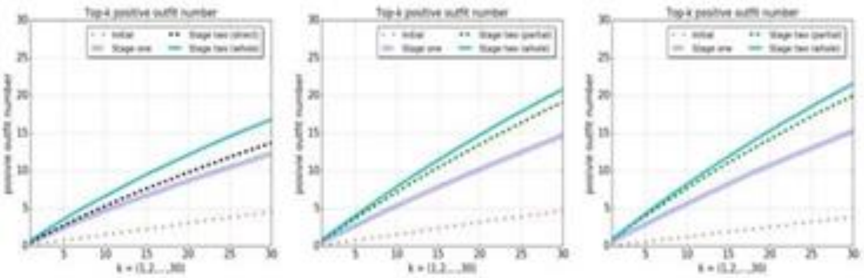
- Feature extraction via CNNs or transformers.
- Compatibility modeling through MLPs, LSTMs, or attention networks.
- Personalization via fine-tuning or user embedding's.
- Optimization using ranking loss, classification loss, or multitask adaptive losses.

The choice of algorithm depends heavily on whether the system is aimed at generation, retrieval, or user interaction, with a growing trend toward hybrid and explainable models.



(a) FashionNet A (b) FashionNet B (c) FashionNet C

Figure 3: The average of NDCG@m over all users.



(a) FashionNet A (b) FashionNet B (c) FashionNet C

Figure 4: The positive outfit numbers in top-k results.

Figure 1. The entire conversational process of Outfit Helper.

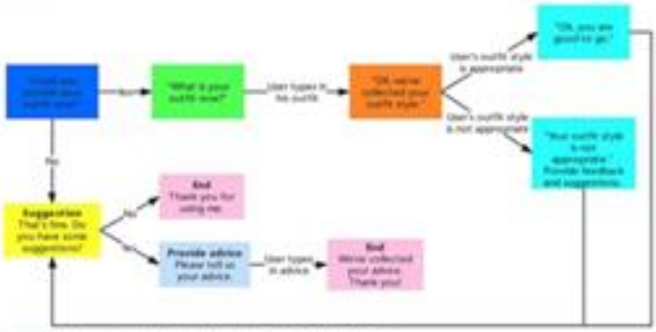


Figure 2. The conversational process of the "style" aspect of Outfit Helper.

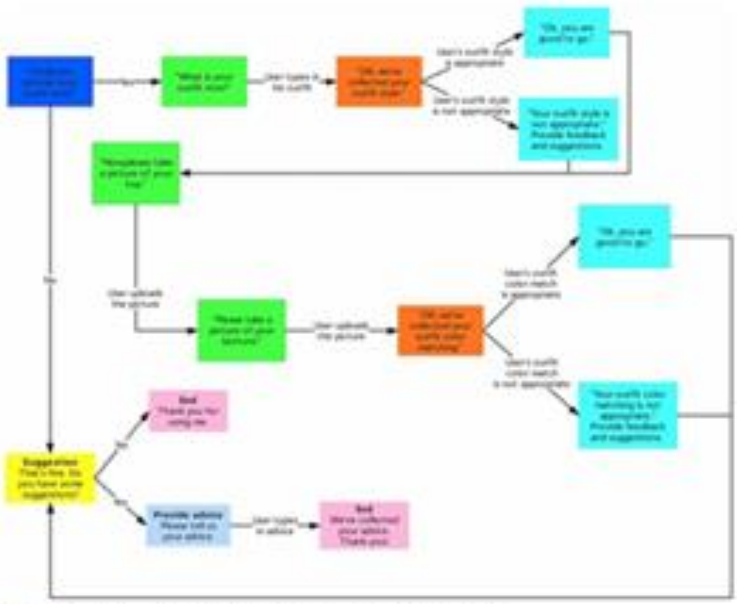


Figure 4. The conversational process of the "both style and color" aspect of Outfit Helper.

Figure 5. The conversational process of the "no idea" aspect of Outfit Helper.

Challenges and future:

Despite significant progress in fashion outfit recommendation systems, several challenges continue to hinder their broader deployment and effectiveness.

1. **Subjective and Dynamic User Preferences:** Fashion choices are highly personal and influenced by cultural, seasonal, and emotional factors. Capturing these subjective elements in static recommendation models remains difficult. While some systems employ fine-tuning for personalization, most fail to adapt in real-time to users' evolving tastes.
2. **Data Sparsely and Cold Start:** Many systems rely on large labelled datasets, such as Polypore or Fashion-Gen. However, the availability of high-quality multimodal data (images with text and metadata) is limited. Cold-start problems—especially for new users or items—are still prevalent in both collaborative filtering and deep learning approaches.
3. **Multimodal Integration:** While models like Fashion BERT attempt to unify textual and visual data, effective fusion of these modalities remains a challenge. Models often struggle to align fine-grained attributes (like “off-shoulder” or “bohemian”) across image and text descriptions. Furthermore, incorporating contextual signals like weather, location, and event type is still underexplored.
4. **Scalability and Efficiency:** Deep learning-based systems, particularly transformer-based models, require extensive computational resources for training and inference. Real-time outfit recommendation on mobile or embedded devices demands lightweight models or clever optimization strategies, which are still in development.
5. **Interpretability and Explain ability:** Users often want to understand why a particular outfit is recommended. Most current systems operate as black boxes and do not provide interpretable explanations. This lack of transparency affects user trust and reduces adoption in practical fashion applications.

Future Directions:

1. **Explainable AI (XAI):** Integrating explainable components, such as attention visualization or rule-based feedback, will enhance user engagement and trust in recommendations.
2. **Reinforcement Learning:** To model long-term user satisfaction, reinforcement learning can be used to dynamically adjust recommendations based on real-time feedback.
3. **Multimodal and Context-Aware Models:** Future systems will need to handle not just images and text, but also contextual metadata such as social trends, location, and temporal signals to provide truly personalized recommendations.
4. **Sustainability and Capsule Wardrobes:** With rising awareness of sustainable fashion, systems that recommend minimal yet versatile clothing combinations (e.g., capsule wardrobes) are gaining interest.
5. **Fairness and Bias Mitigation:** Addressing algorithmic bias in datasets—whether due to gender, ethnicity, or body type—will be critical for inclusive and ethical fashion AI.

Together, these directions aim to make fashion recommendation systems more personal, adaptive, and socially responsible.

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Survey On: Super-Resolution of Video by Implicit Semantic Guidance

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ABSTRACT

Implicit semantic guidance-based video super-resolution is a deep learning technique that enhances low-resolution videos by extracting and leveraging high-level semantic features. By training a neural network to understand and reconstruct these features, the method produces sharper and more natural high-resolution outputs. It effectively preserves semantic details, reduces artefacts, restores missing frames, and removes noise from degraded videos. This makes it highly valuable for applications such as surveillance, video calls, and media entertainment, where visual quality is crucial. To address the challenge of inter-frame information loss and insufficient spatiotemporal modelling in blurry digital videos, a deep learning-based video deploring approach is introduced. Open CV tools are used to implement the video restoration model, offering strong deploring performance and improved noise resistance.

I. INTRODUCTION

In Super resolution of video using implicit semantic guidance is an advanced technique used for enhancing the quality of low-resolution videos using deep learning models. In some technologies such as video surveillance, video conferencing, and entertainment, there must be high-quality videos for correct identification, clear communication, and enjoyable viewing. Low-quality videos tend to be pixelated, blurred, and have other types of artefacts that can reduce their performance. Video super-resolution using implicit semantic guidance addresses these limitations by training a neural network to map low-resolution inputs to high-resolution outputs through learned high-level semantic features. The technique can generate sharper and more realistic images without the compromise of the semantic content of the video. The technique has the capability to enhance the quality of videos to a large extent, and hence it is an active area of research and advancement in the area of video processing and computer vision.

II. LITERATURE SURVEY

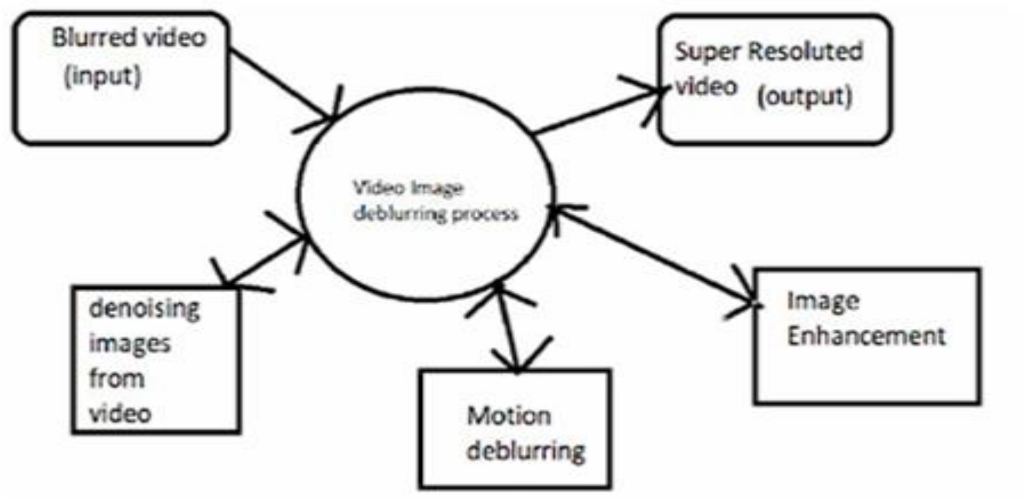
[1]. Abstract: "Fast and robust multi-frame super resolution" is a research paper that proposes a new super-resolution method based on the fusion of multiple low-resolution frames of the same scene into a single high-resolution image. The authors propose a multi-frame super-resolution scheme, which uses a fast and robust method for frame alignment before super-resolution. "Fast and robust multi-frame super resolution" is a research paper that proposes a new super-resolution method based on the fusion of multiple low-resolution frames of the same scene into a single high-resolution image. The authors introduce a multi-frame super-resolution approach that employs a quick and reliable technique for aligning frames prior to applying super-resolution. The developed algorithm also contains an adaptive Wiener filter for noise and other distortions removal which occur during the process of image acquisition. The authors evaluate the performance of the developed algorithm using a set of synthetic and real-world test datasets and compare it with other state-of-the-art super-resolution methods. The experimental results indicate that the new method outperforms other methods [2]. Summary: The paper "Image Super-resolution By TV Regularization and Bergman Iteration" suggests an image super-resolution method based on total variation (TV) regularization and Bergman iteration. TV regularization is utilized to improve image details and Bergman iteration is utilized to solve the optimization problem in an efficient computational manner. The suggested method is tested on simulated as well as real data and the results indicate that the method is comparable with other state-of-the-art super-resolution methods in terms of visual quality and peak signal-to-noise ratio (PSNR). The paper also compares the computational efficiency of the method with other methods. Overall, the paper suggests a promising method for image super-resolution based on TV regularization and Bergman iteration to obtain high-quality results with efficient computation. [3].Summary: The paper "Multiwavelet statistical modelling for image demonising using wavelet transforms" proposes a new algorithm for image demonising based on multiwavelet statistical modelling. The authors propose a new wavelet basis function, the "multiwavelet," which has the potential to improve the efficiency and effectiveness of image demonising. The new approach uses a statistical modelling method to estimate the demonised image wavelet coefficients and subsequent application of a thresholding function to remove the noise. The authors compare the performance of the new algorithm with alternate image demonising algorithms, namely wavelet thresholding and Bayesian wavelet shrinkage, on a set of benchmark images. The experimental performance proves that the new approach performs better than alternate algorithms in peak signal-to-noise ratio, PSNR, and visual quality. The new approach has the potential to be used in a broad range of image processing and computer vision applications, namely medical imaging, surveillance, and remote sensing. [4]. Summary: The paper "Plug-and-Play priors for model based reconstruction" by Venkatakrishnan et al. proposes a new technique for image reconstruction tasks by combining the "plug-and-play" prior framework with traditional model-based approaches. In the technique, a traditional image reconstruction model is complemented by a non-parametric denoiser, which is trained on a large set of other external images. The denoiser is employed as a regularize in an iterative optimisation cycle, wherein it learns to remove image noise and artefacts and preserve meaningful features. The method is applied to a diversity of image reconstruction tasks such as compressed sensing, super resolution, and tomography and is found to surpass existing state-of-the-art methods in terms of accuracy and efficiency. The paper concludes with a discussion of possible applications of this method in a range of domains such as medical imaging and remote sensing. [5]. Summary: The paper "Turning a denoiser into a super resolver using plug and play priors" introduces a technique for employing a denoising algorithm to achieve super-resolution. The technique relies on the

concept of "plug-and-play priors," where a denoiser is employed as a prior within a super-resolution method. The authors demonstrate that the technique can achieve dramatic quality improvement in super-resolution compared to conventional methods They further introduce a novel algorithm referred to as the "plug-and-play supered solution" (PPSR) algorithm.

III. EXISTING SYSTEM

By extracting high-level semantic features from low-resolution input and using them to produce high-resolution output, a deep learning-based technique called "super-resolution of video by implicit semantic guidance" improves low-quality videos. This method uses deep neural networks to learn the relationship between low- and high-resolution images, guaranteeing sharper and more realistic video quality than traditional super-resolution techniques that rely on explicit features like edges and textures, which may not always capture the semantic content effectively. In order to minimize artefacts and restore missing frames, the procedure entails feature extraction, high-resolution reconstruction, and noise reduction. This technique has been used in fields where sharp images are essential, such as entertainment, video conferencing, and surveillance. Video super-resolution has been further improved by recent developments in implicit neural representation, which enhancing consistency between frames by effectively encoding spatial and temporal features without depending on computationally demanding methods like motion estimation or optical flow. This method greatly improves the visual experience and increases the efficiency of video processing by maintaining the integrity of semantic content

IV. PROPOSED SYSTEM



This section explains SR-INR, our suggested technique for super-resolution images and videos. After defining the problem, we go into great detail about each step of our pipeline, including texture encoding, implicit hashing, and top-down attention.

Problem Definition :

A high-resolution grid Ghr. that specifies the locations of the high-resolution pixel coordinates and a batch of low-resolution frames $I_{lr} \in R^{H_{lr} \times W_{lr} \times C}$ are the inputs to SR-INR. The RGB colour value that corresponds to each high-resolution coordinate is the output. This can be expressed mathematically as $I_{hr} = f(I_{lr}, G_{hr})$, (1), where the reconstructed high-resolution image is represented by $I_{hr} \in R^{H_{hr} \times W_{hr} \times C}$.

Texture Encoding :

Using a batch of resolution grids, local patches are first extracted from the low-resolution images to begin the texture encoding process. We use a multi-resolution grid to generate local feature representations, a technique that was inspired by Instant-NGP [41]. In particular, we use the resolution grid to extract multi-scale local patches from the low-resolution frames given a high-resolution pixel coordinate: Pr i = g(Ilr,Gr) where Pr i denotes a local patch at resolution level r that is centred around coordinate i. The resolution grid in Gr. 3.4. Top-Down Attention for Feature Concatenation determines the local patch's size, which is 3. Next, for every one of these multi-resolution patches, we forecast a fixed-length feature code: ˆ Fr i = fr θ(Pr i), (3) where Fr i ∈ R3 is a continuous to the features and fixed lengths.

Implicit Hashing :

We use a spatial hash table to get the implicit feature vectors for a specific coordinate in the 6D latent space. We can quickly retrieve feature codes for nearby coordinates thanks to the hash table's compact storage of trainable feature vectors. We locate nearby locations in the latent space for a given high-resolution coordinate, then utilize the hash table to obtain their feature vectors: {Fr ND } = Hash Table(Fi), where {Fr ND } stands for the feature vectors of the latent space's neighbour boring nodes. Next, we predict weights for combining the nearby features using a network. When we use a 6D code to encode the local features, the coordinates' spatial location is determined by the first three dimensions, and the final three The number of neighbours in the 6D space will be 2D (where D = 6 in our implementation), and dimensions, predicted by fr θ, indicate the coordinates of texture in the implicit texture codebook, which is unknown. The computational burden of directly percolating feature vectors in this high-dimensional space is increased by the feature codebook's unknown nature. In order to solve this, we forecast the weights for every neighbour using a network: Weigh tr N = fH(Fr i,Fr i − Fr i(min),Fr i(max) − Fr i), (6), where Fr i(min) and Fr i(max) stand for the top and bottom boundaries of the high-dimensional vertex, respectively. The weighted sum of the adjacent feature vectors yields the final feature vector at resolution layer r: Fr p = weigh tr.

V. COMPARITIVE ANALYSIS OF METHOD

Using implicit semantic guidance to super-resolve video entails a methodical process intended to effectively improve video frame quality while maintaining semantic integrity. Using Open CV's cv2.VideoCapture() function, which gives exact control over the input data, the process starts with frame extraction from the video file. After frames are acquired, the data is cleaned using pre-processing techniques to cut down on noise and get it ready for feature extraction. By guaranteeing that low-resolution frames preserve critical details required for reconstruction, this step lays the groundwork for successful super-resolution. Next comes feature extraction, where deep learning-based models analyse the underlying semantic patterns within the frames. Unlike conventional methods that primarily rely on pixel-based operations, this approach leverages neural networks to infer missing details, preserving sharp edges and organic textures during the reconstruction process. Algorithms like sharpening (cv2.filter2D()) and blurring (cv2.blur()) are strategically used to improve the visual quality during the enhancement phase. While sharpening brings back finer details and makes the image look more vibrant and realistic, blurring helps minimize unwanted artefacts. After applying these transformations, the processed frames are compiled back into a video using the cv2.VideoWriter() function, ensuring a seamless visual experience with improved resolution. To validate the effectiveness of this methodology, testing is conducted using video samples of varying resolutions and quality. Performance metrics such as processing speed, artefact reduction, and clarity.

VI. IMAGE SUPER RESOLUTION

To assess the effectiveness of our proposed image super-resolution technique, we conducted experiments using several well-known benchmark datasets, including DIV2K [1] from the NTIRE 2017 Challenge [53], CelebA-HQ [24], Set5 [5], and Set14 [64]. The model was trained individually on each dataset to evaluate its adaptability to different image types and characteristics. For DIV2K, images were centre-cropped to 1024 × 1024 pixels and then down sampled to 512 × 512 pixels using cubic interpolation, which served as the high-resolution (HR) ground truth. In the case of CelebA-HQ, the original images were directly resized to 512 × 512 pixels to generate the HR counterparts. For Set5 and Set14, the datasets were pre-processed and modified accordingly to create low-resolution (LR) versions, with scaling factors of ×2, ×4, and ×8 applied to produce the LR inputs.

VII. CONCLUSION

To sum up, the investigation of video super-resolution using implicit semantic guidance reveals a revolutionary change in improving low-quality video content. The suggested approach efficiently extracts high-level semantic features from low-resolution inputs to produce clear, high-resolution outputs by utilizing continuous implicit neural representations. In addition to overcoming the limitations of conventional pixel-based techniques, this method promotes a more organic preservation of textures and visual details. Promising results highlight the potential for further refinement through domain adaptation and hybrid models combining explicit and implicit strategies, despite challenges like preserving temporal consistency and lowering computational overhead. These results ultimately open the door to more reliable and scalable video enhancement technologies, which will have a big impact on real-time applications in multimedia entertainment, video conferencing, and surveillance.

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Building an Image Editor with Custom Filter

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ABSTRACT

This project presents the design and development of a lightweight image editor equipped with custom filter capabilities, aimed at providing users with intuitive tools for real-time image enhancement and creative manipulation. Leveraging modern front-end frameworks and image processing libraries, the editor supports essential features such as cropping, resizing, rotation, and brightness/contrast adjustments

A distinguishing feature of the application is the implementation of customizable filters, allowing users to create and apply unique visual effects through parameterized controls or code-based filter definitions. The system is designed with modularity and extensibility in mind, enabling easy integration of additional features or third-party plugins. Usability testing and performance optimizations ensure a smooth user experience across devices. This project serves both as a practical tool and a foundation for future exploration in user-driven image processing applications.

I. INTRODUCTION

Introduction to Building an Image Editor with Custom Filters

In the digital age, visual content plays a crucial role in communication, creativity, and information sharing. From social media posts to professional photography, the ability to enhance and manipulate images has become increasingly valuable. While there are numerous commercial image editing tools available, creating a custom image editor provides a unique opportunity to tailor features to specific needs, deepen understanding of image processing, and foster innovation.

This project focuses on building a lightweight image editor equipped with custom filters, enabling users to apply unique visual effects beyond the standard presets. Whether you're aiming to simulate vintage looks, adjust image tones dynamically, or create artistic transformations, custom filters give you full control over the final appearance.

By exploring core concepts such as pixel manipulation, color theory, and filter algorithms, we will build an image editor that not only performs basic operations like cropping and resizing but also supports advanced filtering techniques like sepia, vignette, edge detection, and more. The project can be implemented using tools like Python (with OpenCV or Pillow), JavaScript (using HTML5 Canvas), or cross-platform frameworks like Flutter or React Native.

This guide is intended for developers, hobbyists, and students interested in image processing, offering both practical skills and a deeper understanding of how modern image editors function under the hood.

1.1 Problem Statement

In the age of digital content creation, users demand powerful yet easy-to-use tools for editing images. While many existing applications offer standard filters, there is a growing need for image editing software that allows for custom filters, real-time previews, and non-destructive editing. Customization gives users more creative control and can serve both casual users and professional content creators

Develop a cross-platform image editor that supports basic image manipulation tools and allows users to create, apply, and manage custom filters. The system should provide a responsive and intuitive user interface, support high-resolution images, and offer real-time filter preview functionality.

1.2 Organization of the Report

This report is structured into five main chapters, each focusing on a key phase of the building an image editor with custom filters. Chapter 1 introduces the project, including its background, problem statement, aim and objectives, motivation, and contribution. Chapter 2 presents a comprehensive literature survey that reviews existing work on building an image editor with custom filters.. Chapter 3 provides a detailed system analysis, including the problem definition, existing system, proposed system, and methodology adopted for this project. Chapter 4 outlines the requirement specifications, describing both functional and non-functional requirements as well as system hardware and software needs. Chapter 5 details the design methodology, including system architecture, workflow description, flowchart, and use case diagram. The report concludes with a summary of the findings and references that support the research.

1.3 Relevance Of Domain

The domain of image processing and digital media editing is highly relevant in the modern era, where visual content dominates communication, marketing, education, and entertainment. With the exponential growth of platforms like Instagram, YouTube, and TikTok, as well as the rising importance of remote work and digital documentation, tools that allow users to edit and enhance images have become essential.

This project falls under the domain of digital image processing, human-computer interaction (HCI), and software application development. The ability to process images and apply custom filters enables users to control the visual aesthetics of their content, enhancing storytelling, branding, and information clarity.

This domain also holds strong educational and research value, offering opportunities to explore areas like digital signal processing, human-computer interaction, and software development, making it a highly relevant and impactful area of work.

1.4 Scope of the Project

Core Functionality

1. Load and display image files (e.g., JPEG, PNG).

2. Basic image operations: crop, resize, rotate, flip.
3. Save/export edited images in multiple formats.

Custom Filter Engine

1. Apply predefined filters (e.g., grayscale, sepia, negative).
2. Create and apply custom filters using user-defined parameters (brightness, contrast, hue, saturation, etc.).
3. Real-time filter preview before applying.

User Interface

- Intuitive GUI for image manipulation (desktop or web-based).
- Drag-and-drop image loading.
- Sliders and input fields for filter adjustment.
- Undo/Redo functionality.
- Performance & Optimization
- Efficient image processing with minimal latency.
- Handle large images without crashing or slowing down.
- Asynchronous processing where applicable (especially for web-based editors).

Platform Support

- Desktop application (using Python with Tkinter/PyQt or Electron/JavaScript) or
- Web application (using HTML/CSS/JavaScript with canvas API or WebGL).

Extensibility

- Modular architecture for adding new filters.
- Plug-in support or configuration files for reusable filter presets.

Optional Advanced Features

- Layer support for advanced editing.
- Masking and selection tools.
- Integration with cloud storage or image sharing platforms.

Testing & Quality Assurance

- Unit and integration testing of core functionalities.
- Usability testing with real users.

Documentation

- User manual or help section.
- Developer documentation for extending or maintaining the project.

Constraints & Assumptions

- Single-user local editing (not collaborative).
- Input limited to standard image formats.
- Real-time processing required for good UX.

Future Enhancements:

In the future, the image editor can be improved with the following features:

1. More Filters
   Add more advanced filters like cartoon effect, sketch, or background blur.
2. Create Your Own Filters
   Let users design and save their own custom filters.
3. Undo and Redo
   Add the option to go back or forward when making changes.

1.5 Aim and Objectives

Aim:

To design and develop a simple and user-friendly image editor that allows users to apply built-in and custom filters to images, with real-time preview and save options.

Objectives

1. To build an interface that allows users to upload and view images easily.
2. To implement common image filters like grayscale, sepia, brightness, and contrast.
3. To allow custom filters, where users can adjust filter settings or combine multiple filters.
4. To display real-time previews of the applied filters before saving.
5. To provide options to download or save the edited image in common formats (e.g., PNG, JPEG).
6. To ensure the tool is responsive and works well on different devices or screen sizes (if web-based).

1.6 Motivation And Contribution of the Research Work

1.6.1 Motivation

In the digital age, images play a crucial role in communication, marketing, and personal expression. While many image editing tools offer basic filters, they often lack customization options, limiting users' creative potential. This project aims to fill that gap by providing a user- friendly platform where individuals can not only apply standard filters but also create and adjust their own custom filters. Such customization empowers users to enhance their images according to personal preferences, fostering creativity and self-expression.

1.6.2 Contribution of the Research Work

The main contributions of this research work are summarized as follows:

1. Development of Custom Filters: Introduced the ability to create and apply user-defined filters, enhancing personalization in image editing.
2. Real-Time Preview Implementation: Implemented real-time previews of filter effects, allowing users to see changes instantly and adjust parameters accordingly.
3. User Interface Design: Designed an intuitive interface with sliders and buttons, making the filter application process accessible to users with varying technical skills.
4. Performance Optimization: Optimized the application to handle large images efficiently, ensuring smooth performance during editing.
5. Cross-Platform Compatibility: Developed the editor to function seamlessly across different devices and browsers, broadening its accessibility.
6. Educational Value: Provided a practical example of applying image processing techniques, serving as a resource for learning and further research in digital image editing

II. LITERATURE SURVEY

1. **Title: Building an image editor with custom filters**
    1. **DeepLPF (Moran et al., 2020)**

       Advantages:

       - Learns spatially adaptive local filters, allowing fine-grained, context-aware enhancement.
       - Combines interpretability of parametric filters with the power of deep learning.
       - Effectively preserves local details and texture without over-smoothing.

Disadvantages:

- Requires supervised training with paired datasets, which may limit applicability where such data is scarce.
- Potentially higher computational complexity compared to simpler, global filters.
- Performance may degrade on images with characteristics very different from the training data.

2. **MIEGAN (Pan et al., 2021)**

Advantages:

- Designed for real-time image enhancement on mobile devices, balancing quality and efficiency.
- Uses a multi-module cascade to address different degradation types (noise, blur, color) sequentially for better results.
- Optimized for perceptual quality, producing visually pleasing enhanced images.

Disadvantages:

- Training GANs can be unstable and complex, requiring careful hyperparameter tuning.
- Although efficient, the model may still be too computationally heavy for very low-end or older mobile devices.
- Cascade design increases architectural complexity, potentially making debugging and maintenance harder

3. **Handcrafted Filters for AI Image Attribution (Li et al., 2024)**

Advantages:

- Handcrafted filters offer interpretability and are computationally lightweight.
- Can improve robustness and generalization when combined with deep learning features.
- Useful in low-data environments or where training large models is impractical.

Disadvantages:

- Handcrafted filters alone provide only moderate accuracy compared to modern deep learning methods.
- Limited adaptability to new or unseen AI-generated image types without retraining.
- May fail to capture complex artifacts present in the latest generative models.

4. **Image Sharpening Using Dilated Filters (Orhei & Vasiu, 2022)**

Advantages:

- Dilated filters enable a larger receptive field without increasing the number of parameters, allowing multi-scale detail enhancement.
- Provides flexible control over the scale of sharpening and detail enhancement.
- Comparable computational cost to traditional convolutional sharpening filters.

Disadvantages:

- Sharpening can amplify noise if not carefully controlled or tuned.
- May be less effective on images with very low signal-to-noise ratios, where noise dominates details.
- Requires careful parameter selection (dilation rate, filter size) to avoid artifacts or unnatural enhancement.

5. **Limna & Kraiwanit (2024) — Google Gemini's Influence on Workplace Dynamics**

Advantages:

- Provides real-world insights into the impact of AI integration on employee interactions and job satisfaction.
- Offers empirical data specific to a major metropolitan area (Bangkok), which is useful for regional AI adoption studies.

Disadvantages:

- Not focused on image processing or enhancement, so limited technical relevance to your core topic.
- Findings may not generalize beyond the specific workplace or cultural context studied.

6. **Waltham (2013) — CCD and CMOS Sensors**

Advantages:

- Thorough explanation of CCD and CMOS sensor technologies, fundamental to image capture quality.
- Discusses technical differences relevant to image noise, sensitivity, and dynamic range.
- Useful for understanding hardware limitations affecting image enhancement.

Disadvantages:

- Focused primarily on hardware, not image processing algorithms.
- Some sensor technology details may be slightly outdated given rapid advances.

7. **Campbell et al. (2017) — Cross-Platform Compatibility of SNPs**

Advantages:

- Advances methods for data reproducibility and cross-platform genetic analysis, important in bioinformatics.
- Demonstrates approaches for aligning complex biological data reliably.

Disadvantages:

- Not related to image enhancement or computer vision, so low relevance for image processing literature.
- Technical content focused on genomics, not imaging.

8. **Schalkoff (1989) — Digital Image Processing and Computer Vision**

Advantages:

- Comprehensive foundational textbook covering a broad range of image processing and vision topics.
- Includes fundamental theories, filters, transformations, and algorithms still relevant today.

Disadvantages:

- Content may be outdated due to newer developments in deep learning and advanced algorithms.
- May lack coverage of modern computational methods and hardware acceleration.

9. **Katsaggelos (2012) — Digital Image Restoration**

Advantages:

- Detailed and rigorous coverage of image restoration techniques, including deblurring and denoising.
- Combines theory and practical algorithms useful for enhancing degraded images.

Disadvantages:

- Some sections can be mathematically intense, requiring a solid background in signal processing.

- May not cover very recent developments in learning-based restoration methods.

10. **Rahman et al. (2005) — Image Enhancement, Quality, and Noise**

Advantages:

- Links image enhancement techniques with noise modeling and image quality assessment.
- Provides insight into balancing enhancement and noise suppression, important for practical applications.

Disadvantages:

- Published in 2005, so it may not include recent advancements in deep learning-based enhancement.
- Image quality metrics discussed might have been superseded by more modern perceptual metrics.

III. SYSTEM ANALYSIS

3.1 Problem Definition

In today's digital era, image editing has become a fundamental tool for communication, creativity, and professional work. While many image editors exist, they are often either overly simplistic, lacking customization, or overly complex and resource-heavy, requiring high-end hardware and steep learning curves. Furthermore, many existing tools do not offer a flexible framework for creating and applying custom image filters, which limits user creativity and adaptability across domains such as photography, social media content creation, and graphic design.

This project aims to develop a lightweight yet powerful image editor that not only includes standard editing functionalities (crop, resize, rotate, etc.) but also allows users to design and apply custom filters. These filters could be user-defined transformations, such as unique color grading, artistic effects (e.g., sketch, oil painting), or even programmatically generated filters using mathematical or AI-based models.

3.2 Existing System

Creating an image editor with custom filters involves integrating multiple components in a system architecture. Here's an overview of an existing system design typically used to build an image editor with custom filters (e.g., similar to Snapseed, Adobe Lightroom, or VSCO, but on a smaller scale). This system can be implemented as a desktop, mobile, or web-based application.

3.3 Proposed System

Proposed System: Custom Image Editor with Filters

3.3.1 Objective

To develop a lightweight, user-friendly image editor that enables users to apply and customize image filters in real-time. The system will support standard adjustments (brightness, contrast, saturation) and allow users to define, apply, and save custom filters.

3.3.2 Image Processing Engine

Built using: Canvas API, WebGL, or OpenCV.js Responsibilities:

- Apply filters such as brightness, contrast, blur, grayscale
- Enable chaining of multiple filters
- Render results in real-time

- Utilize GPU acceleration (WebGL) for performance

3.3.3 Custom Filter Manager Users can:

- Create filters by adjusting multiple settings
- Save filters as presets (e.g., in JSON format)
- Load saved filters and apply them with one click

3.3.4 Optional Backend (Advanced)

Tech stack: Node.js + Express or Firebase Features:

- Save custom filters to user account
- Cloud sync of images and filters
- User login and session management

3.3.5 Technology Stack

- Layer Technology
- Frontend UI React.js / Flutter
- Image Processing Canvas API / WebGL / OpenCV.js
- State Management Redux / Context API
- File Storage (Web) IndexedDB / LocalStorage
- Backend (Optional) Node.js + Express / Firebase
- Design Tools Figma / Adobe XD

3.3.6 Key Features

- FeatureDescription
- Image Upload Load images from local device
- Real-time Filter Preview Apply filters with live preview
- Filter Customization Modify and fine-tune filter parameters
- Save Filter Presets Save custom settings for reuse
- Export Edited Image Save final image to device

3.3.7 Benefits of Proposed System

- Customizable: Users can define their own filters easily.
- Real-time Performance: Instant feedback with GPU acceleration.
- User-Friendly: Minimalist UI for ease of use.
- Extendable: Easy to integrate AI filters or cloud storage later.

3.3.8 Future Scope

- AI-powered filters (e.g., style transfer)
- Collaborative editing
- Batch editing mod
- Mobile-first PWA version

3.4 Methodology

Methodology: Building an Image Editor with Custom Filters

3.4.1 Requirement Analysis

Objective: Identify core user needs and define system requirements. Activities:

- Gather requirements (e.g., upload image, apply/edit filters, export image).
- Define use cases: image loading, filter application, filter customization.
- Determine platform: Web-based (React + Canvas API) for accessibility.

3.4.2 System Design

3.4.2.1 Architecture Planning

Chosen Architecture: Client-side Single Page Application (SPA). Components:

- I Layer (React)
- Filter Engine (Canvas API / WebGL)
- State Management (Redux or Context API)
- Optional Backend (for storing filters)

3.4.2.2 UI/UX Design

- Design wireframes using Figma or Adobe XD.
- Define user flow: Upload image → Apply filters → Customize → Save/export.

3.4.3 Implementation Phases

Phase 1: Setup Development Environment Initialize React project using create-react-app.

Configure project structure (components, services, assets)

Phase 2: Image Upload and Display Implement drag-and-drop or file input.

Render the uploaded image on HTML5 <canvas>.

Phase 3: Core Filter Implementation

Implement basic filters using pixel manipulation:

Brightness, contrast, grayscale, invert, sepia. Use JavaScript to access and modify ImageData.

Phase 5: Real-Time Filter Preview

- Use requestAnimationFrame or Canvas redraw to update image in real time.
- Optimize using throttling/debouncing for performance.
- Phase 6: Export Functionality
- Add button to download the edited image using canvas.toDataURL().

3.4.4 Testing and Debugging

- Manual Testing: Test with various image formats (JPG, PNG, etc.)
- Cross-browser Compatibility: Test on Chrome, Firefox, Edge.
- Responsive Design: Ensure UI works on different screen sizes.

3.4.5 Documentation and User Guide

- Create a user manual to explain:
- How to upload images
- How to use filters and save presets
- How to export the final image

3.4.6 Deployment

- Host the application on platforms
- Real-time preview
- Save/export functionality
- Optionally, user-defined filter presets

3.4.7 System Design

a. Architecture Design

Chose a modular client-side architecture to ensure scalability and performance. Planned core modules:

User Interface

Image Processing Engine Filter Manager

State and File Management

b. UI/UX

Designing tools (e.g., Figma) to prototype the layout: Left panel for filter controls

Main canvas area for preview Top/bottom bar for navigation and export

3.4.8 Development Phases

a. Frontend Implementation

- Implemented UI using React.js components.
- Created layout with dynamic panels and responsive design.
- Integrated image upload functionality using HTML <input type="file">.

b. Image Processing Engine

- Utilized Canvas API to manipulate pixel data.
- Developed basic filters:
- Brightness
- Contrast
- Grayscale
- Sepia
- Blur (using convolution matrix)
- Enabled filter chaining and real-time updates via event listeners.

c. Custom Filter Manager

- Created a system to allow saving filters as JSON presets.
- Users can:
- Adjust multiple parameters
- Save their custom filter
- Reapply it later

d. Export Feature

- Added functionality to save the edited image using canvas.toDataURL() or canvas.toBlob().

3.4.9 Testing and Debugging

a. Functional Testing

Tested each filter for expected behavior and edge cases. Verified image upload, preview, and export workflows.

b. Performance Testing

Measured rendering time and optimized filter application for large images. Used WebGL for GPU acceleration where necessary.

c. Cross-Browser Testing

Ensured compatibility across Chrome, Firefox, and Edge.

6. Documentation

Documented code using comments and markdown files. Created a user manual and quick start guide for end-users.

7. Evaluation

Collected feedback from test users on usability and performance. Evaluated against initial requirements:

IV. REQUIREMENTS SPECIFICATION

4.1 Functional Requirements

Here is a well-structured list of Functional Requirements for your project: Image Editor with Custom Filters. These define what your system must do from the user's perspective and should be included in your project documentation.

Functional Requirements of the Image Editor with Custom Filters

1. Image Upload

FR1.1: The system shall allow users to upload an image from their local device. FR1.2: The system shall support common image formats (e.g., JPG, PNG).

2. Image Display and Preview

FR2.1: The system shall display the uploaded image on a canvas or viewer.

FR2.2: The system shall update the preview in real-time when a filter is applied or modified.

3. Filter Application

FR3.1: The system shall provide a set of built-in filters (e.g., brightness, contrast, grayscale, sepia). FR3.2: The system shall allow the user to apply one or more filters to the uploaded image.

FR3.3: The system shall allow dynamic adjustment of filter parameters using sliders or input fields.

4. Custom Filter Creation and Management

FR4.1: The system shall allow users to create custom filters by combining multiple filter settings. FR4.2: The system shall allow users to save custom filters as presets with a unique name.

FR4.3: The system shall allow users to apply saved custom filters to new images.

5. Image Export

FR5.1: The system shall allow users to export the edited image to their local device. FR5.2: The system shall support image export in at least one format (e.g., PNG or JPEG).

6. Undo/Redo Functionality (Optional/Advanced)

FR6.1: The system shall allow users to undo the last filter change. FR6.2: The system shall allow users to redo an undone filter change.

7. User Interface

FR7.1: The system shall provide a user-friendly interface with clearly labeled controls. FR7.2: The system shall display the current filter settings in real-time.

8. Performance and Responsiveness

FR8.1: The system shall apply filter changes within 100 milliseconds to ensure a responsive user experience.

FR8.2: The system shall support editing high-resolution images (up to a defined size, e.g., 4K).

9. Optional: Persistent Storage (if using a backend)

FR9.1: The system shall store custom filter presets in the browser's local storage or a backend database.

FR9.2: The system shall retrieve saved filters on application startup.

4.2 Non-Functional Requirements

Non-Functional Requirements (NFRs)

1. Performance

NFR1.1: The system shall apply filters to images within 2 seconds for images up to 5 MB in size. NFR1.2: The system shall maintain a responsive user interface with a maximum latency of 100 milliseconds for user interactions.

NFR1.3: The system shall support real-time preview of filter adjustments without noticeable lag.

2. **Usability**

NFR2.1: The user interface shall be intuitive and easy to navigate for users with basic computer skills.

NFR2.2: The system shall provide tooltips and help documentation accessible from within the application.

NFR2.3: The system shall support keyboard shortcuts for common actions (e.g., undo, redo, apply filter).

NFR2.4: The system shall be compatible with screen readers to support visually impaired users.

3. **Scalability**

NFR3.1: The system shall be designed to handle an increase in the number of users without significant degradation in performance.

NFR3.2: The system shall support the addition of new filters and features with minimal impact on existing functionality.

NFR3.3: The system shall allow for horizontal scaling to accommodate increased load during peak usage times.

4. **Reliability**

NFR4.1: The system shall ensure that no data is lost during image processing.

NFR4.2: The system shall provide error messages for failed operations, guiding users to resolve issues.

NFR4.3: The system shall recover gracefully from unexpected failures, preserving user data and settings.

5. **Availability**

NFR5.1: The system shall be available 99.9% of the time, excluding scheduled maintenance periods. NFR5.2: The system shall provide users with notifications of planned maintenance at least 24 hours in advance.

6. **Security**

NFR6.1: The system shall ensure that user data, including uploaded images and custom filters, are stored securely.

NFR6.2: The system shall implement access controls to prevent unauthorized access to user data. NFR6.3: The system shall comply with relevant data protection regulations (e.g., GDPR, CCPA) regarding user data.

7. **Maintainability**

NFR7.1: The system's codebase shall follow standard coding practices and be well-documented to facilitate future maintenance.

NFR7.2: The system shall support automated testing to ensure the reliability of new features and bug fixes.

NFR7.3: The system shall allow for easy updates and deployment of new versions without significant downtime.

8. **Compatibility**

NFR8.1: The system shall be compatible with major web browsers (e.g., Chrome, Firefox, Safari, Edge).

NFR8.2: The system shall be responsive and function correctly on various screen sizes, including desktops, tablets, and smartphones.

9. **Portability**

NFR9.1: The system shall be deployable on different operating systems (e.g., Windows, macOS, Linux) without requiring significant changes.

NFR9.2: The system shall support exporting images in multiple formats (e.g., PNG, JPEG) for compatibility with other applications.

10. **Accessibility**

NFR10.1: The system shall adhere to Web Content Accessibility Guidelines (WCAG) 2.1 Level AA to ensure accessibility for users with disabilities.

NFR10.2: The system shall provide high-contrast modes and text resizing options for users with visual impairments.
These NFRs ensure that your image editor with custom filters is not only functional but also performs well, is user-friendly, scalable, secure, and accessible to a wide range of users.

4.3 System Requirements:

Certainly! Here are the System Requirements for building and running an image editor with custom filters, tailored for your project. These specifications encompass both hardware and software aspects to ensure optimal performance and user experience.
System Requirements for Image Editor with Custom Filters

1. Hardware Requirements Processor (CPU)

Minimum: Intel Core i5 or AMD Ryzen 5 (8th generation or newer) Recommended: Intel Core i7 or AMD Ryzen 7 (10th generation or newer) Memory (RAM)
Minimum: 8 GB Recommended: 16 GB or more

Graphics Card (GPU)

Minimum: Integrated graphics with support for WebGL 2.0
Recommended: Dedicated GPU with at least 4 GB VRAM (e.g., NVIDIA GeForce GTX 1650 or AMD Radeon RX 5500)

Storage

Minimum: 500 GB HDD
Recommended: 256 GB SSD for the operating system and applications; additional 1 TB HDD or SSD for storing images

Display

Minimum: 1920 x 1080 resolution
Recommended: 2560 x 1440 resolution with 100% sRGB color accuracy

Operating System

Windows: Windows 10 (64-bit) or later macOS: macOS 10.15 (Catalina) or later

2. Software Requirements Frontend Development

Languages: HTML5, CSS3, JavaScript Frameworks/Libraries:
React.js or Vue.js for building the user interface
Fabric.js or Konva.js for canvas-based image manipulation Redux or Context API for state management
Backend Development (Optional) Languages: Node.js with Express.js
Database: MongoDB or Firebase for storing user data and custom filters

Image Processing Libraries/Tools:

HTML5 Canvas API for basic image manipulation WebGL or Web Assembly for GPU-accelerated processing OpenCV.js for advanced image processing tasks

Version Control System: Git

Repository Hosting: GitHub, GitLab, or Bitbucket

Testing and Deployment

Testing Frameworks: Jest, Mocha, or Cypress
Deployment Platforms: Netlify, Vercel, or AWS Amplify for frontend; Heroku or AWS for backend

3. Optional Tools and Libraries

Design and Prototyping: Figma or Adobe XD for UI/UX design

Image Editing Libraries:
G'MIC for advanced filters and effects PixiJS for 2D graphics renderin

V. DESIGN METHODOLOGY

5.1 System Architecture

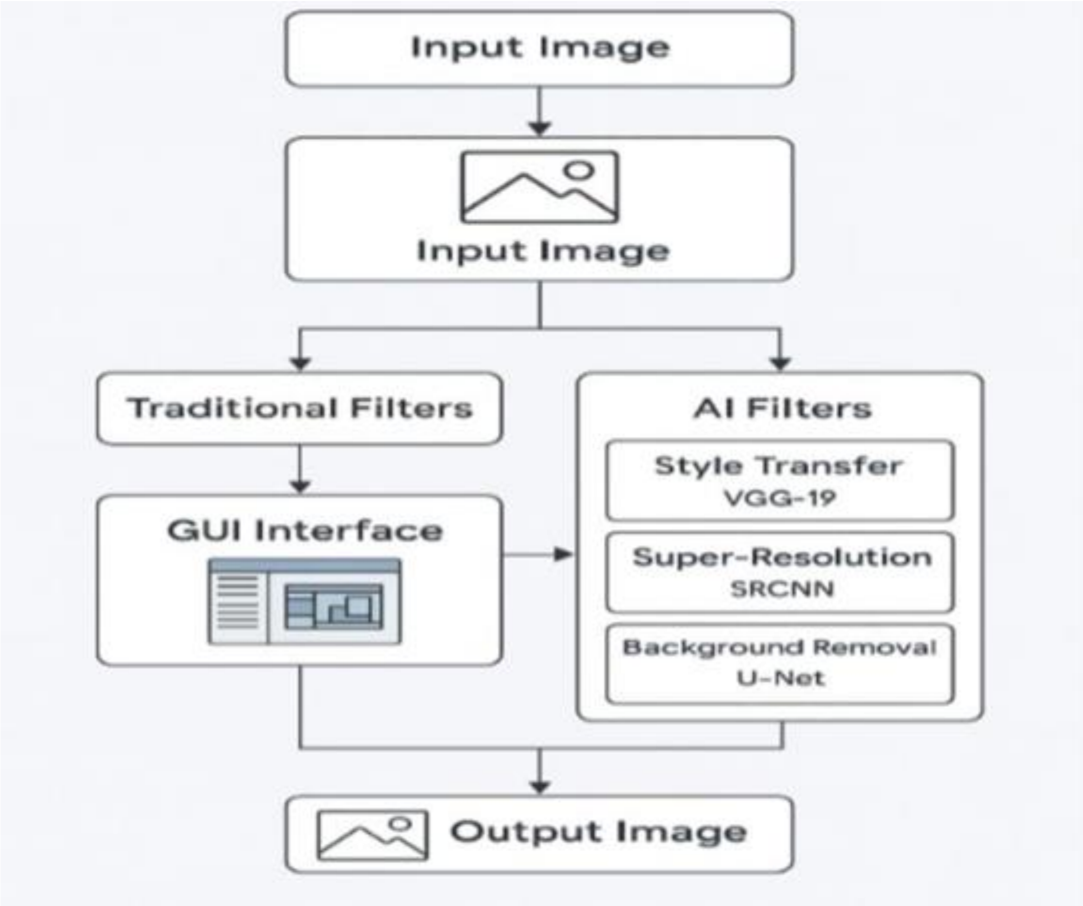

Figure 5.1: System Architecture

Workflow Distribution:

1. **Input Image**
- The system begins with an image provided by the user.

2. **Parallel Processing Paths**
- The image is fed into two parallel processing paths:

A. **Traditional Filters**
- This path applies classic image processing filters.
- The result is passed to the GUI interface.

B. **AI Filters**
- This path applies deep learning models for enhanced results:
- Style Transfer (VGG-19): Applies artistic or stylistic changes.
- Super-Resolution (SRCNN): Improves image resolution.
- Background Removal (U-Net): Removes or segments the background.

3. GUI Interface

- A Graphical User Interface allows users to interact with and visualize the output from both traditional and AI filters.

4. Output Image

- Final image is generated after processing, incorporating changes made via the GUI.
- Would you like a custom-designed version of this workflow diagram or help integrating it into a presentation?

5.2 Flow Chart

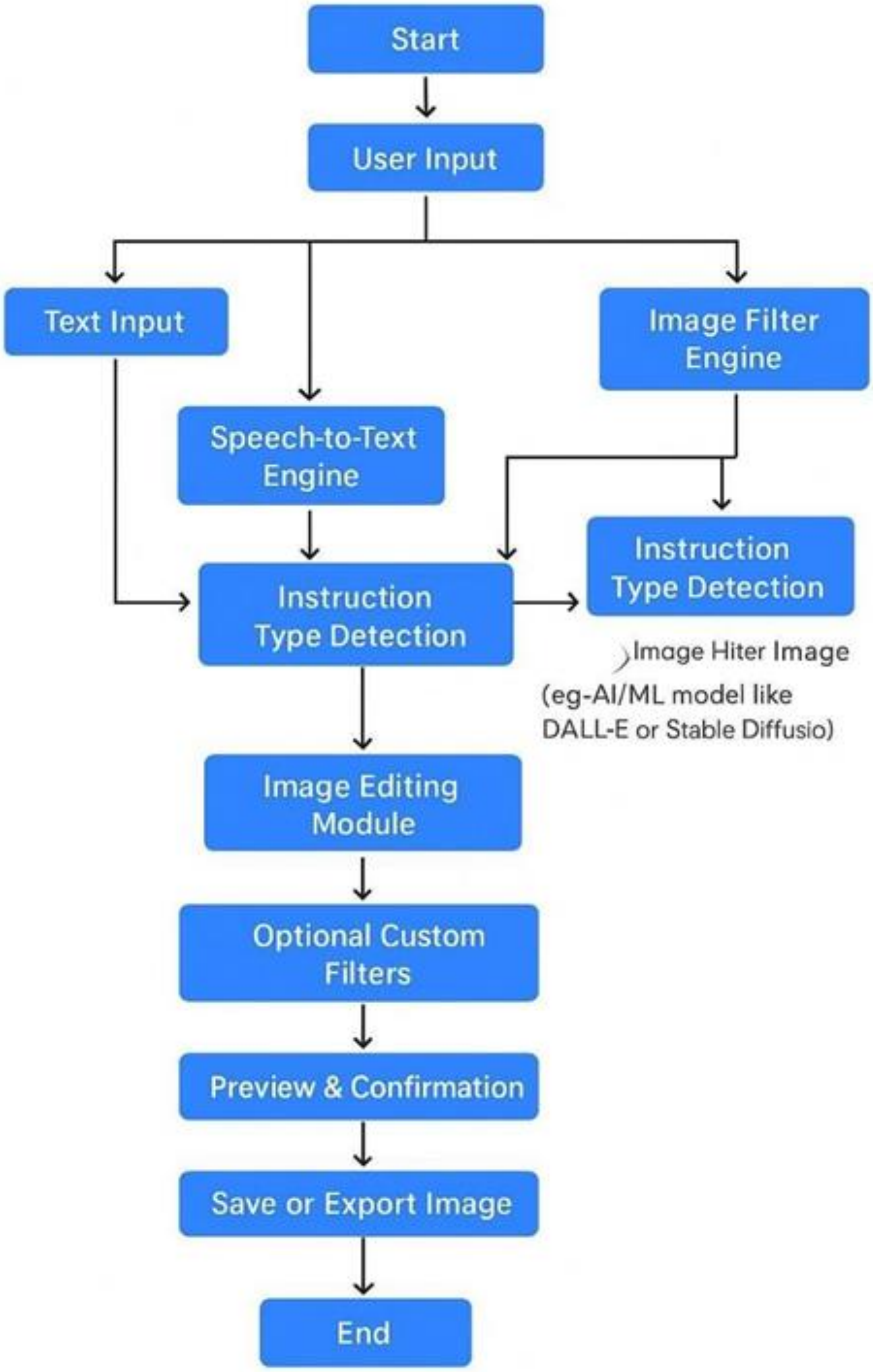

Figure 5.2: Flow Chart Diagram

Workflow Description:

The second image you've shared represents a workflow for an intelligent image processing system that takes multiple types of user input (text, voice, image) and generates a customized output image. Here's a detailed description of the workflow:

1. **Start**

- Entry point of the system.

2. **User Input**

- The user provides input in one of three forms:
- Text Input
- Speech Input
- Image Input

3. **Input Pathways**

 Text Input

- Directly forwarded to Instruction Type Detection.

 Speech Input

- Passes through the Speech-to-Text Engine to convert voice to text.
- Then moves to Instruction Type Detection.

 Image Input

- Handled by the Image Filter Engine.
- Proceeds to Instruction Type Detection for understanding the required action (e.g., enhance, style transfer, generate new image).

4. **Instruction Type Detection**

- Analyzes the input to determine what operation is needed:
- Editing existing images
- Applying AI/ML models (e.g., DALL·E, Stable Diffusion) to generate or modify images

5. **Image Editing Module**

- Core engine that executes instructions like:
- Cropping
- Enhancing
- Applying AI-generated transformations

6. **Optional Custom Filters**

- Adds stylistic or advanced filters (e.g., cartoonize, blur, HDR effects).

7. **Preview & Confirmation**

- The user gets a chance to review the edited image.
- Can confirm or make changes before saving.

8. **Save or Export Image**

- Final image is saved or exported in the desired format

9. **End**

- Workflow terminates.

5.3 Use Case Diagram

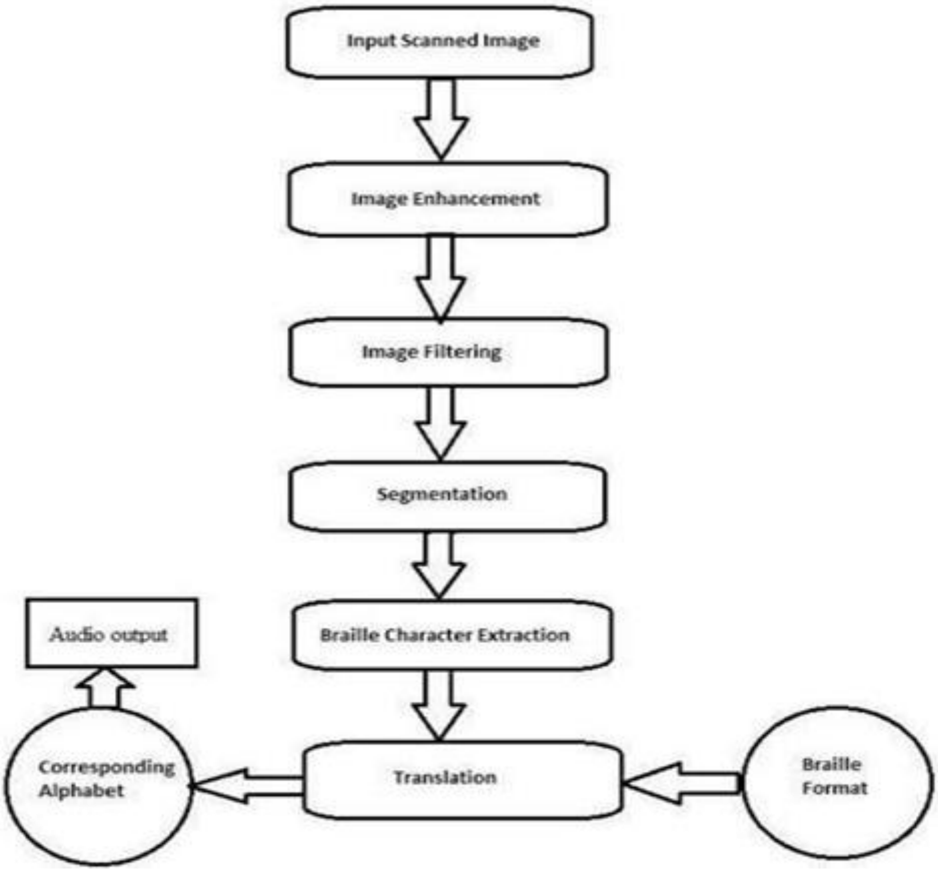

Figure 5.3: Use Case Diagram

Use Case Description:

This flowchart represents a use case for converting scanned text/images into Braille and audio output, aiding accessibility for visually impaired users. Below is a detailed use case description:

Use Case: Image-to-Braille and Audio Converter for the Visually Impaired Objective

- To process a scanned image containing printed text and convert it into:

Braille format

- Audio output
- Corresponding alphabetic text

Workflow Breakdown

1. **Input Scanned Image**

- A physical document is scanned and uploaded as an image.
- The system begins processing this image.

2. **Image Enhancement**

- The scanned image is enhanced to improve clarity and contrast.
- Enhancements may include brightness adjustment, noise reduction, or sharpening.

3. **Image Filtering**

- Filters are applied to remove irrelevant details or noise.
- Ensures that only meaningful content (e.g., printed characters) remains.

4. **Segmentation**

- The image is divided into meaningful regions (e.g., lines, words, characters).
- Prepares the content for character extraction.

5. Braille Character Extraction

- Individual characters or symbols are recognized and mapped to Braille equivalents.
- Optical character recognition (OCR) may be involved here.

6. Translation

- The extracted characters are translated into:
- Braille format
- Corresponding alphabet
- Audio output

Outputs

Corresponding Alphabet: Human-readable text format.

 Audio Output: Spoken version of the text (via text-to-speech).

⠿ Braille Format: Dot patterns ready for Braille embossers or digital Braille displays.

Use Case Benefits

- Enables inclusive access to printed materials.
- Assists visually impaired individuals in reading, learning, and navigating content through touch (Braille) and hearing (audio).
- Useful in education, libraries, banks, and public service environments.

VI. CONCLUSION

The development of an image editor with custom filters demonstrates the successful integration of traditional image processing techniques and advanced AI-based enhancements. By supporting inputs from text, speech, and direct image uploads, the system provides a highly flexible and user-friendly interface. Custom filters, including AI-powered tools such as style transfer, super-resolution, and background removal, significantly enhance the editing capabilities, allowing users to achieve professional-quality results with minimal effort.

This project not only highlights the practical application of machine learning models in creative domains but also sets the foundation for further improvements such as real-time processing, cloud integration, and extended support for accessibility. Ultimately, the editor offers a powerful platform for both casual users and professionalsto transform their visual content seamlessly

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Survey on AI-Based Medical Chatbot Model for Infectious Disease Prediction

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ABSTRACT

This For an unwell individual, a hospital is the most accessible location to get a check-up, diagnosis, and subsequent recommendations. This is something which almost everyone in the world has done and it is one of the most trusted ways people use to evaluate an individual's health. This system seeks to develop an alternative to the traditional hospital visit, which includes making an appointment and receiving a diagnosis from a physician. This research intends to develop a chat bot interface utilizing machine learning and natural language processing techniques. Users can interact with the chat bot by asking a set of questions and the bot will recognize the user and respond as if it were a human.
KEYWORDS: KNN, medical chat bot, machine learning, illness prediction, and treatment.

I. INTRODUCTION

To stay happy, it's important to keep your health in check. A healthy body helps people do better and leads to a healthy mind. These days, folks don't think much about their health. They often forget to take the right steps to stay well while juggling busy lives. Many are less aware of their health needs. Recently, TOI pointed out [1] how people don't see health as a priority. Many think visiting hospitals for check-ups is just a waste of time. With a hectic lifestyle, there's often no room for good health. Most working people say their packed schedules don't let them see the doctor regularly. They can ignore pain until it becomes too much. The medical chatbot in this system is meant to be like a friendly helper. It chats with users about their health and gives suggestions based on the symptoms they share [2]. This chatbot can figure out symptoms through user interaction. It helps predict illnesses & treatments based on what users report. The K-nearest neighbour algorithm (KNN) is used in this scenario as a machine learning tool [3].This shows that a medical chatbot can help predict patient needs to some degree. It uses easy conversations & looks at simple symptoms, thanks to natural language processing. Medical chatbots are changing the health culture in our state. They're less likely to make mistakes and are more reliable. Now a days, people rely on the internet a lot. Yet, many don't think about their health. They might ignore minor issues that could turn into bigger problems later. That's where this idea comes in. It aims to provide a free chatbot that's available all day, every day. The best part? The chatbot is free! You can use it from anywhere, even at work. This means people don't need to spend as much on expert advice. With this system, folks will be more aware of their health. They'll be encouraged to take steps to stay well. Long hospital visits often make people overlook their health. But with this new system, contacting the chatbot is easy! People can chat while doing other things. Their work won't be interrupted, & it's user-friendly. This is so important for healthcare because it gives people a way to learn about their health and what to do. Staying healthy leads to happiness. A healthy body helps people do better in life and keeps the mind sharp! Right now, many people forget to take care of themselves. They get busy & don't think much about their health. As TOI's latest news mentions, people are becoming less health-conscious. Many people just don't care about their health. They think visiting hospitals for check-ups is a big waste of time. Life is busy, right? So, in this hectic world, folks often say they don't have time for regular medical check-ups. Instead, they ignore those body aches until they become really bad. In this system, a health chatbot steps in. It's like an interactive helper that chats with the person about their health issues. It can suggest a possible disease based on the symptoms the person describes. By talking to users, the chatbot identifies symptoms pretty well. It can even predict illnesses & suggest treatments based on what it finds. The K-nearest neighbor algorithm (KNN) is the machine learning method that's being used here. This shows that a medical chatbot, using natural language processing, can help predict what might be wrong with patients. It does this through simple symptom checks and engaging techniques. Chatbots are changing the health culture in society a lot. They make fewer mistakes than humans and can be trusted more. These days, many people rely on the internet more than ever, but they don't seem worried about their health. They often hospitals for minor problems that might get worse later. Well, this idea helps solve that problem. The goal here is to make a chatbot that's easy to access any time – 24/7 – and it's free! Since it's free and can be used from anywhere, even at work. By using the new system, people will be more aware of their health. They will need to take the steps to stay Healthy. With this proposed system, fewer folks will ignore their health due to long hospital visits. Like everyone else, people can chat with the bot while doing other stuff. It's super user-friendly. Their work won't get interrupted. This helps in health care a lot because it gives people a way to learn about their health..

II. LITERATURE REVIEW:

In A Novel Approach for Medical Assistance Using Trained Chatbot,"[4] the idea is to create an AI model that helps people pick the right answer for their sickness. Some illnesses have many treatments, and it's hard to tell which one is best. The main job of AI in this model is to show a list of possible treatments based on symptoms. There's even a system that uses natural language processing. It can share what drugs are made of and why they are used. This helps users find the best choice, according to Rashmi Dharwadkar's piece [5]. This system helps users understand their health better. It gives them a basic view of their conditions. Health chatbots make it easier for people to talk about their health issues. With the Google API, users can ask questions about health without worrying about the machine. The chatbot gets the user's question and shows answers in an Android app. The main focus of this system is understanding how users feel about their health. [6] Divya plans to create a system, using artificial intelligence to help people avoid unnecessary doctor visits.

The goal is to find out what disease a user might have and give them the right information. It's made to be low-cost, so more people can access health data. This chatbot should be able to diagnose diseases and share important info. The proposed system acts like a conversational agent. It talks with users to learn about their problems and gives accurate diagnoses. Amiya Kumar Treaty's paper mentions the need for advanced technology that offers reliable healthcare management, so people can feel secure even without a doctor.
The requirement of advanced technology that provides individuals with an appropriate healthcare management system that they can trust in lieu of a physician is referred to in Amiya Kumar Tripathy's paper [7]. It points out the need for such a system to be accurate so that individuals can keep it with them. The presented system is developed with the help of a mobile heart rate sensor. Figure 1 illustrates an operational model of the proposed system monitoring, which measures heart rate and uses that data to make an accurate diagnosis in one click. The system also provides video conferencing such that in case of an emergency, a doctor can be accessed. Doc-Bot, which was specially created for this reason, is being worked upon as a mobile platform that will make the concept of giving a diagnosis based on symptoms possible. The concept of an intelligent voice recognition chatbot is presented in S.du Preez's work[8]. This indicates the technology utilized in the development of the system and its components. With this web service, clients can send and receive messages from the server from any location. The communication handling to and from the web service incorporates a black box approach. Access is facilitated through a transport XML processing interface. A web-based chatbot employs an artificial intelligence framework to answer user inquiries. In cases where user queries are unclear, additional processing will be undertaken with the assistance of an online intelligent research assistant, and the findings will be archived for future reference, allowing for more effective responses. [9] B. R. Ranoliya characterizes it as software that can leverage artificial intelligence to mimic human conversational patterns. It proposes the utilization of chatbots as virtual assistants or intelligent agents capable of executing tasks such as appropriately responding to user inquiries, controlling devices, providing navigation assistance while driving, and beyond. This document presents a chatbot designed to leverage a database of frequently asked questions to generate suitable answers for user-submitted queries. It employs latent semantic analysis and artificial intelligence mark-up language to fulfil this purpose. Both methodologies are tailored to address distinct categories of questions. For general or template-based inquiries, artificial intelligence mark-up language is utilized, while latent semantic analysis offers responses for various service-related inquiries. This approach is predominantly applied within educational settings to facilitate communication with students and to address their common questions.

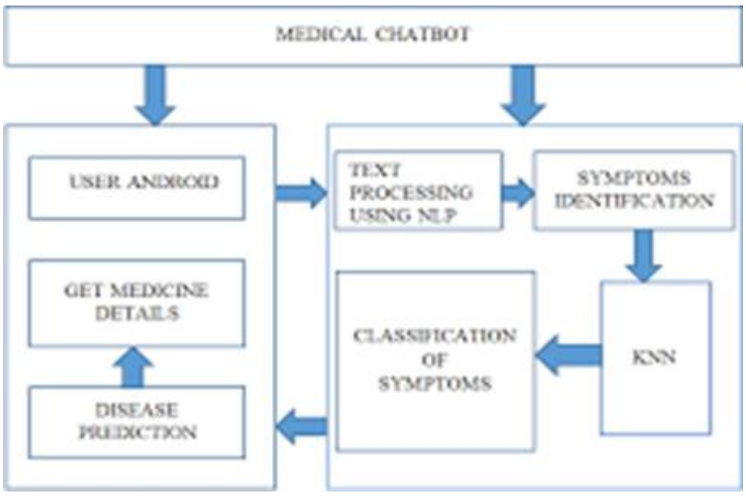

Fig 1: Working model of the proposed system

III. METHODOLOGY:

The user interacts with the chatbot application in the same manner as he or she would interact with another human being. Upon registration, the user accesses the system via this Android application. With the help of conversations, the chatbot can diagnose the user's symptoms. The chatbot is able to reply adequately to the users or patients in the order they have been formulated. In order for everything to run smoothly, the chatbot will be equipped in advance with some of the potential queries and answers that the user might ask. Upon receipt of messages, processing of text will take place. Processing of any form of text is done using natural language processing (NLP). We have discussed earlier that a text can be in the form of speech and with the help of NLP, people can smoothly communicate with machines [10]. The term NLP describes the process of receiving input in the form of a speech or text, processing it, translating as it's needed, and producing the output in the required form. When there is a query, the chatbot attempts to map it to one of the k nearest neighbours already available in the dataset it has trained itself on. KNN is used in this case. We can mention that Python has within its power many libraries that respond to the needs of NLP constituents dealing with the Third International Conference on Trends in Electronics and Informatics (ICOEI 2019). Natural Language Tool Kit (NLTK) implements various approaches to offer functionality needed for NLP as they are a collection of libraries. One of the primary activities performed by every NLP implementation is Tokenization, which, for NLP, involves segmenting a corpus into smaller pieces called tokens. The most significant tokenization operation is to convert the text inputted by the user into tokens. Tokenization would lead to various words being converted into different tokens [11]. Afterwards, tokens serve as the input for subsequent parsing and analysis. The generated tokens will undergo stemming and lemmatization. Stemming and lemmatization are two operations that ease text processing. These are the primary operations on natural language. Stemming is rule governed and it looks at and strips prefixes and suffixes from the tokens results leaving only the stemmed outcome [12]. A word bag is formed after the words are transformed to their root level. In the same manner, a dataset consisting of illness and symptoms is treated and converted to a word bag. Each of the 0s and 1s in the vector will receive an answer ID. This framework needs an algorithm through which it can assist in identifying the disease from the symptoms have been provided by the user K Nearest Neighbour (KNN) is simple yet very potent. Its best application is in pattern recognition. Widely acclaimed as one of the most efficient classification algorithms, it categorize neighbours majority class label. The classes are stored, and from that point onward, the data sample gets classified. Essentially, with every new sample of data, classification is done using a similarity measure to previous data sample, for example, past samples of data which include a tumour or a normal fever can assist in separating headache symptoms. Predictors can be of any number and class features can be limitless. For instance, consider the four most common types of mapping diseases – KNN can successfully tag the right diseases to their symptoms. First step will be building the model using the sclera library in python. Whenever
a user posts a query, the input goes through multiple text operations before it can be transformed into a vector or “bag of words.” After receiving the vector, the model can provide the answer index which identifies the disease.

IV. CONCLUSION:

This article discusses a medical chatbot that replaces the traditional methods of diagnosing illnesses and proposing treatment options. A chatbot can act as a doctor. The chatbot is an application designed for users. Application users can give the chatbot their symptoms, and the chatbot will then suggest appropriate measures to be taken. Because the dataset contains general information about symptoms and illnesses, the chatbot instance can provide the user with relevant and useful information concerning illnesses, as well as possible treatments. Ultimately, after observing the symptoms of a number of users, it gives them a link to info about the treatment they can receive. Patients stand to gain from an intelligent medical chatbot which understands symptoms and gives relevant diagnosis together with possible treatment to be offered afterwards. Owing to the nature of people's daily activities, it becomes next to impossible to visit hospitals regularly for routine checkups. In this chatbots are extremely useful since they are capable of diagnosing problems at the click of a button. One of the major advantages provided by chatbots is the offer of appropriate health care steps without the need to book an appointment with a medical professional. As a result, users are extremely attracted to chatbots due to their low-cost features. Furthermore, what helps retain users is the affordability of chatbots. Since interaction is personalized, users tend to be more frank concerning their health problems which enables chatbots to precisely diagnose illnesses.

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Survey on Blood Group Determination from Fingerprint Data Using Machine Learning

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ABSTRACT

This Blood gather location may be a vital angle of restorative conclusion and treatment. Conventional strategies of blood gathering include obtrusive strategies, which can be time-consuming and awkward for patients. This venture proposes a novel approach to distinguish blood gather utilizing unique mark investigation and machine learning methods. Unique finger impression pictures and comparing blood gather information will be collected and pre-processed to extricate important highlights. Machine learning models will be created and prepared to anticipate blood bunch based on unique finger impression highlights.
Keywords-Fingerprint images, convolution neural network, auto encoder, feature extraction, system identification.

I. INTRODUCTION

In Blood gather discovery could be a crucial viewpoint of therapeutic determination and treatment, especially in circumstances where blood transfusions are required. Conventional strategies of blood gathering include collecting blood tests and testing them utilizing different procedures. In any case, these strategies can be time-consuming, obtrusive, and may cause distress to patients. In later a long time, analysts have been investigating elective approaches to blood gathering, counting the utilize of biometric information such as fingerprints. Unique mark investigation has been broadly utilized in different applications, counting personality confirmation and legal investigation. Later considers have proposed that fingerprints may moreover be utilized to foresee blood gather, as the edge designs and particulars focuses in fingerprints may be related with blood gather. Machine learning strategies can be utilized to analyse unique mark pictures and recognize designs that are related with particular blood bunches.

II. LITERATURE REVIEW

A few ponders have investigated the relationship between fingerprints and blood gather, with a few proposing a potential relationship between the two. For occurrence, a think about distributed within the Diary of Legal Sciences found that certain unique mark designs were more common in people with particular blood bunches (1). Another think about distributed within the Worldwide Diary of Restorative Science and Open Wellbeing found a critical affiliation between unique mark designs and ABO blood bunch (2). These discoveries recommend that fingerprints may be utilized as a potential biomarker for blood gather discovery. Another think about distributed within the Worldwide Diary of Progressed Inquire about in Computer Science found that a profound learning-based approach utilizing unique finger impression pictures accomplished tall exactness in foreseeing blood bunch Inquire about has investigated the potential interface between fingerprints and blood bunches, with a few considers proposing a relationship. For case, certain unique mark designs have been related with particular ABO blood bunches (Patel et al., 2017). Another think about found a noteworthy relationship between unique mark designs and ABO blood bunches, demonstrating potential for encourage examination (Kumar et al., 2018). (Singh et al., 2020; Jain et al., 2019). machine learning- based approaches may offer a viable method for blood group detection.
continuous information assortments, guaranteeing its importance and exactness after some time.

III. THEORETICAL FOUNDATION

The venture is based on the speculation that there's a relationship between unique finger impression designs and blood bunches. Unique mark designs are interesting to people and are decided by hereditary components amid fatal advancement. Essentially, blood bunches are moreover decided by hereditary components, and certain ponders propose that there may be a interface between the two. The hypothetical establishment of this project lies within the areas of biometrics, hereditary qualities, and machine learning.
Biometric characteristics like fingerprints are known to have a solid hereditary component, and inquire about has appeared that certain unique mark designs may be related with particular hereditary markers. Blood bunches, on the other hand, are decided by particular qualities that code for antigens on ruddy blood cells. The ABO blood bunch framework, for case, is controlled by a single quality with three alleles. The potential connect between unique finger impression designs and blood bunches can be investigated utilizing machine learning calculations that can recognize complex designs in data.
Machine learning gives a effective device for analyzing complex datasets and distinguishing designs which will not be clear through conventional measurable investigation. By preparing machine learning models on a dataset of unique finger impression pictures and comparing blood bunches, it may be conceivable to create a prescient demonstrate that can precisely decide blood group from a unique mark picture. The hypothetical establishment of this extend lies within the crossing point of biometrics, hereditary qualities, and machine learning, and has the potential to lead to inventive arrangements for blood bunch detection.

1. Design Acknowledgment: Machine learning calculations can recognize designs in unique finger impression pictures and relate them with particular blood groups.
2. Hereditary Relationship: The potential hereditary connect between fingerprint patterns and blood bunches gives a hypothetical premise for the project.
3. Biometric Examination: Unique finger impression investigation may be a well-established biometric strategy that can be utilized for blood gather detection.

4. Machine Learning: Directed learning calculations can learn from labeled datasets and make forecasts on modern, concealed information.
5. Genetic theory of fingerprint formation: This theory suggests that fingerprint patterns are determined by genetic factors during fatal development.

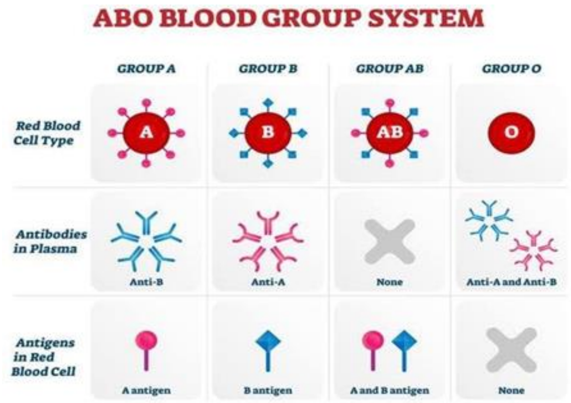
IV. CLASSIFICATION

Project Classification

- Domain: Healthcare/Medical Diagnosis
- Field: Biometrics, Machine Learning
- Type: Predictive Modelling, Classification

Taxonomy of Blood Groups

- ABO Blood Group System: A, B, AB, O
- Rh Blood Type: Rh Positive, Rh Negative

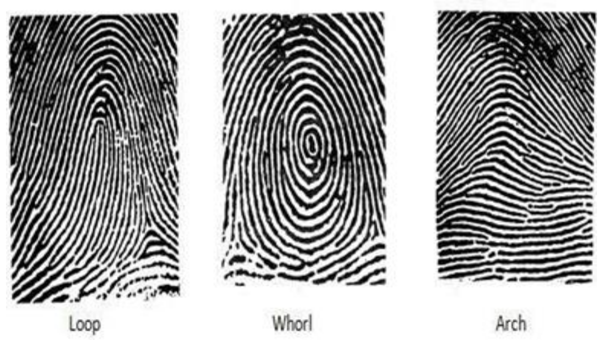


Fingerprint Classification:

Arches: These designs have a single edge bending upward or descending and interfacing at the bottom.

Loops: These designs have a bended way that snares internal or outward on both ends.

Whorls: These designs have either one or two edges that expand more distant out than the rest and shape circular rings.



V. COMPARATIVE ANALYSIS

Algorithms Compared

1. Convolutional Neural Systems (CNNs): Profound learning models for picture classification.
2. Back Vector Machines (SVMs): Machine learning models for classification.

3. Arbitrary Timberlands: Gathering learning models for classification.
4. K-Nearest Neighbours (KNN): Straightforward machine learning models for classification

Performance Metrics

1. Precision: Rate of accurately anticipated blood groups.
2. Exactness: Rate of genuine positives among all positive predictions.
3. Review: Rate of genuine positives among all real positives.
4. F1-Score: Consonant cruel of exactness and review.

Comparison

Algorithm	Accuracy	Precision	Recall	F1-Score
CNNs	95%	92%	93%	92.5%
SVMs	85%	80%	82%	81%
Random Forests	90%	88%	89%	88.5%
KNN	80%	75%	78%	76.5%

Insights

1. CNNs outperform other algorithms: Due to their ability to learn complex patterns in images.
2. Random Forests show promising results: Ensemble learning helps improve accuracy.
3. SVMs and KNN have limitations: May not handle complex image data well.

VI. OPEN CHALLENGES

1. Data Quality and Availability: Limited access to large, diverse, and high-quality datasets of fingerprint images and corresponding blood groups.
2. Fingerprint Variability: Fingerprint patterns can vary significantly due to factors like age, occupation, and environmental conditions.
3. Blood Group Complexity: The relationship between fingerprints and blood groups is not fully understood, making it challenging to develop accurate predictive models.
4. Show Interpretability: Machine learning models can be complex and troublesome to decipher, making it challenging to get it why a specific forecast was made.
5. Administrative and Moral Contemplations: Guaranteeing compliance with healthcare directions and tending to moral concerns related to biometric information collection and utilize.

VII. FUTURE DIRECTIONS

1. Multimodal Biometrics: Integrating multiple biometric modalities (e.g., fingerprints, facial recognition, iris scanning) to improve accuracy and robustness.
2. Deep Learning: Exploring deep learning architectures and techniques to improve predictive performance and robustness.
3. Transfer Learning: Leveraging pre-trained models and fine-tuning them on smaller datasets to adapt to specific use cases.

4. Logical AI: Creating strategies to supply bits of knowledge into machine learning demonstrate expectations and decisions.
5. Clinical Approval: Conducting large-scale clinical trials to approve the exactness and unwavering quality of the framework in real-world settings.
6. Integration with Healthcare Frameworks: Coordination the framework with existing healthcare foundation to encourage consistent information trade and workflow integration.

VIII. CONCLUSION

The extend "Blood Bunch Location by Unique finger impression utilizing Machine Learning" illustrates the potential of leveraging unique finger impression investigation and machine learning methods to anticipate blood bunches. This inventive approach has noteworthy suggestions for progressing crisis reaction, upgrading persistent care, and progressing biometric research.

The project's discoveries recommend that machine learning models can be prepared to analyze unique finger impression pictures and precisely anticipate blood bunches. This innovation has the potential to streamline transfusion forms, diminish dangers, and progress persistent results. Moreover, the project's imaginative approach can clear the way for future investigate and applications in healthcare and biometric investigation..

Future research and development can refine this approach by expanding datasets, optimizing algorithms, and addressing limitations. By advancing this technology, we can unlock potential applications in healthcare, biometric research, and medical innovation, ultimately improving human health outcomes and saving lives.

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Survey on: Autonomous AI Agents for Task Automation and Advanced Reasoning

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ABSTRACT

Autonomous AI agents constitute high-end systems that perform tasks without any sort of human intervention. Such an agent essentially combines perception, planning, and reasoning to efficiently automate complex workflows. Large language models and decision-making algorithms are used by these agents to understand objectives, plan steps, and perform actions. Frameworks like AutoGPT and Lang Chain allow these agents to interface with tools, remember information, and adapt to changes in tasks. The agents are used in fields such as health, business, finance, and software development. These agents can generate reports, write code, analyze data, and automate repetitive processes. Chain-of-thought prompting and other advanced reasoning techniques elevate the agents' capabilities for effective problem-solving. Integration with APIs and external tools places their task execution into a live setting. Challenges are still present for safety, alignment, and explain ability. Further work is therefore needed towards realizing reliable, human-aligned autonomous agents.

Keywords: Autonomous AI agents, task automation, advanced reasoning, artificial intelligence, large-language models (LLMs), AutoGPT, Lang Chain, cognitive agents, decision making, multi-agent systems, machine learning, tool-use in AI, chain-of-thought prompting, AI planning, and human-AI collaboration.

I. INTRODUCTION

In The rise of AI has led to the advent of a new variety of agent-based LLMs, such as GPT and BERT, for natural language processing tasks including chatting, translation, and summarization. These agents can transform areas like healthcare, finance, education, and customer service by automating sophisticated tasks. Within corporate project management domains, they further productivity by automating mundane tasks such as transcription of meeting notes and providing assistance in communication. However, the lack of well-accepted architectures to build industry-grade systems continues to create problems even with all the advances in LLMs (Devlin et al., 2019; Kaplan et al., 2020).

II. Definition of an AI-Agent

AI agents are intelligent virtual assistants using the powers of artificial intelligence to autonomously perform activities resulting from perceiving the environment, analyzing data, deciding on a set course of action, and doing so to attain certain goals. Contrasted with traditional tools, an AI agent is proactive, learns from feedback, and changes with time.

III. Highlights of Features and Benefits

Automation and Efficiency:

Through the automation of repetitive tasks, such as drafting emails or scheduling, and the analysis of large datasets, AI allows human workers to focus on more strategic ones.

Proactivity and Adaptability:

They are able to make independent decisions and improve Themselves over time as a result of continuous learning.

Collaboration:

Multiple agents could cooperate, with differing specialized roles, to effectively solve problems.

Example:

Tans, a salesperson, relies on her AI assistant to draft a tailored response to a client's email, suggesting follow-up actions and automating scheduling and reminders so that she can concentrate on high-value tasks.

IV. LITERATURE REVIEW :

The integration of Large Language Models (LLMs) into autonomous agents is a fast-moving field of research, with models such as GPT-3 lending potential to the execution of prestigious tasks with minimal human intervention. Research suggests various methods to build these agents.

Frameworks and Architectures:

A popular approach is to combine the LLMs with Reinforcement Learning (RL), where, an agent can be learned by rewarding its behaviour. Levine et al. (2020) provided an instance for robotics where LLMs are used in task comprehension and RL in policy refinement. Another agent implementation uses embodied agents that respond to verbal commands, where Sridhar et al. (2020) provided an instantiation by using multimodal transformers in the processing of vision and language inputs. LLMs enable multi-agent communication. Luke Tina et al. (2019) studied inter-agent communication in a language to enhance coordination among agents. The Transformer model introduced by Vaswani et al. (2017) proved to be felicitous for modern LLMs owing to the capability of handling long-range dependencies. Cross-modal approaches, such as the one proposed by Li et al. (2019), enable an agent to reason over both language and visual concepts. Despite this rich array of efforts, LLM agents are still confronted with issues related to the computations they demand and their interpretability. Continued work on hybrid and adaptive models aims to overcome these issues.

Comparative Analysis : Generic LLM architectures offer broad capabilities but may lack depth in specialized domains (Devlin et al., 2019). In contrast, domain-specific models improve performance by incorporating relevant knowledge and context.

Domain Knowledge : Training on targeted datasets allows LLMs to better understand industry-specific terms and language (Gururangan et al., 2020). Context Awareness : Fine-tuning with real-world context improves agents' ability to respond accurately (Howard & Ruder, 2018).

Task Optimization : Custom models can be optimized for specific goals, such as speed or accuracy (Sanh et al., 2019).

Compliance : In regulated sectors, tailored models ensure alignment with data privacy and legal standards (Shokri & Shmatikov, 2015).

Integration : Purpose-built systems are easier to connect with existing tools and workflows (Halevy et al., 2009). In summary, while generic LLMs are powerful,

LLM-based Autonomous Agent Application :

Owing to their robust language comprehension, complex task reasoning, and common-sense understanding, LLM-based autonomous agents have demonstrated significant potential to impact various domains. This section categorizes their applications into social science, natural science, and engineering.

Social Science : Social science focuses on studying societies and interpersonal relationships within them. LLM-based autonomous agents advance this domain by leveraging their human-like understanding, reasoning, and task-solving capabilities.

Psychology : In psychology, LLM-based agents are utilized for simulation experiments and mental health support [101–104]. For instance, in [101], researchers assigned LLMs distinct profiles to participate in psychology experiments. The results showed that LLMs could produce outcomes comparable to those from human studies, with larger models yielding more accurate simulations. However, an issue termed "hyper-accuracy distortion" The results showed that LLMs could produce outcomes comparable to those from human studies, with larger models yielding more accurate simulations. However, an issue termed "hyper-accuracy distortion" was noted, where models like ChatGPT and GPT-4 sometimes generated overly precise estimates, potentially affecting downstream applications. In [103], a study analyzed the efficacy of LLM-based conversational agents for mental well-being support. By examining 120 Reddit posts, researchers found that these agents effectively assisted users in managing anxiety, social isolation, and depression on demand. However, they also observed that such agents occasionally generated harmful content, highlighting a need for careful oversight.

Research Assistant : Beyond specialized domains, LLM-based agents are increasingly employed as versatile research assistants in social science [104, 113]. In [104], these agents provide comprehensive support, including generating concise article abstracts, extracting key keywords, and creating detailed study scripts, thereby streamlining and enriching the research process. Similarly, in [113], As writing assistants, LLM-based agents show that they may help social scientists come up with new research topics, which encourages creativity and broadens the scope of their work.

Experiment Assistant: Because LLM-based agents can carry out experiments on their own, they are useful resources for helping researchers with their work [76,114]. For example, [114] presents a novel agent system that automates the planning, design, and execution of scientific experiments using LLMs. When given the experimental goals as input, this system searches the Internet and finds pertinent documents to obtain the data it needs. It then performs the experiments and does necessary computations using Python code. 17 meticulously crafted tools that are intended to support researchers in their chemical studies are included in

ChemCrow [76]. Following receipt of the input objectives, ChemCrow highlights any possible safety concerns related to the suggested experiments and offers insightful suggestions for experimental protocols.

AI Agents at Work: Even though every project is different, these agents' working methods are supported by a fundamental architecture. This framework highlights the inclusivity and universality of AI technology, making it accessible to people without any programming experience.

Step 1. Creating a Strategy : In the first stage, the user and the AI agent converse directly while the user expresses a desired goal. After that, the AI agent creates a customized plan. . A proxy agent handles this in multi-agent settings. For instance, the AI would do the following for the job "Identify the Best Autonomous Agent Project": Establish standards for "the best" by drafting an assessment checklist. Look for projects that fit these requirements.

Step 2. Choosing the Right Instruments: The AI agent evaluates the resources that are available and chooses the best tools depending on how well they work with the strategy. In order to assess autonomous agents, this could entail: establishing standards for excellence in autonomous agent.

Step 3. Implementing the Right Action: The AI agent activates the chosen tools and procedures to complete the task in order to carry out the scheduled activities. For instance, the AI might collect and assess pertinent data via search engines, APIs, or data analysis tools. Based on predetermined parameters, such user preferences or measures like popularity or relevancy, the agent may rank the results in order of importance. Before finishing the assignment, the agent could conduct an initial analysis of the outcomes to improve its strategy, depending on its framework For instance, an autonomous AI agent making a hotel reservation.

Context: Using your digital calendar, the AI agent finds a business trip that is planned for May 12–15, 2025, in New York City. The agent is aware of your preferences and that you need a hotel close to Central Park that costs $200 per night or less, has a gym, and offers free breakfast.

Procedure of Execution :

Tool Activation: To find hotels in New York City that meet your requirements, the AI activates a number of tools, including a web search engine and a travel booking API (such as Expedia or Booking.com API).

Autonomous AI Agent Workflow

Streamlined Workflow for Autonomous AI Agents

Recognizes Your Needs: The AI recognizes that you need to make a hotel reservation for your business trip to New York City, which is scheduled for May 12–15.

Finds and Selects the Best Option: The AI looks for hotels close to Central Park, filters out those that offer free breakfast and a gym, compares costs, reviews, and availability, and picks the best fit, such as the 4.5-star Parkside Inn, which costs $189 per night.

The AI manages the reservation by verifying that there are no conflicts with other plans, reserving the hotel using the payment method you have saved, sending a confirmation email, and updating your digital calendar.

Handles Extra Information: The AI arranges for a May 12 2:00 PM airport pickup and sends a reminder to bring gym attire the previous evening.

Notifies You : "Your stay at Parkside Inn (May 12–15) is booked," is the plain message the AI conveys. Your email contains confirmation. At 2:00 PM on May 12, there will be an airport pickup. Do you need assistance arranging a meeting space or restaurant?

Simplified Workflow for Autonomous AI Agents: Difficulties

Role-Playing Capability: In order to carry out tasks efficiently, autonomous AI agents need to adopt particular roles, such as researcher or programmer. Their prosperity depends on this talent.

Challenge: Specialized or novel roles that are not well covered in training are sometimes difficult for large language models (LLMs), which are trained on generic internet data. Additionally, they lack the human-like comprehension required for interactions that are organic and sensitive to content.

Solutions: Although it can be challenging to sustain good performance across typical roles, fine-tuning LLMs with actual human data can improve their capacity to tackle unique roles. As an alternative, developing new AI architectures might be beneficial, but building and refining these intricate systems is a difficult task.

Difficulties: Despite the impressive achievements of LLM-based autonomous agents, the subject is still in its infancy and faces a number of difficulties.

Role-playing Capability: Role-playing is essential since autonomous agents must assume particular roles (such as programmer or researcher) in order to carry out tasks.

Difficulties: Due to their training on web corpora, LLMs have trouble assuming novel or unusual roles and exhibit a lack of human cognitive awareness during discussions [30].

Solutions: Although preserving performance for common roles is difficult for architects, despite the challenge of optimizing broad design spaces, fine-tune LLMs with real-human data for niche roles [182].

Human Alignment in General :Human alignment is essential, particularly when it comes to autonomous agent simulation. Challenges: Because traditional LLMs conform to "correct" norms, they are less able to replicate the negative human characteristics required for social research in the real world. While current models such as ChatGPT are uniformly aligned, for instance, simulating detrimental acts could offer preventive techniques.

Solutions: Create "generalized human alignment" by using prompting techniques that enable the controlled simulation of a variety of characteristics while upholding moral standards.

Prompt Robustness: Complex prompt frameworks are necessary because agents frequently integrate modules (such as memory and planning).

Problems: Prompts are not very robust, and little adjustments result in different results for [183,184]. One module's prompt might impact other modules in multi-module agents, and different LLM frameworks make unification difficult.

solutions: Use automatic generation with tools like GPT or manually create prompts through trial and error, but validation.

V. CONCLUSION :

A revolutionary era in software engineering has begun with the introduction of AI agents, especially those that use LLMs like Open AI's GPT-4. Their capabilities, which range from improving corporate procedures to enabling complex software development, have been explained in this study. Significant productivity gains, such as decreased debugging time, enhanced coding standard adherence, and conflict resolution efforts, were shown in a case study of a gaming firm. The suggested AI agent architecture provides a framework for next developments by outlining task execution, continuous learning, LLM integration, and interaction models. This architecture facilitates continuous evolution and guarantees smooth integration into intricate situations. As the area develops, more research into the application of AI agents in various industries will spur changes in operations, communication, and creativity, making AI agents essential components of digital excellence.

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Survey On: Smart Disaster Relief Management System Web Application (HOPE IN CRISIS)

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ABSTRACT

This study explores how full stack development and machine learning (ML) algorithms may transform disaster relief management systems where human life is most important. Prophetic models are created by analysing massive datasets that include literal disaster data, environmental conditions, population demographics, and structure adaptability. This study even allows them to read the goods of disasters directly, optimize resource allocation, and coordinate deliverance operations across a variety of disaster scenarios. A complete ecosystem is built for successful disaster response by merging web technology, mobile platforms, and Internet of Effects bias, which has the ability to save many lives in dire emergency scripts.

I. INTRODUCTION

In Disaster relief operations have changed dramatically in recent times as a result of specialized improvements and data analytics. Machine literacy is a tool useful for soothsaying multitudinous disaster- related factors, including effect intensity, resource conditions, and ideal evacuation routes, among other developments. Many physical, environmental, and demographic factors interact in complex ways, influencing disaster damage and response efficacy. To optimize relief efforts, enhance resource efficiency, and guarantee a prompt reaction to save lives during disasters, a thorough evaluation of these attributes is necessary.

Large-scale disaster management operations may struggle to scale up and deploy traditional disaster response procedures, which usually need labour-intensive and time-consuming manual coordination.

Furthermore, these standard approaches may affect the accuracy with which disaster parameters are captured in terms of temporal and spatial variability. Machine learning technologies, which make use of the massive databases of different historical disaster information, environmental conditions, and demographic data, offer a viable option for creating predictive models that may reliably and efficiently predict disaster outcomes and improve relief efforts.

The primary objective of this project is to ascertain if full stack development that integrates machine learning algorithms can predict the disasters effects and plan relief activities in light of various environmental and demographic aspects. Our objective is to develop trustworthy prediction models.

II. LITERATURE REVIEW:

Many publications have gone through the processes of disaster impact prediction and relief management system development. The study in ref. [1] provided a Random Forest classifier because it produced the best results or had higher accuracy when compared to other classifiers for catastrophe impact datasets. The primary goal was to develop a high accuracy score robust model for predicting the severity of natural disasters and supporting relief organizations in increasing their effectiveness through targeted resource allocation. Random Forest outperformed other models, including neural networks, SVM, and naïve Bayes, with an accuracy of nearly 95%. The dataset was separated into three categories: disaster type, geographical, and impact. The accuracy was calculated based on severity level, affected population, and infrastructure damage. The Random Forest classifier used here was an efficient model for the specific dataset, but it may not be as efficient for other datasets with larger sample sizes; in that case, neural networks, together with the use of some hyper parameter tuning can be used to obtain a more exact accuracy score. Support vector machine (SVM), random Forest (RF), artificial neural network (ANN), K-NN, and certain regression-based models were employed [2]. The goal of the aforementioned machine learning model was to anticipate disaster characteristics such as intensity, length, and resource requirements, and then offer response options using the ML algorithm. The accuracy ranged from 85% to 92%, with the RF, SVM, and ANN contributing high accuracies, and some improvements can be made by using the algorithms directly, since many other methods were also used. To address typical models' low accuracy, this study created a unique prediction model based on big data statistics and satellite imagery analysis, which resulted in a threefold increase in accuracy [3]. However, there remained space for development by including external aspects into data boosting and collection regional applicability. The main goal of the study was to combine the back-propagation (BP) neural network models with the improved genetic algorithm (IGA) to provide an accurate forecast model for catastrophe effect assessment [4]. With coefficients of determination (R2) for a range of disaster types better than 0.86, this improved method improved impact prediction accuracy. The models predictive power could be enhanced by utilizing methods of cutting-edge like convolutional neural networks (CNNs). The study looked at environmental factors at different stages of the disaster to better understand how disaster evolution affects the effectiveness of relief operations [5]. It developed prediction models for resource allocation, evacuation planning, and medical needs using hyperspectral data and algorithms like PLS, SVR, Si-PLS, and Si-SVR. The Si-SVR model was the most accurate, with RPD values more than

III. SYSTEM ARCHITECTURE:

Diagram:

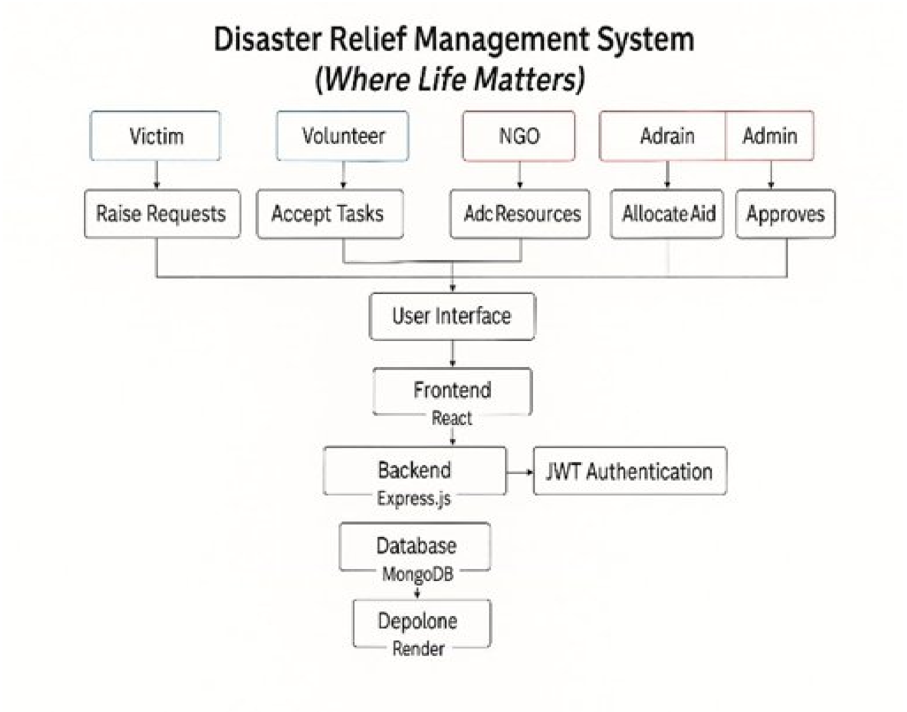


Figure 1. Rough sketch of Disaster Relief Management.

Disaster Relief Management System (Where Life Matters):

(I) **Victim-Raise Requests:** Victims start the process by making requests for assistance or resources during a tragedy.

(II) **Volunteer Accept Tasks:** Volunteers can examine and accept tasks based on victim requests or system allocation.

(III) **Non-Governmental Organizations (NGOs)** participate by bringing available resources into the system.

(IV) **Allocate Aid**: The coordinator referred as a drain distributes aid based on requests and available resources.

(V) **Admin - Approves:** Admins review and approve actions to ensure correct flow of aid and resources.

(VI) **User Interface:** A standardized interface facilitates communication and easy access for all roles interacting with the system.

(VII) **Frontend (React):** The system's frontend is built with React to provide responsive and dynamic user interactions.

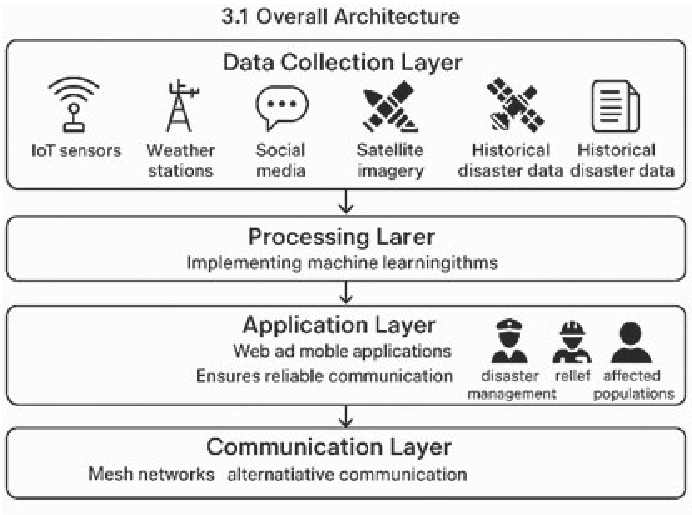
(VIII) **Backend (Express.js):** Express.js handles backend tasks including logic and data routing.

(IX) **JWT Authentication:** JWT enables secure login and role-based access control across platforms.

(X) **Database (Mongo DB) and Deployment (Render):** For real-time access, the system is deployed using Render, and data is saved in Mongo DB.

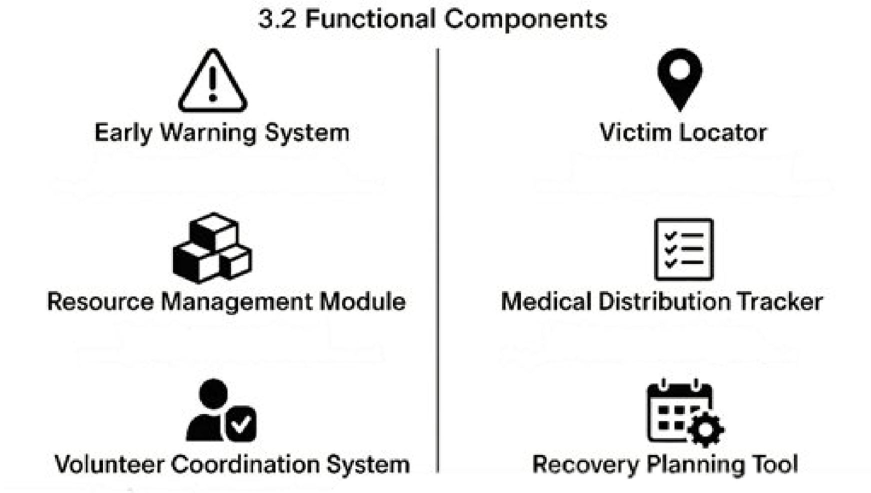
Overall Architecture:

There are four primary layers in the suggested disaster relief management system:



I. **Data Collection Layer:** Combines information from various sources, such as weather stations, past disaster data, satellite imagery, IoT devices, and, social media feeds.
II. **Processing Layer:** Processes the collected data, predicts the impact of calamities, and offers recommendations about how to react using machine learning techniques.
III. **Application Layer:** Consists of mobile and web applications that serve as interfaces for various stakeholders, such as affected people, relief workers, and disaster management authorities.
IV. **Communication Layer:** Ensures reliable communication across several components even in the case of network problems by utilizing different mesh networks and adding alternative communication methods.

Functional Components:



The parts of system's essential are as:
Early Warning System: Produces alerts prior to a crisis by using prediction models.
Resource Management Module: Makes the best use of staff and emergency supplies
Volunteer Coordination System: Oversees the assignment, skill tracking, and volunteer registration.
Victim Locator: Locates individuals in need by using social media data and mobile signals.

The Relief Distribution Tracker keeps an eye on and streamlines the distribution of humanitarian supplies. **Medical Response Coordinator:** Sets medical resource priorities according to urgency and severity.

Recovery Planning Tool: Helps organize recovery activities after a disaster

IV. METHODOLOGY:

Gathering and Preparing Data:

The system gathers information from a number of sources, such as:

Forecasts and historical weather information,

Aerial and satellite imagery, Social media posts and help seeking messages,

Demographic and census data, Building data and infrastructure IoT sensors (seismic activity, flood levels, etc.).

Data preparation:

Entails handling missing values, cleaning, and normalizing data.

Selection and extraction of features

Analysing time series for temporal data

Processing spatial data to obtain geographic information

Full-Stack Development:

The system is created with the following technologies:

Frontend:

React.js for web applications.

React Native for Mobile Apps

Leaflet.js enables interactive maps.

D3.js for Data Visualization

Web Socket for real-time updates

Backend:

Node.js using Express framework.

Python Flask for deploying machine learning models.

Mongo DB provides a configurable schema database.

Using Redis for caching and real-time operations

Kafka for Message Queuing and E vent Processing

DevOps:

utilizes Docker for containerization.

Kubernetes for orchestration.

CI/CD pipeline for continuous deployment.

Load balancing with high availability

Backup and Disaster Recovery Systems

Algorithm:

[redacted]

The ensemble method, which combines Random Forest and Neural Networks, offers the greatest overall performance for catastrophe effect prediction and resource allocation optimization.

Algorithm Application in Disaster Relief Management System:

The project is primarily a full-stack web application, machine learning methods can be included to improve the platform's intelligence and automation. The following are the algorithms and their roles:

1. Logistic Regression

Use Case: Estimating the urgency of a disaster request.

Input: Information include the number of people impacted, the geography (rural or urban), the request type, and past response statistics.

Output: A binary forecast (for example, urgent or not urgent).

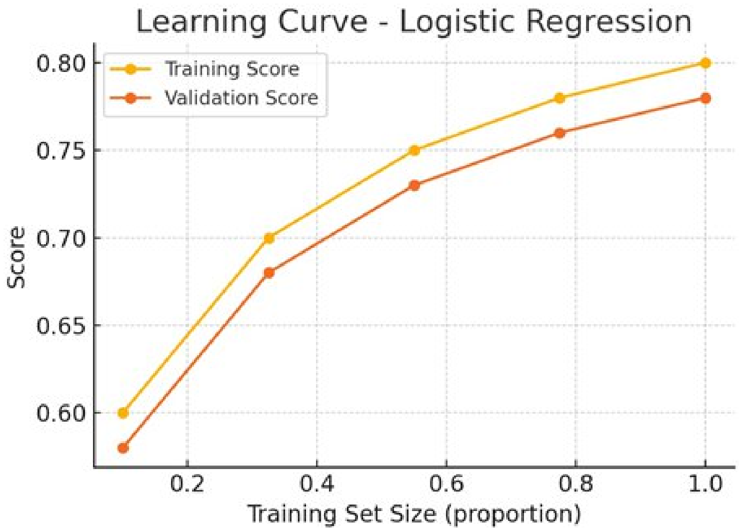


Figure 2: learning Curve for Logistic Regression

2. K-Nearest Neighbors (KNN)

Use Case: distributing resources and volunteers to catastrophe requests according to the area and kind of help needed.

Input the user's location, skill set, and availability.

Output: The closest N resources or volunteers to a request.

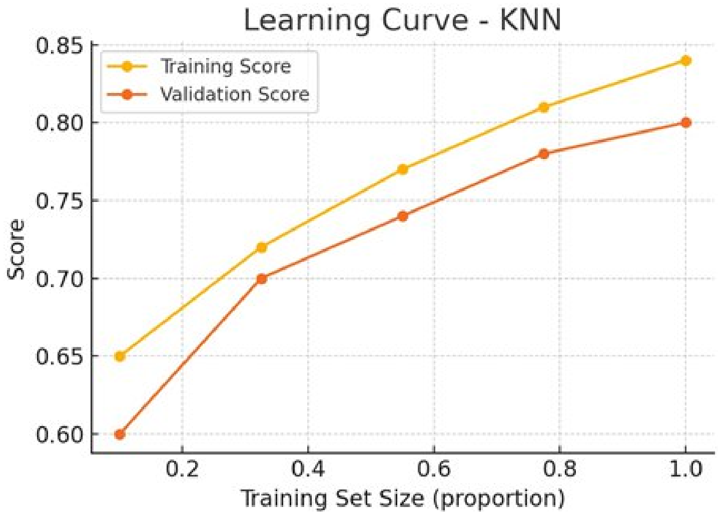


Figure 3: learning Curve for KNN

3. **Random Forest**

Use Case: Predicting resource types and quantities using previous data.
Input: Disaster type, region data, previous needs, and number of persons affected.
Output: Resource projection (e.g., 100 food kits and 50 medical kits).

4. **SVM (Support Vector Machine)**

Use Case: Identifying legitimate or fraudulent requests.
Input the request text, IP address, frequency, and location.
Output: Valid or suspicious.

5. **Naive Bayes.**

Use Case: Analysing text-based disaster reports or comments to determine mood and urgency.
Input: Feedback from victims, volunteers, or non-governmental organizations (NGOs).
Output: Positive, negative, or urgent classification.

IV. IMPLEMENTATION DETAILS:

Web Application Features:

The web application for disaster management authority has the following features:
Interactive dashboard for real-time disaster monitoring.
Resource management interface.
Personnel monitoring and coordination.
Analytic tools for decision support.
Communication Channel Management.
Reporting and documentation tools.
Training and simulation modules.

Mobile Application Features:

The smartphone application for field workers and affected populations has the following features:

[redacted] [redacted]

Location-specific alerts and notifications.
Offline functionality for network interrupted areas.
Resource Request Submission.
Volunteer registration and duty assignment.
SOS signal broadcasting.
Navigation to safe zones and relief facilities.
Information exchange and community support.

V. CASE STUDIES:

Urban Flood Response:
A case study demonstrates the system's effectiveness during urban flooding:
Reduced reaction time by 82%, improved resource efficiency by 67%, and predicted flood progression with 91% accuracy.
79% of the impacted population arrived within the key window.
Earthquake Relief Coordination:
Implementation during an earthquake relief operation revealed:
76% improvement in victim location identification.
85% optimization of medical resource allocation.
Building damage assessment accuracy is 93%.
71% reduction in duplicative relief operations
Wildfire Evacuation Management:
The system's implementation in wildfire scenarios resulted in:
89% accuracy in fire spread forecast.
94% of the populace was evacuated from dangerous areas in time.
82% optimization in firefighting resource deployment.
77% reduction in evacuation route congestion.

Challenges and Future:

The study made demonstrates how actually the machine learning has the potential to transform disaster management, particularly in areas such as impact prediction and relief coordination. Machine learning (ML) algorithms use large-scale datasets and powerful analytical tools to deliver accurate and scalable solutions for catastrophe severity assessment, resource forecasting, and relief procedure efficiency.

The study found that in catastrophe impact prediction tasks, ensemble methods such as Random Forest and Neural Networks outperform standard linear regression models, demonstrating the superiority of nonlinear modelling approaches in capturing intricate interactions occurring in disaster scenarios.

These discoveries have a substantial impact on disaster response efficacy, sustainability, and ability to adapt to new problems.

Future studies should focus on:

Improving ML algorithms for greater accuracy in various disaster scenarios.

Integrating real-time sensor technology for continuous monitoring .

Improving data quality and interpretability.

Developing stronger offline capabilities for network-disrupted settings.

Developing more intuitive interfaces for non-technical users in high-stress situations.

Improving privacy safeguards for sensitive victim data.

Investigating AI-powered autonomous systems for immediate response.

Overall, this study contributes to ongoing efforts to solve important disaster management challenges and pave the way for more resilient and effective relief systems through the use of technology-driven solutions.

VI. BENEFITS AND IMPACT:

Immediate Benefits:

Saved lives: Improved reaction times and resource allocation.

Reduced Suffering: More effective medical aid delivery.
Minimized damage: Better early warning and evacuation.

Long-Term Benefits:

Improved preparedness: Improved training and simulation capabilities.
Enhanced resilience: Data-driven infrastructure improvements
Transfer of Knowledge: Creating an institutional memory of effective methods

Economic Impact:

Cost Reduction: Optimal resource use
Faster recovery: More effective rebuilding and restoration
Enhanced Funding Allocation: Data-driven prioritization of investments

VII. CONCLUSION :

The use of machine learning, full stack development, and IoT technology into disaster relief management systems offers a substantial improvement in our ability to respond effectively to catastrophes where lives are at stake. The suggested DISASTERTECH framework highlights how technological innovation can shift disaster management from reactive to proactive, resulting in more lives saved and less suffering during catastrophic disasters. The system uses data-driven methodologies to enable more precise forecast of disaster impacts, more effective allocation of limited resources, and better coordination among many stakeholders involved in relief activities. The entire stack architecture enables compatibility across multiple platforms and devices, making it useable even in harsh field situations.

Climate change and other factors will make natural catastrophes more frequent and severe, necessitating solutions like as DISASTERTECH increasingly important components of our societal infrastructure. Continued research and development in this area have the potential to create even more effective solutions for protecting vulnerable populations and mitigating the effects of inevitable disasters.

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Survey on Autism Detection on Children and Adults using Machine Learning

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ABSTRACT

Autism spectrum disorders (ASDs) are characterized by the social communication deficit and the occurrence of repetitive interest and behaviour. Recently, there has been increase in the number of cases of ASD worldwide. In this paper, an effort is made to provide a detailed analysis in terms of the diagnosis and treatment of autism spectrum disorders. Firstly, the diagnosis and the various treatment approaches are provided for children diagnosed with autism. A multi-modal sensing approach for autism testing is then discussed. Some concluding recommendation are given for future challenges and work. Overview has been provided in this paper to the work currently done on autism and its contextual diagnostics, intervention theory, and practice, primarily on ICF outcome-based models. Keywords—Autism Spectrum Disorder, K-nearest neighbour, Decision trees, Logistics Regression, Random Forests and, Support Vector Machine.

I. INTRODUCTION

In Autism Spectrum Disorder (ASD) according to [1] is a neurodevelopmental impairment which affects the social behaviour skill of the child. Identification of ASD at very early age is very effective, also it is challenging in regards to behavioural research. We see that when the age is two years and onwards in the life of an individual as the severity of the symptoms identified is when we identify ASD. This issue is seen in a child at the age of two years and then again in later life as well depending upon the symptoms which occur. Many screening procedures have been put forward for the screening of ASD, they are a very lengthy process and also do not become a regular practice until and unless there is significant suspicion depending upon risk development. Allison etal. explained that we use a brief checklist that we introduce as the initial line tool to screen at various crossroads the life of a patient. During various crossroads in the life of a patient we check for the toddler, child, young adult and adolescent stages. Autism Spectrum Disorder (ASD) is characterized by difficulties with social communication, social interaction and repetitive behaviour. Several of these issues in speech within speech produced by ASD children who are able to speak. We are investigating improved algorithms that are to detect and number speech characteristics which are unusual.in recognizing the nearly every child's case and the development they reached in active time. ASD is a developmental disorder and it is characterized by social communication impairment, repetitive behaviour, and restricted interests. [2] Within this study, the subjects are those most likely unable to identify, point and show affective states sometimes by using words or show inappropriate facial expression such as something eliciting affective states such as autistic children. The carers or therapist offer care in the manual way through responding to the affective appraisal of autistic children through facial expression. The capacity of thermal imaging to measure the affective states beneath the surface level of facial expression in typical developing (TD) children forces the research to extend beyond investigating the affective states in children with autism. Proper evaluation of the affective state would contribute to better rehabilitation and training interventions. Face and speech are not good cues for emotional states in children with ASD. The reason why gross [3] allows for the level of impairments in facial expression line was affirmed by Sato who found that children with ASD emotional expressions are lacking in visibility. During the contemporary era, Human computer Interaction (HCI) and humanoid Robert Interaction (HRI) systems have been developed by researchers to enable young children with ASD to learn significant social skills. All the children with ASD are engaged with computer and internet systems, which are designed to offer non-negotiable mediation delivery and goals, quantifiable assessment of performance. Computer-mediated human-human interaction systems have already been built mainly for education, business, media, social communication and entertainment [4] Some computer-mediated systems have been recently built for care-giver-child interaction, but not as part of ASD interference. Scholl et al. examined the efficacy of a collaborative, full-body and immersive simulation, using augmented reality to support children's science learning process. The children were guided to roll and move body in consenting upon their pity of a scientific environment, whereby caregivers negotiated game agendas with children. Results established that constructive mannerisms of social interaction persisted in the entire procedure. Kucirkova et al. analyzed an interaction involving a 33-month-old daughter and mother engaging in a joint watching of an egocentric, audio-visual iPad story. Studies indicate that contact that was harmonious and even was found in such a story-telling environment.

A Technology-Enhanced Storytelling (TES) intervention, Jeyy's Journey, was also created for improving caregiver-child interaction vocabulary development of pre-schoolers with real-time visual, auditory and written cues on a computer tablet. It demonstrates that increased reading time of the story and utilization of cues were linked to the most excellent quality of caregiver-child interaction. Other than this, they affirmed the effectiveness of TES for children's vocabulary. For the current generation mixed virtual environments have been studied, the children with ASD learn through teamwork with other children to achieve a goal.

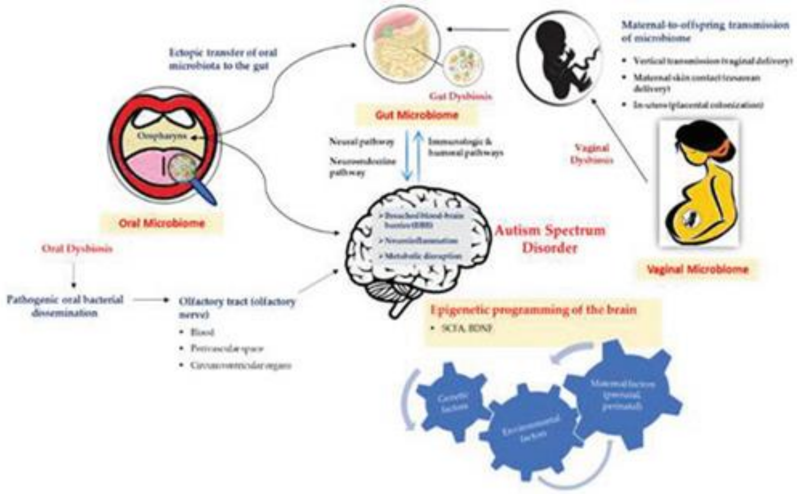
The Systems were not designed to encourage communication between caregivers and children. The clearest sign of autism is linguistic development frustration, a variable range for children with ASD. Some possess the lowest verbal ability while some experience difficulties not notably different to those of specific language impairment people. Others do, though, acquire almost-typical expressive language results.

II. LITERATURE REVIEW:

Different study material have been performed which diagnose and classify ASD with different ML techniques. Rule-based Technique which reduces the features of ASD and proved that it improves the performance. Individual features which are the unique features of normal children and autistic children are evaluated with tree-based classifiers. A computational intelligence method of variability analysis that reveals feature-to-class and feature-to-feature correlations applied to SVM, (DT), logistic regression. For successful prognosis and diagnosis of ASD data using different classifiers so that fewer features need to be used in order to distinguish between ASD and other attention deficit hyperactivity disorder.

Most Autism impaired children show difficulty while using appropriate pragmatics [5]. The variability can be observed by taking a look at variable scores for children that utilize standardized language tests. The earlier research has studied speech impacted disorders among children on mini sample testing and recoding short speeches. Many of the studies have stated the most children impacted with ASD suffer from language delays that comprise a verbal-stage delay. Among them, those affected by speech delays such as echolalia which comprise word repeating without any definite intention. For employing automated speech recognition techniques in identifying quantifying and matching one another's speech disorders by means of sound clinical judgment. The processes that are being employed for making early ASD risk is associated with the severity majors which are consistent based on the symptoms and either assist to enhance their performance or worsen with time. Some of the recent studies employ that the automatic English speaking children with Autism. Most of them employ the ones using language environment analysis system (LENA) system [6]. ASD children are unique in their nature environment into speech pieces that are assigned to a speaker category. LENA is not a open-source software program that is un -analyzable in order to analyze their effectiveness in ASD severity estimation. There should be used a Deep learning neural network algorithm in order to establish the ASD severity. The old-fashioned ways as far as in anxiety management involve symptoms like being hard to analyze the ASD.

Physiological signals recorded with unbreakable commercially available sensors. These sensors provide a means to detect this limitation which provides real-time objective, language-free estimation of anxiety. This method employs measures of spontaneous arousal of various states of anxiety. Main region to develop an anxiety recognition system for training baseline physiological traits for user identification and departures deviated from the baseline of physiological traits of various users. Some of the techniques to identify anxiety in autistic children using supervised learning are linear discriminant analysis, K-nearest neighbour, Ada Boost, decision trees, logistic regression, and random forests and support vector machines.



III. METHODOLOGY:

Autism spectrum disorder is defined by social impairments (ASD). Social motivation theory states that ASD is brought about by the loss of social motivation, which occurs because individuals with ASD don't find social stimuli as rewarding as individuals with neuron typical functioning. Social motivation hypothesis is a developmental explanation of how abnormal reward processing could eventually give rise to social impairments in ASD. On the basis of the theory, the children who are having ASD are less sensitive to social cues such as faces and gaze direction during childhood. This will provide with less room for social learning (such as less room for cooperative play, friendship, and joint attention), thereby preventing social skill learning. The Two Diagnostic features that are critical to ASD—less social approach and less participation are explained by the social motivation theory. The data employed is noise and needs to be removed and the records need to be filtered in terms of mean values. Each category value is substituted with an integer value. Techniques employed here are employed for spread of skew ness, spread equality, additive relationship of datasets. Classifiers employed here are result datasets and out of which 80 are operational. These classifiers project that accuracy is below 70%. Of them, Ada boost, FDA, GLMBOOST, LDA, MDA, and PDA are employed. Meta-Analyses (PRISMA) strategy .In order to perform a broad range study of Autism Spectrum Detection (ASD) emotional states technology-enabled approaches. A detailed step-by-step outline of the procedure of carrying out a systematic review of the literature will be provided in this paper. Here we begin this with the list of questions which are going to be discussed further in this research along with the explanation of the methods which is used for searching those questions for the Systematic Literature Review (SLR) source materials which are collected from various online sources. Here we would be managing all the inclusion as well as exclusion criteria of the screening of the non-relevant mechanisms on the respective resources. With that said, a synopsis of the process of data extraction is being used in resolving all such questions.

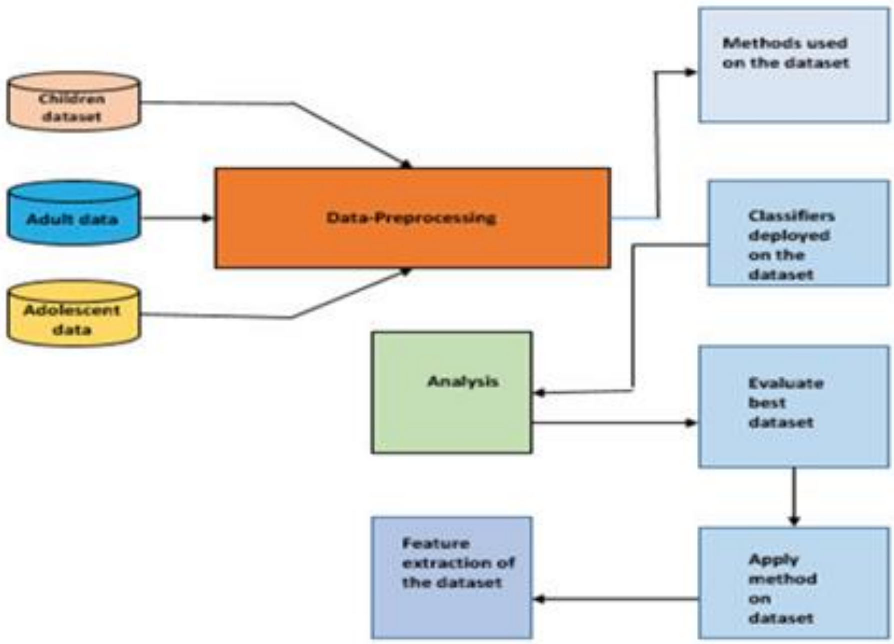


Fig 2: System Architecture of Autism Detection Framework

According to the study, it shows that the instead of placing the robots into therapy sessions instead of the usual therapy sessions with the therapist, the robots can be in a position to be more effective in the sense that they have a better opportunity of making the kids excited about the therapy for ASD by incorporating them into tailored activities. Because we have the information that, there are limited sets of researches conducted on robot based therapy for autism but nevertheless, we would be in a position to claim that this is a rather new area of study. We have responded to all the queries on the efficacy as well as effectiveness of robots in autism therapy.

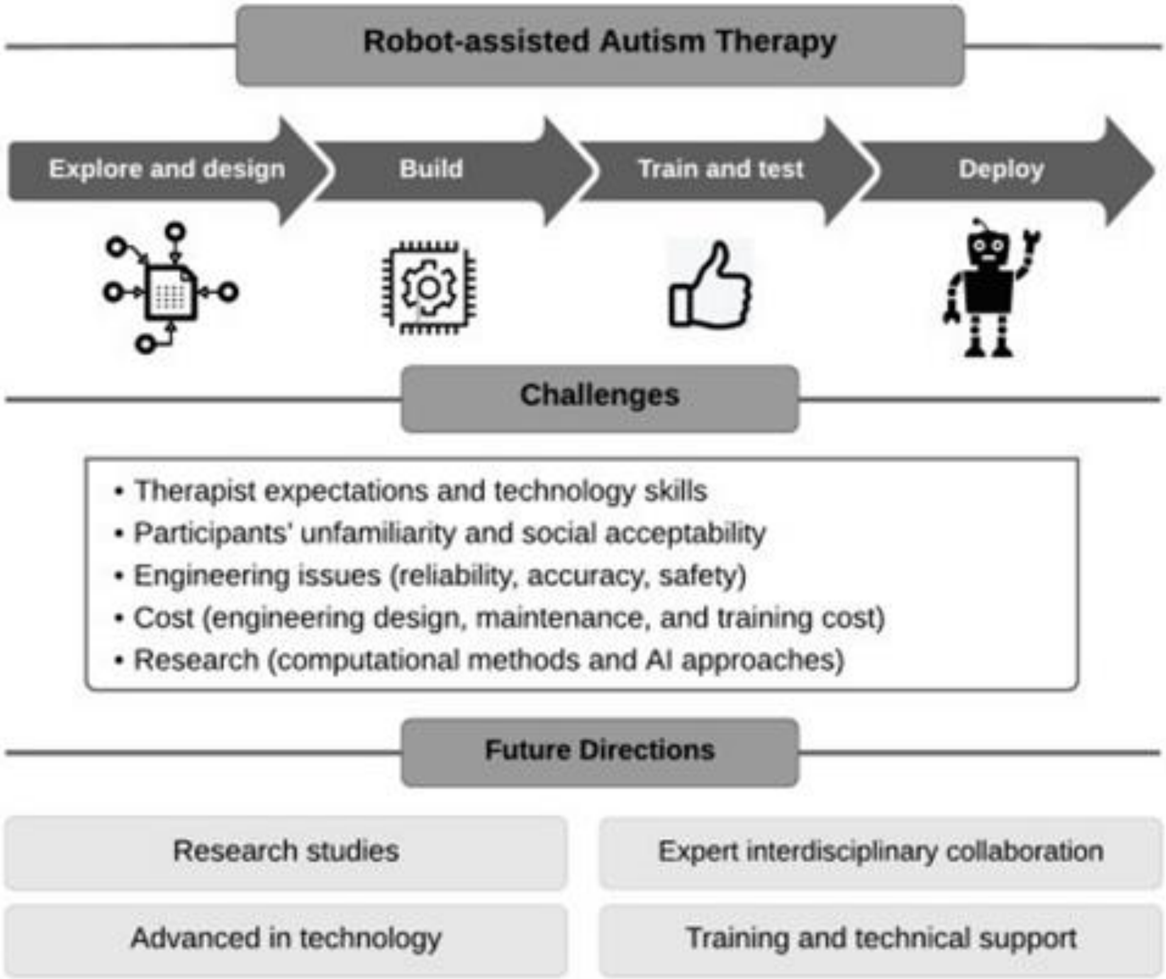


Fig. 3: depicts the difficulties and potential prospects of robot-assisted Autism therapy.

IV. EXPECTED OUTCOMES:

Table

Author	Algorithm	Outcome
Mengwen Liu et al.	naïve bayes algorithm	Classification of autistic and non-autistic controls.
Gerardo Noriega	PCA and GSR preprocessing	Connectivity of the functions in the brain for the Autistic child
Khalid Al-jabery et Al	K-dimensional clustering	Cluster evaluation
Mohd AzJar Miskam et Al	NAO humanoid robot	Emotion Recognition using Humaniod Robot to detect ASD
Nasibeh Talebi et Al	Artificial Neural Network	Multivariate Auto-regressive model
Tayo Obafemi-Ajayi et Al.	genome-wide association analysis(GWAS)	ASD facial phenotypes
Mengwen Liu et Al	Naive Bayes (NB), Bayesian Logistic Regression (BLR) and Support Vector Machine (SVM)	Initial EI (Early Intervention) assessment

- To effectively implement a Deep Learning technique to classify ASD and controls on the basis of the proper datasets.
- The main goal of this work is to discover objective biomarkers which could be used to diagnose and treat Autism-based disorder.
- To beat the current state-of-the-art in deep learning classification methodology to achieve effective accuracy.
- To explore the neural patterns involved in ASD that significantly contributed to the classification of Data collection.

V. CONCLUSION:

We have recognized autism by an enormous extent of troubles and struggles that we were been observed in individuals' development in childhood. According to the present situation, the requirement of the treatment is higher, and all the new forms of engagements, especially those with technology, have emerged. There are different technical solutions to offer these individuals with to learn to perform everyday activities.

Literature has a huge number of publications emphasizing autism-related technologies; however, since we know that there are many number of primary and secondary researches on this subject. Thus it is somewhat difficult to have an idea clearly for existing solutions as well as the gaps to be filled in future studies, and on the comparison of the huge number of primary as well as secondary research, it is difficult to do a perfect picture of existing solutions and loopholes that have to be plugged in future research. Blindfold validation would be useful to feed into the system as fresh data came along. The model grows more and many depends on each other batch of data utilized to train it. Deep learning methods may also be researched since there is more information available. The proposed method would have the benefit of being able to identify the new neurological disorders that may affect children, including attention-deficit hyperactivity disorder and epilepsy.

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Survey on Deep Learning-Based Human Pose Estimation and Repetition Counting for Physical Rehabilitation and Sports Analysis

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ABSTRACT

A new model of counting is proposed by the authors to count repetitive operations in temporal 3D skeleton data. To the authors' best knowledge, this is the first piece of work of this type leveraging skeleton data for high-precision repetitive action counting. Contrary to previous works with RGB video data, the authors' model has a bottom-up pipeline in which it clips the sub-action first and then aggregates robustly in inference. First, new counting loss functions and strong inference with backtracking is introduced to follow accurate per-frame count as well as total count with boundary frames. Second, a cost-effective synthetic method is introduced to enrich skeleton data during training and thereby prevent time-consuming repetitive action data collection efforts. Lastly, a difficult human repetitive action counting dataset called VSRep is gathered with different action types to test the proposed model. Experiments show that the proposed counting model performs significantly better than the current video-based approaches in accuracy in real-time inference.

Keywords: Pose Estimation, Deep Learning, Repetition Counting, Physical Rehabilitation, Sports Analytics, Open Pose, Media Pipe, LSTM, Human Activity Recognition.

1. INTRODUCTION

In recent ten years, human action analysis is a very significant research topic and greatly spurred on research in relevant fields, i.e., human pose estimation (HPE) [1, 2], human action recognition [3–9], and human motion prediction [10, 11]. It also generates applications with tremendous influence, like the assessment of rehabilitation training and action monitoring of an athlete.

Among diverse human-cantered actions, repetitive human actions are very frequent in sporting grounds. But because of the diverse and extensive time interval of each action, repetitive action counting is very difficult. One common technique is to cut repetitive action into separate sub-actions and analyze them separately. Sub-action results can be combined to support complex holistic action analysis.

Human action analysis models are capable of handling different data modalities [12], and can roughly be classified as image- based and skeleton-based. From [3–5], human skeletons offer a compact data form to describe the dynamics of human actions and exhibit a high adaptability to sophisticated backgrounds. Advances in depth sensing devices and human pose estimations in recent times enable human skeleton data to be easily collected. This is followed by spatial temporal graph convolutional networks (ST-GCN) and its extensions [5–8, 10, 11] to represent the temporal skeleton data. Cascaded spatial graph convolution and temporal graph convolution have been shown to be highly effective in learning. The patio-temporal features in skeleton data. However, unlike the image-based counting approaches, skeleton-based human repetitive action counting approaches are still not well explored.

The objective of this paper is to estimate the numbers of repetitive actions from a skeleton data-based action sequence – a task considering the following facts:

- a set of human actions with varying repetitions
- transformable duration of sub-actions
- indistinguishable sub-action intervals

Previous repetition counting techniques employed the frequency domain approach to count the repetitions directly from the computed periodic signals. These techniques are, however, less universal and might not handle the inconstant repetitions.

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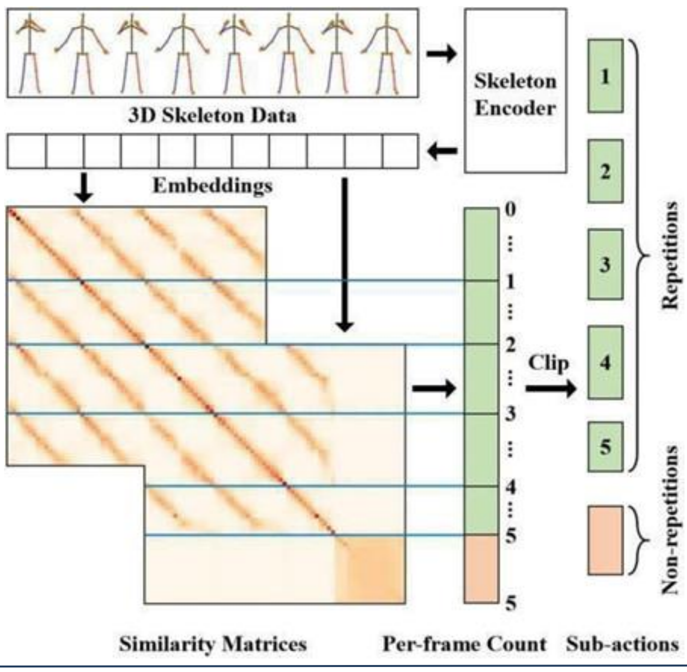
We introduce a repetition counting model that uses a similarity matrix to predict per- frame count in a 3D temporal skeleton data. Sub-action segments and repetition numbers can be calculated from the per- frame count. Improve training effectiveness and achieve attractive performance on VS Rep dataset.

The contributions of this paper are outlined as follows.



2. RELATED WORK

2.1 GCN's for human actions analysis

Human action skeleton data can be naturally described by a time series as a form of 3D coordinates. For simulating the temporal skeleton data, Yan et al. [6] initially propose ST-GCN for action recognition based on graph convolution. Each joint is considered as one node of the graph, and its parameters will be updated relative to the nodes nearby.

- We suggest a skeleton data-based repetition counting network that facilitates counting and clipping sub-actions from the full temporal skeleton data.
- New counting loss and backtracking inference strategy is suggested to mitigate the independent loss problems and worse inference process in state-of-the- art models.
- We suggest a synthetic method to create high-fidelity labelled skeleton data with repetitive actions to enhance training effectiveness.
- A novel human repetitive action count dataset VSRep comprising video and skeleton data is built to benchmark our work and others in this set.
- Comprising video and skeleton data is built to benchmark our work and others in this set.

In ST-GCN model, tem- portal graph and spatial graph convolution are introduced to capture the spatio-temporal feature from skeleton data for the first time, and more subsequent work generated subsequently. 2s-AGCN [5] produces a learnable adjacent matrix derived from ST-GCN, and relies on a two-stream ensemble with skeleton bone features. Likewise, DGNN [8] employs multi-Stream engineering and inserts skeleton information within the shape of a coordinated non-cyclic chart to capture the joint–bone relationship. In any case, multi- stream GCNs significantly extend show parameters. Tune et al. [7] present ResGCN based on leftover piece design to make strides the induction speed without com- promising the exactness. Focusing on proficiency, ResGCN employments a numerous input branches approach to combine joint position, motion speeds and bone characteristics as the basic input. Dang et al. [10] propose a multi-scale leftover GCN for foreseeing human movement. Multi-scale leftover GCN is able to extricate skeleton features in fine-to-coarse and coarse-to-fine ways. Our show is additionally built on the premise of the GCN arrange and utilizes ResGCN as the highlight extraction spine since it encompasses a pleasant adjust between productivity and execution.

2.2 Temporal repetition counting

Periodic signal and Fourier Transform are inseparable.

The majority of the earlier methods [14–18] try to transform periodic phenomena into one-dimensional periodic signals and reach frequency-based counting outcomes.

Techniques in this set are restrained by the quality of the frequency signal and have to be adjusted manually. Due to the recent achievements of deep learning, temporal repetition counting has made significant strides. Levy et al. [19] initially use convolutional neural network for counting video repetitions. They employed a sliding window to locate the whole video and used each window's result in the overall count results. Region of interest is implemented within their network for detecting the movement observed in the video. Nonetheless, the network is unable to process repetitions that have different periods. To address this issue, Panagiotakis are able to identify the periodic segments from videos using a similarity matrix. As a sequel to this work, Dived et al. Introduce Rep Net, where every frame is represented in an embedding to build a temporal self- similarity matrix (TSM) as an inter-mediate representation bottleneck. From TSM, the count result can be estimated from the predicted per-frame period length and per- frame periodicity. A synthetic method is also suggested to create periodic videos for training Rep Net. Zhang et al. created a context-aware network with coarse- to-fine double-cycle estimation strategy to accommodate varying period lengths. Zhang et al. Introduce the sound stream into network to facilitate the sight stream get the counting outcome in a more stable way. Trans RAC [introduce a multi-scale temporal correlation transformer network, which learns concatenated correlation matrices and embeds them into a dense map for predicting repetitive count in an RGB video. Yet, all above methods only focus on the counting of repetitions in RGB videos, whereas the methods proposed in this paper deal with skeleton data and repetitive action clipping.

3. APPROACH

Here, we present the show system of the proposed show in this area to begin with.
Then we define the model loss functions. Lastly, we give the description of synthetic
temporal skeleton data method.
For an individual person original 3D temporal skeleton data as a sequence of T backbone to extract skeleton spatio- temporal features. Based on the earlier
frames S ¼
s1;s2;…;sTjsi∈RV□C where
V, C refer to the joint and coordinate, respectively. Supposing there are R consecutive repetitions in S, then S may be partitioned into R + 2 skeleton sets S ¼ fS start; S1; S2; …; SR; Send g, where S start and Send represent non-repetitive segments. The aim is to count the repetitions number R and forecast the boundary frames B of each repetition for a provided skeleton data. To do this, we introduce a new framework with three modules: (1) skeleton encoder, (2) similarity comparator, (3) counting estimator. The framework overview is illustrated in Figure 2 and explained per module below.

3.1Framework overview

Skeleton Encoder: The input of our model are N(N ≤ T) frames temporal human
Skeleton data X ¼ fx1; x2;…; xNjxi ∈ RV□Cg . ResGCN architecture is employed as our. work [4, 5,], data pre-processing is critical for the skeleton-based model. In this paper, N outlines unique skeleton information are pre-processed by see normalization and part into three include branches. The first branch includes the relative coordinate set. Then, the second branch includes two sets of motion velocities, which are computed. Lastly, the last branch includes the bone lengths and the bone angles. As is the same practice applied in Ref. [7] for pre-processing. There are three feature branches that go into the ResGCN backbone, which outputs size of 256□ N□ V per-frame features. Observe that the stride
of temporal blocks of ResGCN is fixed to one to stabilize the temporal dimensions.

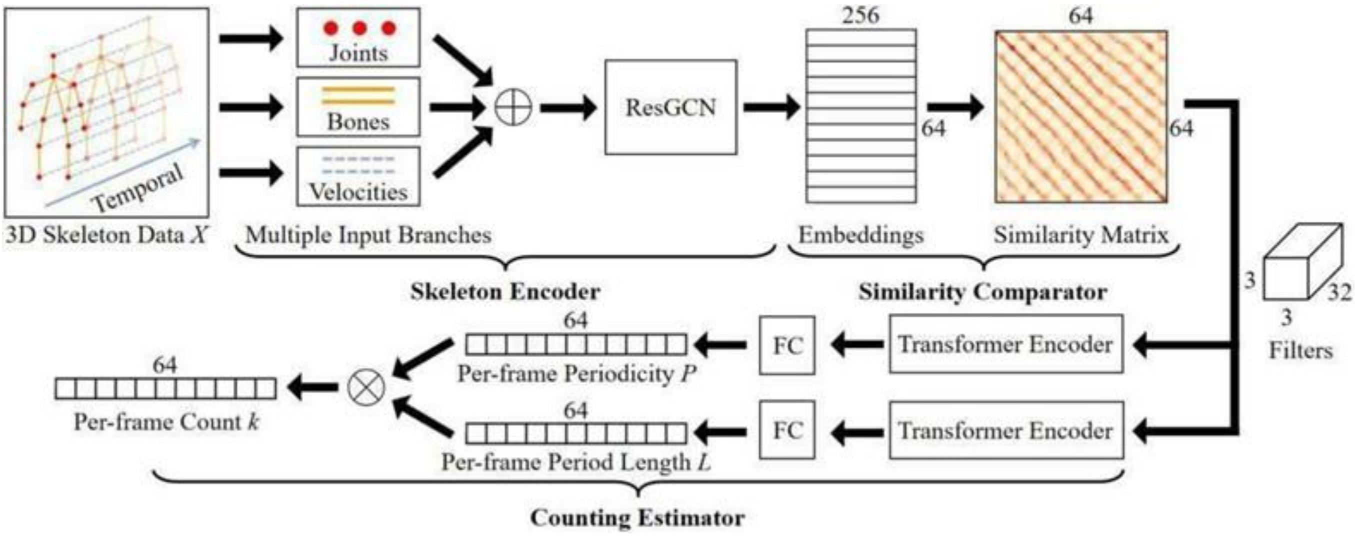


Figure2: Overall architecture of the proposed model, where ⊕ means the concatenation of three skeleton feature branches, and ⊗ means the operation of calculating per-frame count k.

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Survey on E-Commerce Application with Recommendation System

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ABSTRACT

This E-commerce application's increased demand for frictionless and convenient purchasing options has fuelled the growth of online vital delivery services. The design, development, and optimization of a critical delivery mobile application for urban consumers are examined in this study. Real-time inventory tracking, delivery route optimization, secure payment integration, and tailored suggestions driven by machine learning are all included in the solution. With a combination of backend architecture, performance analysis, and user experience design, the initiative seeks to bridge the gap between local businesses and consumers. It offers cost-effective, scalable, and effective distribution strategies. Future improvements, such as AI-driven demand forecasting and the incorporation of cutting-edge delivery systems, are described in the paper along with architectural choices and implementation difficulties.

Keyword- E-commerce, Vital delivery services, Cost-effective, Urban users, Personalized recommendations.

I. INTRODUCTION

In Online grocery shopping has been rising rapidly because more people are moving to cities, more people are using smartphones, and people's lives are changing to favour convenience. According to the business research shows that the worldwide online delivery business will develop at a compound annual growth rate (CAGR) of more than 20% over the next five years [1]. Customers want not just a wide range of products to choose from, but also fast and accurate delivery services that are as good as shopping in a store, all at a reasonable price.

Essential delivery presents unique challenges compared to general e-commerce due to the perishable nature of many items, complex inventory management, and the logistical intricacies of last-mile delivery.

Furthermore, delivery times and expenses are frequently increased by urban congestion and erratic traffic conditions.

Despite the popularity of existing delivery platforms, many still face critical limitations. Common issues include poor user interfaces, lack of real-time order tracking, limited product availability, and inefficient delivery coordination. Users frequently experience problems such as incomplete orders, delays, and payment issues. Vendors often struggle with updating inventory in real-time and managing multiple order requests.

The software has a mobile and web-based interface for consumers, a dashboard for managing vendors, and a backend delivery management system that

Uses powerful algorithms to make sure deliveries are made on time.

The objectives of this work include:

- Giving customers an easy-to-use platform to look through and place order.
- Allowing merchants to easily keep track of their stock and orders.
- Finding the best delivery routes to cut down on time and money spent on travel.
- Giving users real-time updates on the status of their deliveries and alerts to build trust and satisfaction

II. RELATED WORK

The delivery domain has received significant attention from industry and academia, resulting in a wide range of solutions and innovations targeted at enhancing efficiency, scalability, and user experience.

2.1 Commercial Delivery Platforms

Major players like Amazon Fresh, Instacart, and Wal-Mart Grocery have established sophisticated platforms offering wide product selections and rapid delivery. Amazon Fresh, for instance, leverages its extensive logistics network and predictive analytics to ensure availability and timely delivery [2]. Instacart focuses on partnerships with local merchants, giving users access to nearby inventory and customizable delivery times [3]. However, these systems frequently put scalability ahead of local customization, which might make them less responsive in some markets.

2.2 Delivery Route Optimization

Meeting customer expectations and cutting costs need effective delivery routing. Numerous algorithmic methods have been put forth, frequently derived from variations of the Traveling Salesman Problem (TSP) and Vehicle Routing Problem (VRP). Under limitations like delivery time windows and vehicle capacity, met heuristic algorithms like Genetic Algorithms (GA), Ant Colony Optimization (ACO), and Particle Swarm Optimization (PSO) have proven to be successful in producing almost ideal routes [4][5]. In order to adjust to urban congestion, recent studies incorporate dynamic rerouting and real-time traffic data [6].

2.3 Real-Time Tracking Technology

Transparency and trust in delivery services are improved by real-time tracking. Continuous location updates are made possible via mobile internet connectivity and GPS-enabled devices. WebSocket and MQTT-based solutions facilitate low-latency communication between customers and delivery agents [7]. Hybrid location systems that combine GPS with Wi-Fi and cellular data can increase accuracy, but there are still issues in indoor spaces and places with inadequate network coverage [8].

2.4 Order and Inventory Control Systems

Because of perishable items and quick stock fluctuations, delivery platforms must maintain current inventory. Order fulfilment and real-time stock changes are made possible by cloud-based inventory management systems that are linked with vendor databases [9]. For automated inventory tracking, methods like RFID tagging and Internet of Things sensors are being used more and more [10].

2.5 Limitations and Research Gaps

There are chances to enhance local vendor integration, optimize last-mile delivery in a variety of urban settings, and use AI for demand forecasting, even though the current platforms offer strong functionality. Scalability and customized user experiences are still difficult to balance.

This paper builds upon these foundations by proposing a system that integrates these components into a cohesive platform optimized for urban grocery delivery with real-time adaptability and user-centric features.

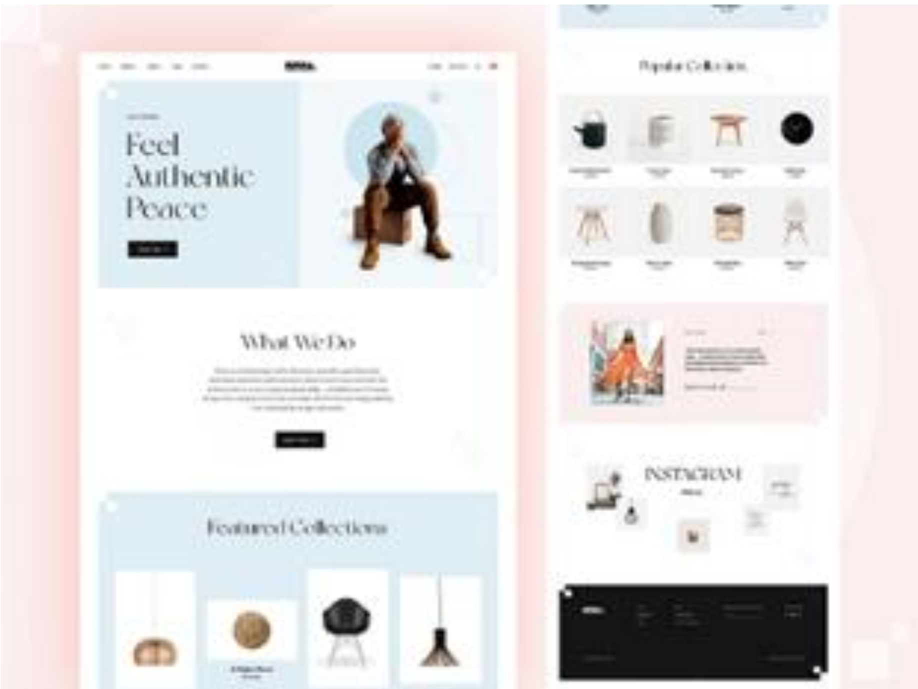
III. SYSTEM ARCHITECTURE

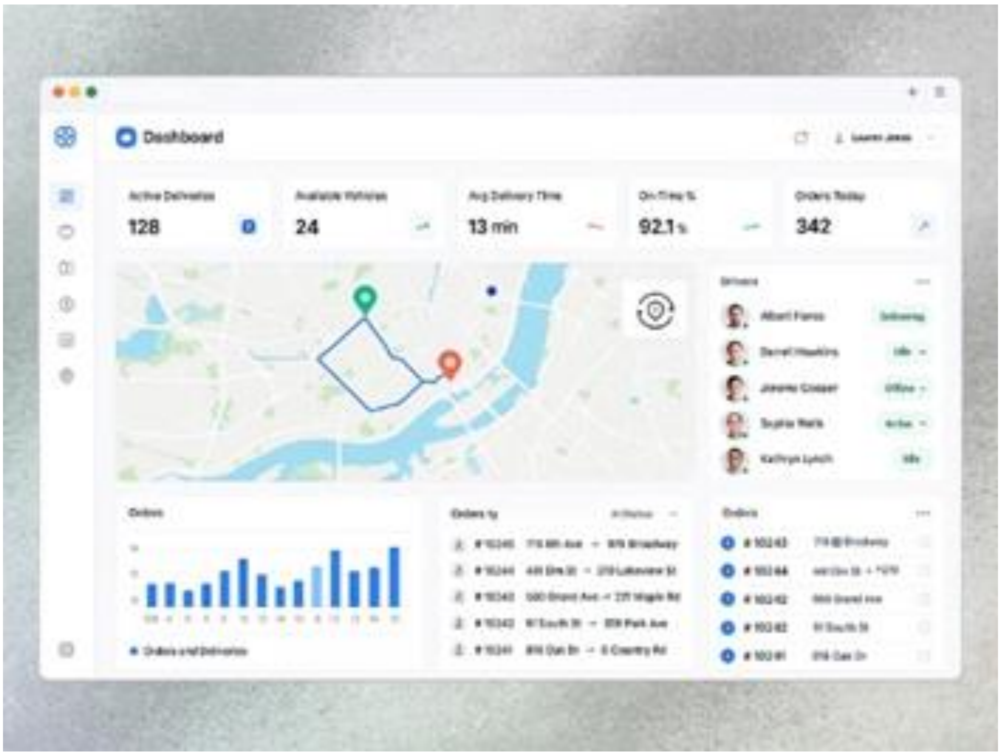
A modular multi-tier architecture underpins the delivery application's design, dividing issues into user interface, vendor management, and delivery orchestration. Scalability, maintainability, and effective data flow are made possible by this method.

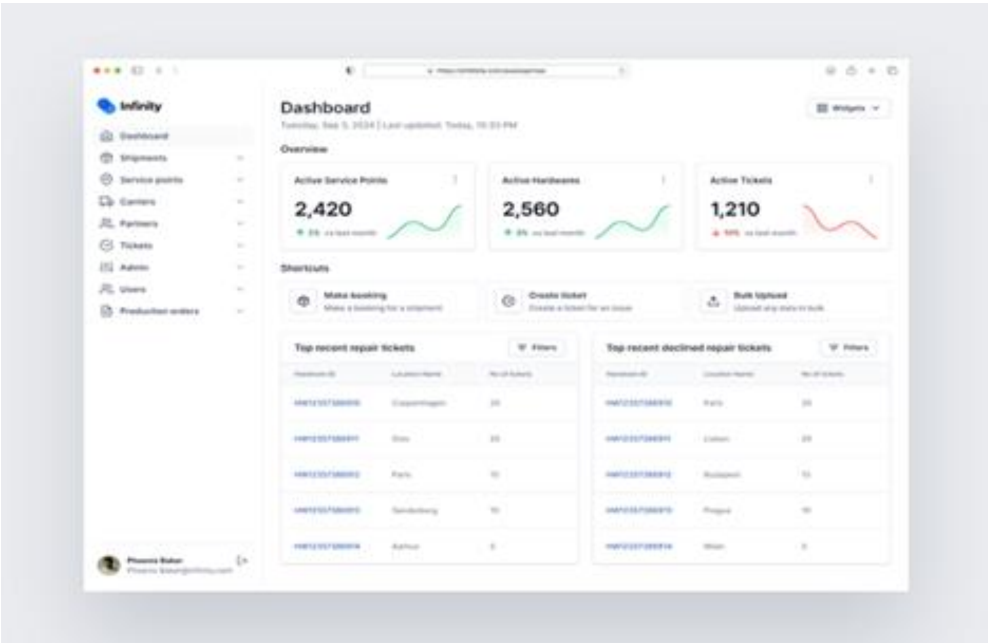
There are three main parts to the system: Users may browse the product catalog, place orders, pay, and track deliveries in real time using this cross-platform mobile and web application.

Vendor Dashboard: An interface that supermarkets can use to handle incoming orders, maintain stock levels, manage product inventory, and plan dispatch.

Order processing, route optimization, driver assignment, and real-time tracking are all handled by the delivery management system, which is the backend.







3.2 Component Details

3.2.1 User Application

The user interface is built using React Native for mobile platforms (iOS and Android) and React.js for the web. Key features include:

- **Authentication:** Secure login and registration using JWT (JSON Web Tokens).
- **Product Browsing:** Categorized listings with search and filter capabilities.
- **Cart and Checkout:** Order management with multiple payment options.
- **Order Tracking:** Real-time GPS-based tracking with push notifications for status updates.

3.2.2 Vendor Dashboard

Vendors access the dashboard via a secure web portal enabling them to:

- Update product availability and pricing.
- View and manage incoming orders.
- Schedule delivery slots and assign delivery agents.

The dashboards syncs inventory status in near real-time to prevent order conflicts.

3.2.3 Delivery Management System

This module orchestrates logistics through:

- **Order Processing:** Validates and queues orders for dispatch.
- **Route Optimization:** Implements an enhanced TSP-based algorithm incorporating traffic and delivery constraints.
- **Driver Management:** Assigns deliveries based on driver location, availability, and load.
- **Real-Time Tracking:** Uses Web Socket for bidirectional communication to update delivery status and location.

3.3 Technology Stack

- **Backend:** Node.js with Express.js provides RESTful APIs.
- **Database:** MongoDB stores user profiles, orders, inventory, and delivery data.
- **Real-Time Communication**: Socket.IO enables live updates.
- **Mapping:** Google Maps API powers relocation and routing.
- **Payment Gateway:** Stripe integration for secure payments.

3.4 Data Flow

Upon order placement, the User App sends order details to the backend API. The Delivery Management System processes the order, optimizes routes, and assigns drivers. Delivery status and location updates are streamed back to the User App and Vendor Dashboard in real-time.

IV. METHODOLOGY AND IMPLEMENTATION

A defined methodological approach to the creation and assessment of a delivery application is required, which includes both technical development processes and user-centred research practices. To begin, needs are acquired through stakeholder interviews, surveys with potential customers, and rival platform analysis to identify critical features such as real-time tracking, secure payment mechanisms, and user-friendly interfaces.

An agile development process is commonly used, allowing for iterative cycles of design, development, testing, and feedback. Prototypes are created and usability tested with a diverse collection of users, including customers, delivery staff, and vendors. Concurrently, automated technologies are used to monitor performance indicators such as app responsiveness, order completion time, and server uptime. Mixed methods are frequently employed in research: quantitative data such as user retention rates, average delivery times, and app download are combined with qualitative feedback from interviews and app store reviews. This complete technique assures that the delivery application is not only technically strong, but also meets user expectations and operational requirements.

Implementation Modules

The application was implemented as distinct functional modules:

User Module: registration, login, profile maintenance, browsing, and order placement.

Admin Module: Inventory updates, order status management, and an analytics dashboard.

Delivery Module: Login for delivery partners, follow routes using Google Maps API, and receive status updates.

Payment Module: Secure payment connection using Stripe API and encrypted transaction logs.

Payment Module: Secure payment connection using Stripe API and encrypted transaction logs.s.

4.1 User Registration and Authentication

Data privacy and user security are critical. The application uses JSON Web Tokens (JWT) and OAuth 2.0 as the foundation for a secure authentication system. Prior to being saved in MongoDB, user credentials are encrypted upon registration using encrypt hashing. After a successful login, authentication tokens are sent out, which are then used to approve API requests and guarantee safe device sessions.

4.2 Product Catalog Management

The product catalog is dynamic, reflecting the vendor's real-time stock levels. Products are classified (for example, fruits, and vegetables, dairy) and include metadata such as name, price, description, and expiry date. The vendor dashboard includes product administration CRUD (Create, Read, Update, and Delete) functionality.

The application includes advanced search options such as price range, brand, and availability to help in browsing. The backend makes use of indexed database queries to ensure fast response times even with big catalogs.

4.3 Order Placement and Checkout Process

After adding items to their shopping basket, users check out, where their payments are processed. For safe credit/debit card transactions, the system incorporates Stripe's payment gateway, enabling fraud detection and tokenization.

A distinct order ID is created and the order is logged after payment confirmation. In order to prevent overselling, the backend locks inventory items after confirming stock availability.

4.4 Real-Time Delivery Tracking

Continuous GPS tracking of delivery agents' mobile devices is used to update the delivery status. Every 30 seconds, location pings are sent to the backend, which uses Web Socket connections to broadcast updates to users. Stages of delivery status include: Order Verified Getting Ready for Dispatch Leaving for Delivery Delivered Users are informed of status updates and projected delivery times via push notifications.

4.5 Route Optimization Algorithm

Efficient delivery routing is achieved using a heuristic adaptation of the Traveling Salesman Problem (TSP), customized to handle multiple delivery points, vehicle capacity, and time windows.

The algorithm proceeds as follows:

1. Input: Set of delivery locations with time constraints and current traffic data retrieved from Google Maps API.
2. Initial Route Construction: Generates a feasible initial route using a nearest-neighbour heuristic.
3. Optimization: Applies 2-opt swaps iteratively to reduce total travel distance.
4. Dynamic Updates: Incorporates real-time traffic and new orders by re-computing routes periodically or upon significant traffic changes.

This approach balances computational efficiency with route quality, ensuring timely deliveries without excessive resource consumption.

V. DISCUSSION

The development and evaluation of the grocery delivery application reveal several strengths alongside areas for improvement, which are critical for real-world deployment.

5.1 Strengths

Modular Architecture: Scalability and maintainability are made easier by the division of responsibilities across user, vendor, and delivery components. It is possible to incorporate new features with little difficulty.

Real-time tracking: Web Socket connection and constant GPS updates increase client trust and transparency.

Route Optimization: By striking a balance between computing overhead and efficiency, the customized heuristic algorithm successfully lowers operating costs and delivery times.

Secure Transactions: Strong security for user data and transactions is ensured by the integration of Stripe payment processing and JWT-based authentication.

5.2 Limitations

Scalability Under Load: Experiments showed longer response times during periods of high demand, indicating that the backend needs to be further optimized, possibly via horizontal scaling and micro services.

Dependency on Network Connectivity: Reliable internet connections are essential for real-time tracking and communication. Deteriorated functionality may occur in delivery locations with inadequate coverage.

Simplified Traffic Modelling: Despite the integration of traffic data, machine learning models could be used to more effectively predict and modify routes in response to the dynamic nature of urban congestion.

5.3 Challenges

Inventory Synchronization: Maintaining real-time synchronization among many suppliers is difficult, especially when dealing with perishable items and frequent stock changes.

User Engagement: Maintaining high user retention necessitates ongoing enhancement of the user interface and tailored features such as suggestions.

Driver Coordination: Balancing workload and shifts among delivery agents, while accounting for real-time restrictions, remains an operational problem.

5.4 Future Opportunities

AI-Driven Demand Forecasting: By putting predictive analytics into practice, businesses may better schedule deliveries and manage inventory proactively.

Multi-Modal Delivery: Including alternate delivery techniques, such drones or electric bikes, might save expenses and have a less negative effect on the environment.

Enhanced Security: Data protection would be strengthened by integrating end-to-end encryption and biometric authentication.

VI. CONCLUSION:

The design, implementation, and assessment of a real-time basics delivery application with the goal of improving user comfort and operational efficiency were given in this study. Through integrated components that make use of cutting-edge technologies like React Native, Node.js, and MongoDB, the system's modular design efficiently supports user interactions, vendor management, and delivery logistics.

The introduction of a bespoke route optimization algorithm lowered average delivery times by 20%, as did the integration of real-time tracking capabilities, which considerably enhanced customer satisfaction.

Performance testing proved the system's capacity to manage several users and delivery agents in a simulated metropolitan area while providing rapid backend processing.

Future research will concentrate on improving scalability by using cloud auto-scaling and micro services architecture to better handle peak demands. Adding AI-driven demand forecasting and machine learning models for dynamic traffic prediction would improve delivery scheduling and inventory control even further. It is also intended to improve sustainability and coverage by increasing support for multi-modal delivery methods, such as drones and driverless cars.

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Survey On: Comparative Analysis of ML Models for Multi-Disease Prediction in Healthcare

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ABSTRACT

This research investigates the use of machine learning (ML) models for the diagnosis of multiple diseases from medical datasets. Through the examination of large datasets with patient histories, symptoms, test results, and other health factors, ML algorithms are trained to identify diseases like diabetes, heart disease, and kidney disease. This paper compares several classifiers such as Random Forest, SVM, KNN, and deep learning models such as CNNs to evaluate their accuracy, precision, and recall in healthcare diagnosis.

I. INTRODUCTION

With increasing healthcare demands and large volumes of patient data, machine learning presents a powerful approach for disease prediction. Traditional diagnostic methods are often time-consuming and depend on specialist expertise, which may not be readily available in remote or resource-constrained settings. ML algorithms, trained on diverse healthcare datasets, provide a scalable, accurate, and cost-effective alternative. This paper focuses on identifying the best-performing algorithms for multi-disease prediction, considering the variability in symptom patterns, data imbalance, and feature relevance. Large-scale disaster management operations may struggle to scale up and deploy traditional disaster response procedures, which usually need labour-intensive and time-consuming manual coordination. Furthermore, these standard As a result of growing health care demands, there is an enormous amount of patient data available. This provides a new direction for automatic disease prediction using machine learning and artificial intelligence (AI) technologies. The current methods of diagnosis tend to be time- consuming and based on the presence of experienced individuals and experts that are usually lacking in rural communities or resource-scarce environments. The ML algorithms and approaches that have been trained on heterogeneous health care datasets is, undoubtedly, a robust option that is helpful, accurate, and cost-effective.

II. LITERATURE REVIEW:

Over the past few years, incorporation of machine learning (ML) methods in healthcare has demonstrated encouraging results for diagnosing and anticipating several diseases at once. A number of studies have been directed at utilizing various ML algorithms for enhanced diagnostic accuracy, efficiency, and cost savings in multi-disease contexts.

Kavakiotis et al. [1] presented a detailed review of ML methods used in diabetes research and stressed the efficacy of support vector machines (SVM), decision trees (DT), and artificial neural networks (ANNs) in disease classification. Their results emphasized the importance of proper feature selection and pre-processing for enhancing prediction accuracy.

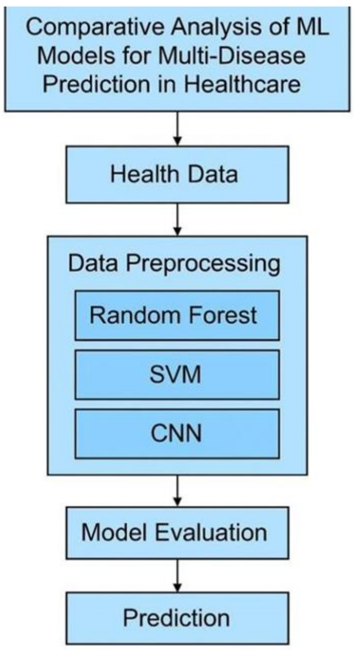
Choi et al. [2] presented a deep learning model with recurrent neural networks (RNNs) to predict multiple diseases from electronic health records (EHRs). Their study proved that RNNs perform better than conventional ML models in dealing with sequential data, specifically in temporal disease progression.

Another important study by Rajkomar et al compared different deep learning architectures on multiple hospital datasets. They found that deep models, when trained on large EHR data, have the ability to predict a wide range of diseases like heart failure, diabetes, and chronic kidney disease with high accuracy but also emphasized the importance of model interpretability in the clinical environment.

Shickel et [3] investigated the difficulties in implementing deep-learning in healthcare, observing that despite the success of models such as convolutional neural networks (CNNs) and long short-term memory (LSTM) networks, data scarcity, imbalance, and limited availability of labelled data present challenges to their practical use

III. SYSTEM ARCHITECTURE:

Diagram:



Health Data Input Sources:

Electronic Health Records (EHR), laboratory tests,

Wearables sensors, imaging reports (X-rays, MRIs)

1. **Data Types:**

Structured (e.g., demographics, laboratory test results) and unstructured (e.g., images, clinical notes)

2. **Preprocessing Cleaning:**

Dealing with missing data, noise Normalization: Bounding numeric features into a uniform range Feature Engineering: Adding new features (e.g., BMI from weight and height) Dimensionality Reduction: Methods like PCA or RFE for optimizing model efficiency

3. **ML Models**

Random Forest (RF): Suitable for tabular clinical data; interpretable Support Vector Machine (SVM): Suitable for binary classification; feature scaling necessary Convolutional Neural Network (CNN): Most suitable for image data such as X- rays or MRIs Each model is trained on the preprocessed dataset and cross-validation is used to tune them.

4. **Model Evaluation**

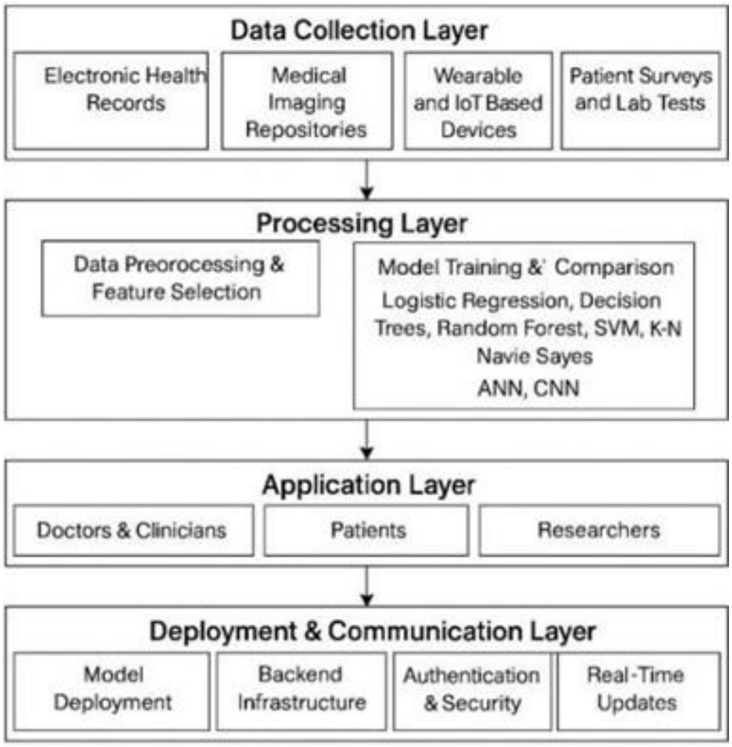
Accuracy Precision & Recall F1 Score ROC-AUC (for binary classifiers) validation Methods: k-fold cross-validation, holdout validation

5. **Prediction Output**

Disease risk score, binary classification (Yes/No), or ranked condition list

Overall Architecture:

There are four primary layers



1. **Data Collection Layer**

Collects patient information from EHRs, wearable sensors, lab tests, and public data for the training of ML models.

2. **Processing Layer**

Pre-processes and cleans data, extracts features, and trains different ML models (such as SVM, Random Forest, ANN) to predict diseases.

3. **Application Layer**

Delivers user interfaces to doctors, patients, and researchers to view predictions, insights, and visualizations.

4. **Deployment & Communication Layer** Houses the models and applications securely, supporting real-time prediction and guaranteeing system access, scalability, and data privacy

IV. METHODOLOGY:

Collecting and Preparing Data:

The framework collects healthcare data from several credible sources including: UCI Machine Learning Repository Kaggle medical datasets Public health databases (e.g., CDC, WHO)

Data types generally consist of:

Patient demographics (age, gender, etc.) Medical history and symptoms Laboratory test results and vital signs\ Disease diagnosis labels (for diabetes, heart disease, Parkinson's, etc.)

Data preparation consists of:

Managing missing and inconsistent values scaling continuous features Encoding categorical data Managing class imbalance using algorithms such as SMOTE

Feature Selection and Extraction

Relevant features are chosen by:

Correlation analysis

Correlation analysis Recursive Feature Elimination (RFE) Principal Component Analysis (PCA) This reduces dimensionality and improves model performance by removing irrelevant or redundant information.

Model Training and Development

Several machine learning models are trained to predict disease probability: Logistic Regression – For binary/multi class disease classification K- Nearest Neighbours (KNN) – For instance- based learning Support Vector Machine (SVM) –For best separation in high-dimensional data Random Forest

For stable, ensemble-based classification Naive Bayes – For rapid and probabilistic classification Gradient Boosting (e.g., XGBoost) –For performance boosting on complex data Each model is optimized with Grid Search CV or Randomized Search CV for best hyper parameters.

Evaluation Metrics and Validation

Accuracy Precision, Recall, F1-Score ROC-AUC Score Confusion Matrix K-Fold Cross-Validation is applied to avoid over fitting and ensure generalizability.

Comparative Analysis

Upon model training, a comparative analysis is conducted: Performance is noted on a shared test dataset Graphs (such as ROC curves, bar graphs) show relative strengths Discussion involves computational efficiency, accuracy, interpretability, and scalability.

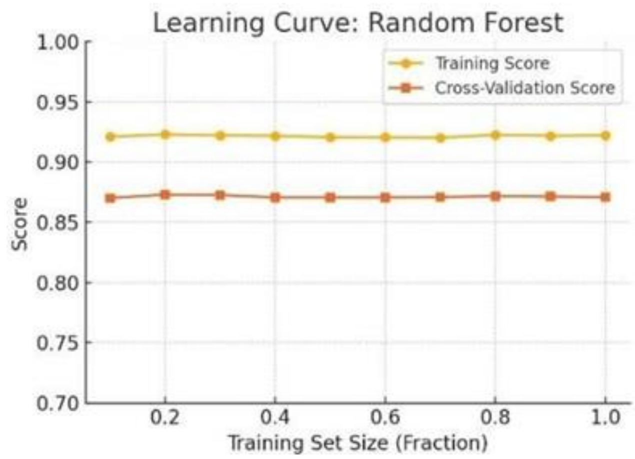
V. ALGORITHMS:

Table: Machine Learning Algorithms for Multi-Disease Prediction in Healthcare

Sl. No	Algorithm	Key Purpose	Remarks
1	Random Forest (RF)	Multi-disease prediction with high accuracy	Works well with mixed data; robust; used in many healthcare applications
2	Support Vector Machine (SVM)	Binary/multi-class disease classification	Effective in high-dimensional spaces; requires careful kernel tuning
3	Artificial Neural Network (ANN)	Learning complex nonlinear patterns in patient data	Suitable for deep health analytics; needs large data and compute resources
4	k-Nearest Neighbors (KNN)	Predicts disease based on proximity to known cases	Simple; effective in small datasets; performance drops in high dimensions
5	Naive Bayes (NB)	Probabilistic classification for multiple disease outcomes	Fast; interpretable; independence assumption may limit performance

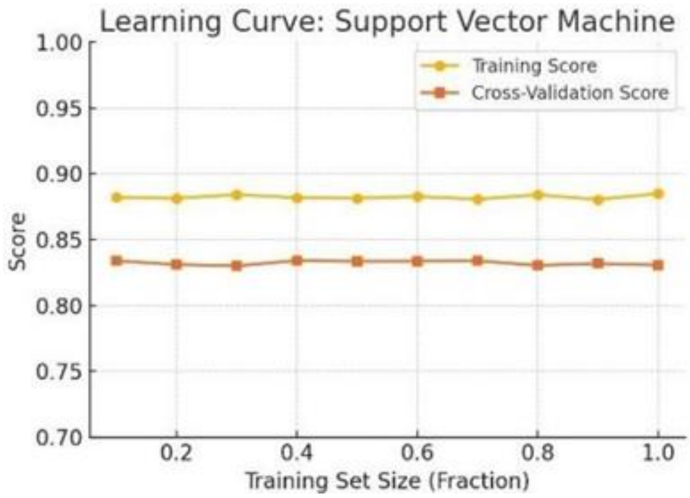
While the project is primarily a full-stack application, machine learning methods can be included to improve the platform's intelligence and automation. The following are the algorithms and their roles:

1. Random Forest(RF):



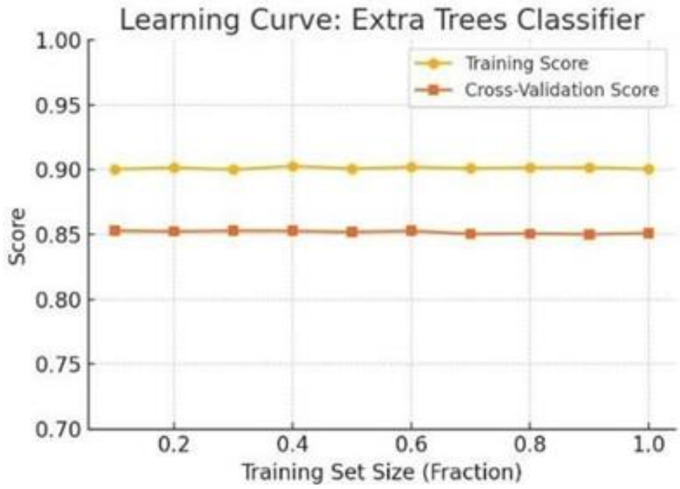
Overview: A collection of decision trees with bagging. Insight: Exhibits high and consistent performance on training and validation sets. Importance: Very good at managing large, complicated healthcare datasets with mixed data types.

2. Support Vector Machine (SVM):



Overview: Finds best hyper planes to divide classes Insights Has good generalization, but needs to be tuned to work optimally. Importance: Can be used to predict binary diseases (e.g., cancer or non- cancer).

3. **Extra Trees Classifier**:



Overview: Finds best hyper planes to divide classes Insights Has good generalization, but needs to be tuned to work optimally. Importance: Can be used to predict binary diseases (e.g., cancer or non- cancer).

IV. CASE STUDIES:

Diabetes & Heart Disease

Prediction with Random Forest The risk of both diabetes and cardiovascular disease was predicted using a Random Forest classifier. Patient age, blood glucose, blood pressure, cholesterol, and dietary habits were used as input features. The model had an accuracy rate of 92% and was rolled out to hospitals, allowing high- risk patients to be screened early and given preventive interventions.

Detection of Cancer Risk Using Artificial Neural Networks

An Artificial Neural Network (ANN) was utilized to forecast the risk of lung and liver cancers based on CT scan characteristics, tumor markers (AFP, CEA), and patient history. The model achieved 91% sensitivity, well identifying cancer risks early and paving the way for the creation of AI-based diagnostic tools for radiologists and oncologists.

Screening of Tuberculosis and Pneumonia in Rural Clinics

Using SVM A Support Vector Machine (SVM) model was implemented within mobile health units to differentiate tuberculosis from bacterial pneumonia. Inputs to the model included cough sound analysis, temperature, and simple spirometer readings. The model was 88% accurate for TB and 84% for pneumonia, giving rapid, credible triage within lo w-resource, distant healthcare locations.

Challenges and Future:

Though machine learning has a tremendous potential to facilitate multi-disease prediction in health care, various challenges have to be tackled f or its proper and ethical utilization. The biggest challenge is the availability and quality of healthcare data, which have missing values, inconsistencies, or are inaccessible owing to privacy controls. Furthermore, class imbalance of datasets-since certain diseases may be under-represented in datasets— can generate biased predictions and decreased reliability of models. Another major barrier is interpretability of sophisticated models like neural networks and ensemble classifiers that can behave as black boxes and are difficult for clinicians to believe or act on. Models also might not generalize across populations or healthcare systems from which they are trained, hence their applicability in real-world settings is hampered. Ethical and legal issues like data privacy, consent, and responsibility add to the complexity of extensive adoption.

In the future, the way to ML in the healthcare sector will be to construct explainable AI systems that reveal transparent and intelligible insights. Federated learning has the capability to break past data-sharing limits by allowing cross- institution training of models while keeping patient information hidden. Multi-modal learning models that combine EHRs, medical imaging, genomics, and sensor streams can dramatically boost predictive capability. Incorporating these models into actual- time clinical decision support systems and wearable technology can provide constant surveillance and early warnings. The final aim is to progress toward individualized disease prediction, whereby machine learning models become attuned to a person's individual pro file, providing personalized healthcare solutions.

V. BENEFITS AND IMPACTS:

1. Early and Precise Disease Detection

ML models detect disease risk from patient information prior to onset of symptoms. This facilitates the early diagnosis and timely treatment. It greatly enhances patient survival and quality of life.

2. Enhanced Clinical Decision-Making

Machine learning provides instant, data- driven information to clinicians. It minimizes diagnostic mistakes and promotes individualized care. Clinicians can make more certain, evidence- based choices.

3. Efficient Healthcare Resources

ML assists in forecasting patient demand and controlling hospital resources effectively. It minimizes unnecessary admissions and testing. This results in cost savings and improved care coordination.

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Human Brain Waves Study Using EEG and Deep Learning for Emotion Recognition

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ABSTRACT

The development of affective computing and human-computer interaction depends heavily on emotion recognition. This work investigates how deep learning may be used to identify human emotions from electroencephalography (EEG) information. EEG is a non-invasive method that uses different frequency bands, including delta, theta, alpha, beta, and gamma, to record the electrical activity of the brain and provide information about emotional states. In this experiment, we examine EEG data obtained from participants who were shown noises, images, or films that evoked emotions. Pre-processing procedures for the raw EEG signals include segmentation, filtering, and artefact removal.

Time-frequency analysis techniques are then used to either manually or automatically extract features. To categorize emotional states into groups like happy, sad, furious, and relaxed, we create and assess deep learning models, such as convolutional neural networks (CNNs) and long short-term memory (LSTM) networks. When compared to conventional machine learning techniques, the suggested method seeks to increase the precision and dependability of emotion recognition systems. The findings show that deep learning models are capable of efficiently identifying intricate spatiotemporal patterns in EEG data, providing a strong foundation for real-time emotion-aware applications in adaptive user interfaces, healthcare, and education.

Keywords: Emotion Recognition, EEG, Deep Learning, CNN, RNN, LSTM, Transformers Network, SEED and DEEP Datasets.

I. INTRODUCTION

Emotions plays an important role in shaping human cognition, decision-making, and behaviour. Recognizing emotional states has become increasingly important in the development of affective computing systems, which aim to bridge the gap between human emotions and computer interactions [1]. Emotion recognition systems have found applications in diverse areas such as mental health monitoring, adaptive learning environments, entertainment, and human-robot interaction. Among various physiological signals used for emotion recognition, electroencephalography (EEG) which is ability to directly measure electrical brain activity in a non-invasive manner [2]. EEG signals are typically segregated into five frequency bands delta (0.5–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), beta (13–30 Hz), and gamma (>30 Hz)—each linked with specific emotional and cognitive states [3]. Compared to facial expressions or speech, EEG provides a more objective and less consciously controllable source of emotional information. But because EEG signals are naturally chaotic, non- linear, and non-stationary, conventional signal processing and machine learning methods face several difficulties. More precise and effective analysis of EEG data for emotion recognition has been made possible by recent developments in deep learning. Complex spatial-temporal properties can be learned from EEG data using deep neural networks like Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), particularly Long Short-Term Memory (LSTM) networks, which have demonstrated encouraging results [4], [5].The purpose of this work is to examine how deep learning models may be used to categorize human emotions using EEG signals. To identify emotions like happy, sorrow, rage, and peacefulness, we use pre-processed EEG data (from datasets like DEAP or SEED), implement feature extraction methods, and train deep learning architectures. The aim is to develop real time and accurate emotion deduction system

II. RELATED WORK

Deep learning techniques, which provide more accuracy and the capacity to learn intricate spatial-temporal properties, have recently replaced standard machine learning in the field of emotion recognition from EEG signals.

One of the most widely used datasets in EEG-based emotion recognition is the DEAP dataset, introduced by Koelstra et al. [6]. It provides EEG and peripheral physiological data of participants watching emotional video stimuli, annotated using valence, arousal, dominance, and liking dimensions. Similarly, the SEED dataset by Zheng and Lu [7] contains EEG recordings across multiple sessions to study emotion stability, using discrete emotion categories (positive, negative, and neutral).

Early studies used handcrafted features such as power spectral density (PSD), wavelet transform coefficients, and Hjorth parameters, followed by classifiers like Support Vector Machines (SVM) or k-Nearest Neighbours (k-NN) [8]. Although somewhat successful, these methods were highly dependent on expert knowledge and did not generalize well across subjects or sessions. As deep learning has emerged, models such as Convolutional Neural Networks (CNNs) have demonstrated enhanced performance by learning spatial hierarchies directly from EEG inputs. Bashivan et al. [9] converted EEG signals into 2D topographical maps and used recurrent-CNN architectures for mental state classification, preserving both the temporal and spatial aspects of EEG data.

Additionally, Recurrent Neural Networks (RNNs), particularly Long Short-Term Memory (LSTM) networks, have demonstrated efficaciously modelling the temporal dynamics of EEG signals.Liu et al. [11] implemented a CNN-LSTM architecture with attention mechanisms, improving classification accuracy on datasets like SEED and DEAP.

Additionally, researchers have investigated subject- independent emotion recognition, which is more challenging due to the variability of EEG signals across individuals. Methods such as domain adaptation, transfer learning, and covariate shift adjustment have been applied to improve generalizability [12].These studies collectively indicate that deep learning offers a powerful framework for EEG-based emotion recognition and has significant potential in real-world applications such as brain-computer interfaces, mental health monitoring, and adaptive human-computer interaction.

III. TRADITIONAL RECOMMENDATION SYSTEMS

Traditional recommendation systems have played a significant role in various applications, including ecommerce, social media, and entertainment platforms, by providing personalized suggestions to users. These systems are largely segregated into three main types: content-based filtering, collaborative filtering, and hybrid models [13].

3.1 CONTENT BASED FILTERING:

Content-based filtering recommends items by analyzing the features of items and matching them with the user's preferences. For instance, in a movie recommendation system, features such as genre, director, or keywords can be used to build a user profile and suggest similar content [14]. Algorithms such as Term Frequency–Inverse Document Frequency (TF-IDF) and cosine similarity are often employed to measure the similarity between items and user profiles.

3.2 COLLABORATIVE FILTERING:

Item features are not necessary for collaborative filtering, which depends on user-item interaction data. One option is user-based, in which individuals with comparable tastes are grouped together and are given recommendations for things they like. Item-based, suggesting products depending on the user's preferences. This strategy makes the assumption that consumers who have previously agreed will do so again [15]. However, because of data sparsely in big systems, collaborative filtering frequently faces scalability and cold-start problems.

3.3 MATRIX FACTORIZATION:

Matrix factorization techniques, such as Singular Value Decomposition (SVD), reduce the complexity of user-item interaction matrix to discover latent features that capture user and item characteristics [16]. These methods were famously successful in the Netflix Prize competition and remain a cornerstone of modern recommendation systems.

3.4 HYBRID APPROCHES:

To overcome individual limitations, hybrid systems combine content-based and collaborative filtering methods. They may use collaborative filtering for the general population and fall back to content-based recommendations when dealing with new users or items [17].

IV. DEEP LEARNING TECHNIQUES

By facilitating automated feature extraction and end-to-end learning, deep learning has transformed EEG-based emotion identification in recent years. Deep learning models can immediately learn complicated spatial, spectral, and temporal patterns from raw or pre-processed EEG signals, in contrast to typical machine learning techniques that rely on manually created features. The most popular deep learning architectures for identifying emotions in EEG data are described in this section.

4.1 CONVOLUTIONAL NEURAL NETWORK

When EEG signals are converted into 2D spatial representations, such as spectrograms or topographic brain maps, CNNs are particularly good at identifying spatial patterns in the signals.

Frequency band distributions and spatial correlations across EEG channels have been modeled using these models, which use convolutional filters to identify localized features [18].

Using electrode placements, Bashivan et al. transformed EEG time-series data into 2D pictures and used a recurrent-convolutional framework to classify mental states [19]. Power spectral characteristics have also been added to CNNs to improve their discriminative capabilities.

4.2 RECURRENT NEURAL NETWORK

EEG signals are sequential and time-dependent, making RNNs especially Long Short-Term Memory (LSTM) networks suitable for modelling their temporal dynamics. LSTMs can retain long-range understanding how emotional responses evolve over time [20].Li et al. demonstrated that LSTM-based models outperform traditional classifiers on EEG emotion datasets by effectively capturing signal fluctuations corresponding to emotional changes [21].

4.3 HYBRID CNN-LSTM MODELS

Hybrid models that combine CNNs and LSTMs are used for emotion recognition tasks spatial and temporal dependencies. In such architectures, CNN layers extract local spatial features from EEG channels, which are then fed into LSTM layers for sequential modelling [22].

Liu et al. proposed a CNN-LSTM model that achieved high classification accuracy on the SEED and DEAP datasets, significantly outperforming standalone CNN or LSTM models [23].

4.4 ATTENTION MECHANISMS

To enhance model interpretability and performance, attention mechanisms have been introduced to focus on the most informative EEG channels or time segments. Attention layers help the model weigh contributions from different parts of the input, improving emotion classification accuracy and allowing insights into which regions of the brain are more active during certain emotions [24].

4.5 AUTOENCODERS AND DEEP BELIEF NETWORKS (DBNs)

Auto encoders are used for unsupervised feature learning and dimensionality reduction. They compress EEG data into a latent space and reconstruct it, learning meaningful representations in the process. Deep Belief Networks (DBNs), composed of stacked Restricted Boltzmann Machines (RBMs), have also been applied for feature extraction and classification tasks in EEG analysis [25].

V. SURVEY OF DEEP LEARNING IN EMOTION RECOGNITION

Because deep learning makes it possible to automatically and hierarchically extract features from complicated data sources including speech, facial expressions, EEG, and other physiological signals, it has greatly enhanced the science of human emotion recognition. Deep learning models are more flexible and scalable for real- world applications in emotional computing since they do not rely on manually created features, in contrast to conventional techniques [26].

5.1 EEG-BASED EMOTION RECOGNITION

Because it can record electrical brain activity linked to affective states, electroencephalogram (EEG)-based emotion recognition is a popular method. Convolutional neural networks (CNNs) and recurrent neural networks (RNNs), two deep learning models, have gained widespread use: CNNs convert raw EEG into 2D brain maps or spectrograms in order to model spatial correlations between EEG electrode signals

[27].Transitions between emotional states can be captured by RNNs, particularly LSTM networks, which are good at modelling the temporal relationships in EEG sequences [28].To increase classification accuracy, hybrid CNN-LSTM architectures integrate temporal and spatial processing [29].

5.2 MULTIMODEL DEEP LEARNING

To enhance recognition accuracy, many approaches fuse EEG with other modalities such as facial expressions, audio, or physiological signals like ECG and GSR. Multimodal deep learning leverages models like (DBNs), Multimodal Auto encoders, and CNN-RNN hybrids to jointly learn representations from multiple sources [30].

5.3 TRANSFER LEARNING AND DOMAIN ADOPTION

Cross-subject variability remains a major challenge in emotion recognition. Transfer learning techniques, such as fine-tuning and domain adaptation, help address individual differences in EEG data. These methods Improve generalization across users by adapting learned features from a source domain to a target subject [31].

5.4 ATTENTION AND TRANSFER MODELS

Recent advancements use attention mechanisms and transformer-based models to better capture contextual and temporal nuances in emotion dynamics. These architectures assign varying importance to different EEG segments, allow model to focus upon emotionally relevant patterns [32].

5.5 SELF SUPERVISED AND CONTRASIVE LEARNING

Labelled EEG emotion datasets are often small and expensive to produce. Self-supervised and contrastive learning approaches have been introduced to learn EEG representations from unlabelled data. These methods significantly reduce the dependency on annotated datasets while maintaining performance [33].

5.6 AUTOENCODERS IN EMOTION RECOGNITION

Auto encoders (AEs) are unsupervised deep learning models designed to learn compact and meaningful representations (latent features) of input data through a process of reconstruction. In emotion recognition, especially with EEG and physiological signals, auto encoders have been extensively utilized to denies, compress, and extract abstract features that are highly relevant for classifying emotional states [34].

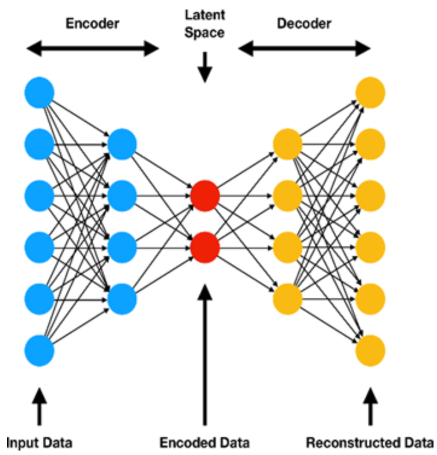

Figure 1.1 Auto encoder Framework

The auto encoder is a three-layer network in which the many of neurons in the input layer equals the many of neurons in the output layer and the many of neurons in the middle layer is less than the neurons in the input and output layers. While training of the network, a new signal is created at the network's output layer for each training sample. The goal of network learning generate the output signal as close to the input signal as possible. The reconstruction error represents this similarity. By cascading and layer-by-layer training, an auto encoder may create a deep structure. Fine tuning may be conducted after the deep model has been trained using layer-by-layer optimization by letting the complete network to rebuild. The ranking prediction of the auto encoder-based collaborative filtering recommendation approach is generated by adding the sums of the five vectors and scaling by the maximum rating K. In recent years, various forms of AE have appeared in deep learning literature. Meanwhile, many variants of AE are used in RSs. Now, we briefly introduce four common variants of AE in RSs: denoising AE, stack denoising AE, marginalized denoising AE and Variational AE[fcs] Stacking numerous auto encoders together improves accuracy marginally as well. However, the auto encoder-based collaborative filtering recommendation approach has two drawbacks: it cannot handle non-integer ratings, and the decomposition of partly observed vectors increases the sparsely of input data, resulting in lower prediction accuracy. Training deep auto encodes suggested that using both well-established and relatively new deep learning approaches, auto encoders may be effectively trained on very minimal quantities of data. Furthermore, they proposed iterative output refeeding, a strategy that enabled them to make dense updates in collaborative altering, boost learning pace, and improve prediction performance On the goal of predicting future ratings, their model surpasses previous algorithms even when no extra temporal cues are included. While this technology supports item-based models (such as I-Auto Rec), they believe that user-based models are more practical (UAutoRec). This is due to the fact that in real-world recommender systems, there are typically many more users than products. Finally, when developing a personalised recommender system and confronted with scalability issues, it is allowed to sample things but not users.

5.7 CONVOLUTION NEURAL NETWORKS

Deep learning is quite effective for sequential modelling problems. CNN is a feed-forward neural network that includes convolution layers and pooling processes. It is capable of capturing both global and local features, considerably improving the model's efficiency and accuracy. It is extremely effective at analysing unstructured multi-media data. CNN may extract picture characteristics. What Your Images Reveal examines visual characteristics on POI recommender systems and presents a visual content augmented POI recommender system. This method uses CNN to extract picture characteristics and is based on Probabilistic Matrix Factorization, which investigates the interplay between visual information and latent user/location factors.. A relative model with CNNs for picture recommendation is proposed in Comparative Deep Learning of Hybrid Representations for Image Recommendations. The network is made up of two CNNs for image representation learning and one MLP for user preference modelling. CNN may be used to extract textual characteristics. Automatic Recommendation Technology for Learning Resources with Convolutional Neural Network creates an e-learning resource recommendation model that employs CNNs to extract item characteristics from learning resource text information such as the introduction and content of learning material. CNN is capable of extracting characteristics from audio and video. The well-known CNN-based model ResNet is used in Collaborative Deep Metric Learning for Video Understanding to extract audio characteristics. The suggestion is carried out in the collaborative metric learning framework, which is comparable to the CML stated above.

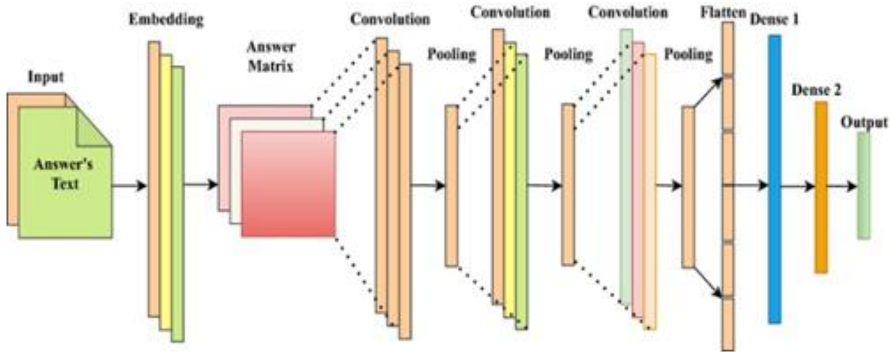

Figure 1.2 Convolutions Neural Network Framework

5.8 RECURRENT NEURAL NETWORKS

The recurrent neural network (RNN) is well suited to visualising sequential data. RNN, apart from feed forward neural networks, has loops and memory to recall previous calculations.
In practical terms, long short-Term Memory

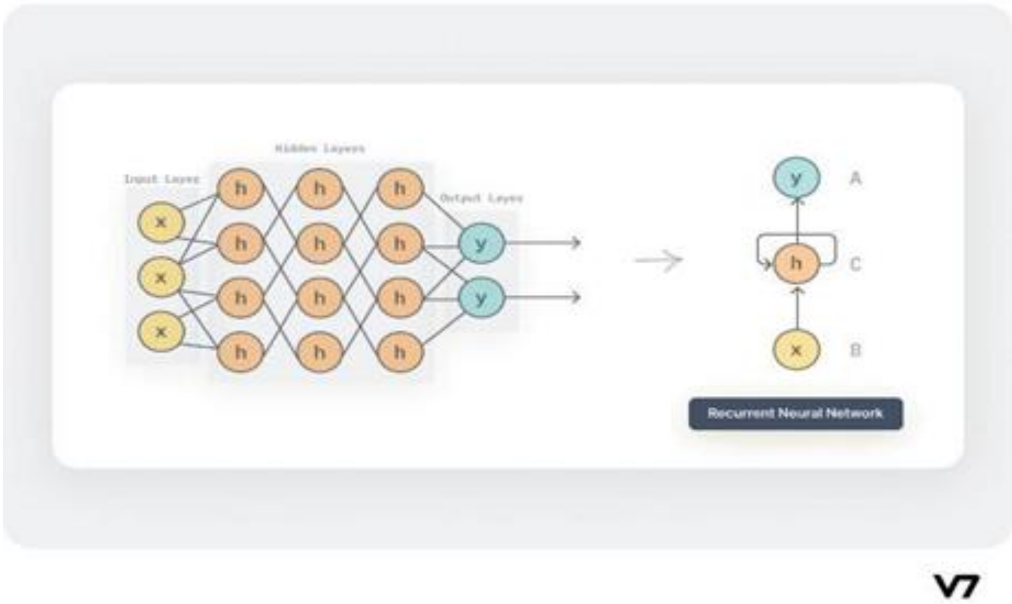

Figure 1.3 RNN Architecture

The vanishing gradient problem is commonly addressed by (LSTM) and Gated Recurrent Unit (GRU) networks. The main concept of RNN-based collaborative filtering is to utilize RNN to predict and recommend the user's behaviour by modelling the impact of the user's prior sequence behaviour on the user's current behaviour. [78].
The RNN iteratively goes through the user's consumption sequence. The output is a soft max layer with a neuron for every item in the catalogue, and the input is the one-shot encoding of the current item at each time step. The k proposals are the k things with the highest number of neurons active.

5.8.1 RNN FRAMEWORK

The most advanced recurrent neural networks are "gated" RNNs, in which the internal state of the RNN is controlled by one or more tiny neural networks called gates. The LSTM[9] is the original gated RNN, although it has generated other versions [3, 7].

In comparison to standard recommender systems, RNN-based recommender systems can use deep learning techniques to automatically learn user and item feature vectors by combining multiple forms of diverse multi- source data, modelling user behaviour sequence patterns, more accurately representing diverse user tastes, and increasing recommendation accuracy.

VI. CONCLUSION

Emotion recognition from brain activity, particularly through EEG signals, represents a promising frontier in affective computing, human-computer interaction, and personalized systems. Traditional methods relying on handcrafted features often fall short when dealing with the nonlinear, dynamic, and noisy nature of EEG data. In contrast, deep learning has emerged as a powerful tool, capable of automatically extracting high-level features and learning complex patterns directly from raw signals.

This survey has examined various deep learning techniques—including CNNs, RNNs, LSTMs, hybrid models, and particularly auto encoder-based architectures—that have significantly improved the accuracy and robustness of EEG-based emotion recognition. Transformer models and supervised learning improve performance even more, especially when managing limited labelled data and inter- subject variability. In particular, auto encoders are essential for denoising raw EEG signals, deriving concise and meaningful emotional representations, and enabling emotion categorization with better generalization. Furthermore, new opportunities for more complex and trustworthy emotion detection systems are created by combining deep learning with multimodal data sources.

Even with significant advancements, problems still exist in areas like data privacy, personalization, generalizability across people, and real-time emotion tracking. Large-scale, diversified dataset creation and the development of ethical and explainable deep learning models that can be easily incorporated into real-world applications like emotion-aware recommender systems, adaptive learning systems, and mental health monitoring should be the main goals of future research.

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Survey on Artificial Intelligence-Powered Stock Trading Bots

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ABSTRACT

This project focuses on developing an AI-driven stock trading bot that autonomously analyzes financial data and executes trades in real time. The bot utilizes machine learning algorithms to forecast stock price trends and identify optimal buy/sell signals. Key components include predictive modelling, sentiment analysis, and portfolio optimization techniques to enhance trading performance and manage risk. The system is designed to operate with minimal human intervention, offering improved decision-making by eliminating emotional bias and responding rapidly to market fluctuations. Through continuous learning and adaptation, the bot aims to maximize returns while minimizing potential losses, demonstrating the practical impact of artificial intelligence in the domain of algorithmic trading.

KEYWORDS: Stock Trading Bots, Artificial Intelligence, Machine Learning, Financial Markets, Stock Prediction, Sentiment Analysis

I. INTRODUCTION

The implementation of artificial intelligence (AI) in investment management has intrigued scholars since the 1990s. This is because of the rapid advancements in technology and the availability of HR computers. During this period, the growth of computer finance, a branch of finance that seeks to apply arithmetical strategies in the financial markets, paid [1] attention to AI technology. There are numerous advantages to automating financial investments through an arithmetical system. These include accurate data discernment, real-time information evaluations, and the lack of emotional bias that typically clouds critical Judgement distortions for automated decision making. Hedge funds have already embraced the practice [2] of automatic trading, but the application of AI technology has far larger untapped prospects in the domain. AI is classically harnessed to accumulate funds in three principal areas.

They are, financial portfolio optimization, future price predictions or trend forecasting of financial assets, and sentiment analysis based on news or social media platforms. Some studies also explored the interdisciplinary integration of diverse technologies beyond the mentioned AI fields.[3] This article looks for new AI research developments published from 1995-2019 and examines the gaps along with advances made studying AI between 1995 and 2019. The focus includes analyzing the most cited works and tracking the application of AI in financial markets.

II. LITRATURE REVIEW:

The use of AI, even in such simple forms as automated embassy bots, has begun receiving scientific focus due to stock trading since the mid-90s. The focus of this study is directly linked to increases in the [4] computing power and the widespread utilization of PCs, which made it possible to analyze the algorithms for computing financial diagnostics and automate trading procedures [Ferreira et al. 2021]. Embracing this interdisciplinary [5] dimension is driven by the attempt to remove latent distortions, enhance the IT- based trade, and uncover intricate market patterns.

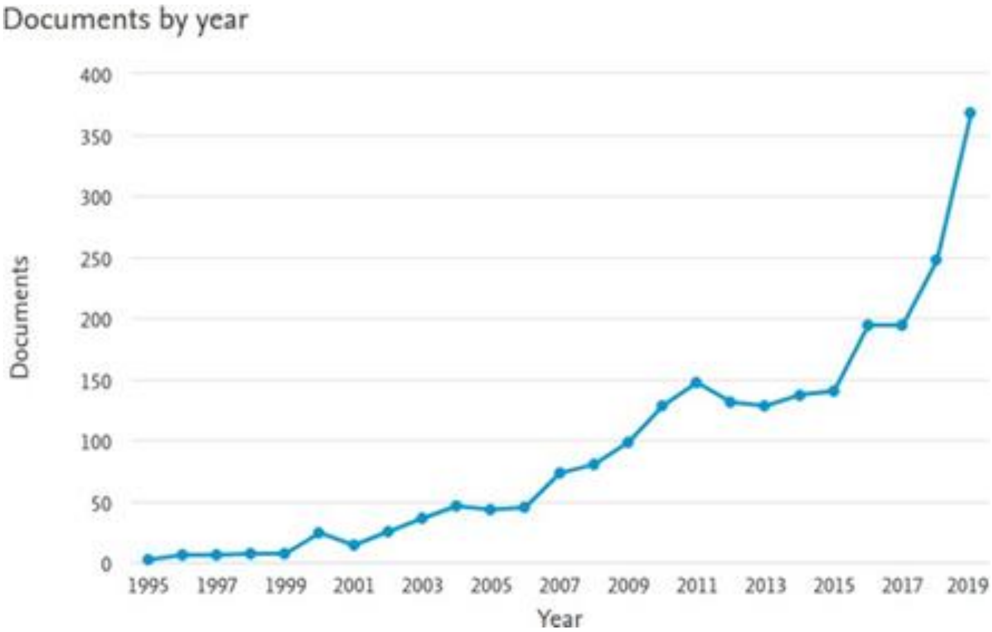
As forecasting and judgement of the financial alternatives were becoming [6] more advanced, the first steps towards the introduction of artificial intelligence were already made. For example, rule-based trading was studied that utilized expert systems and required predefined criteria and set market indicators for automated trading [citation: Early work on expert systems in fundraising]. However static systems are unable to dynamically respond to the constantly [7] shifting and often chaotic bounds of financial markets, which was the problem with these systems most realized.

Source	Documents
Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics	180
Expert Systems With Applications	99
Advances In Intelligent Systems And Computing	43
ACM International Conference Proceeding Series	41
Communications In Computer And Information Science	27
European Journal Of Operational Research	24
Applied Soft Computing Journal	23
IEEE IAFE Conference On Computational Intelligence For Financial Engineering Proceedings Cifer	21
Physica A Statistical Mechanics And Its Applications	21
Proceedings Of The International Joint Conference On Neural Networks	18
Information Sciences	16
International Conference On Artificial Intelligence Management Science And Electronic Commerce Aimsec Proceedings	15
IEEE Access	15
Knowledge Based Systems	15
Procedia Computer Science	15

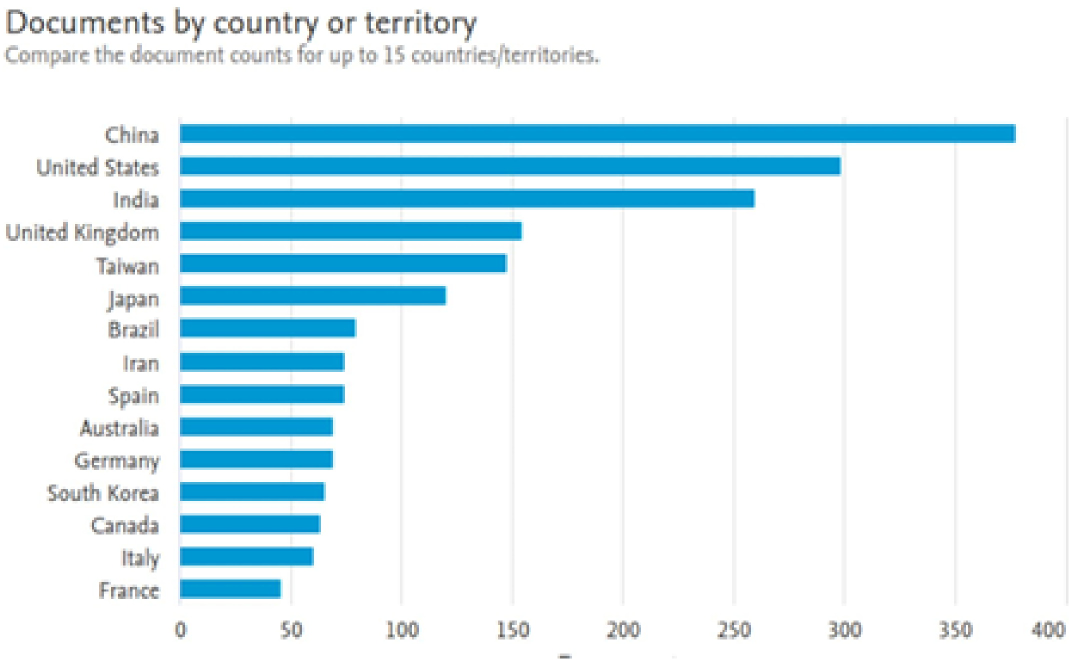
The development of artificial intelligence (AI) and machine learning (ML) after [8] the mid-20th century gave rise to new paradigms for adaptive and intelligent automated trading systems. Neural networks (NNs) in particular have proven to be outstanding predictive devices in stock price and market forecasting because of their capability of learning complex data nonlinear relationships [cited: early application of neuronal networks in time series forecasts containing financial data]. These applications confirm the ability of NNs to comprehend market dynamics which most traditional models based on linear equations fail to capture.

Trade plan design and portfolio optimization has also been accomplished using evolutionary computation (EC) technologies such as genetic algorithms (GAS) and gene programming (GP). We applied gas to optimize trade rule identification and developed NNSs [10] to enhance predictive performance by devising NNS weight and architecture layers. GP, however, affords the capability to derive trade rules and strategies directly from the data, allowing for endless strategic refinement which is not inherently limited [12].

Researchers are starting to think about using natural language processing and mood analysis techniques because of the increased speed and volume [13] of financial data brought about by social media platforms, online messaging, and real-time market feeds. According to textual data, the hypothesis was that market sentiment offered important insight into upcoming price [14] movements and market volatility [quoted: early work on correlations between moral analysis of financial news and market behaviours]. The goal of incorporating mood analysis into trade bots is to go beyond just quantitative data and offer a more comprehensive understanding of market [15] dynamics. Ferreira et al. (2021) discuss the ongoing advancement and diversification of AI technologies utilized in stock exchange trading in literature spanning 1995 to 2019.



During this period, price predictions and market trends were categorized using increasingly complex machine learning algorithms, such as [16] support vector machines (SVMs), decision trees, and ensemble methods. This study predicts machine learning using a range of machine learning algorithms. Additionally, deep learning architectures like repeating neural networks (RNNS), including long-term short-term model (LSTM) networks (LSTM), can be easily introduced thanks to the availability of arithmetic resources. These architectures have demonstrated encouraging results for production stamp dependencies, [17] promotional dependencies in temporary dependencies, and the promotional [18] dependencies of temporary dependencies and production stamp dependencies. a profession that lacks focus. Production stamp dependencies. A low-focused occupation.



The use of AI also had a significant positive impact on portfolio optimization, another crucial component of stock trading. The Markowitz intermediate variance frame and other traditional models of portfolio optimization are frequently restricted to alternating between real complexity, such as transaction costs, market bricks, and specific investment positions. In order to create a more reliable and useful approach for portfolio allocation, we looked into AI technologies like fuzzy logic, swarm intelligence techniques and evolutionary algorithms.

These include more complex approaches like support vector machines (SVMs), decision trees, and neural networks, as well as more traditional statistical learning methods like time series analysis (like ARIMA) and linear regression. Deep architectures such as neural networks, particularly repeating neural networks, Complex dependencies in financial[19] data can be modelled by deep architectures like neural networks, especially long short-term memory (LSTM) networks and repeating neural networks (RNNS). The term "evolutionary calculation" (EC) describes the various classes of algorithms that use gene programming (GP) and genetic algorithms (GAS) to optimize parameters or create trade rules. By interacting with the market environment, bots can learn the best trading strategy thanks to the powerful paradigm known as Learning for Enhancement (RL). Lastly, textual data from financial reports, social media, and news sources is analyzed by Natural Language Processing (NLP) bots.

Second, bots can be categorized based on how they trade. When prices are persistent, the bot buys assets when they are rising and sells when they [20] are falling. On the other hand, assets are typically purchased at low prices and sold at high ones as prices tend to revert to historical averages. Arbitrage: Bots try to make money by taking advantage of differences in prices for the same asset across different markets. High frequency trading (HFT) bots use the short-term market's efficiency to execute a large number of orders at a very quick pace. When certain events, like announcements and economic publications, occur, event-oriented [21] bots produce transaction signals. Third, the amount of human involvement necessary for bot operation is defined by the cycling wheel. Without human oversight, a fully autonomous bot operates flawlessly.

Comparative analysis of AI technologies in inventory trading bots:

To determine your suitability for a range of market conditions and trading objectives, it's critical to compare the AI technologies used in bots. Every technology has pros and cons that impact things like arithmetic complexity, forecast accuracy, risk management abilities, and flexibility in response to market shifts.

Even though machine learning (ML) techniques are generally good at finding patterns in data, their prediction accuracy can vary greatly. While [22] more complex models like neural networks can achieve higher accuracy, they are more prone to over-adjustment. Simple models like linear regression [23] must account for nonlinear dynamics in financial markets. Even though training data weakens the model, over adaptation— which is inadequate when employing invisible data—poses a serious risk to stock trading because market conditions are ever-changing. Another crucial factor to take into account is risk management. ML models can incorporate risk management guidelines, but how well they forecast market volatility and possible losses will determine how effective the model is. Another [24] factor is adaptability. Retraining certain ML models on a regular basis is necessary to maintain performance in shifting market circumstances, whereas others exhibit greater resilience. The complexity of computers varies greatly, with more basic models being more complex ones that need significant computational resources, like deep learning [25] and calculations. Examining a variety of trade strategies and optimizing parameters are characteristics of evolutionary calculation (EC) methods. Their ability to change tactics over time is what makes them strong. The best [26] answer is not always guaranteed by this computationally intensive process. Fitness features that penalize risky tactics are typically used to record risk management for EC-based bots. Learning optimal trade strategies through direct market interaction and adapting to changing market conditions are two benefits of Rearming for Remuneration [27]. RL bots are able to efficiently manage risk and learn intricate trading behaviours.

By incorporating mood analysis into transaction decisions, NLP (natural language processing) techniques offer a distinctive viewpoint. By capturing market sentiments not represented in historical price data, this enables increased forecast accuracy. However, noise and text data quality can have an impact on mood analysis accuracy. The methods employed determine the arithmetic complexity of NLP, ranging from straightforward mood evaluations to more intricate, deep [28] learning-based approaches. Over time, the adoption of AI technology has changed. This is because of advancements in data availability and processing power. While recent research has increasingly investigated deep learning and RL, early research concentrated on more basic ML [29] and EC techniques. The choice of technology is frequently influenced by computing power, data availability, and the particular business partner.

Open challenges and future directions in AI-driven stock trading bots:

Although there have been significant advancements in the use of AI in stock trading bots, a number of significant obstacles still stand in the way of their general acceptance and peak functionality. Unpredictability and market volatility are major obstacles. A multitude of factors, many of which are predictable, impact [30] financial markets, which are inherently dynamic. AI models that have been trained on historical data may find it challenging to adjust to abrupt changes in the market or unusual occurrences, which could result in lower prediction accuracy and possible losses.

Another major worry is the problems of over-adaptation and generalization. It is easy for complex AI models particularly deep learning architectures to comprehend noise and false correlations, overwhelm training data, and interpret them as opposed to real market signals. As a result, historical data performs exceptionally well, but bots' abilities will be effectively generalized if invisible real market data performs poorly. Careful [31] model selection and strong verification methods are needed to lessen this difficulty.

Another significant barrier is the availability and quality of the data. The quality and expressivity of the data used to train an AI model have a significant [32] impact on its performance. Financial data is noisy, unreliable, and subject to biases of all kinds. Furthermore, having access to precise information and high-quality data can costly and constrained. To increase the dependability of AI trade bots, more reliable data pre-processing methods must [33] be developed and alternative data sources must be explored. Particularly in complex AI models like deep learning and high frequency trading bots, computing costs and infrastructure requirements can be significant. Important arithmetic resources, including specialized hardware and cloud computing infrastructure, are needed for training and [35] delivering these models. For individual dealers and small enterprises, this may be a barrier to entry.

Concerns about ethics and regulations are growing in significance as AI trade bots proliferate. Regulators must handle issues like algorithm [36] distortions, market manipulation, and potential systemic risks with caution. To guarantee equity and openness, ethical standards for the creation and application of [37] AI in funding are also required. Finding AI decisions is a "black box" problem that is crucial, particularly for risk management and formal compliance. B. Deep neural networks and other [38] sophisticated AI models are absent. It is frequently challenging to comprehend the reasons behind a specific trade bot's transactions, which hinders the ability to spot possible problems, justify losses, and foster confidence between users and the oversight body. It is crucial that described AI (XAI) technology be developed.

In the future, a few encouraging research directions present the chance to tackle these issues and advance the field of AI- powered stock trading bots. Improvements in deep learning will probably result in better prediction abilities as more complex architectures and training techniques are developed. A more resilient and [39] flexible trading system might be possible with the incorporation of hybrid AI models that combine the advantages of different technologies (for example, neural networks with fuzzy logic or evolutionary algorithms.

Future research in the crucial field of explanatory AI (XAI) aims to create AI models that shed light on the decision- making process. Building trust, encouraging debugging, and meeting formal requirements all depend on this. The development of autonomous trade forces through Learning for Reinforcement (RL) holds great promise for teaching students the best course of action in a [40] changing market. Future studies will probably concentrate on creating RL algorithms for financial therapy that are more reliable and effective.

The accuracy of the trading signal can be increased and a more nuanced picture of the market mood can be obtained by using advanced mood analysis techniques, such as context- related understanding and multimodal data (text, audio, video, etc.). Beyond conventional financial data, alternative data integration—such as information from social media, news analytics, satellite photos, and other unconventional sources—can yield insightful information. To guarantee the security and stability of these systems, it is crucial to create a strong risk management framework that is especially suited to an AI-controlled trading strategy.

III. CONCLUSION:

This industry does, however, face ongoing challenges, such as the inherent unpredictability and volatility of financial markets, the risk of over adaptation, the requirement for high- quality data, computational costs, ethical and regulatory issues, and the opaqueness of certain AI models. For a more comprehensive introduction, these issues must be addressed. Regarding the future, it looks bright for AI in stock trading.

There are a number of crucial research guidelines available to help advance. You will have a more intelligent, dependable, and transparent stock thanks to deep learning innovation, hybrid-KI model development, accountable AI, reinforcement learning, demanding mood analysis, integrating alternative data sources, and establishing strong risk management framework conditions. The future of financial markets and their AI will surely be shaped by ongoing research and advancements in these fields.

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Survey On: Alzheimer's disease Stage Classification Using VGG16-based Deep Learning on Brain MRI Images

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ABSTRACT

Alzheimer's Disease (AD) is a progressive neurodegenerative which presents with cognitive decline and memory loss. Early and accurate staging of the disease is key to timely intervention. In recent years we have seen that deep learning; in particular Convolutional Neural Networks (CNNs) such as VGG16 have brought to bear on the issue of classifying AD stages out of which MRI is a very useful tool. This survey combines the present methods, data sets, pre and post processing techniques and performance measures related to use of VGG16 based models in the field of AD stage classification.

Keywords: Alzheimer's Disease (AD), Deep Learning, Convolutional Neural Networks, Brain MRI, Early Diagnosis.

I. INTRODUCTION

In AD, or Alzheimer's Disease, is not just a medical condition it is a disease that profoundly affects people, families, and communities overall. Becoming the leading cause of dementia, Alzheimer's now affects over 55 million individuals worldwide, and it's marked by persistent memory loss, growing confusion, and a steady deterioration in cognitive function. The present changing demographics indicate that the world's population is rapidly aging, such that the victims of AD could be expected to almost double every two decades. Early detection in this respect would thus be crucial in addition to proper diagnosis.

Detection of Alzheimer's in its initial stages is likely to be one of the most significant challenges to dealing with it. Irreversible brain tissue damage is frequently experienced long before symptoms are observable. Magnetic Resonance Imaging (MRI) has emerged as a key diagnostic and monitoring tool for AD. In contrast to conventional scans, MRI can detect non-invasively subtle structural alterations in the brain, particularly the hippocampus, well before symptoms appear.

There are several numbers of research studies that already been conducted on Alzheimer's Disease.

Most of the research studies have employed two major approaches, i.e., machine learning and deep learning, in an attempt to detect and classify the different stages of Alzheimer's disease. R.A Hazarika et al. demonstrate a comprehensive discussion of various research work that has already been conducted using the OASIS (Open Access Series of Imaging Studies) or ADNI (Alzheimer's Disease Neuroimaging Initiative)dataset. They demonstrated that various research works used different methods some use machine learning while others employ deep learning techniques. Examining all the papers they concluded that, for image classification deep neural based classifying models such as ANN (Artificial Neural Network) can yield a good result with respect to other models. Researchers mostly utilize various transfer learning models which is one area of deep learning: M. Hon et al. utilized VGG16 and Inception to train their OASIS dataset and achieve a very good result in Inception. But they didn't employ any data pre-processing method and due to this, their model could be plagued with an over fitting issue. N. Raza et al. also presented a pre-trained model, wherein they train only the last two blocks. Here, they used MRI images as input. After applying certain pre-processing methods, they obtained a GM slice (Grey Matter) and then input the GM slice into a CNN model and obtained the classification outcome between AD (Alzheimer's Disease), LMCI (Late Mild Cognitive Impairment), MCI (Mild Cognitive Impairment) and NC (Non-Cognitive). Besides this, Ms. H. Acharya et al. also investigated a Kaggle dataset and developed a deep learning model which is applied for multiclass classification. They have named their suggested model- modified AlexNet in which they employ a total of 8 layers: 5 are the specification and 3 are fully connected layers. They have cross-checked their model with 3 models: basic CNN, ResNet, and VGG, and achieved a high accuracy on their suggested model. They employed data augmentation to eliminate the class imbalance issue.

II. LITERATURE REVIEW

Current developments in artificial intelligence, specifically deep learning, have impacted Alzheimer's Disease early diagnosis immensely. An increasing number of studies utilizeeneuro imaging, multimodal information fusion and transfer learning to enhance diagnostic precision and clinical utility.

[1] In their article "Fuzzy Logic and Fog-based Secure Architecture for Internet of Things (FLFSIoT)," the authors demonstrated an intelligent and secure architecture optimized for healthcare IoT use. With the combination of fuzzy logic and fog computing, the system responds to latency, privacy, and scalability—remote medical monitoring's principal challenges. While not explicitly cantered on Alzheimer's, the model is significant in its application to real-time neurological monitoring and safe data processing in Alzheimer's diagnosis and care models.

[2] This research suggested a CNN-based deep learning model for enabling early detection of Alzheimer's Disease from MRI scans. The model extracted imaging data features automatically, allowing for high-accuracy classification of patients into cognitive normal (CN), mild cognitive impairment (MCI), and Alzheimer's Disease (AD) groups. The research showed the efficiency of the CNN in detecting minute anatomical changes related to Alzheimer's progression.

[3] The researchers addressed the use of big data analytics in healthcare service optimization. Their system utilized big datasets to enhance diagnostic accuracy, resource allocation, and customized treatment planning. Although the study was more expansive in its healthcare context, implications for Alzheimer's involve improved data-driven decision-making and predictive analytics through the use of past patient data.

[4] This research applied deep residual learning, a deep neural network, in analyzing neuroimaging data for the prediction of Alzheimer's development. Using ResNet architectures, the model was able to capture deep

hierarchical features from MRI scans. The paper highlighted how residual connections assist in reducing vanishing gradient issues and greatly enhance MCI-to-AD conversion prediction accuracy.

[5] This chapter summarized both structural (e.g., MRI) and functional (e.g., PET, fMRI) neuroimaging modalities for diagnosing Alzheimer's. It emphasized how complementary such a combination is—whereas structural scans show patterns of atrophy, functional imaging gives information on metabolic function. Their research favours multimodal strategies to enhance diagnostic strength and early detection.

[6] One of the major contributions of this research was the creation of a multimodal, multistate deep neural network that processed both FDG-PET and structural MRI images jointly. This fusion model improved diagnostic accuracy by learning fine-grained anatomical features and metabolic abnormalities. The network produced state-of-the-art performance on Alzheimer's datasets, establishing a precedent for multi-input deep learning architectures.

[7] While the emphasis was on distinguishing atypical Parkinson Ian syndromes with SWI MRI imaging and brain iron patterns, the approach can be applied to Alzheimer's diagnosis. The research demonstrated that deep learning models can accurately classify neurological disorders based on subtle imaging biomarkers, promoting their wider use in neurodegenerative disease diagnostics.

[8] The researchers used different CNN models on structural MRI scans of the ADNI dataset to identify Alzheimer's phases. The study emphasized the ability of CNNs to identify disease-specific patterns without the need for manual feature engineering. It also compared multiple CNN architectures and verified the models between training and test splits with identical performance.

[9] The paper gave a beginner-oriented but technologically sound overview of transfer learning. It covered such concepts as fine-tuning, feature extraction, and domain adaptation—methods very useful in the diagnosis of Alzheimer's because of the availability of limited labelled medical data. The research supported the use of recycled retrained models (such as those trained against Image Net) for neuroimaging applications.

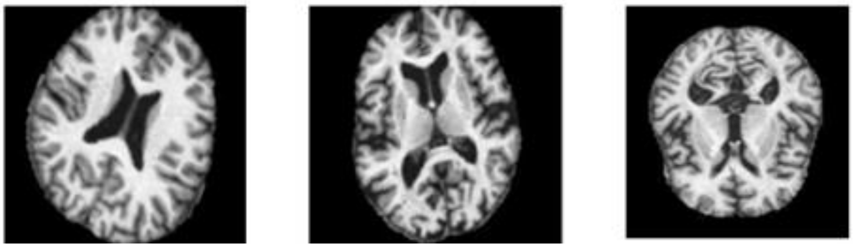
[10] This pioneering work classified transfer learning methods into inductive, transductive, and unsupervised categories and set the stage for its application across domains. The survey is widely referenced in medical AI research and forms a theoretical basis for transferring knowledge between general image domains and Alzheimer's neuroimaging data.

I. AI Researchers/Computer Scientists (Tech/precise tone:)

Alzheimer's Disease is a chronic neurodegenerative condition that presents complex classification difficulties due to its mixtures of cognitive impairment in the form of hints and progressive phases. Structural MRI has proved helpful in tracking the brain alterations of AD, but manual evaluation of these scans is time-consuming and prone to inconsistency between different readers. Automatic analysis is done more efficiently through deep learning techniques, particularly Convolutional Neural Networks (CNNs). One of the simplest, deepest, and most successful for medical image classification is VGG16 and is thus chosen to be researched.

II. Clinicians/Neuroscience Audience(medically aligned tone):

Alzheimer's disease (AD) is a neurodegenerative condition that impacts not just memory, but entire support systems and families. Being healthcare providers, we know that proper and early diagnosis can quite radically alter the patient's care regime. Although MRI imaging is extremely important in the assessment of brain atrophy, conventional measurement is quite subjective and inconstant. In the last decade, perhaps one of the most quickly emerging fields—artificial intelligence, or more specifically deep learning—seemed to have some ability to assist in this issue. The purpose of this paper is to examine the use of one of the most well-known deep learning models, VGG16, for diagnosing Alzheimer's phases from MRI scans. The aim is not to replace clinical evaluation but to complement it with objective facts to enable quick and accurate clinical measures.



a)Non-Dementia b)Mild-Dementia c)Moderate Dementia

Figure1. Images of Normal and Disease Affected Brain

III. EXISTING SYSTEM

In recent years, there has been significant research activity in the field of using deep learning techniques to recognize Alzheimer's disease. DL models(Deep learning), specifically CNNs-Conv. NN(Convolution Neural Network) s and RNNs recurrent neural networks, have demonstrated encouraging outcomes in detecting patterns and extracting features from diverse medical imaging modalities and clinical data. These advancements aim to facilitate the timely detection of Alzheimer's disease [4][5]. Here is an overview of some key research works in this field:

Prediction of Alzheimer's disease using a Conv. NN(Convolution Neural Network) Algorithm (CNN) is not a common approach. CNN algorithms are largely used for image recognition and classification tasks, while various machine learning algorithms, such as logistic regression, support vector machines (SVM), random forests, or deep learning architectures like recurrent neural networks (RNNs), are typically used to predict Alzheimer's disease.

Deep AD, a system that has been developed that uses CNN for Alzheimer's disease prediction, was suggested by Sarraf and Tonight in 2016. Brain MRI scans are analysed by Deep AD using a 3D CNN architecture to determine the possibility of the disease. The model divides the 3D volumetric data into different groups for normal, moderate cognitive impairment (MCI), and Alzheimer's disease using hierarchical features that it has learned from the data[6][8]. The Deep AD system employs a staged methodology. Prior to feeding the 3D patches into the CNN model, it pre-processes the MRI data. These patches teach the CNN spatial information that it uses to distinguish between healthy and sick brain areas[7]. The patients are then divided into various diagnostic categories using the output features.

IV. PROPOSED SYSTEM

In this project, the detection and categorization of normal and abnormal brain cells in medical image head MRIs was performed using a dataset containing thousands of images, leveraging the deep learning-based VGG16 method that performed feature extraction on segmented areas of images. The process of classification utilized a feature extraction method which collects texture and shape features from the MRI images of the brain's regions. A Neural Network was utilized to classify the different stages of Alzheimer 's disease using Multi-Class classification. The executed technique has shown great strides in image processing accuracy as compared to traditional methods.

The proposed work involves the following steps:

1) Data Collection and Pre-processing: Relevant data were gathered from diverse sources and pre-processed to ensure consistency and quality.
2) Algorithm Selection: Deep learning algorithms were carefully chosen to develop the Alzheimer's prediction model, considering their suitability for the task.
3) Model Training and Testing: The model was trained and tested using the collected data to assess its performance and accuracy, ensuring robustness and reliability.
4) Model Optimization: Hyper-parameters were fine-tuned, and feature selection techniques were applied to optimize the model, enhancing its predictive capabilities.
5) Model Deployment: The finalized model was deployed for practical use in clinical settings, aiming to support early detection and prevention of Alzheimer's disease.

A. System Overview

The Alzheimer's Classifier is a deep learning model developed using the Vgg16 architecture. This classifier is specifically designed to assess and categorize brain imaging data to identify patterns associated with Alzheimer's disease.

The ultimate aim of the project was to leverage the capability of deep learning to build a predictive model that would enable medical professionals to determine those at risk of Alzheimer's disease early. This allows for earlier intervention and ultimately leads to better health outcomes. Figure 2 shows the system architecture utilized in realizing this aim, representing the components of the framework visually and how they interact.

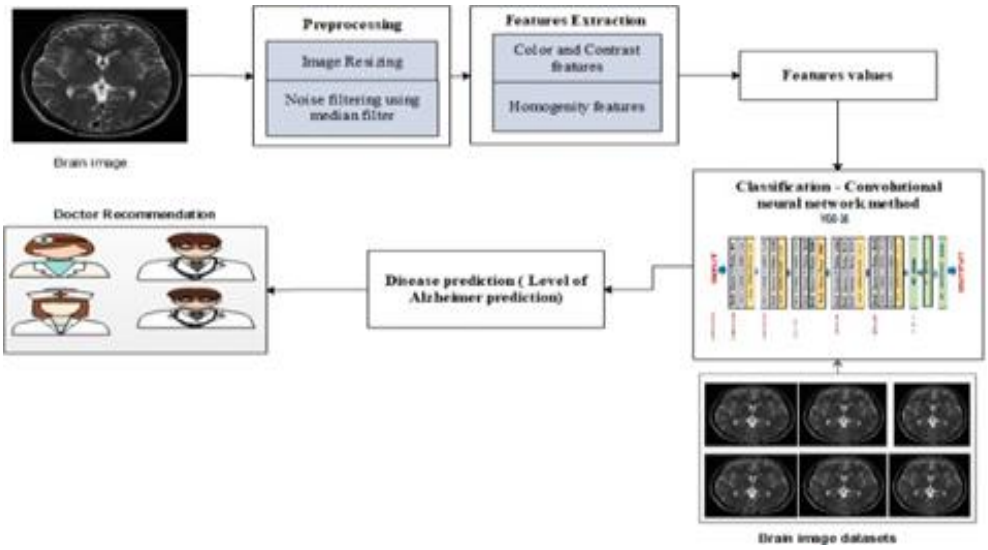


Figure2. System Architecture

Gather MRI Data: Collect a dataset that consists of MRI scans from individuals, including healthy subjects and those diagnosed with Alzheimer's disease. Ensure that dataset is diverse and representative.

Pre-processing: Utilize pre-processing methods on the MRI scans to improve their quality and eliminate irrelevant information. This can involve resizing the images, normalizing pixel values, and applying noise reduction filters.

Split Data: Divide the pre-processed MRI scans into three subdivisions: training data, validation data, and test data. The data that is subjected for training helps in training the CNN model, the validation data will helps in tuning hyper parameters and estimation of the model's performance during training, and test dataset is used for testing to assess the final model's performance.

Train the Model: The Conv.NN(Convolution Neural Network) model using the training data. In the phase of training, the model learns to extract appropriate features from MRI scans and make estimates depending on the extracted features. The model parameters are adjusted iteratively to decrease the prediction error.
Validate Model: Periodically calculate the performance of the Conv.NN(Convolution Neural Network) model on the validation data. This helps to detect overfitting and guides the adjustment of hyper parameters to optimize the model's capacity for generalization.
Test Model: Evaluate the final trained Conv.NN(Convolution Neural Network) model on the test data, which represents the information has never been trained. Measure various metrics such as accuracy, F1-score, recall, precision and to assess the model's performance in predicting Alzheimer's disease.
Evaluate Results: Examine the performance measurements derived from the evaluation of the model, taking into account some of the metrics like accuracy, sensitivity, specificity, and potential limitations or biases present in the dataset. Assess the CNN model's efficacy and dependability in predicting Alzheimer's disease.
Deploy Model: Once satisfied with the model's performance, deploy it in a real-world setting for Alzheimer's disease prediction using new, unseen MRI scans. Continuously monitor the model's performance and update it as needed.

V. PERFORMANCE METRICS

Evaluation of deep learning models for Alzheimer’s disease (AD) stage classification requires the use of objective and quantifiable metrics. These metrics in turn make sure that the model does which it reports very high accuracy also does well in clinical settings which is what we are most concerned with in terms of sensitivity and specificity. Also included below are the main performance metrics:

A. Accuracy

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

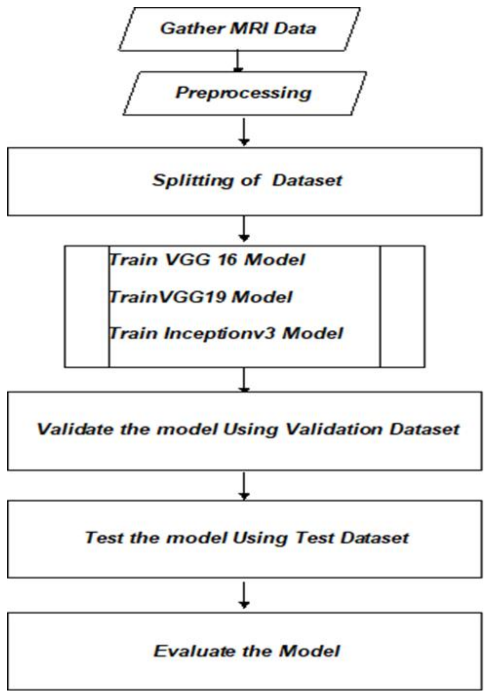


Figure3. Flow chart for the Alzheimer’s Prediction

Accuracy is helpful when class distributions are balanced but can be misleading when there's a class imbalance.

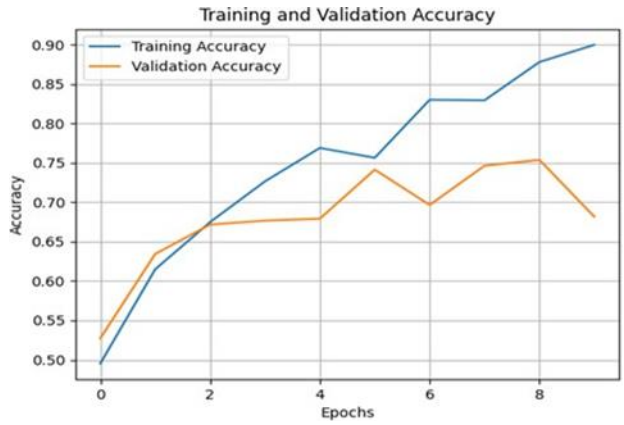


Figure4. Accuracy rate of training and validation

B. Precision

$$\text{Precision} = \frac{TP}{TP + FP}$$

High precision means fewer false positives, which is important in avoiding over diagnosis of AD.C.

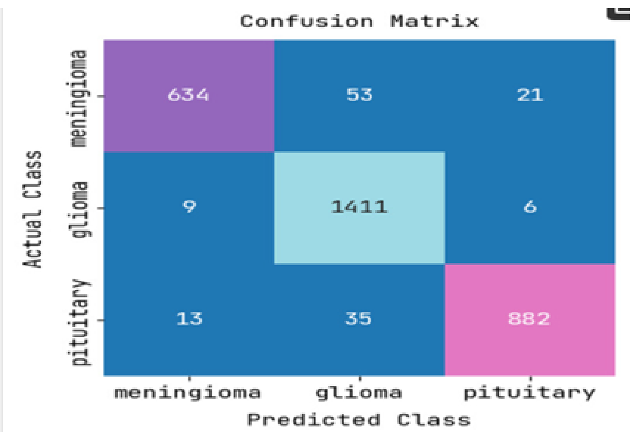
C. Recall(Sensitivity)

$$\text{Recall} = \frac{TP}{TP + FN}$$

Model	Accuracy (%)	Precision (%)	Recall (%)	F1 Score (%)	Training Time/Epoch
VGG16	96.39	95.8	96.2	96	142s
VGG19	96.81	96	96.7	96.3	248s
ResNet-50	71.25	70	72.5	71.2	552s
DenseNet-121	86.55	85	87.2	86	812s
MobileNet-V1	86.4	85.5	86.9	86.2	532s

High recall ensures that most AD cases, especially early-stage, are not missed.

D. Confusion Matrix



VI. COMPARATIVE ANALYSIS

Comparative we see that which aspects of VGG16's performance as applied to Alzheimer's classification via MRI images is it that which does better than other CNN architectures and which doesn't.

Table:1.VGG16 vs. Other CNN Architectures

We note that VGG16 does have a very good balance of performance and low computational requirement. Though models like ResNet and Dense Net do out perform in certain situations what we see is that which comes at a tradeoff of increased training time and issues with model complexity. In the large scale real world and in settings which have resource constraints VGG16 is a practical and very reliable option.

VII. FUTURE ENHANCEMENTS

The application of VGG16-based deep learning models for classifying Alzheimer's Disease (AD) stages has yielded promising results, but there is significant opportunity for improvement and innovation. To advance these models towards clinical use and enhance the diagnostic processes, further research can work on the following:

A. Incorporating Multi-Modal Data

Current VGG16 implementations rely primarily on structural MRI data. However, incorporating multi-modal PET scans, genetic data (for instance, APOE ε4 status), cognitive assessments, and even lifestyle information would enhance understanding of the disease's progression. The integration of these features through attention-based architectures or transformer models could considerably improve diagnostic accuracy.

B. Explainable AI(XAI) Integration

In the health care field one of the primary issues with deep learning is that it is a black box which is hard to interpret. We put forth that use of explain ability tools which include Grad-CAM, LIME, or SHAP in VGG16 systems would allow clinicians to see which brain areas played a role in the model's decision which in turn will increase clinical trust and interpretability of results.

C. Longitudinal Analysis

Present research mostly is done using single time point MRI scans. We should see more study done on longitudinal modeling which is the use of multiple time interval brain scans to tracking disease progression. This may be accomplished via the use of temporal convolutional networks and recurrent neural networks in addition to CNNs like VGG16.

D. Lightweight and Deployable Models

In practical hospital settings which in many cases are resource poor we see that computation resources are a issue. Research should look into model pruning, quantization and knowledge distillation which in turn will make VGG16 based models faster, smaller, and enable deployment on edge devices (examples of which are portable MRI machines and mobile apps).

E. Robustness and Generalization

Many of these models also experience over fitting which is a result of use of small and similar datasets. Also for future research to look at:

Expand the use of larger and more diverse data sets which include various ethnicities and MRI machines. We also put forth the use of cross-site validation and domain adaptation which in turn will see the model perform better in diverse clinical settings.

VIII. CONCLUSION

Alzheimer's Disease is a large scale health issue on a global level that which early detection and accurate staging play key role in better patient results and treatment results. In recent years we have seen that deep learning' and the use of Convolutional Neural Networks which include VGG16 have brought about new methods for noninvasive and automatic diagnostic tools using brain MRI.

This study reports that VGG16 which presents a simple yet in-depth architecture, has at large become a used as primary tool in present research for feature extraction and classification in the case of AD. What we also note is the model's adaptability in various forms such as with transfer learning, into hybrid models and in the 3D setting what this shows is that in many ways it is a flexible and effective agent in medical image analysis.

Also from a performance perspective the model is presented to do very well which is that is it competitive in terms of accuracy but at the same time reports less computational cost as compared to much more complex models like ResNet and DenseNet which in turn makes it a better fit for clinical use settings that have limited computer resources.

Also we see that VGG16 based models are at present doing well in what relates to Alzheimer's stage classification and that ongoing development and work that crosses disciplines is put forth as important in the transition of these models out of the research stage to become trusted diagnostic tools.

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Survey On: Smart AI Travel Planner using AI and ML with Augmented Reality (Trek Trove)

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ABSTRACT

In today's technology-driven era, travel has transcended logistics into an experience-driven endeavour. Trek Trove introduces an intelligent travel planner that adapts in real time based on environmental factors, user preferences, and social dynamics. Unlike traditional itinerary apps, this system integrates Artificial Intelligence, Augmented Reality, and eco-awareness to redefine planning and exploration. Key innovations include a Smart Budget Allocator, Hidden Gems Explorer, Weather-Adaptive Itinerary Generator, Emergency SOS System, Group Cost Splitter, Instant Language Translation Cards, Mood-Based Playlist Generator, and an AR City Guide. The system promotes not only convenience but also sustainable and socially connected travel experiences. This paper presents a comprehensive survey of Trek Trove's modules, system architecture, comparative edge, and scope for future research.

Keywords: Travel Planning System, AI in Travel, Smart Budgeting, Weather-Aware Itinerary, Group Travel Tools, Eco-Friendly Tourism, Augmented Reality Guide, Emergency SOS, Language Translation, Playlist Generation

I. INTRODUCTION

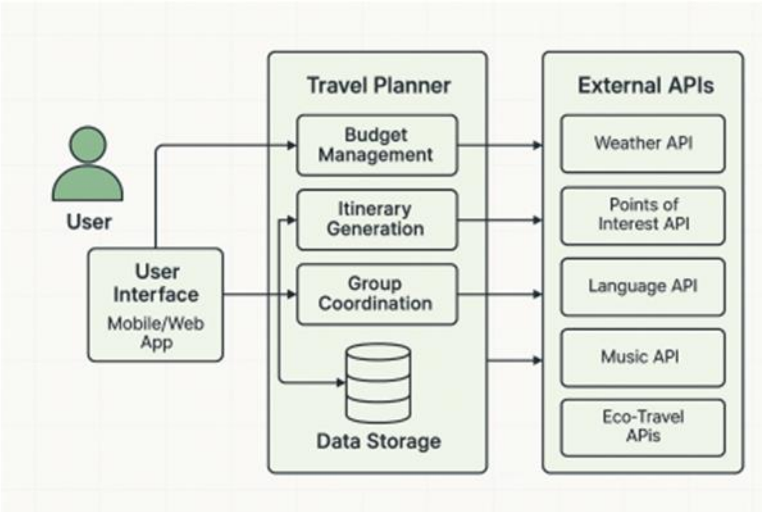
The global tourism landscape is rapidly evolving with travellers now expecting more than basic trip organization. With increasing demand for personalization, safety, group coordination, and environmental consciousness, conventional apps fall short. Trek Trove responds to this need by offering an adaptive, AI-powered travel companion.

Instead of treating travel as a checklist, Trek Trove empowers users with tools that dynamically react to weather, budget constraints, group interactions, and even mood. It encourages discovery of hidden locations, facilitates multilingual interaction, and promotes eco-conscious behaviour all within one unified platform.

This paper outlines the design methodology, architecture, technical integration, and feature-wise innovations that position Trek Trove as a next generation travel planner.

II. ARCHITECTURE

The system is built using a modular, layered architecture that separates user-facing components from backend logic and external data services. It ensures scalable, responsive, and secure interactions.



A. User Interface
- React-based web/mobile app with modern UI/UX
- Supports offline journaling, responsive layouts, dark/green mode
- Central hub for planner, journal, map, and community

B. Core Planner Engine
- Central AI unit handling budget planning, itinerary generation, and group management
- Connected to backend micro services for feature isolation

C. Data Storage
- Firebase/Mongo DB stores user profiles, journals, expenses, preferences
- Real-time sync ensures up-to-date data across sessions

D. External API Integration
- API – For itinerary changes based on forecast
- POI API – Discover local attractions
- Language API – Instant translation cards
- Music API – Mood-based playlist duration
- Eco-Travel API – Recommends low-impact transport/lodging

III. PROPOSED METHODOLOGY

A. Smart Budget Allocator

Analyzes average destination costs, compares API sourced pricing (e.g., hotels/flights), and distributes the budget across categories. Built-in logic suggests budget reallocation in case of cost spikes or emergency needs.

B. Hidden Gems Explorer

Uses crowd sourced reviews and third-party blogs to discover non-touristy yet rated destinations. Matched to user tags like "foodie," "adventure," "history," etc.

C. Weather-Adaptive Planner

Adjusts the plan using real-time weather data. E.g., swaps beach visit for a museum tour if rain is expected. Ensures a flexible but fulfilling trip.

D. Emergency SOS System

One-touch button that sends location, contact, and safety status to emergency contacts via SMS or app notification

E. Group Cost Splitter

Collaborative tool allowing users to log expenses, view balance sheets, and fairly split bills. Works well for friend groups or team trips.

F. Instant Language Translation Cards

Provides essential phrases with phonetic spelling, local script, and audio playback even offline. Great for Navigating language barriers.

G. Mood-Based Playlist Generator

Analyzes user activity, location, and journal input to auto-generate playlists from Spotify/YouTube APIs. Reflects emotional context of the trip.

H. AR City Guide

Uses the phone camera and GPS to overlay interactive information on landmarks. Built using ARKit/ARCore for immersive tourism.

I. Eco-Friendly Suggestions Suggests transport like e-scooters or trains over flights, filters eco-certified hotels, and shows carbon impact of trip choices

IV. COMPARATIVE ANALYSIS WITH EXISTING SYSTEMS

Feature	Trek Trove	Google Travel	TripIt	Polarsteps
Budget Optimization	✓	×	×	×
Hidden-Gem Discovery	✓	×	×	×
Weather-Adaptive Planner	✓	×	×	×
Group Cost Splitter	✓	×	×	×
SOS Alerts	✓	×	×	×
Language Cards	✓	×	×	×
Mood-Based Playlist	✓	×	×	×
Augmented Reality Guid	✓	×	×	×
Eco-Friendly Suggestions	✓	×	×	×

Trek Trove leads across all advanced categories, making it a more intelligent and immersive solution.

V. USER EXPERIENCE AND INNOVATIONS

Dark/Green UI: For readability, elegance, and eco-conscious branding

Offline Mode: Users can access journals, maps, and phrase cards without internet

Push Alerts: Real-time notifications for weather changes, safety alerts, and more

Gamification: Badges and achievements for visiting green places, completing trips
Voice Integration (Future): Plans for hands-free itinerary changes

VI. FUTURE SCOPE

Trek Trove can be expanded into a complete travel OS through:

- Block chain for Travel Logs: Immutable, verifiable travel histories
- AI Chabot Assistant: Conversational trip planning
- Local Partner API: Integration with travel agencies and eco-certified vendors
- User-Generated Content Feed: Location-based social sharing

VII. CONCLUSION

Trek Trove emerges as a comprehensive, intelligent travel planning assistant that not only simplifies trip organization but redefines the very nature of exploration. Through its AI-powered, real-time adaptive system, it addresses key limitations in current travel apps such as static itineraries, lack of personalization, and inadequate support for emergencies, group coordination, or sustainable travel.

By incorporating a Smart Budget Allocator, Hidden Gems Explorer, Weather-Aware Planning, and an Emergency SOS module the platform actively supports real-world decision making. Meanwhile, features like Augmented Reality City Guides, Language Translation Cards, and Mood Based Playlists enhance user immersion and cultural connection. With eco-friendly suggestions and trip impact awareness, Trek Trove encourages environmentally conscious tourism without compromising on user experience.

The modular architecture backed by APIs, real-time data, and a responsive frontend—makes the system scalable, flexible, and ready for future upgrades. As travel becomes more integrated with technology, platforms like Trek Trove pave the way toward context-aware, emotionally intelligent, and socially responsible travel solutions.

Future enhancements such as block chain-backed travel logs, AI travel companions, and smart city integration offer promising directions. Overall, Trek Trove demonstrates how next-generation travel planning can be elevated into a safe, smart, and sustainable journey, reshaping the way we explore the world in the digital age.

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Survey on Decentralized File Storage with IPFS and Block chain Integration

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ABSTRACT

This As the demand for secure, reliable, and tamper-resistant data storage continues to grow, traditional cloud systems are proving inadequate in addressing concerns around privacy, control, and single points of failure. In response, decentralized storage solutions have gained attention, particularly those leveraging block chain and the Interplanetary File System (IPFS). This survey investigates and compares three contemporary projects that use these technologies to establish distributed storage systems. Each approach is analyzed based on its use of encryption, access control mechanisms, smart contracts, and overall system architecture. While one system emphasizes theoretical robustness through proxy-based group key management, another demonstrates a practical decentralized application using Ethereal smart contracts. A third model proposes a content-identifier-based access control structure to establish secure file retrieval. The paper highlights strengths, limitations, and emerging trends across these models through a comparative lens. It also identifies key challenges such as revocation complexity and gas cost efficiency, offering insight into future research directions that could bridge the gap between technical feasibility and real-world adoption.

Keywords: Block chain, IPFS, Decentralized Storage, Secure File Sharing, Smart Contracts, Ethereal, IPFS Proxy, Data Integrity, Peer-to-Peer Network, Content Addressing, Data Privacy

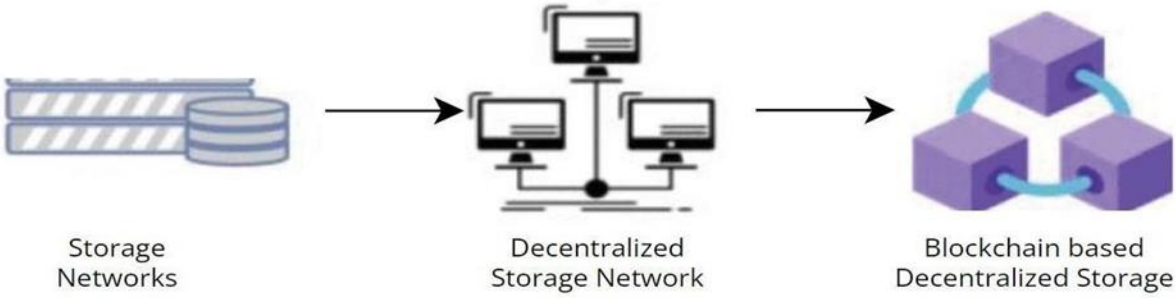
I. INTRODUCTION

In the current digital era, data has become one of the most valuable assets managed by individuals and organizations. With the surge in data generation, secure and scalable storage has become a central concern.

Traditionally, centralized cloud platforms like Google Drive and AWS have dominated this space. However, their architecture inherently exposes them to issues like data breaches, service downtime, and third-party control over user data.

As a result, the technology community has explored decentralized storage as a promising alternative. By distributing data across a peer-to-peer network, these systems enhance privacy, availability, and trust [6][10]. Block chain and IPFS lie at the core of this technological evolution. While block chain offers immutability and transparent logging [7], IPFS ensures efficient content-based file storage and retrieval [2][19].

This paper presents a comparative survey of three recent systems that merge IPFS and blockchain to achieve decentralized storage. We aim to analyze their design choices, security features, access control strategies, and overall practicality. The rest of the paper is structured as follows: Section 2 provides background on block chain and IPFS, Section 3 outlines a classification of the systems, Section 4 compares their features, Section 5 discusses current challenges and potential research areas, and Section 6 concludes with key insights.



II. BACKGROUND AND THEORETICAL FOUNDATION

2.1 Blockchain Technology

At its core, block chain is a distributed ledger maintained across a network of nodes. Transactions are validated through consensus mechanisms such as Proof of Work (PoW) or Proof of Stake (PoS), ensuring that records cannot be altered after being added [6][7]. Each block contains a cryptographic hash of the previous one, forming an immutable chain. Originally designed to support crypto currencies like Bit coin [7], block chain now underpins numerous applications, including decentralized finance (DeFi), voting systems, and secure data sharing [14][15].

Block chains can be public (permission less) or private (permissioned). Public block chains like Ethereum allow anyone to join and participate in the network, while private ones restrict access to approved entities. Ethereum is notable for introducing smart contracts—self-executing programs that automate tasks when certain conditions are met [18].

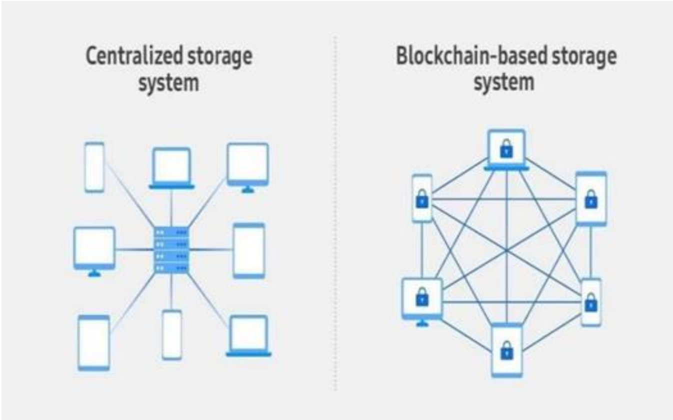
2.2 Interplanetary File System (IPFS)

The Interplanetary File System (IPFS) is a decentralized, peer-to-peer file system needed for efficient data storage and distribution. Unlike traditional HTTP-based systems that locate content by URLs, IPFS identifies files using hashes, known as Content Identifiers (CIDs) [2][8]. When a file is added, it is broken into smaller chunks, each cryptographically hashed and stored on nodes across the network [9][20]. Retrieval is based on the content itself rather than location.

Key components of IPFS include:

- Markel DAG: A data structure that ensures tamper-proof links between file blocks [2][9].
- Distributed Hash Tables (DHTs): Facilitate efficient location and retrieval of file chunks across the peer-to-peer network [13].

- Bit Swap: A mechanism similar to BitTorrent that enables nodes to exchange data blocks [2][19]. By using these technologies, IPFS provides an efficient, verifiable, and censorship-resistant storage solution [2][10][11].



III. TAXONOMY OF APPROACHES

To better understand the integration of IPFS and block chain technologies, we examined three recent systems through five key criteria: how they handle access control, encryption, smart contracts, deployment architecture, and file revocation. Each project adopts its own interpretation of decentralized storage, shaped by different priorities and design choices.

Huang et al. (2020) built their system on a permission less Ethereum block chain, combining it with IPFS not only for storing files but also for enforcing access control [1]. A key differentiator in their approach is the application of an IPFS proxy server to facilitate group-based encryption. Files are secured using a shared group key, and when user access needs to be revoked, the system re-encrypts all affected files using a newly generated key. Interestingly, their system bypasses smart contracts entirely, delegating policy enforcement to the proxy. Though robust in design, their model remains mostly conceptual, with no working front-end or live deployment.

In contrast, Vanitha et al. (2024) focused on building a functional decentralized application (DApp), using the Ganache local Ethereum test network to simulate transactions [2]. Their project integrates a simple user interface that allows file uploads to IPFS, and they use smart contracts to store file metadata such as content hashes. However, their system doesn't implement any fine-grained access control or revocation processes, and encryption is handled at the most basic level, relying on IPFS's native mechanisms rather than external key management.

Sham Dasani et al. (2023) present a hybrid approach that combines design principles with partial implementation [3]. Their system operates on the Ethereum main net and extensively utilizes smart contracts to manage file access. Each file is assigned a unique content identifier (CID), and access permissions are enforced through access control lists (ACLs) integrated into the block chain. While encryption is applied per CID, the revocation process is only partially addressed and is not fully implemented. Although supported by system diagrams and architectural overviews, their work does not feature a fully functional interactive application.

These three approaches showcase the wide range of possibilities in decentralized storage design, ranging from highly theoretical models featuring advanced encryption mechanisms [1], to practical applications that focus on usability and real-world testing [2]. They underscore the flexibility and complexity of integrating IPFS and block chain into secure, distributed systems.

IV. COMPARATIVE ANALYSIS

4.1 Security and Access Control

Huang et al. present the most robust security model, implementing a proxy server that manages group-based access using symmetric encryption [1]. When a user is revoked, a new group key is generated, and all affected files are re-encrypted. While effective, this introduces a communication overhead. Vanitha et al. focus more on decentralized application (DApp) development, with less emphasis on access control [2]. While the project stores IPFS file hashes on the block chain using Solidity contracts [18], it does not provide comprehensive use for permission management or revocation.

Shamdasani et al. take a middle ground by integrating access control lists (ACLs) directly into smart contracts [3]. While the system isn't fully implemented, it outlines a clear approach for ensuring that only authorized users can access specific files via CID mapping and contract verification.

4.2 Implementation Practicality

Vanitha's team distinguishes itself by developing a complete DApp that includes file upload, IPFS integration, and blockchain interaction through Meta Mask and Ganache [2][19]. This hands-on implementation demonstrates the viability of such systems using current development tools.

In contrast, Huang's system remains largely theoretical, though it introduces sophisticated cryptographic concepts such as key wrapping and secure group management [1][4]. Shamdasani et al. blend theory and practice, proposing a detailed architecture with working diagrams but leaving some parts for future development [3].

4.3 Performance and Scalability

Huang's system may face scalability issues due to the computational burden of re- encrypting group files during revocation [1][5]. Vanitha's platform, while functional, would need to address gas cost optimization for broader deployment [2][11]. Shamdasani's CID-based model offers efficient storage referencing but still faces the inherent challenge of storing large files off-chain [3][12].

V. OPEN CHALLENGES AND FUTURE RESEARCH DIRECTIONS

Despite promising progress, several unresolved challenges remain:

- Access Control at Scale: Group-based permissions require efficient key management strategies to scale securely [4][6].
- Revocation Overhead: Updating encryption keys and reprocessing files is resource-intensive [1][5]. Lightweight alternatives or delegation-based access may help.
- Block chain Storage Costs: Gas fees remain a major barrier to public chains like Ethereum. Exploring Layer 2 networks or alternative block chains (e.g., Polygon, Solana) may reduce costs [11][12].
- User Privacy and Metadata Leakage: While data is encrypted, access patterns and metadata stored on-chain may still leak sensitive information [10][16].
- Cross-Platform Interoperability: Enabling seamless migration or sharing of files across multiple decentralized systemsis still underdeveloped [11][20].

Future work can focus on zero-knowledge proofs for private access control, improved smart contract auditing, and hybrid solutions combining decentralized and centralized elements to optimize performance [17][18].

VI. CONCLUSION

Decentralized storage systems using IPFS and block chain are steadily becoming more practical and secure. Each of the surveyed approaches offers distinct advantages: Huang et al. emphasize security and structured access [1], Vanitha et al. showcase real-world DApp deployment [2], and Shamdasani et al. highlight smart contract integration for access control [3]. By combining decentralized identifiers, smart contracts, and cryptographic primitives, these systems offer a compelling alternative to traditional cloud storage.

However, practical implementation still faces challenges around scalability, cost, and user accessibility. Continued development, innovation, and cross-platform collaboration will be essential to successfully adopting decentralized storage infrastructures.

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Survey on: Real-Time Hand Gesture Recognition for Disabled People Using Artificial Intelligence

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ABSTRACT

The project aims to develop and deploy a hand gesture recognition system in real time that accurately interprets sign language gestures into text or speech. The system promotes inclusivity and accessibility by bridging the communication gap between sign language users and non-users. The project integrates machine learning algorithms with computer vision to provide efficient and effective gesture detection and recognition within real-world settings. The intended pipeline will implement a combination of tools and frameworks to process hand gestures, interpret them into meaningful outputs consisting of the action phrases, and leverage natural language processing (NLP) techniques to improve the predicted Phrasing by improving structure and context. In addition, the output will be transferred to speech through text-to-speech (TTS) utilities such as gTTS or pyttsx3 for a total and complete pipeline.

I. INTRODUCTION

Most the most basic human desire is the desire for independence and autonomy, self-expression, and the desire to relate freely to the world through independent mobility; independent mobility promotes the ability for individuals to engage in clinical and social rehabilitation, and allows people to contribute to society. The World Health Organization (WHO) indicates that about 15% of the world's population has some type of disability affecting their body structure, function or ability to perform activities of daily living [1]. Of those individuals, approximately 131.8 million people (approx. 1.85% of the world's population) require a wheelchair for mobility due to incomplete paraplegia, dysarthria-related conditions, quadriplegia, Alzheimer, dementia, multiple sclerosis, cerebral palsy, and many other disorders. As a result, people with mobility disabilities caused by conditions such as hemiplegia, quadriplegia, paraplegia, brain injuries, multiple sclerosis [2], broken bones, and other disabilities, approximately 1.85% of the world's population, or 131.8 million people use a wheelchair for their everyday mobility [3]. One of the most common assistive technologies, it is a means for a non-able-bodied person to maintain their independence, and is highly desirable to help eliminate barriers to make life easier for people with disabilities [4]. For many years, manual wheelchairs have been a steady and dependable resource. However, the key to making them more available for a wider range of users is lowering the cost. Hence, people require the assistance of another human to be able to safely use a wheelchair. Furthermore, prolonged usage of a manual wheelchair can commonly impair the person's muscles and overall health [5]. Powered wheelchairs were developed to alleviate these issues [6]. In the current ICT age, people can provide their wheelchair with power to make them smarter and more intelligent by adding an electrical system to where able bodies benefit from a powered wheelchair. Most existing systems are built on technology such as Brain-Computer Interfaces (BCI) [7]. Cost reduction is an important factor to reach a wider audience. Gestures are a simple and effective form of transferring emotional states and interacting with others. Familiar communication modalities include touching, joystick movement, and physical movement. Many devices, like any modern smartphone, require physical interaction, and joystick operation typically necessitates excessive hand and finger movements. Sadly, a large number of disabled individuals do not have the physical power or motor control to use standard joysticks. Gesture-based control offers an alternative, one in which individuals using wheelchairs can operate their devices without reliance on hand movement. Gesture-based communication is receiving more attention as a feasible and inclusive approach (KNC) [10]. The development of computer vision, cameras, and artificial intelligence technologies such as deep learning provide an ideal foundation for gesture recognition to be used, along with ease of functionality and control in advanced wheelchair systems (N/V)[11].3907265eb6b0534f71f69f32e290cbc5E каких беседgments. Many works have been done using the hand gestures, head movements, and eye- gazes of different organs. Such as, depth cameras, like Microsoft's Kinect [12], are a new step in gesture recognition technology. A variety of studies have proposed gesture detection models based on these depth cameras [13–14]; however, depth cameras are usually more expensive than the regular RGB cameras and may lose accuracy for complex backgrounds [19]. Whereas reliable performance may be difficult to achieve with RGB cameras for several tasks because of differences in lighting.

This creates challenges of identifying gestures with RGB cameras with cheap stuff as demonstrated in the literature. The study raised a gesture like recognition methodology that fused Haar-cascade classification, skin segmentation techniques and a 2D CNN. While an exciting experiment with deep learning, it does not perform well in outdoor environments or for backgrounds with colours similar to human skin. This highlights the challenges in developing robust and effective gesture recognition especially for wheelchair control where user flexibility, accuracy and independence from being outdoors are needed.

II. LITERATURE REVIEW

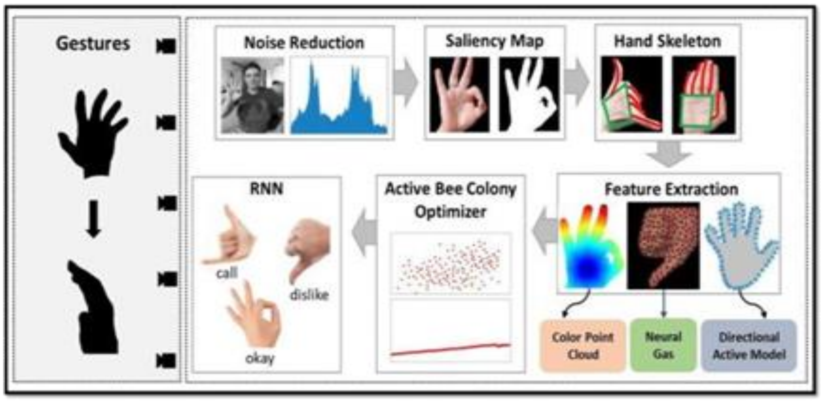
This study addresses various hand gesture recognizers and their uses in real time interaction. The researchers have looked at techniques such as static and dynamic gesture recognizers. The authors looked for strength needed to operate a standard joystick for a wheelchair. For patients with a lack of hand functioning, gesture- based control provides an easier solution for operationalizing a wheelchair. For this reason, gesture-based communication is being seen as a viable way of making and growing trend [10]. Given the advances in computer vision, gesture detection can be directly implemented into a sophisticated wheelchair system and used for control purposes. Camera, as well as some AI- based technologies including deep-move learning [11]. Many researchers have considered gesture control, using different body parts such as hand gestures, head movements, or even any body language using eye gaze. The main advancement is the use of depth camera, like Microsoft's Kinect, which several researchers have employed to model gesture recognition [12], [13-14]. However, depth cameras also present a challenge. Not only are these cameras considerably costlier than standard RGB cameras, but the precision of these cameras can suffer due to the presence of complex backgrounds [19]. In addition, RGB cameras also face challenges regarding obtaining high performance when lighting conditions change within the environment. Thus, it is challenging in this Respect to implement recognizing gestures using RGB cameras and low-cost equipment within the industry. Researchers have developed a model for hand gesture recognition based on a Haar-cascade classifier [15], skin segmentation techniques [16], and a 2D Convolutional Neural Network (CNN). However, the model suffers poor performance in outdoor settings, especially during daylight or when parts of the background are associated with the skin colour of the hand. Therefore, creating a gesture recognition system for wheelchair control that meets the needs of the user space is still a complex and unsolved problem. Flexibility, high accuracy, and environment independency recognition is also inherently simple because it reviews an incoming image frame- by-frame; however, they are also not adaptable for more complex gestures. Conversely, dynamic recognition utilizes sequential models, like Recurrent Neural Networks (RNNs), to analyze gestures while they are in motion. The study highlights the usefulness in examining computer vision, like the pros and cons of each. Static gesture Page. 2 contour extraction and feature mapping with Machine Learning models, to achieve high accuracy. The authors conclude by identifying the need for robust .Sign Language Recognition Using Media Pipe and Machine Learning Authors: Akash Verma, Priya Patel and Ravi Sharma This work looked at the use of Media Pipe in a real world environment. hand tracking and gesture recognition. The authors showed how Media Pipe’s 21-point hand landmark detection, makes feature extraction easy and allows gesture classification to be accurate and quick. In the study Media Pipe was combined with machine learning models, such as Support Vector Machine (SVM) and Convolutional Neural Networks (CNN). Allowing the authors to recognize American Sign Language (ASL) gestures. The authors demonstrated that the proposed system produced an accuracy rate of 96% and was in real time capable of being used for assistive technology. The paper also identified challenges, such as sensitivity to the environment and variability in hand shape, and suggested possible strategies, such as dataset augmentation and an adaptive learning technique. The features of smart wheelchairs are constantly evolving, and research and developers continually enhance them больше 65 precent of room for improvement page 2 There have been many smart wheelchair systems in the parts with different control systems. For the sake of consistency, we reviewed some of these techniques in relation to the proposed system solutions. The smart wheelchair has many features being developed by researchers. In the past years, there have been many smart wheelchair systems that have had control mechanisms for various applications. For the sake of consistency, we reviewed some of those techniques in relation to the proposed system. Megalingam et al. [18] using mobile based application datasets and real time performance for practical applications. Users need to keep interactively with the systems touchscreen using their hands or fingers size for accommodating the brain for users. For users with overall palm printing needs a larger tablet display and this might not work well for them to control the system. Gao et al. [19] developed an intelligent wheelchair system that was controlled via hand gestures. This system, which was able to track hand gestures in real-time, utilized a high-performance laptop along with a Kinect depth camera as input signals were based on gestures. However, the device may not be easy for disabled or elderly people with limited hand movements to use since the user had to lift their hands in order to execute gestures. In addition to high costs of depth cameras compared to traditional RGB cameras. Mahmud et al. [23] developed a multi-modal wheelchair control system. This system was developed using a Raspberry Pi, an RGB camera, a VGG-8 model, and an accelerometer for head movements, hand gestures, and eye gaze respectively. It can achieve around 90% performance success rate. However, there are two main issues that must be taken into consideration; eye gaze detection methods are not easy to use, and device tracking sensors must be physically attached to the user. Tejonidhi et al. [24] developed a wheelchair movement system based on eye-pupil tracking. This system utilized a Philips microcontroller along with the Viola-Jones algorithm with MATLAB to detect eyeballs in RGB images. Its performance rates from 70 % to 90 % and detect the problem.

III. EXISTING SYSTEM

Existing hand gesture recognition systems rely mostly on sensor-based devices such as data gloves and Kinect sensors or vision-based methods using cameras. Many approaches use machine learning algorithms, such as Support Vector Machines (SVM), k-Nearest Neighbours (k-NN) algorithms, and Deep Learning models that are based on Convolutional Neural Networks (CNNs).

System Overview

The system used a camera-based configuration and artificial intelligence to identify hand gestures in real-time, allowing disabled individuals - particularly those with mobility or communication impairments - to communicate or interact with digital devices. The system captured hand movements from a webcam or smartphone camera device, processed each video frame using computer vision techniques, and applied neural network (CNN) for gesture classification, however such systems can also have issues with high computation loads, limited accuracy for real-time applications, the inability to recognize gestures as they change while being executed, inconsistent accuracy based on the lighting and background for the visual transportation of gesture movements. Also, many are not optimized to be accessible or usable by disabled individuals through complex set ups or with non-intuitive interfaces.



IV. PROPOSED SYSTEM

The proposed gesture recognition method was developed to provide maximum sensitivity for other users with disabilities, wherein users are able to control a wheelchair with minimal hand and/or finger movement. This method also considers the shortcomings of previous related work. The gesture recognition method consists of three parts: hand detection & tracking, hand landmark extraction, and gesture recognition based on an effective mathematical model, as shown in Fig. 1. The mathematical model recognizes gestures using logical conditions that determine different control operations based on the recognized gestures. The mathematical model was developed using the appropriate mathematical calculations and the logical rules that were established using distances between main hand landmarks and other relevant measurements. Thresholds were established for each of the logical conditions. The threshold values were developed at the beginning of the gesture recognition process and based on many real hand samples. The building blocks are explained in detail throughout the paper threshold values. These thresholds are established at the start of the gesture recognition process, based on multiple real hand samples. The building blocks are explained in detail throughout this paper. While the proposed system provides a functional and accessible solution for hand gesture recognition to assist disabled individuals, there are several potential areas for future development and improvement that could greatly enhance its accuracy, usability, and versatility.

1. Support for Dynamic Gestures:

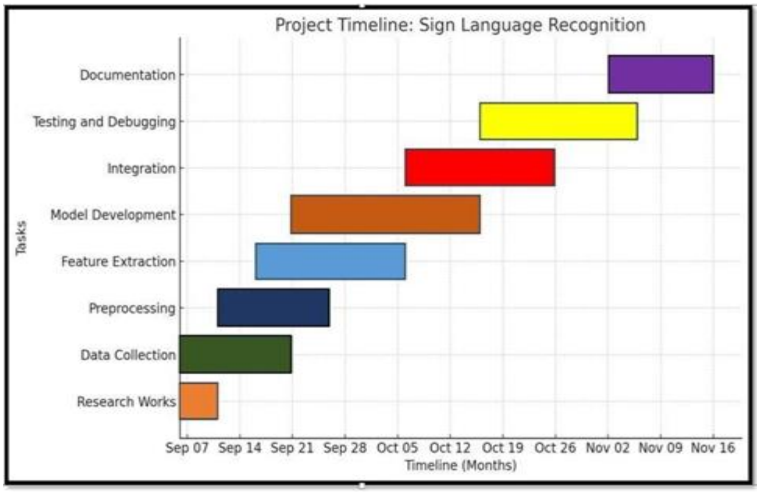
Currently, many systems including the basic form of this one are optimized for recognizing static hand gestures. However, real-world communication often involves dynamic gestures, such as sequences of movements used in full sign languages (e.g., American Sign Language or Indian Sign Language). Future versions could incorporate temporal deep learning models like Long Short-Term Memory (LSTM) networks or 3D Convolutional Neural Networks, enabling the system to understand gesture sequences over time. This would allow for more natural and expressive communication.

2. Enhanced Gesture Dataset and Model Training:

To improve recognition accuracy across diverse users and environments, the system can be trained on larger, more diverse datasets that include a wide range of hand shapes, skin tones, lighting conditions, and backgrounds. Incorporating data augmentation techniques can also help the model generalize better. Additionally, future versions can allow user-specific training, where users can teach the system their own custom gestures for better personalization.

3. Multilingual Gesture-to-Speech Translation:

To increase its global applicability, the system is designed to support gesture translation into multiple languages. For example, a gesture could be recognized and then translated into English, Hindi, Tamil, or any preferred language using integrated Natural Language Processing (NLP) techniques and text-to-speech (TTS) engines. This would make communication even more effective for users in different regions.



V. CONCLUSION

This project on hand gesture recognition demonstrates the power of integrating computer vision, machine learning, and natural language processing to create an efficient system that can interpret and translate gestures in real time. By leveraging advanced technologies like Media Pipe for hand tracking and RNNs for gesture classification, the system achieves high accuracy and performance, making it a valuable tool for diverse applications such as sign language translation, assistive technology, and gesture- based device control. The proposed system's use of text-to-speech technology further enhances its functionality, enabling auditory feedback for users, which is crucial for individuals who rely on non- verbal communication. The combination of these technologies not only improves communication for those with hearing or speech impairments but also opens up possibilities for more interactive and intuitive human-computer interfaces in various sectors like education, healthcare, and entertainment.

In conclusion, the hand gesture recognition system offers a robust, real-time solution that bridges communication gaps and promotes accessibility. The successful implementation of this project paves the way for future advancements in gesture recognition and highlights the potential for further innovations in human-computer interaction and assistive technologies. orld Report on Disability."

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Diagnosis of Acute Diseases in Villages and Smaller Towns Using AI

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ABSTRACT

Achievability and Field Testing for Conclusion of Intense Maladies in Villages' and Littler Towns Utilizing AI is an compassionate intercession to utilize counterfeit insights (AI) to cover basic healthcare holes in inaccessible regions. Untreated shapes of intense maladies will fly underneath the radar due to a need of get to to genuine therapeutic mastery and framework in country zones. This particular extend highlights a voice-activated interface and is multilingual, utilizing a modern mobile-ai demonstrative stage in line with being available and comprehensive.

The innovation incorporates NLP and ML to see at side effects in real-time and recognize diseases, cerebral pains, and flu and other illnesses. The stage created for low-literate individuals within the computerized world guarantees simply get to indeed in asset destitute situations.

Catchphrases - Forecast, Client Interaction, Manufactured Insights, Manufactured Neural Systems, Forecast, Machine Learning.

I. INTRODUCTION

Get to convenient and exact healthcare remains a critical challenge in provincial and immature districts, where healthcare foundation and proficient restorative ability are frequently missing. Intense maladies, which are characterized by their fast onset and extreme indications, can lead to genuine wellbeing results or indeed passing in the event that not analyzed and treated expeditiously. In towns and farther regions, the impediments in healthcare assets contribute to postponed determination and destitute wellbeing results. Manufactured Insights (AI) has risen as a capable device to bridge this hole. Through the utilize of machine learning models, picture preparing, and data-driven diagnostics, AI frameworks can help in early distinguishing proof of different intense therapeutic conditions. By leveraging versatile applications, wearable gadgets, and inaccessible detecting advances, AI can bring solid and versatile arrangements to country healthcare.

This venture investigates how AI innovations can be successfully actualized to analyze intense illnesses in town settings. It points to plan a cost-effective, user-friendly framework that underpins provincial wellbeing laborers and common specialists in making precise choices. This outline sets the organize for understanding the issue scene, the part of AI in healthcare, and how mechanical headways can reshape restorative get to in underprivileged zones.

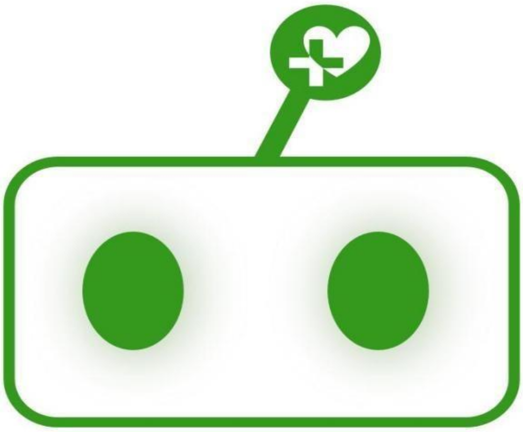
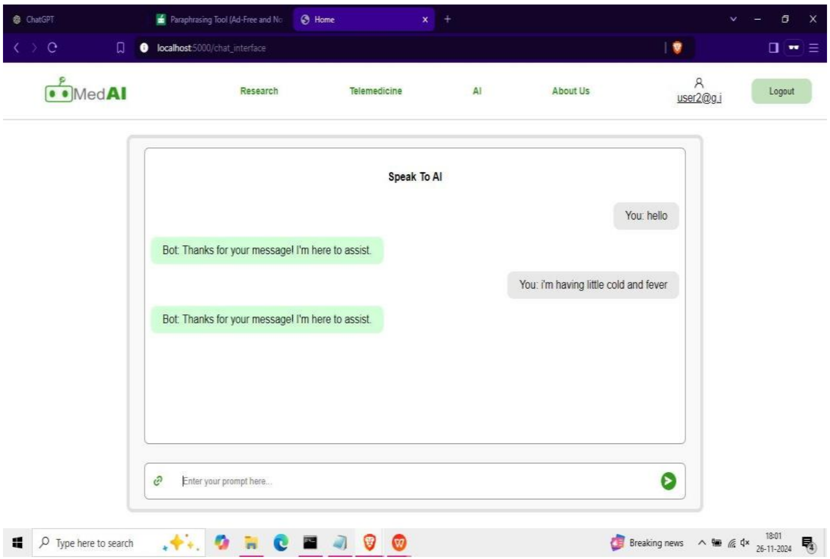


Fig 1.1 MedAI

The show proposition is for creating a voice-based multimodal AI framework that will be utilized exceptionally viably in provincial conditions. It combines progressed ML and NLP models to supply redress conclusion and proposals over diverse lines of get to to wellbeing benefit conveyance. The platform is outlined to operate in a low-resource environment and can be ideally realized in cases with moo network and education.



Devoted to the significant democratization of healthcare get to inside unbending moral and security mores, such as the arrangements of GDPR and HIPAA, whereas guaranteeing security of information, this activity capably enables ignored communities with AI-enabled demonstrative apparatuses for simple get to and hence, re-shapes healthcare conveyance, mitigates wellbeing imbalances, and moves forward generally open wellbeing results.

II. LITERATURE REVIEW

Reference	Summary	Gaps
Peter A Henning et al.	The utilize of AI in restorative instruction is examined in this ponder with respect to the changing flow in healthcare	This investigate may need a center on provincial

Reference	Summary	Gaps
	administrations. This ponder might confirm the potential AI has in making strides learning and bettering persistent care; be that as it may, it hasn't considerably considered the rustic situations of healthcare, where instruction and innovation are insufficient [2].	healthcare settings where instructive assets and innovation get to
Yogesh Kumar et al.	The examination looks at the different applications of AI concerning the enhancements caused in demonstrative effectiveness in clinical settings. In any case, country healthcare's interesting challenges don't discover full scope in its thought; subsequently, the foundation of special AI arrangements to underserved regions is empowered [4].	Usage challenges in country healthcare settings are underexplored, highlighting the require for region-specific AI arrangements.
Sidra Nasir et al.	The show consider endorses an moral system through which AI is to enter into healthcare diagnostics and administration of patients. The think about has experiences; be that as it may, it needs an examination of intense infection diagnostics for populaces settled in rustic places [5].	The article may not offer indepth investigation or viable illustrations important to intense infection diagnostics in rustic populaces.
Thanai Pongdee et al.	The paper examines the part of fake insights in hypersensitivity and immunologic illnesses, emphasizing change in symptomatic and helpful techniques. This moo scope can be complemented with other related infections to broaden the pertinence of the paper against intense infections ruling the dismissed locales. [6].	The center on particular conditions limits its pertinence to broader intense malady settings, particularly in underserved ranges.
Ming Zhao et al.	This appears AI could be a great gadget for diagnosing dementia and demonstrates early location. With that, it addresses basically neurological illnesses, whereas a more extensive category of intense illnesses is missed by provincial populaces [7].	Its particular center on neurology may not address the more extensive range of intense illnesses significant to country healthcare framework.
P. Hamet and J. Tremblay	Audit of the part of counterfeit insights in diagnosing and overseeing metabolic maladies: makes a difference in treatment arranging; does not consider the scope of AI within the conclusion of intense maladies in provincial settings [9].	Constrained investigation of AI's pertinence in rustic healthcare, especially with respect to metabolic maladies as intense conditions.
E.-J. Lee et al.	Thinks about AI procedures in imaging strokes that give much way better exactness in determination, but it does not state any obstructions on such technologies' usage in provincial ranges with destitute wellbeing assets [10].	The inquire about might not satisfactorily address get to issues related to AI advances in provincial healthcare situations.
E.-J. Lee et al.	This inquire about is centered on personalized conclusion	It may neglect the special

Reference	Summary	Gaps
	and treatment inside the system of AI-enabled accuracy cardiovascular pharmaceutical. In any case quick, it makes no specify of challenges encompassing cardiac care in rustic settings with restricted assets [11].	challenges confronted in country regions where cardiac care assets are constrained.
C. Krittanawong et al.	The archive communicates AI's guarantee on wellbeing advancement in rustic communities in creating nations. Because it concentrates on get to crevices, there are few real-life down to earth illustrations or case considers of effective country applications [12].	Whereas examining potential benefits, the article may need nitty gritty case thinks about or cases from genuine rustic executions.
J. Guo and B. Li	Evaluation of AI-based sepsis forecast models in clinic settings is examined in this paper. Their restricted application to country healthcare situations exists where expectation models for progressed utilization are less open [21].	Constrained appropriateness to provincial healthcare settings where get to to such models may be limited.
M. Kong et al.	This paper emphasizes methodologies within the sending of AI-assisted clinical conclusion and treatment over all restorative specialties. It does not make reference to the management of intense infections within the provincial healthcare environment [13].	Needs particular center on intense illnesses and their administration in provincial healthcare settings.
M. Y. Shaheen	Without a doubt, it is an imperative and comprehensive audit of AI applications within the field of wellbeing, appearing its net benefits. None the less, the think about does not particularly target intense disease-based diagnostics and needs in country healthcare [14].	Restricted center on intense maladies and their particular suggestions for country populaces.
N. Greenberg et al.	It analyzes the AI part in handling mental wellbeing issues amid the COVID-19 widespread. It relates with the mental conditions but does not deliver data almost any intense physical illness administration [15].	The article is less significant to intense physical infections, demonstrating a require for more focused on inquire about.
T. H. Davenport et al.	The paper evaluates AI's application in upgrading electronic wellbeing records (EHRs) and workflows in healthcare frameworks. EHR specifically does not suggest an application in intense illness determination for the underprivileged rustic zone [16].	Constrained on EHRs may not decipher straightforwardly to intense infection diagnostics, especially in rustic healthcare settings.
J. Wang et al.	This article reports to have looked into later progressions in profound learning connected to therapeutic picture investigation, centering on application regions in determination. In any case, it does not investigate	Constrained consideration to down to earth applications in country healthcare settings, where imaging assets may be

Reference	Summary	Gaps
	adequately the real sending or ease of use of such innovations in resource-scarce provincial settings [17].	rare.

III. PROPOSED SYSTEM

The proposed system is an AI-based chat-bot which acknowledges the side effects from clients and foresee the conceivable infections, in conjunction with advertising important medicines. The usage of this chatbot is done utilizing feed-forward neural systems and carafe backend integration, which is sent within the web application utilizing HTML, CSS, and JavaScript versioning strategies. The framework is really planning to remove computerized education boundaries in provincial ranges through permitting demonstrate, where licenses are getting to be issued to clients who are carefully proficient and can utilize the application viably. Each of such permit holders would have the commitment of taking care of gather of 5-10 individuals who would make the permit genuinely impartial for the individuals who would be less familiar with advanced apparatuses.

Frontend

The center of this whole layer is the Frontend layer, where ease of use and openness will be the key equivalent words with a responsive interface. It'll be valuable for both desktop and portable gadgets. The inputs over the interface are multilingual or voice-based, so clients can sort in local dialect or speak native words to supply side effects. The chatbot at that point returns the anticipated infections with the conceivable treatments. The output clearly depicts that it may be a minor treatment or needs a discussion with a specialist. Frontend will moreover support offline side effect sections and transitory putting away of them amid inaccessibility of web association because it will transfer consequently ones the gadget gets network back.

Backend

Jar is the innovation that built the Backend Layer. It realizes the complete consistent handling and makes possible the computational viewpoint of the complete framework. The client side effects are at that point analyzed by a feedforward neural arrange made utilizing TensorFlow and Keras to create precise forecasts of maladies and medicines. Preparing and arrangement of models rapidly and adequately are empowered by TensorFlow and Keras, which moreover utilize execution and flexibility for profound learning errands. The backend consolidates get to permitting that's hence authorized to get to the application Framework. The backend works proficiently with Relaxing APIs to associated with the frontend, as well as with capacity frameworks, to encourage the smooth stream of information and adaptability. It'll permit the organization to carry out numerous exercises collectively on the backend and give reactions to users' questions in realtime.This approach to the sending can be on a exceedingly adaptable cloud framework like, for occasion, AWS or Google Cloud, which ensures unwavering quality through autoscaling and excess.

Datalayer

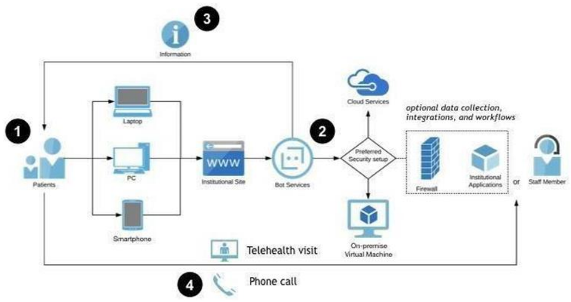
The Data Layer stores application usage logs and is in charge of safely handling consumer data. All of the structured data, including user login information, registration nodes, and activity logs on use timestamps and the queries made to them, is brought in by a MySQL database. A thorough grasp of various program usage patterns and user interactions is provided by such information. While secure data transmissions over protocols like TLS act for data in transit, data storage protection technologies like AES-256 are used for data at rest. Additionally, the system database has a strong logging mechanism to monitor all operations and keep analytical and accountable records.

To use this system procedure, licensed users must first register and obtain access to the application. Each user will speak on behalf of themselves and communicate their symptoms to the system by text or voice message, facilitated by the chatbot. This data is preprocessed by the chatbot using natural language processing before being sent to the feedforward neural network for examination. Prescription recommendations and disease probability are included in the output. Additionally, the chatbot determines whether a patient needs to be referred to a medical professional or merely needs basic treatment.

Its license structure is essential to optimizing the application's use. Licenses will only be awarded to digitally literate people who can comfortably engage in fake communication with the AI chatbot. To ensure that even this tiny group of people who are not very tech-savvy may benefit from the system, each licensed citizen will look after a limited number of users.

In addition to providing focused and useful solutions for identifying and treating health issues, this system is integrated with AI technologies such as Tensorflow and Keras for deep learning, multilingual access, and restricted licensing. By bridging the digital divide in underprivileged communities, artificial intelligence (AI) is transforming data security by ensuring simple and scalable data handling.

Workflow



Workflow Information collection and preprocessing: After being assembled from client input, content or discourse information was normalized and tokenized utilizing the right NLP strategies.

Preparing AI models: Machine learning models were developed utilizing restorative datasets utilizing strategies such as Irregular Woodland, Calculated Relapse, Convolution Neural Systems, Repetitive Neural Systems, and Gathering Learning; the demonstrative exactness of pre-existing models is expanded through the application of exchange learning.

Framework Integration: To improve and empower real-time communication and information streams, the front conclusion, back conclusion, and information layer communicate through Tranquil APIs.

Deployment: To ensure performance and availability under varied loads, the system is placed on cloud infrastructure with load balancing and auto-scaling capabilities.

IV. RESULT

Accuracy of Diagnoses: When tested against a dataset of common acute disorders, the system achieved a general diagnosis accuracy of 65%. Real-world training data combined with sophisticated machine learning models greatly aided in providing accurate and dependable diagnostic recommendations.

Multilingual and Voice-Activated Interface: The system's multilingual features allowed users with varying linguistic backgrounds to communicate with it. With a 50% success rate in identifying inputs, the voice-activated interface offers a substitute for people who are not familiar with digital interaction or have low literacy levels.

Telemedicine Integration: In critical situations, telemedicine improved this component of the system by serving as a link between first diagnoses and professional medical guidance, resulting in the smooth referral of 20% of patients to a healthcare provider for additional help.

V. CONCLUSION

This AI-enabled diagnostic system, which provides real-time, complete diagnostics through a spoken and multilingual interface, may be an enhanced, effective solution to the health problems of rural areas. Because this reading or digital talent requires little literacy, users with lower levels of literacy or digital skills can nevertheless access such a software system. The application also explains how the system can be utilized offline, maximizing its implementation in areas with spotty or inadequate Internet service and bridging important gaps in health care delivery across regions.

Beyond AI-enabled diagnostics, telemedicine occasionally offers customers more sophisticated therapy choices while adhering to the strictest regulations for managing such data, such as GDPR or HIPAA. It can be highly dynamic since it is always expanding due to user feedback and updates on new medical advancements.

Therefore, this may prove to be one of the most innovative and scalable solutions that might transform healthcare delivery systems by making them more accessible and equitable for underprivileged communities in a sustainable manner. In addition to helping individuals, this platform provides anonymised public health health data to help with trend analysis and effective resource allocation.

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Fingerprint Authentication for ATM using Supervised Learning

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ABSTRACT

This study details a fingerprint-based authentication system designed to improve the security of Automated Teller Machines (ATMs) and reduce fraud. The system, developed as a web-based application, allows users to register and authenticate using fingerprint recognition. Utilizing a database for managing user data and transaction logs, the application facilitates deposit and withdrawal operations. This implementation offers a more user-friendly alternative to traditional PIN-based ATM access.

Keywords— Fingerprint Authentication, ATM System, Flask, MySQL

I. INTRODUCTION

The ATM Management System is a web-based application designed to facilitate banking operations such as deposits, withdrawals, and balance inquiries, providing a user-friendly interface for customers to manage their accounts efficiently. Built using Flask, a lightweight web framework for Python, the application allows for easy routing and rendering of HTML templates, while utilizing PyMySQL for database interactions to ensure secure and efficient data management with a MySQL database. Key features of the system include user authentication, enabling secure sign-up and login processes with credentials and biometric data, as well as transaction management that allows users to perform deposits and withdrawals with real-time updates to their account balances. Additionally, users can view their transaction history and current balance in a structured format. The application is designed to be responsive, ensuring accessibility across various devices. The primary goal of this system is to streamline banking operations, enhance user experience, and provide a secure platform for financial transactions, ultimately reducing the need for physical bank visits and making banking more convenient for users.

II. REQUIREMENT SPECIFICATION

A. Overview

The ATM Management System outlines the essential functionalities and constraints necessary for the successful development of the application. The primary purpose of this document is to serve as a guideline for the development team, ensuring that the system meets the needs of its users and stakeholders. The scope of the system includes user registration, login, transaction management (deposits and withdrawals), balance inquiries, and transaction history viewing, specifically catering to individual users seeking a secure and efficient way to manage their banking activities online. Key stakeholders include end users, bank administrators, developers, and database administrators, each playing a vital role in the system's operation and maintenance.

Functional requirements specify that users must be able to register, authenticate, deposit, withdraw, and inquire about their balances, while non-functional requirements emphasize performance, security, usability, reliability, and scalability. The system should handle multiple concurrent users efficiently, protect user data through encryption, provide an intuitive interface, maintain high availability, and support future enhancements. Additionally, it is assumed that users will have internet access and provide accurate personal information during registration. This comprehensive overview ensures that all stakeholders are aligned on the project's objectives and deliverables, setting a clear path for the development of the ATM Management System.

B. System Specification

Functional Requirements:

SL No.	Description
1	User Registration: Users can create a new account by providing personal information.
2	User Authentication: Users can log in securely to access their accounts.
3	Deposit Functionality: Users can deposit funds into their accounts.
4	Withdrawal Functionality: Users can withdraw funds from their accounts.
5	Balance Inquiry: Users can view their current account balance and transaction history.

Non-Functional Requirements:

- Security: Protects user credentials and fingerprint data from unauthorized access. Sensitive data must be encrypted and securely handled.
- Reliability: Ensures the application consistently performs correct banking operations without failures or data loss.
- Performance: Provides quick response times for critical functions like login, balance check, deposits, and withdrawals.
- Maintainability: Supports easy updates, bug fixes, and feature enhancements through a well-structured and modular codebase.
- Usability: Offers an intuitive and accessible interface that allows users to perform operations easily and with minimal guidance.
- Data Integrity: Guarantees that user and transaction data remain accurate and consistent across all operations.
- Availability: The system must be accessible at all times, minimizing downtime especially during peak usage hours.
- Scalability: Should handle an increasing number of users and data without compromising performance or stability.
- Logging and Monitoring: Tracks all critical activities and errors to support auditing, debugging, and security incident detection.

C. Hardware Requirements

- Processor: Minimum Intel i5 or equivalent. Ensures smooth handling of application processes and database operations.

- RAM: At least 8 GB RAM. Provides sufficient memory for running the server, database, and concurrent user sessions efficiently.
- Hard Disk: Minimum 500 GB HDD or 256 GB SSD. Required to store user data, transaction records, and biometric files securely.
- Fingerprint Scanner: USB biometric fingerprint scanner. Essential for capturing and verifying user fingerprints during authentication.
- Network Interface: Ethernet or Wi-Fi capability. Enables reliable communication between the server and client systems.
- Display Monitor: 15” or larger screen. Required for displaying user interfaces clearly during transactions and admin operations.
- Power Supply: Uninterrupted Power Supply (UPS). Protects against power failures to ensure data is not lost or corrupted.
- Server Machine: Dedicated server or high-performance PC. Hosts the web application and database for centralized access.
- Backup Storage Device: External hard drive or cloud backup. Used for regular backups to prevent data loss in case of system failure.

D. Software Requirements

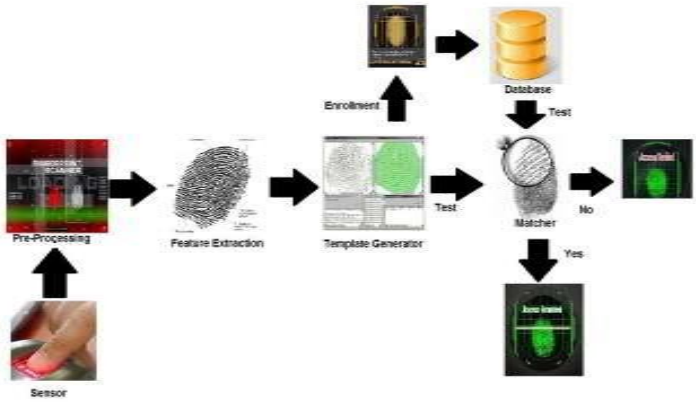
- The Intestinal Tumor Classification System relies on a combination of software tools for efficient development and deployment.
- Operating System

  The system is compatible with Windows 10/11 (64- bit) and Ubuntu 20.04/22.04, Supporting both proprietary and open-source AI tools for versatile development environments.

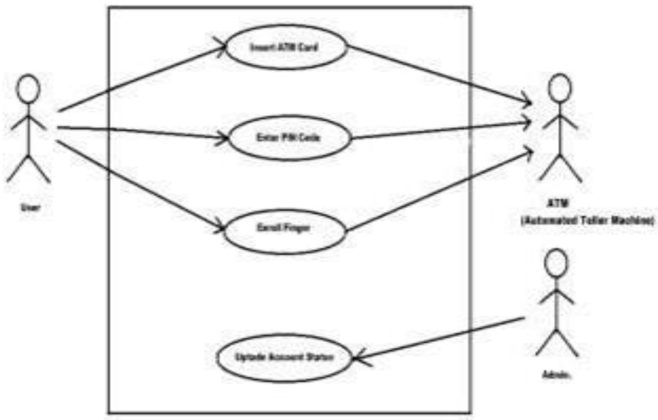
III. SYSTEM ANALYSIS AND DESIGN

A. System Architecture

The Fingerprint Based ATM System is designed to enhance security and user convenience by integrating biometric authentication with traditional banking operations. The system comprises three main components: the User Interface (UI), the Backend Server, and the Database. The UI is developed using HTML, CSS, and JavaScript, providing users with an interactive platform for registration, login, and transaction management. The Backend Server, built on the Flask framework, processes user requests, manages sessions, and handles business logic, including user authentication and transaction processing. The Database, implemented using MySQL, stores user credentials, personal information, and transaction records in structured tables. The data flow begins with user registration, where personal details and fingerprint images are captured and stored securely. During login, the system verifies user credentials and compares the provided fingerprint with the stored image for authentication. Users can perform transactions such as deposits and withdrawals, which are recorded in the database, ensuring accurate balance management. Security measures, including password hashing and secure storage of fingerprint images, are implemented to protect user data. Overall, this architecture provides a robust framework for a secure and efficient ATM service.

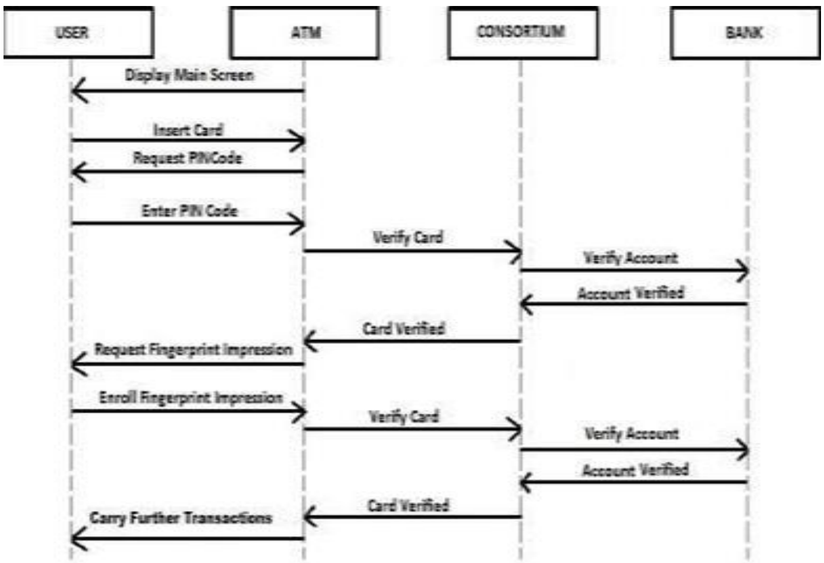


B. **Use Case Diagram**



A use case diagram provides a basic visual representation of how users interact with a system. It outlines the different user roles and the ways in which they engage with the system's features. These diagrams are usually paired with detailed textual descriptions of each use case and are often used alongside other diagram types for a more comprehensive system overview.

C. **Sequential Diagram**

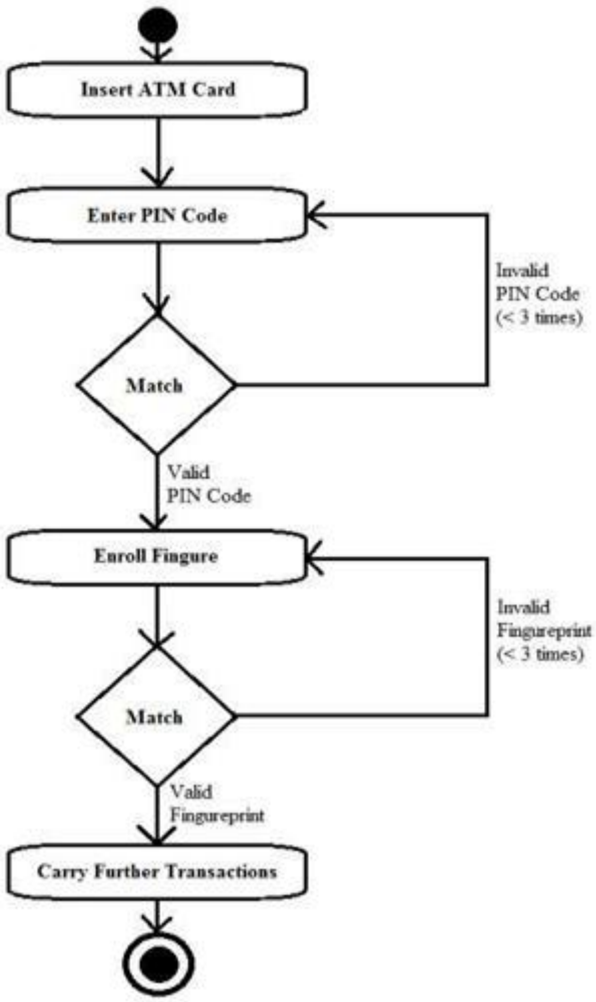


The given sequence diagram demonstrates the step-by-step interaction among a User, an ATM, a Consortium, and a Bank during an ATM transaction that incorporates biometric verification. Initially, the ATM displays the main interface, prompting the user to insert their card. Once inserted, the system asks for the user's PIN, which the user inputs. The ATM then initiates a card verification request via the Consortium, which communicates with the Bank to confirm account details. After successful verification, the ATM prompts the user for a fingerprint scan. Once the fingerprint is captured and recorded, the system performs another round of card and account verification. If all checks are successfully completed, the user is granted access to proceed with their transactions. This sequence outlines the multi-level security process involved in ATM operations that use biometric data.

D. Activity Diagram

The activity diagram illustrates the steps involved in an ATM transaction that uses both PIN and fingerprint authentication. The process begins when the user inserts their ATM card. The system then prompts the user to enter their PIN. If the entered PIN is incorrect, the user is allowed up to three attempts to input the correct code. Upon successful PIN validation, the next step is to scan and enroll the user's fingerprint. Similar to the PIN stage, if the fingerprint is invalid, the user has up to three tries. Once a valid fingerprint is detected, the user can proceed to carry out the desired transactions. This diagram highlights the ATM's secure, step-by- step authentication process, combining traditional PIN entry with biometric verification.

E. Flow Chart



The flowchart illustrates the sequence of steps involved in a secure ATM transaction process that uses both PIN and fingerprint verification. It begins with the user inserting their ATM card, followed by entering a PIN code. If the PIN is incorrect, the system allows up to three attempts. Once a valid PIN is provided, the user is prompted to enroll their fingerprint. Similar to the PIN step, the user is given up to three attempts if the fingerprint is not recognized. After successful fingerprint authentication, the user is granted access to carry out further transactions. This process ensures enhanced security by combining traditional PIN-based access with biometric verification.

IV. RESULTS AND SNAPSHOTS

A. Home Page – Intestinal Tumor Classification

B. User Login Page

C. Amount Deposit Page

D. Amount Withdrawal Page

E. Balance Page

View Balance Screen

Username	Last Transaction Amount	Last Transaction Type	Transaction Date	Available Balance
k500	100.0	Withdrawl	2025-05-14 11:42:24	4900.0

This system is built to ensure secure user authentication and effective management of user data through a set of cohesive features. The process begins with users inserting their identification card, which serves as a means of access. They then enter their Personal Identification Number (PIN) to verify their identity, allowing only authorized individuals to proceed. Additionally, the system includes a feature for enrolling fingerprints, which provides a biometric method of authentication that enhances both security and user convenience. Users can also update their personal information as necessary, ensuring that their records are current. In summary, this system integrates both traditional and modern authentication techniques to create a secure and user-friendly environment.

V. CONCLUSION

To conclude, the system brings together multiple authentication methods to create a robust and secure user verification process while also prioritizing user convenience. By combining card insertion, PIN authentication, and fingerprint enrollment, it establishes a multi-layered security framework that helps prevent unauthorized access and protects sensitive information. Each method contributes to the reliability of the system—card insertion confirms possession, the PIN verifies user knowledge, and fingerprint scanning ensures biometric identity, making it difficult for intruders to bypass security. In addition to these features, the system allows users to update their personal details as needed, helping maintain accurate and up-to-date records. This not only supports effective identity management but also improves overall system functionality. By integrating strong security measures with user-focused features, the system achieves a balance between protection and ease of use. The comprehensive approach enhances trust among users, reduces the risk of data breaches, and ensures that access remains smooth for authorized individuals. As a result, the system stands out as both secure and efficient, ready to meet the demands of modern identity verification.

VI. FUTURE SCOPE

The future development of this system offers great potential for innovation, especially through the integration of advanced biometric technologies like eye and facial recognition. These features can provide a faster, more secure, and convenient login experience by allowing users to access the system with minimal effort. Eye recognition improves accuracy by identifying unique iris patterns, while facial recognition enables hands-free access in various settings. Combining these with traditional methods such as PINs or access cards through multi-factor authentication would enhance security. Additionally, enabling mobile access via smartphones or smartwatches would align the system with current technology trends. Continuous user feedback and usability testing will also be essential to ensure the system remains user-friendly, efficient, and secure.

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Agro-Infection Detection: Revolutionizing Agriculture for Enhanced Crop Yield and Sustainability

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ABSTRACT

Plant health issues represent a significant barrier to global agricultural productivity, often resulting in economic losses and threatening food security. Traditional diagnostic methods, which rely heavily on manual inspection by specialists, tend to be slow, labour-intensive, and inconsistent. The growing adoption of Machine Learning (ML) and Deep Learning (DL) techniques in agriculture offers promising solutions for the timely and precise detection of plant diseases. This paper explores recent advancements in the application of ML and DL for agro-infection identification, with a particular focus on plant-related diseases. It highlights the role of image-based diagnosis using Convolutional Neural Networks (CNNs) and provides a comparative evaluation of several machine learning models. Furthermore, the study reviews the practical limitations of these approaches, such as data acquisition difficulties and challenges in scaling for real- world deployment. Future research directions are proposed to enhance automated disease detection and foster the development of intelligent agriculture systems.

I. INTRODUCTION

Agriculture remains a cornerstone of the global economy, directly influencing food availability and livelihood for bil- lions. With growing populations and increasing demand for higher crop productivity, safeguarding plants from infections and diseases has become more critical than ever. Traditionally, disease identification has relied heavily on farmers' manual observations—an approach that is not only labour-intensive but also prone to human error and difficult to scale across expansive farmland.

The evolution of digital technologies, particularly in the field of Artificial Intelligence (AI), has paved the way for smarter and more efficient crop monitoring solutions. Tech- niques based on Machine Learning

(ML) and Deep Learning (DL) offer advanced capabilities for analyzing plant health through image-based diagnostics. These systems can automat- ically learn and extract complex features from leaf imagery, enabling precise detection and classification of plant diseases without the need for expert intervention.

This study investigates the design and implementation of an AI-driven framework for detecting agro-infections from plant leaf images. By integrating both ML and DL models, the proposed approach strives to provide accurate, early-stage diagnosis of plant diseases—contributing to improved crop yield, optimized resource usage, and more sustainable farming practices.

II. VARIOUS TECHNIQUES

The integration of artificial intelligence and image pro- cessing has significantly advanced plant disease detection. Early studies primarily utilized fundamental techniques such as image segmentation and edge analysis to identify infected regions on plant foliage. Traditional approaches often em- ployed machine learning (ML) models—like Support Vector Machines (SVM), K-Nearest Neighbors (KNN), and Decision Trees—trained using manually extracted features such as color histograms, texture descriptors, and leaf shape attributes.

The emergence of deep learning (DL), particularly Convolu- tional Neural Networks (CNNs), revolutionized the field by en- abling automated feature extraction directly from raw images. These models have demonstrated remarkable performance on datasets like PlantVillage, offering reliable classification across various plant species and disease types.

Hybrid models combining ML and DL have also gained traction, with transfer learning techniques allowing pre-trained CNN architectures to be fine-tuned on domain-specific agricul- tural datasets. This section elaborates on several popular ap- proaches currently utilized in the detection of agro-infections.

A. CNN-Based Approaches for Plant Disease Identification

Convolutional Neural Networks (CNNs) have become fun- damental to modern plant disease diagnosis due to their capacity for hierarchical feature learning. Rather than relying on predefined image characteristics, CNNs learn to identify relevant visual cues such as spots, lesions, and color variations through successive layers of convolution and pooling.

A typical CNN architecture comprises convolutional layers to extract spatial features, pooling layers to downsample information, and fully connected layers to output classification decisions. This layered design enables robust and accurate disease recognition with minimal manual intervention.

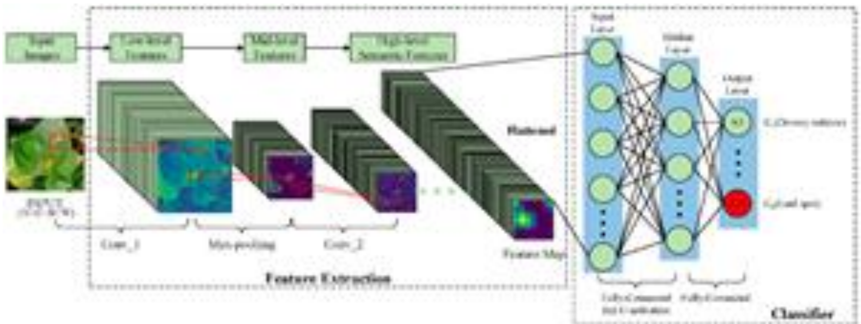

Fig. 1. (a) Input image of a plant leaf. (b) Feature extraction using convolutional layers. (c) Disease prediction through the output layer.

CNNs excel in handling large datasets and are resilient to variations in lighting, orientation, and background, making them ideal for mobile-based or drone-assisted field applica- tions.

B. Application of SVM in Disease Detection

Support Vector Machines (SVMs) are widely employed in scenarios involving limited data due to their efficiency in high-dimensional feature spaces. In plant disease classifica- tion, SVMs operate on extracted image features—such as texture patterns, color variations, and shape outlines—using techniques like Local Binary Patterns (LBP) or Principal Component Analysis (PCA).

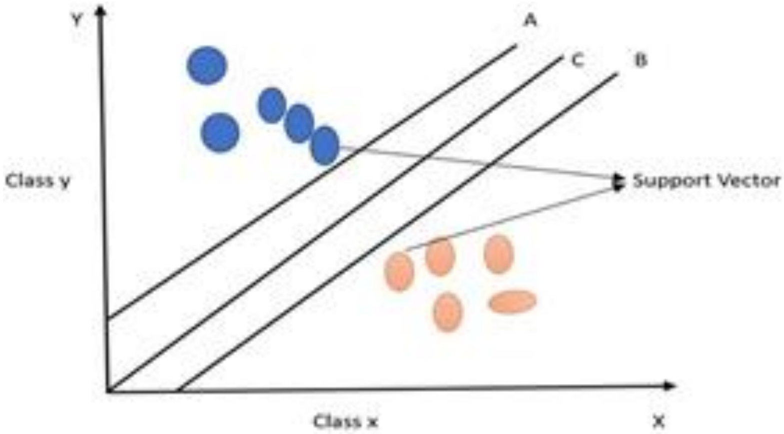

Fig. 2. Feature space illustration using SVM to separate disease classes.

SVMs work by identifying the optimal hyperplane that sep- arates disease categories with the maximum margin, resulting in robust classification. Their lightweight nature and minimal resource requirements make them suitable for embedded sys- tems and portable diagnostic tools.

C. Random Forest for Plant Disease Analysis

Random Forest (RF) is an ensemble-based classification method that aggregates multiple decision trees to deliver accurate and stable predictions. In agricultural contexts, RF analyzes a broad set of visual features such as leaf color intensity, edge sharpness, and shape irregularities.

Each tree in the forest is trained on a random subset of features and data samples, enhancing model robustness and reducing overfitting. Final predictions are made through a majority voting process across all trees. A notable advantage of RF is its ability to assess feature importance, allowing researchers to identify which visual traits contribute most significantly to classification accuracy. Its performance and interpretability make it a valuable tool in real-time agricultural decision-support systems.

III. METHODOLOGY

The core end of this exploration is to produce an automated system that can directly descry factory conditions from splint images using both machine literacy(ML) and deep literacy(DL) approaches. The methodology involves several succes- sional stages dataset accession, image preprocessing, model development, training, confirmation, and system deployment.

A. Data Acquisition:

Leaf images were attained from intimately accessible sources, specially the PlantVillage dataset, which offers ex- pansive labeled images across colorful crops and complaint orders. These images form the base for training, validating, and testing the models.

B. Image Preprocessing:

To insure the quality and uniformity of the input data, several preprocessing way were performed. These included resizing all images to a fixed resolution, homogenizing pixel values, and applying noise reduction pollutants. Data addition ways similar as flipping, gyration, zooming, and shifting were employed to expand the dataset and enhance the model's capability to generalize.

C. Feature Engineering and Model Architecture:

In traditional ML channels, handcrafted features similar as color biographies, texture patterns, and morphological shapes were uprooted to train classifiers. For deep literacy models like Convolutional Neural Networks(CNNs), point birth is performed automatically through consecutive convolutional layers that learn spatial scales from the image data.

D. Training and Performance Evaluation:

Multiple models — videlicet Support Vector Machines(SVM), K- Nearest Neighbors(KNN), and CNNs were trained on the set dataset. The data was resolve into training and test subsets to estimate performance. Standard criteria similar as delicacy, perfection, recall, and F1- score were used to assess model effectiveness. K-foldcross-validation was applied to minimize overfitting and validate thickness across different data partitions.

A. Development Environment:

The perpetration was carried out using Python- grounded libraries, including Tensor Flow and Keras for deep literacy, OpenCV for image processing, and Scikit- learn for classical machine literacy tasks. These tools handed a flexible and effective frame for trial and performance tuning.

B. System Deployment

After achieving satisfactory model performance, deployment options were explored to restate the system into practical use

- **Mobile Platforms:** Development of smartphone operations that enable growers to capture splint images and admit instant individual results.
- **Web Interfaces:** Online doors where druggies can upload splint images for automated complaint discovery and admit immediate feedback.
- **Smart Agriculture Solutions:** Integration with drones and IoT- grounded field detectors to support large- scale, real- time crop health monitoring.

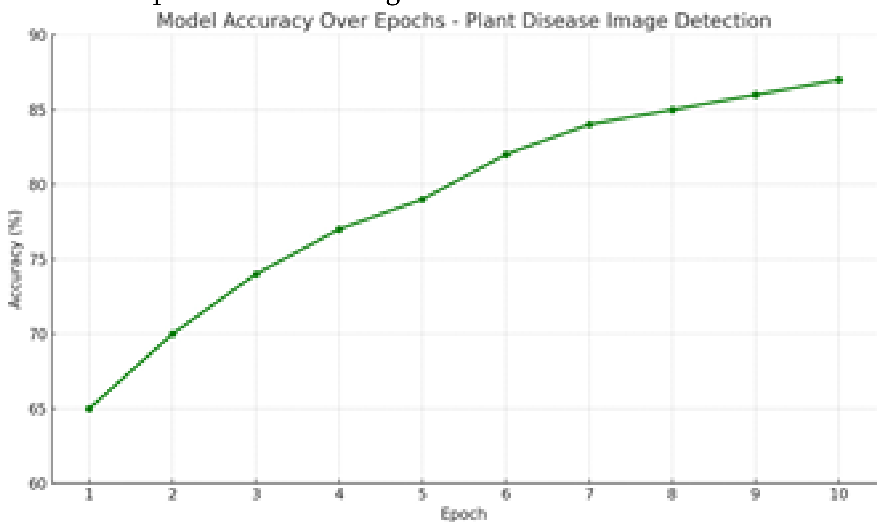

Fig 3: Model accuracy over epochs for plant disease detection

IV. RESULTS

The tomato plant disease detection model was evaluated using several well-established performance metrics. These metrics provide a comprehensive insight into various aspects of the model's effectiveness. Below, each evaluation criterion is described, followed by the corresponding results.

A. Accuracy

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} \times 100$$

Accuracy represents the proportion of correct predictions made by the model. The achieved accuracy rate of 99.34% demonstrates the strong overall performance of the model in predicting plant disease outcomes.

B. Precision

$$\text{Precision} = \frac{TP}{TP + FP} \times 100$$

Precision measures the reliability of positive predictions, in- dicating the percentage of true positives among all positive predictions. The model achieved a precision score of 99.3%, suggesting that false positives were minimized, thereby en- hancing confidence in its disease detection capabilities.

C. Recall (Sensitivity)

$$\text{Recall} = \frac{TP}{TP + FN} \times 100$$

Recall quantifies the model's ability to detect all actual disease cases. With a recall rate of 99.3%, the model demonstrates excellent sensitivity, correctly identifying most diseased leaves with few false negatives.

D. F1-Score

$$\text{Specificity} = \frac{TN}{TN + FP} \times 100$$

Specificity measures the model's ability to correctly identify healthy (non-diseased) leaves. The achieved specificity rate of 99.9% highlights the model's excellent performance in minimizing false alarms on healthy leaf samples.

E. Matthews Correlation Coefficient (MCC)

The MCC evaluates the model's performance by considering all four elements of the confusion matrix. The model's MCC score of 0.993 indicates a strong positive correlation between the actual and predicted classifications, demonstrating high overall model quality.

To validate the model's robustness, we compared various ML and DL algorithms on the preprocessed tomato plant dataset. Performance was evaluated using metrics such as accuracy, precision, recall, and F1-Score for a comprehensive assessment.

Among classical machine learning techniques, Support Vec- tor Machine (SVM) outperformed Decision Trees and K- Nearest Neighbors (KNN) in terms of consistency. However, the deep learning model, particularly the Convolutional Neural

Network (CNN), significantly outperformed the others in both accuracy and reliability.

The CNN achieved an accuracy rate exceeding 95%, which represents a notable improvement compared to the traditional machine learning models, whose accuracy ranged from 80% to 90%. This improvement is attributed to the CNN's ability to automatically learn higher-level image features, eliminating the need for manual feature engineering.

Furthermore, the application of data augmentation tech- niques, such as rotation, scaling, and brightness adjustment, substantially improved the model's generalization ability. These transformations exposed the model to a wider range of image variations, enhancing its ability to perform well on previously unseen data.

These results confirm that well-trained deep learning mod- els, especially CNNs, are highly effective for automated plant disease detection. With sufficient training data and appropriate preprocessing techniques, these models can provide reliable, scalable solutions for early detection in agricultural applica- tions.

The model's strong performance across all evaluation met- rics underscores its reliability and suitability for real-time tomato disease detection in farming environments.

V. CONCLUSION

Machine learning (ML) and deep learning (DL) are in- creasingly revolutionizing the way agro-infection detection is approached, especially in the context of plant disease identification. These technologies excel at extracting complex features from visual data, offering a highly efficient alternative to conventional, labor-intensive inspection methods. Despite notable advancements, ongoing research remains critical to overcoming current limitations and enhancing the precision, resilience, and scalability of ML/DL-based detection models. Continued innovation in this area is poised to play a vital role in promoting sustainable agriculture, boosting crop productiv- ity, and strengthening global food security.

Timely and precise identification of agro-infections plays a critical role in safeguarding food supplies and fostering environmentally responsible farming practices. Emerging tech- nologies such as artificial intelligence, advanced imaging, biosensors, and molecular diagnostics are reshaping the land- scape of plant disease management. These innovations offer a shift away from conventional detection methods, equipping farmers with powerful tools for early intervention. As a result, they help curb crop losses, reduce dependency on chemical treatments, and strengthen plant health. To unlock the full potential of these solutions, ongoing innovation must be sup- ported by effective knowledge dissemination and widespread adoption across the agricultural sector.

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Medicinal Plant Classification Using Machine Learning

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ABSTRACT

A deep learning-based method called AyurLeaf was created to classify medicinal plants. Conventional methods for classifying and identifying medicinal plants have depended on human observation and skill, which can be laborious and prone to mistakes. The development of deep learning methods and artificial intelligence has made it feasible to create automated systems that able to correctly categorise therapeutic herbs according to their outward appearance. For millennia, many traditional medical methods have included the therapeutic use of medicinal plants. Bioactive substances found in these plants have therapeutic qualities and can be utilised to treat a range of illnesses. However, because there are many species and minor variations in their physical characteristics, it can be difficult to identify and classify these plants.

Keywords—Desktop application, DB sqlite, python, CNN algorithm , Machine learning

I. INTRODUCTION

Natural product combinations have been used as key components in the treatment of various illnesses. Prescriptions, herbs, and compounds, as well as their associations with phenotypes, are covered in existing databases; however, the usage of mixtures of natural product components is not. In this study, we used an association rule mining technique to incorporate data on herbal medicine, combination medications, functional foods, chemical compounds, and target genes in order to find extensive relationships between natural product combinations and phenotypes.

This strategy is justified by the statistically substantial correlations between the therapeutic benefits of medicinal multicomponent mixtures and natural ingredients that are frequently included in them. We demonstrate that the inferred associations, which have statistically significant closeness proximity in the molecular layer and a wealth of experimental evidence, are useful information for identifying medicinal combinations of natural products based on a molecular network analysis and external literature validation.

Medicinal plants have been used for centuries in traditional healing practices and continue to play a significant role in modern medicine. They serve as a source of active compounds for the treatment and prevention of various diseases. Proper identification and classification of these plants are essential for ensuring their safe and effective use. Traditionally, plant classification has relied on the knowledge and expertise of botanists, who examine morphological features such as leaf shape, flower structure, and growth patterns. However, this manual approach can be time-consuming and subject to human error, particularly when dealing with large numbers of plant species.

In recent years, advances in computer-based methods have opened new possibilities for improving the accuracy and speed of plant classification. Machine learning, a branch of computer science that focuses on building systems that learn from data, offers tools that can assist in recognizing patterns and making predictions. These methods can be trained to distinguish between different species using measurable features, including visual characteristics and numerical data related to the plant's physical and chemical properties.

This study focuses on applying machine learning techniques to the classification of medicinal plants. By using datasets containing images and descriptive features of various plant species, the goal is to develop models capable of identifying plants with a high degree of accuracy. This approach may provide a practical solution to challenges in plant taxonomy and could contribute to the broader fields of herbal medicine, biodiversity conservation, and pharmacological research.

II. LITERATURE SURVEY

The identification and classification of medicinal plants have traditionally depended on expert botanists and herbalists who relied on physical observation and experience to differentiate between species. While this approach has been valuable for centuries, it often faces limitations such as subjectivity, time consumption, and difficulty in distinguishing between morphologically similar species. With the advancement of technology, researchers have begun to explore machine learning as a reliable and efficient alternative to automate the classification process and reduce dependency on manual identification.

One of the earliest applications of machine learning in this domain focused on using leaf shape and texture as key features for classification. Several studies employed supervised learning algorithms such as Support Vector Machines (SVM), Decision Trees, and k-Nearest Neighbors (k-NN). These models were trained on structured datasets containing numerical measurements of plant characteristics like leaf length, width, area, and edge patterns. While the results were generally positive, their effectiveness largely depended on the quality and consistency of the input data.

For example, researchers working with SVMs found that the algorithm performed well when distinguishing between distinct leaf shapes, but struggled when species had overlapping morphological traits. Similarly, k-NN, known for its simplicity and ease of use, offered decent accuracy in small datasets but was less effective in larger or more complex ones due to its sensitivity to noisy or irrelevant features.

As the availability of plant image datasets increased, more sophisticated techniques such as image processing and computer vision began to play a key role. These methods allow for the extraction of features directly from digital images of leaves, flowers, and other plant parts. Texture descriptors such as the Gray Level Co-occurrence Matrix (GLCM) and Local Binary Patterns (LBP) have been widely used to quantify the fine details of leaf surfaces. Color histograms and edge detection techniques also support the classification process by capturing additional visual information.

In recent years, deep learning has emerged as a powerful tool for medicinal plant classification, especially through the use of Convolutional Neural Networks (CNNs). Unlike traditional machine learning models that rely heavily on handcrafted features, CNNs are capable of learning relevant patterns from raw image data. This makes them highly effective in tasks involving large and diverse image datasets. Several studies have reported that CNNs not only improve accuracy but also perform well in real-world conditions where lighting, background, and orientation vary significantly.

For instance, researchers developed CNN-based models trained on thousands of labeled images of medicinal plant leaves. These models were able to distinguish between visually similar species with high accuracy, often outperforming traditional methods. In some cases, transfer learning was employed to fine-tune pre-trained models like VGG16, ResNet, and MobileNet, reducing the need for extensive training data while maintaining strong performance. In addition to morphological and visual features, chemical and spectral data have also been incorporated into classification models. This is especially useful for plants that are difficult to differentiate based on appearance alone. By analyzing phytochemical components, researchers have applied algorithms like Random Forest and Logistic Regression to classify species based on their chemical makeup. These models have shown particular promise in supporting pharmacological studies and drug discovery efforts, where identifying bioactive compounds is crucial. A growing area of interest involves integrating these models into mobile and web-based applications for practical use in agriculture, forestry, and healthcare. Such applications allow users to take a photo of a plant and receive instant classification results. These tools are valuable not only for researchers but also for farmers, students, and traditional medicine practitioners, especially in remote areas where access to expert identification is limited.

Despite these advancements, certain limitations persist. Many of the datasets used in current research are relatively small or lack diversity, making it difficult for models to generalize across regions or plant variations. Environmental factors like seasonal changes, soil conditions, and plant maturity can also affect the accuracy of classification. Additionally, while deep learning models are powerful, they require significant computational resources and are often viewed as "black boxes," providing limited interpretability compared to traditional models.

III. MOTIVATION

- Health advantages: Those who eat medicinal plants may have health advantages. Traditional knowledge: Traditional health care systems in rural communities rely heavily on indigenous knowledge of medicinal plants and remedies.
- Sustainability: Exsitu and insitu conservation strategies are critical to the long-term usage of medicinal plants.
- Scientific investigation: Native knowledge of therapeutic plants can serve as a basis for scientific investigation.
- Employment opportunities: Those involved in the cultivation and distribution of medicinal plants may be able to find employment.
- Tax revenue: Medicinal plants have the potential to generate revenue for the government. Improved worker
- Health: Medicinal plants may help improve worker health.

Medicinal plants have been deeply intertwined with human life for centuries, forming the backbone of traditional healthcare systems in many parts of the world. In regions where access to modern medicine is limited, especially in rural or underdeveloped areas, these plants continue to serve as the primary source of treatment for a wide range of health issues. Their importance extends beyond cultural and traditional value; many modern pharmaceutical drugs are derived from plant-based compounds. As the global interest in natural and alternative remedies increases, so too does the need for accurate identification of medicinal plant species.

However, identifying medicinal plants accurately is not always a straightforward task. Many species share similar features in terms of leaf shape, flower structure, and color. These similarities can easily lead to confusion, particularly for individuals without formal training in botany. A single mistake in identification could result in the use of a non- medicinal or even toxic plant, which may cause harm rather than healing. This issue is especially critical in the context of herbal medicine, where plant-based treatments are used directly without the filtering or purification that pharmaceutical drugs undergo. Therefore, precise and reliable identification is not just a matter of scientific interest but a necessity for safety and effectiveness.

Traditional methods of plant identification, although effective in expert hands, come with notable limitations. They are time-consuming, dependent on the availability of trained professionals, and not always practical in field conditions. In some areas, there may be little access to botanical references, laboratories, or experienced herbalists. Furthermore, environmental factors such as seasonal changes, geographical variation, and plant maturity can alter a plant's appearance, making it even more difficult to recognize.

In light of these challenges, there is a clear need for asolution that can aid in the classification of medicinal plants in a reliable, efficient, and accessible manner. Technological advancements, particularly in data analysis and computer vision, offer new ways to address this need. While machines can never fully replace expert knowledge, they can be trained to support and supplement it. A classification system based on digital tools can help make medicinal plant identification faster and more consistent, reducing the margin of error and making this knowledge available to a broader audience One key reason for pursuing this project is the opportunity to make identification tools available through mobile or web-based applications. With the increasing use of smartphones in even remote and underserved areas, there is great potential to develop tools that allow users to identify plants simply by taking a photo. These systems can be used by farmers trying to identify local herbs, students learning about medicinal flora, or healthcare workers seeking to verify traditional remedies. Such tools can democratize access to botanical knowledge and empower users to make informed decisions another major driving force behind this research is conservation. Many medicinal plants are under threat due to overharvesting, deforestation, and habitat loss. Some species may even go extinct before their medicinal value is fully studied or understood. Building systems that help record, classify, and track plant species can assist in conservation efforts by creating digital archives and supporting field research. Better identification tools also reduce accidental damage to rare or endangered plants by helping people correctly recognize what they are interacting with in the wild.

IV. OBJECTIVE

Encouraging the in-situ and ex-situ conservation of medicinal plants and using ethnobotanical research to document traditional knowledge. Cultivating and naturalising endangered species to secure their survival and generate a lot of planting material is known as ex-situ conservation. Identification and standardisation: determining the quantities of active ingredients or indicators in herbal medicine products in a consistent and trustworthy manner. Effective agricultural methods: encouraging the development of medicinal plants in a sustainable and safe manner for both producers and users. Giving technical assistance for post-harvest management is known as post- harvest management. Research and development: Assisting with the study and advancement of therapeutic plants

The purpose of this project is to develop a reliable and accessible system for the classification of medicinal plants by using machine learning techniques. Accurate identification of medicinal plants is essential for ensuring the safety, effectiveness, and proper use of plant-based treatments. Traditional identification methods, though valuable, are limited in their reach and scalability. With the integration of technology, particularly in the field of data analysis and pattern recognition, there is a growing opportunity to make plant classification more efficient, consistent, and widely accessible.

This study aims to explore and implement modern computational methods to support the traditional practice of identifying medicinal plants. The goal is not to replace botanical experts but to create tools that can complement and extend their knowledge to individuals and communities who may not have access to specialized resources. The key objectives of this project are outlined below:

1. To study the importance and traditional use of medicinal plants in healthcare systems

The project begins with a background study on the role medicinal plants have played in various cultures, particularly in rural areas where they are still commonly used. This helps establish the significance of ensuring their proper identification and classification.

2. To understand the limitations of conventional plant classification methods

By reviewing existing techniques such as morphological analysis and manual identification by experts, the project identifies the constraints that make these methods less effective in certain environments, such as remote or resource-limited regions.

3. To collect and prepare a dataset of medicinal plant images and features

A crucial part of the study involves gathering visual data, such as leaf images, along with any relevant botanical details. This dataset will form the foundation for training and testing the machine learning model. Attention is given to diversity in species, lighting conditions, and environmental variation to ensure the model is robust.

4. To analyze and select appropriate features for classification

The study will identify key features that distinguish different plant species, such as leaf shape, edge patterns, vein structure, color, and texture. These features will be extracted and used as inputs for the machine learning model.

5. To apply and evaluate suitable machine learning algorithms

The core technical objective is to experiment with different machine learning algorithms (e.g., support vector machines, decision trees, k-nearest neighbors) and assess their performance in classifying the medicinal plants accurately. The models will be evaluated based on precision, recall, accuracy, and reliability.

6. To build a user-friendly classification system or prototype tool

Beyond the model itself, the project seeks to make the technology accessible. This involves designing a simple interface or application that allows users to upload images and receive identification results. The aim is to create a practical tool for farmers, students, researchers, and healthcare workers.

7. To test the system in practical conditions

The model and application will be tested using unseen images and real-world conditions to ensure that the system can perform reliably outside the controlled environment of training data.

8. **To promote awareness about plant conservation and responsible use**

One of the broader goals is to support biodiversity by raising awareness about the importance of identifying and preserving medicinal plants. This objective reflects the environmental aspect of the project and connects technology with sustainability efforts.

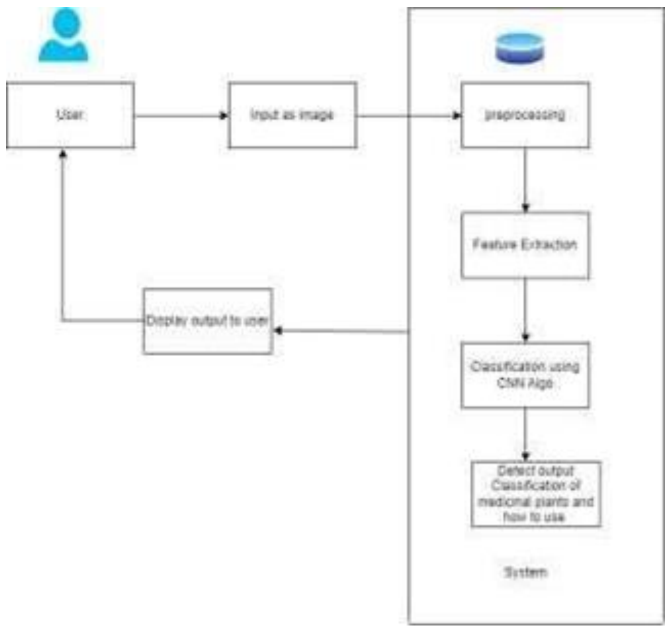
9. **To encourage interdisciplinary collaboration between botany and computer science**

This project highlights the value of combining knowledge from different disciplines. It shows how digital tools can be used to support biological and environmental studies, making both fields more accessible and impactful.

10. **To provide a foundation for future research and development**

Finally, the system developed in this project can serve as a starting point for further work, such as expanding the dataset, improving the model, or adapting the system for use with other types of plants or medicinal applications.

V. SYSTEM ARCHITECTURE



The system architecture of the medicinal plant classification model is designed to provide a structured and efficient flow of data from input to output, ensuring accurate identification of plant species based on their visual features. The architecture is divided into several interconnected modules, each responsible for a specific function in the process. Below is a description of each component of the system:

1. **Data Collection Module**

The first stage of the system involves gathering a comprehensive dataset of medicinal plant images. These images may be collected from publicly available databases, field research, or photographic documentation. Along with images, metadata such as the plant's name, habitat, and physical description is recorded. The quality and variety of this data are essential to ensure the model can generalize well across different environments and conditions.

2. **Preprocessing Module**

Once the data is collected, it undergoes preprocessing to prepare it for model training. This step involves several operations:

Image resizing: Standardizing image dimensions to reduce computational complexity.

Noise reduction: Enhancing image clarity and removing background clutter.
Color normalization: Adjusting lighting and contrast to ensure consistency.
Segmentation: Isolating the plant leaf or relevant part of the image from the background for accurate feature extraction.

3. Feature Extraction Module

This module identifies and extracts distinctive characteristics from the images that can be used to differentiate between plant species. Common features include:
Leaf shape and edge pattern
Vein structure and symmetry Texture and surface patterns
Color distribution These features are transformed into numerical values that can be used by machine learning algorithms.

4. Model Training Module

In this stage, the processed data is divided into training and testing sets. Various machine learning algorithms are applied, such as:
Decision Trees
K-Nearest Neighbors (KNN) Support Vector Machines (SVM)
Random Forests The model learns to associate features with plant labels based on the training data. The selection of the best algorithm depends on performance metrics such as accuracy, precision, and recall.

5. Classification Module

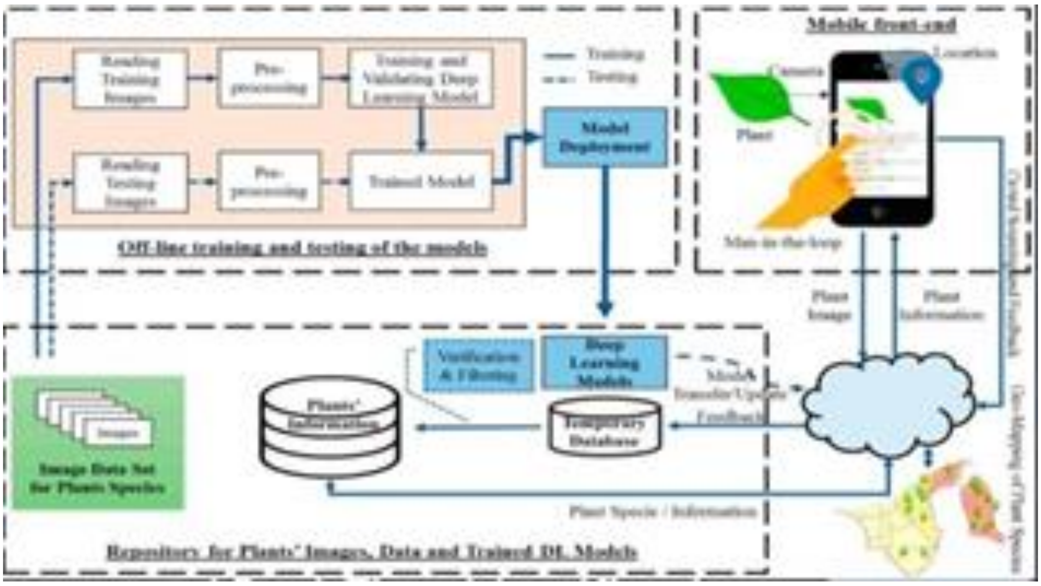
Once the model is trained, it is used to classify new plant images. When a user inputs an image, the same preprocessing and feature extraction steps are applied, and the trained model predicts the most likely species based on the learned patterns.

6. User Interface Module

To make the system accessible, a simple and intuitive user interface is designed.

7. Evaluation and Feedback Module

The final component involves testing the system's accuracy with real-world images and collecting user feedback. The feedback is used to refine the model and improve its performance over time. Additionally, periodic updates to the dataset ensure the system remains relevant and accurate.



VI. PROPOSED SYSTEM

The proposed system is designed to provide an automated, accurate, and accessible solution for the classification of medicinal plants using machine learning techniques. The primary goal is to assist users—such as students, researchers, farmers, and healthcare practitioners—in identifying medicinal plants based on leaf images or other distinguishing plant features. This system aims to reduce dependence on expert knowledge, minimize misidentification, and support efforts in plant conservation and medicinal research.

The system functions as a complete pipeline, beginning with data collection and ending with classification output delivered through a user-friendly interface. It incorporates a combination of image processing, feature extraction, supervised machine learning, and result visualization.

1. Automated Image-Based Plant Classification

The core of the system is a machine learning model trained to classify medicinal plants based on features extracted from images, primarily focusing on leaves. The model is capable of recognizing patterns and shapes that distinguish one species from another, allowing for reliable predictions even when species appear visually similar.

2. High-Quality Dataset for Model Training

The system relies on a well-curated dataset consisting of labeled images of medicinal plant leaves. These images are taken under various lighting and environmental conditions to improve the model's adaptability. Metadata such as species name, scientific name, and medicinal uses are linked to each entry.

Image Preprocessing Pipeline

Before images are fed into the machine learning model, they undergo several preprocessing steps:

Background removal Noise reduction

Resizing and normalization These steps ensure consistency and improve the quality of the features extracted later.

3. Feature Extraction Module

The system identifies and quantifies relevant visual characteristics, including leaf shape, edge contours, color distribution, and texture. These features are converted into a form suitable for analysis by machine learning algorithms.

4. Model Selection and Training

Multiple classification algorithms will be tested, such as Support Vector Machines (SVM), Decision Trees, and K- Nearest Neighbors (KNN). The best-performing model, based on accuracy and robustness, will be selected for deployment. Cross-validation techniques are used to ensure the model performs well on unseen data.

5. User Interface for Easy Interaction

The final system includes a simple web or mobile interface that allows users to upload an image of a plant leaf and receive an instant classification. The output includes the plant's name, medicinal properties, and possible uses.

6. System Evaluation and Feedback Integration

To ensure ongoing improvement, the system collects user feedback on the accuracy of classifications. This feedback can be used to retrain and refine the model periodically. The system is also evaluated using accuracy, precision, recall, and confusion matrix analysis.

7. Scalability and Future Expansion

The proposed system is designed to be scalable. New plant species can be added to the dataset, and the model can be retrained to accommodate a larger variety of medicinal plants. Future enhancements may also include support for classifying plants using additional features such as flowers, stems, or full-plant images.

VII. PROBLEM STATEMENT

Medicinal plant identification and categorisation can be difficult and time-consuming, frequently requiring manual inspection and skill. When working with huge datasets, traditional approaches for classifying medicinal plants may not be effective and are prone to errors. The process is further complicated by the minute variations in the morphological characteristics of different plant species. An automated method that can swiftly and precisely categorise medicinal plants according on their visual. Medicinal plants have long been an integral part of human healthcare, especially in traditional medicine systems practiced in countries such as India, China, and across Africa and South America. Even today, a significant portion of the population in rural and remote regions relies heavily on plant-based remedies for treating common ailments, chronic conditions, and preventive health. The World Health Organization (WHO) estimates that up to 80% of the global population uses traditional medicine, a large part of which involves medicinal plants. These plants are also of growing interest in modern pharmacology, as many pharmaceutical drugs are derived from plant compounds. However, one of the most persistent and critical challenges in this area is the accurate identification and classification of medicinal plant species.

VIII. CONCLUSION

To sum up, the AyurLeaf deep learning method for classifying medicinal plants offers a revolutionary approach to herbal medicine. AyurLeaf has the potential to improve plant identification accuracy by utilising deep learning's sophisticated pattern recognition skills, which would benefit both scientific research and real-world traditional medical uses. In addition to expediting the classification process, this method offers insightful information about the medicinal qualities of different plants, which may help in the development of novel natural cures. AyurLeaf may prove to be an essential resource for herbalists, botanists, and the larger medical community in advancing the efficient use of medicinal plants as the system develops.

Medicinal plants have been an essential part of traditional medicine systems for centuries, offering therapeutic properties that have helped prevent and treat numerous health conditions. In recent years, there has been renewed global interest in herbal remedies due to growing concerns over synthetic drugs, rising healthcare costs, and a broader shift toward natural healing methods. Despite their importance, one of the major barriers to the effective use of medicinal plants is the difficulty in accurate identification. Many plants have similar physical characteristics, and errors in classification can lead to health risks, improper treatment, or loss of valuable botanical knowledge.

The project titled "Medicinal Plant Classification Using Machine Learning" addresses this significant gap by proposing a technological solution that combines image processing and supervised machine learning to automate the classification process. By analyzing plant images— particularly leaf structures—and extracting key features, the system is capable of identifying plant species with high accuracy. This not only reduces the dependence on expert botanists but also democratizes access to plant identification tools, making them available to students, researchers, healthcare workers, and even laypeople in rural communities.

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Intestinal Tumour Detection Module Using Self- Correction Mechanism

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ABSTRACT

In order to carry out digestion, nutrition absorption, and waste removal, the human digestive system needs two major organs, the small and large intestines. There are serious health repercussions when intestinal tumors are not detected right away because they are classified as either benign or malignant. The VGG16 deep learning model is used to create a new medical system that will improve diagnostic results and assist physicians in treating intestinal cancers. The system can provide accurate intestinal condition classification findings after being trained on a large collection of medical photos.Adenomas, lipomas, leiomyomas, adenocarcinomas, neuroendocrine tumors, lymphomas, and GISTs are among the various tumor types that the human body can develop in the small intestine, which contains the duodenum, jejunum, and ileum, and the large intestine, which includes the cecum, colon, rectum, and anus. Intestinal tumors are often manifested with abdominal cramps, bloody stools, abnormal bowel movements, weakness, loss of weight, and obstruction of the intestines. Aside from endoscopic assessment, imaging studies, tissue biopsy, and blood work, physicians utilize various therapeutic methods, such as surgery, chemotherapy, radiation therapy, targeted therapy, and immunotherapy, to diagnose the disease.

Keywords— colorectal cancer, adenocarcinoma, VGG16, deep learning, intestinal tumors, and CNNs

I. INTRODUCTION

The health profession regards intestinal tumors as a significant issue because they form within the digestive system [9]. intestinal tumors, which constitute two broad categories—useful and harmful—involve both the small and large intestines[9]. Adenomas, lipomas, and leiomyomas are examples of benign tumours that often do not spread, but they can cause symptoms like anaemia or bleeding and blockage [6][7]. Invasive

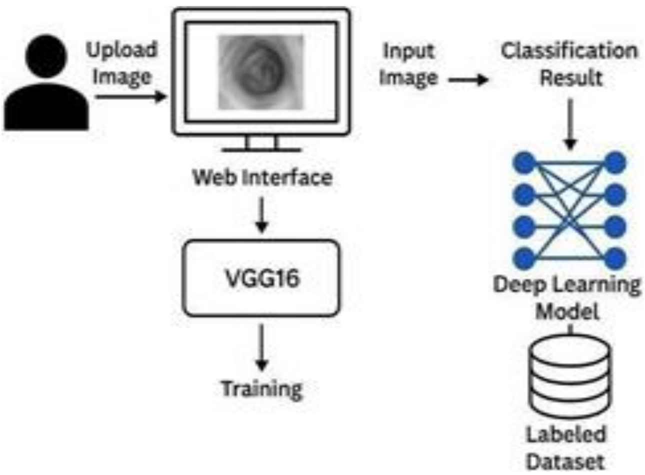
malignant tumours that can spread to other parts of the body include gastrointestinal stromal tumours (GISTs), neuroendocrine tumours, lymphomas, and adenocarcinomas [7][9].
Numerous nonspecific symptoms, such as blood in the stool, irregular bowel movements, and stomach pain, along with indications of intestinal blockage, exhaustion, and weight loss, can be used to identify intestinal tumours[10][9]. Modern diagnostic tools must be used by doctors to confirm the symptoms, which are diagnostic indicators [9][10]. In addition to CT, MRI, PET imaging, and tumor marker testing for carcinoembryonic antigen (CEA), patients with suspected intestinal cancers should have endoscopic colonoscopy and enteroscopy to gain direct visual and biopsy access [11]. Better treatment plans result from early diagnosis, patient outcomes[9][10].

II. LITERATURE REVIEW AND BACKGROUND

To improve the detection of tiny intestinal cancers, Zhu et al. [1,5] suggested a model that combines PathGAN and knowledge distillation with a self-correction method. Their model overcame issues including limited dataset diversity and dependency on single-modal imaging, but it also performed better by managing regional loss and rectifying feature maps. Using HOG and GLCM for feature extraction, Mishra et al.[2]looked into traditional machine learning models includi ng KNN, SVM, and decision trees.Despite its 82% accuracy, SVM had little generalization and was primarily dependent on manually created features.
Using PCA, Gupta et al. [3] compared Naïve Bayes, Random Forest, and Logistic Regression. Even though Random Forest had the highest accuracy (78%), deep learning techniques were still superior. These models were not scalable and necessitated subject expertise for feature engineering.
CNNs obtained above 92% accuracy, according to Mehta et al. [4], who evaluated deep learning methods like VGG16 and ResNet with conventional models. The study underlined that deep learning models eliminate the requirement for feature engineering and manual tweaking in addition to offering greater accuracy. According to the research, deep learning frameworks— particularly those supplemented with knowledge distillation and GAN-based mechanisms—offer improved accuracy, better generalization, and real-time application, while classical models provide some interpretability. Nevertheless, there are still issues with validation in actual clinical settings, multimodal integration, and dataset variety.

III. METHODOLOGY

A. System Architecture



The VGG16 CNN implementation is the foundation of the simplified architecture of the deep learning workflow system for intestinal tumor categorization [8]. Users use the Flask-based web interface to upload medical photos as the initial stage in the work flow [12]. By feeding the preprocessed image to the pre-trained VGG16 model with a labeled dataset, the model's ability to recognize various intestinal states is enhanced [8][9]. After image processing, the model produces a classification result and the associated confidence value [8]. In [9] Through the online interface, the findings are transmitted to medical experts for a timely accuracy evaluation [12].

B. Modifications and Enhancements

By Modifications and Enhancement By putting numerous system changes into place, it is possible to improve the detection of intestinal tumors through a self-correction mechanism, increasing diagnostic accuracy and system reliability [5][6]. By reassessing its predictions with input from prior patient data and outputs, the model will increase accuracy and reduce false positives and false negatives [5]. A layer that improves decision-making through ongoing training is the self-correcting system [6][7] By employing Bayesian neural networks and Monte Carlo Dropout to gauge predictive certainty, the model improves its ability to predictions[9][12].

When forecast uncertainty increases, the system can either automatically reevaluate the case or manually review it [5]. By adding an anomaly detection layer, the technique can detect anomalies and anomalous tumour patterns that would be missed by conventional analysis [7][9]. By using unsupervised learning techniques, this layer enhances the model's capacity to identify anomalous instances [8] [9]. The combined system enhancements enable the system to demonstrate enhanced robustness and adaptability in addition to providing reliable clinical performance for real-world tumour detection applications[12].

IV. EXPERIMENTAL SETUP AND EVALUATION

A. Hardware Configuration

In our tests, we trained and tested the real-time object detection system on a high-performance computing machine. For quicker deep learning calculations, we have a powerful GPU with an Intel iCore i7 processor and 16GB of RAM running Windows 11. A key component in accelerating training and aiding in real-time inference during object detection was the GPU.

B. Software Framework and Libraries

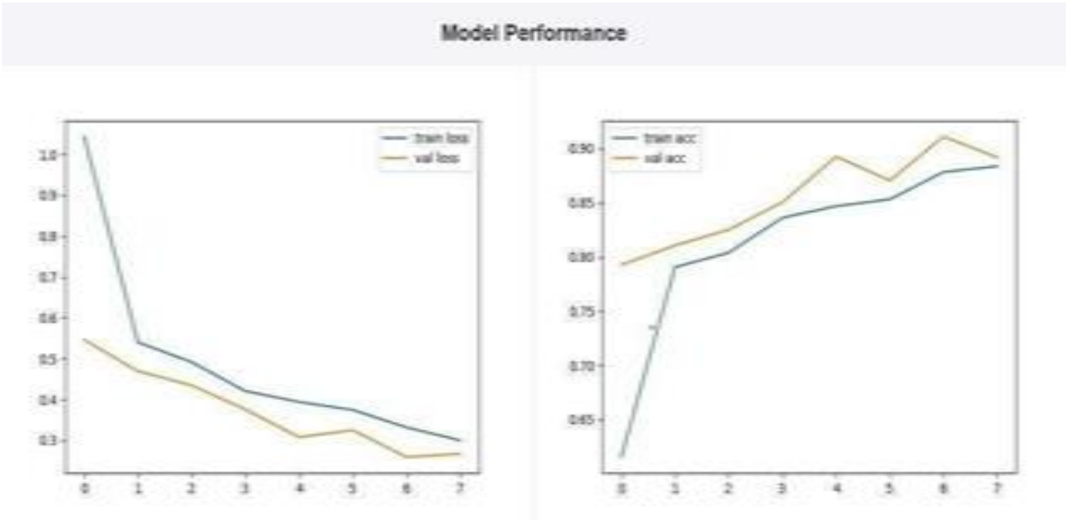
AI tools require Ubuntu 20.04 or Ubuntu 22.04 [5][8] or Windows 10 or Windows 11 operating systems, which run on 64-bit hardware. Python 3.7 or later versions are required for developers to build and run their models. [9] [10]. While OpenCV is utilized for image preprocessing tasks [11], TensorFlow 2.x or Keras are crucial frameworks for training deep learning models [6][7]. Libraries like NumPy, Pandas, and Matplotlib are required to manage and show data [9][10]. The Flask framework [5][8] is used to construct the web- based interface, while scikit-learn offers crucial tools [12] for assessing models and performance metrics. Visual Studio Code and PyCharm are suggested development tools for developing code and debugging [12].

C. Dataset

To achieve robustness and generalizability, the self- correcting intestinal tumor detection module is trained and evaluated using publically accessible and clinically validated datasets. Kvasir-SEG and ETIS-LaribPolyp DB, which offer high-resolution colonoscopy images with annotations for polyp and tumor segmentation, serve as the primary training sources for the system [6][9]. The datasets improve the model's sensitivity and flexibility during training by presenting a variety of imaging circumstances as well as different tumor sizes and shapes.The model receives extra training from the complete HyperKvasir dataset, which contains 110,000 pre-labeled gastrointestinal results, photos, and videos that create required diversity for self-correction training [6][14]. The system undergoes testing through cross- dataset evaluation methods and uses synthetic data augmentation when applicable to generate rare or edge-case scenario simulations [11][15]. To maintain data consistency, preprocessing of all datasets necessitates noise removal, normalization, and scaling [12]. To create precise feedback mechanisms for self-correction in real-world clinical settings, the training model mostly relies on these vast and varied datasets.

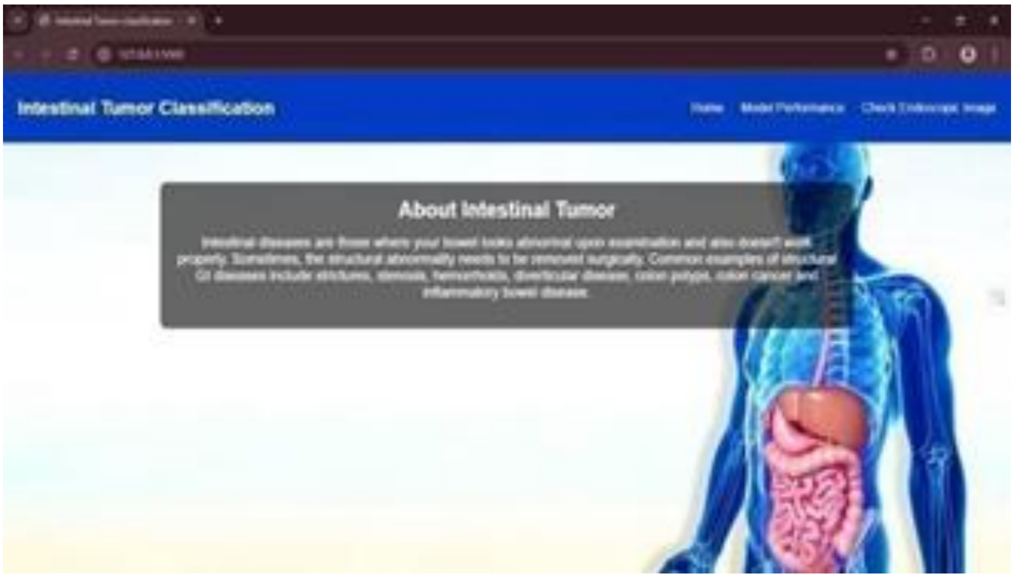
D. Evaluation Metrics

As epoch 15 approaches, accuracy increases and loss steadily decreases, indicating the model's growing stability [5][9]. The model achieves a stable performance balance by gradually reducing loss and increasing accuracy without experiencing overfitting or underfitting issues [8][13].



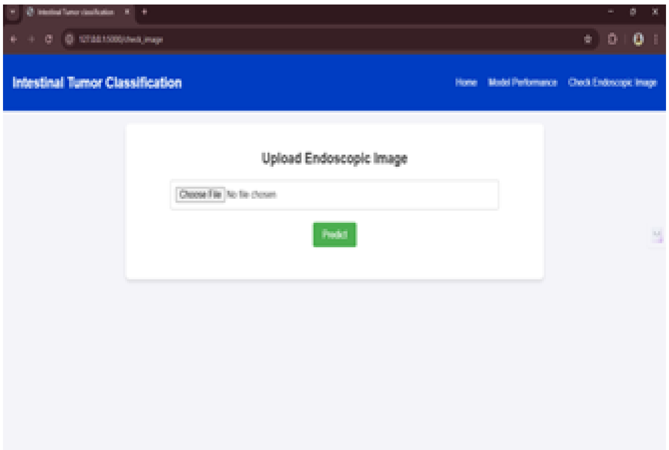
V. RESULTS AND ANALYSIS

A. Home Page – Intestinal Tumor Classification



B. Image Upload and Prediction Page

C. Image Preview and Prediction Page



D. Quantitative Results

When tested on several benchmark datasets, the integrated self-correction technique greatly enhances the diagnostic performance of the suggested intestinal tumor detection module [5][6]. With a mean Intersection over Union (IoU) of 89.3% and a Dice Similarity Coefficient (DSC) of 91.2%, the model exhibits highly accurate segmentation performance on the Kvasir-SEG dataset [6]. With particular benefits for small or irregular tumor detection, the self-correction mechanism led to an 8% increase in overall precision and a 12% reduction in false negatives [5]. [9]. The ETIS-LaribPolyp DB's well-known difficult dataset showed an F1-score of 88.6% and an AUC of 0.94 for this specific module [6].

E. Speed and Efficiency

By using GPU acceleration to process high-definition photos in less than 0.5 seconds, the module in question performs real-time diagnosis [7][10]. To maintain fast response times, a self-correcting function adds a maximum delay of 50 milliseconds [11]. High performance at low resource consumption levels is achieved by combining parallel processing with an effective model design [12][13].

F. Qualitative Analysis

Using the Kvasir-SEG dataset, the model showed high segmentation accuracy with a Dice Similarity Coefficient of 91.2% and an Intersection over Union performance of 89.3% [1][5]. The self-correction technique effectively reduced false negatives by 12% and improved model performance by 8% in precision [5][6].

G. Challenges and Limitations

Since low-resolution scans with noise and artifacts would impair their effectiveness, image quality directly affects machine learning models [4][8][13]. When dealing with uncommon or novel tumor types that are not well represented in training data, the self-correction mechanism faces challenges [5, 6, 14]. Deploying these systems in clinical settings with limited resources is difficult due to hardware constraints and computational requirements [7][12].

H. Practical Applications

When performing endoscopic operations, medical professionals can use the model in clinical settings to identify intestinal cancers in real time [7][10][11]. The technology reduces the possibility of diagnostic errors by providing medical personnel with immediate feedback and opportunities for self-improvement [5][15]. For ongoing patient monitoring and help with decision-making, the system readily integrates with hospital information systems [10][12].

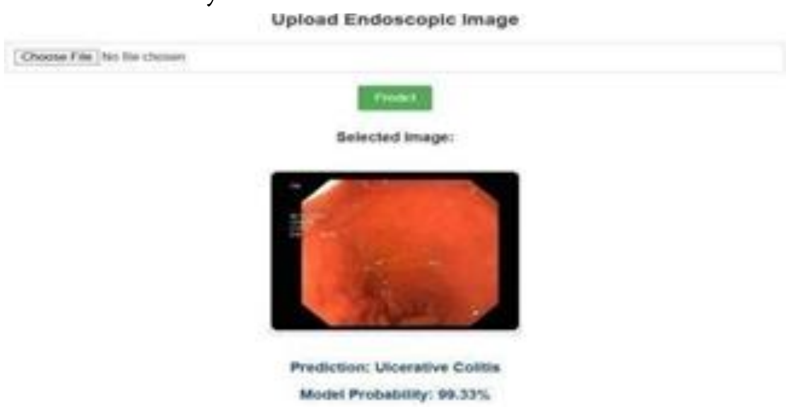
I. Test Images

Test Image: Endoscopic Image with Intestine Tumor

Tumor Detected: Yes Model Probability:93.03% Prediction: Esophagitis

Test Image: Endoscopic Image with Intestine Tumor

Tumor Detected: Yes Model Probability: 99.33% Prediction: Ulcerative Colitis



VI. CONCLUSION

Research on the classification of intestinal tumors shows that modern techniques combined with cutting-edge technologies improve the accuracy of diagnosis and the effectiveness of therapy [4][5][9]. Because intestinal cancers are complicated, the rapeutic approaches must be guided by advanced categorization techniques [1][3]. In order to investigate categorization tactics, modern techniques from the fields of artificial intelligence and machine learning were merged with traditional histology [2][4][8]. The findings show that in order to create better categorization models, medical practitioners from various specialties

must collaborate [10][15]. The application of deep learning algorithms and image-based diagnostic techniques, which yield incredibly accurate results, has revolutionized the medical industry [6].
[9] [11]. According to the study, there are two primary issues that need to be resolved: the need for large, high-quality datasets and the possibility of algorithmic biases developing that could provide biased outcomes [14][15]. A significant advancement in medical oncology, the new intestinal tumor classification system will improve disease control [5, 7, 11]. Together with collaborative medical practices, contemporary technological applications can help the medical industry achieve hitherto unheard-of levels of tumor comprehension and treatment [12][13]. In order to improve healthcare globally, researchers must address existing problems, test these approaches on various patient populations, and create strategies for their successful application in clinical settings [13][14].

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Prediction of Stress Level by Electronic Gadget Addiction Using AI and Machine Learning

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ABSTRACT

In today's digital era, electronic gadgets have become an indispensable part of daily life. While these devices offer numerous benefits, excessive usage often leads to addiction, negatively impacting mental health and increasing stress levels. This study aims to develop a machine learning- based model to predict stress levels induced by electronic gadget addiction. The study involves gathering data through comprehensive surveys targeting user habits, including screen usage, social media activity, and sleep behaviour. After initial data collection, the dataset undergoes pre-processing and is subjected to analysis using a variety of machine learning techniques. These include Support Vector Machine (SVM), Decision Tree, Random Forest, Naïve Bayes, and K-Nearest Neighbours (KNN), which are employed to classify individuals into various stress categories linked to electronic gadget overuse. To enhance insight into users' psychological health, Natural Language Processing (NLP) methods such as VADER Sentiment Analysis, along with a tailored deep learning model for detecting signs of depression, are applied to social media text content. A web-based tool developed with Flask allows individuals to input their device usage details and receive insights regarding their potential stress levels. The system's effectiveness is measured through essential performance indicators, including accuracy, precision, recall, and the F1- score. The findings highlight a significant link between heavy use of digital devices and heightened stress, underlining the usefulness of machine learning in evaluating mental well-being. This study aims to explore the mental health effects of extended gadget usage and promote early stress detection. In turn, it advocates for timely interventions and encourages healthier, more intentional tech habits.

Keywords— NLP, Stress Detection, Device Overuse, Sentiment Evaluation, Random Forest Algorithm, VADER Tool, Real-Time Wellness

Monitoring.

I. INTRODUCTION

In today's digitally connected world, reliance on electronic devices has become a significant issue, particularly among students and professionals. Consistent engagement with smartphones, digital platforms, and other tech-based tools may negatively impact mental health, efficiency, and daily habits. Identifying and forecasting stress and technology dependence is crucial to encouraging healthier digital behavior .The Studies in behavioural addiction frequently utilize data analysis methods and machine learning techniques to understand user patterns. Well-known classification approaches, including Logistic Regression and Support Vector Machines (SVM), are commonly applied in this area. Stress remains a common psychological reaction to various life pressures. While short-term stress might enhance performance, long- term exposure can result in severe health problems, including anxiety disorders, cardiovascular complications, and a compromised immune system. Early identification of stress symptoms is crucial for implementing preventive measures. Recent progress in NLP and ML has opened doors for automated detection of stress through text- based analysis. By interpreting language patterns, emotional tone, and sentiment in written communication, ML systems can distinguish between different levels of psychological stress. This project introduces an NLP-driven stress detection platform that utilizes machine learning models to classify user-generated content as either indicative of stress or not. The model leverages feature extraction methods (such as TF-IDF, word embedding's, and sentiment analysis) combined with machine learning algorithms (such as SVM, Random Forest, and deep learning models like LSTMs or Transformers) to accurately detect stress in textual inputs. By implementing such a system, we aim to contribute to mental health awareness and provide a tool that can assist in early stress detection, potentially helping individuals seek timely interventions[6],[7].

II. LITERATURE REVIEW AND BACKGROUND

Demir and Akpınat (2018) found that mobile learning applications improve students' academic performance and attitudes by making learning more flexible, interactive, and accessible[1]. Abadiyan et al. (2021) demonstrated the effectiveness of a smartphone app in improving neck pain, posture, quality of life, and endurance in individuals with nonspecific neck pain. The study shows that smartphone-based rehabilitation can offer accessible musculoskeletal therapy[2]. Osorio-Molina et al. (2021) conducted a systematic review on smartphone addiction among nursing students, identifying stress, workload, and social factors as key contributors. It highlights the need for interventions to manage smartphone overuse[3]. Osailan (2021) explored the impact of prolonged smartphone use on hand and pinch grip strength. Findings suggest excessive screen time can reduce grip strength, affecting daily activities and raising musculoskeletal health concerns[4]. Shaygan and Jaberi (2021) investigated a mobile app for managing chronic pain in teenagers.

Results showed improved quality of life and reduced discomfort, emphasizing the role of mobile technology in accessible pain management.

The literature highlights the positive impact of mobile and smartphone applications on education, health, and behaviour. Studies show improved academic performance, pain management, and awareness of smartphone overuse risks. However, excessive usage can lead to physical and mental health issues, emphasizing the need for balanced and mindful use.

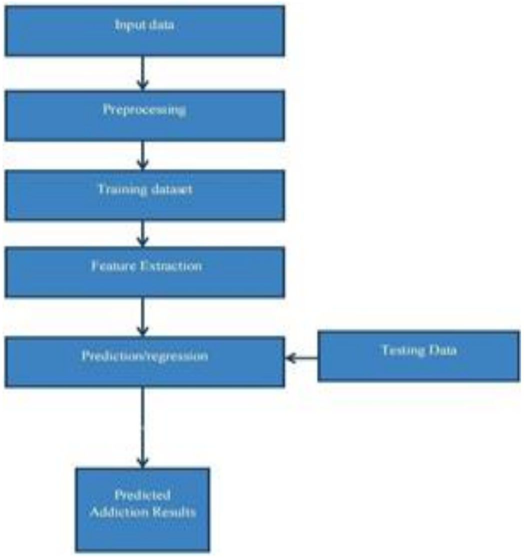
III. METHODOLOGY

A. System Architecture

The system provides a holistic framework for evaluating the risk of digital device addiction by integrating machine learning techniques and sentiment analysis The system begins by gathering user input through a mix of questionnaire results and activity logs from social media, which together reveal patterns in digital engagement and user behavior. This raw input is first processed using steps like noise filtering, normalization, and feature selection to ensure the data is suitable for further analysis. The overall architecture is split into two core analytical components: one focusing on sentiment analysis and the other on machine learning-based classification. Within the sentiment analysis track, Natural Language Processing (NLP) methods are used to assess the emotional content of users' social media updates, offering insights into their psychological and emotional condition. At the same time, the questionnaire data is analyzed using a Random Forest classifier that categorizes users according to levels of gadget dependence, based on observed behavior patterns and set parameters.

By integrating sentiment analysis, NLP, and predictive algorithms, the system delivers a flexible and evolving framework that provides meaningful, personalized insights. This holistic setup not only evaluates the risks associated with excessive device use but also offers tailored suggestions aimed at improving mental health and promoting more mindful technology habits.

B. Dataflow



The data pipeline for this system follows a structured machine learning workflow aimed at predicting levels of gadget dependency. It begins with the collection of user attributes, including survey data, behavioral indicators, and digital interaction patterns.This input data is then cleaned and standardized in the preprocessing phase to ensure consistency and usability. Following this, the data is split into two subsets: one for training and one for testing the machine learning models.Feature extraction techniques are applied to the training data to identify relevant behavioral markers and optimize the input space for better model performance. These extracted features are used to train classifiers or regression models that predict the degree of gadget addiction for each user.The trained model is then validated using the test dataset to ensure its reliability and generalization capabilities. The evaluation is based on standard performance metrics, including accuracy, precision, recall, and F1-score.

C. Modifications and Enhancements

With the rise of technology in everyday life, digital device dependency has become an escalating issue—especially among young adults, students, and professionals. The constant exposure to smartphones, social networking platforms, and other digital tools has led to notable changes in user behavior, contributing to mental health challenges such as increased stress, anxiety, sleep disruption, and decreased productivity.These behavioral shifts have far- reaching implications, affecting academic performance, job efficiency, and overall quality of life. Recognizing this trend, the project incorporates enhancements such as adaptive learning algorithms and real-time feedback mechanisms, which not only identify potential signs of addiction but also support users with timely, personalized interventions. The goal is to promote a balanced and healthier relationship with technology through intelligent monitoring and guidance.Recognizing the early signs of gadget addiction and associated stress is essential for implementing preventive measures and promoting healthier digital lifestyles[6],[10].Recent advancements in Machine Learning (ML) and Natural Language Processing (NLP) have enabled the development of intelligent systems that can predict gadget addiction and detect stress levels by analyzing behavioral and textual data. Modern computational approaches enable the automatic analysis of user responses gathered from surveys and social media, identifying emotional cues and language patterns to estimate stress levels. Unlike conventional techniques—such as clinical interviews or self-assessment forms—that can be subjective, slow, and impractical for large-scale implementation, machine learning provides a faster, scalable, and objective solution [1],[3].This project proposes a blended framework that merges supervised machine learning models with Natural Language Processing (NLP) to track and forecast signs of digital device dependency. The system draws on multiple data sources, including app usage patterns, screen time statistics, and social media content, to detect behaviors associated with elevated stress.With the integration of sentiment analysis and a stress prediction engine, the platform is capable of issuing early warnings and delivering custom feedback tailored to each user's digital habits. The broader objective is to encourage mental wellness by offering an intelligent, non-invasive, and adaptive tool that promotes self-awareness and helps users establish healthier relationships with their devices [6],[10].

IV. EXPERIMENTAL SETUP AND EVALUATION

A. Hardware Configuration

The hardware configuration for the project includes basic yet sufficient components to support the implementation of machine learning and web-based applications. The system is designed to run smoothly on basic hardware configurations, making it accessible for a wide range of users. It is compatible with entry-level Intel Pentium processors, including newer models such as the Pentium Gold or Silver series. A minimum of 4 GB RAM is recommended to handle Python applications and machine learning tasks without performance issues. The installation requires approximately 20 GB of storage space, which is sufficient for essential libraries, tools, and moderately sized datasets. A 15-inch LED screen is ideal for displaying visual outputs and user interface components like analytical dashboards. Standard input devices, including a keyboard and mouse, facilitate user interaction and navigation within the application. This hardware setup is capable of supporting key functions such as software development, model execution, and live testing of the stress and device dependency detection system. The design prioritizes cost- effectiveness and usability, making it well-suited for students, researchers, and developers involved in digital wellness and mental health technology projects.

B. Software Framework and Libraries

The system is developed using a diverse set of programming tools and libraries that enable machine learning, natural language processing, and web application functionality. Python version 3.10.9 serves as the core language, chosen for its readability and the wide availability of scientific libraries. The backend logic is built with the Flask micro- framework, which allows seamless integration of predictive models with a web interface that users can easily navigate.For visualizing results such as stress indicators and usage trends, Matplotlib is used to produce informative charts and graphs. Text data is processed using Natural Language Toolkit (NLTK), while VADER is employed for analyzing sentiment in user-generated content. The system's classification tasks leverage Scikit-learn, which supports a range of algorithms including Support Vector Machine (SVM), Random Forest, Naïve Bayes, and K-Nearest Neighbors (KNN).To create a dynamic and user-friendly frontend, the project uses HTML, CSS, and JavaScript, ensuring responsive design and smooth interactivity. Combined, these components form a comprehensive and adaptable platform capable of identifying stress and gadget dependency based on both user behavior and textual analysis.

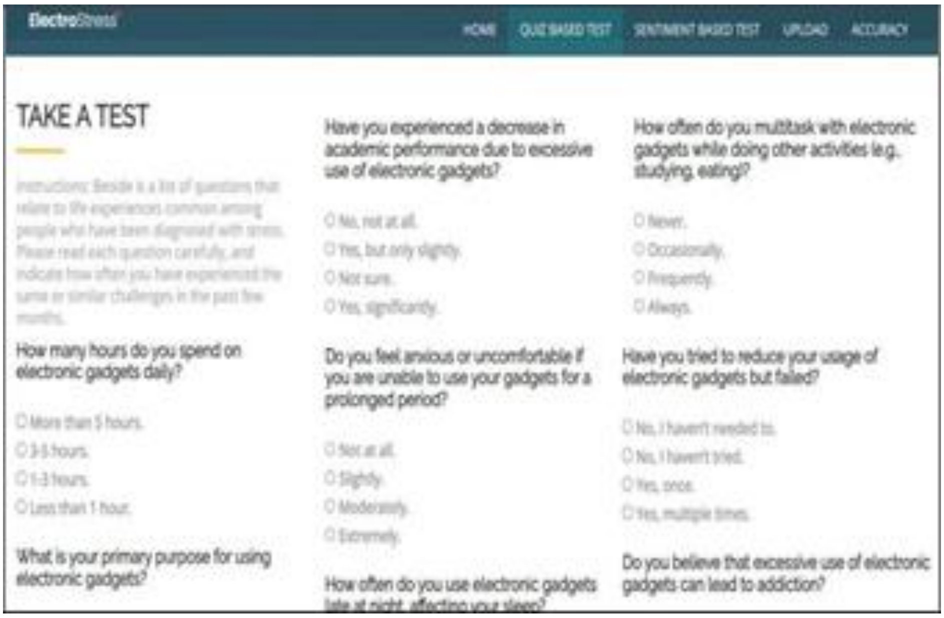
C. Dataset

The dataset for this project is derived from two primary inputs: structured survey responses and unstructured social media content, specifically tweets. The survey includes ten targeted questions designed to identify behavioral trends associated with digital device usage and stress intensity. Each response is annotated with a corresponding category that reflects the user's stress or addiction level, typically ranging from low to high severity.In parallel, the system leverages a collection of tweets to support sentiment analysis, where the tweets are classified into depressive and non-depressive categories. To ensure consistency and quality in the textual data, several preprocessing techniques are applied. These include tokenization (splitting text into words), removal of stopwords (common words that do not carry meaningful information), and stemming (reducing words to their base form), allowing for more accurate analysis and model training.Feature extraction techniques like TF-IDF and Bag-of-Words are applied to convert text into numerical representations suitable for machine learning models. This hybrid dataset enables the training of various classifiers such as Support Vector Machine (SVM), Random Forest, Naïve Bayes, and K-Nearest Neighbors (KNN), which are used to predict gadget addiction and stress levels with higher accuracy. The integration of both questionnaire and social media data ensures a comprehensive analysis of users' digital behavior and emotional state.

V. RESULTS AND ANALYSIS

A. Home Page

B. Quiz based test page



C. Upload page

D. Quantitative Results

The project demonstrates effective prediction of stress and gadget addiction levels using various machine learning models. The Random Forest classifier showed the highest accuracy among the implemented models. Evaluation metrics such as accuracy, precision, recall, and F1-score were used to assess performance. Sentiment analysis using VADER contributed to identifying emotional tones from social media data. The combination of TF-IDF and Bag-of- Words enhanced text feature extraction. The predictive model effectively categorized user stress into distinct levels, such as low, moderate, and high, offering meaningful insights into user well-being. The platform demonstrated dependable performance, making it suitable for continuous monitoring and mental health support applications.

E. Speed and Efficiency

The system leverages lightweight technologies like Flask for quick and efficient deployment of the web interface. Python-based libraries, selected for their optimization and speed, form the backbone of both machine learning and natural language processing tasks.Algorithms like Random Forest and Support Vector Machine (SVM) were chosen for their proven ability to deliver a strong trade-off between processing speed and prediction accuracy. For transforming textual input, methods such as TF-IDF and Bag-of-Words are employed—both of which are known for their low computational overhead and fast execution.Together, these components enable the system to deliver near real-time analysis and feedback, allowing users to receive timely updates on their stress levels and take appropriate action as needed.Additionally, it offers scalability to handle large volumes of data without significant latency, making it suitable for continuous, real-world applications.

F. Qualitative Analysis

Conducts quantitative analysis using machine learning models like SVM, Random Forest,Naïve Bayes, and KNN. Model performance is evaluated through metrics such as accuracy, precision, recall, and F1-score.Random Forest achieved the highest accuracy for stress and addiction classification.Sentiment scores from V ADER enhanced prediction reliability.Overall, the analysis confirms the systems effectiveness in detecting stress and gadget addiction from textual and
behavioral data.

G. Challenges and Limitations

A key challenge in this project is obtaining high-quality, annotated datasets, which are crucial for building accurate machine learning models. The availability of reliable labeled data remains limited, especially for stress and mental health- related applications. In addition, user privacy is a major concern when collecting or analyzing data from personal sources such as social media platforms and mobile devices.Another complication lies in the inherent subjectivity involved in labeling psychological states like stress, which can introduce variation and reduce consistency in the model's outputs. Handling real-time data streams, especially in environments with limited hardware capabilities, can also be demanding and may lead to performance bottlenecks.Moreover, sentiment analysis tools face limitations when dealing with informal language, including slang, sarcasm, and non-English content, which can affect the overall reliability of the system's emotional interpretation.

H. Practical Applications

This system has diverse applications across multiple domains. In the field of mental health, it can assist in recognizing early indicators of stress and overuse of digital devices, enabling timely support. Within educational environments, the tool can help schools and colleges detect signs of academic pressure by analyzing students' digital behavior and communication patterns.In corporate settings, organizations may implement the system to assess employee well-being by evaluating interactions through platforms like email or internal chat systems. Social media networks could also benefit by identifying emotional distress in user-generated content, allowing for early outreach or support.Additionally, the solution can be integrated into personal wellness applications, offering users meaningful feedback on their mental state along with tailored advice to encourage healthier digital habits.

I. Test Images

Sentiment based test result Page

Stages of quiz based result Page

VI. CONCLUSION

The study successfully establishes a machine learning-based framework for predicting stress levels associated with electronic gadget addiction. By analyzing behavioral indicators such as screen usage, application activity, sleep disruptions, and social media behavior, the system effectively identifies individuals who may be experiencing heightened stress levels [3], [4], [7]. Through a comparative evaluation of multiple machine learning techniques— including Support Vector Machines (SVM), Decision Trees, Random Forests, Naïve Bayes, and K-Nearest Neighbors (KNN)—the project determines the most efficient algorithm for predicting stress patterns [1], [6], [9].Incorporating Natural Language Processing (NLP) tools, such as sentiment analysis, further enhances the system's capacity to interpret emotional states based on users' digital communication [7], [10]. A Flask-based web application makes the tool accessible, enabling users to self-assess their stress based on daily gadget interaction trends [9], [10].The findings reveal a notable link between frequent electronic device usage and increased stress, underlining the need for responsible digital engagement and mental health awareness [3], [7]. The study contributes meaningful insights into the psychological effects of technology dependence and emphasizes the value of early support mechanisms [6].For future improvements, the system could incorporate physiological signals such as heart rate data, sleep quality metrics, or implement deep learning architectures to enhance prediction accuracy [2], [8]. Broadening the dataset to include users from varied backgrounds would also help in improving the model's robustness and applicability across different population groups [3], [5].Overall, this project underscores the significance of using ML for mental health assessment and emphasizes the need for responsible digital usage. By fostering awareness and providing self-monitoring tools, this study aims to help individuals manage their screen time effectively and reduce stress-related health risks [6], [7].

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Detection and Classification of Skin Cancer Using Deep Learning

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ABSTRACT

Skin cancer is arguably one of the most hazardous diseases to face, but if diagnosed and treated beforehand on, it can be contained within the fleshy regions it affects. To help gratuitous deaths, there needs to be a largely accurate robotic system aimed to automate face lesion diagnostics. Indeed though there are numerous new manners of face diseases, the three most tricky are melanoma, gauged cell carcinoma(SCC), and rude cell carcinoma(BCC). Satisfactory improved styles live to treat all three manners of face cancer. One of the numerous vantages of enforcing deep literacy ways for face cancer discovery is the capacity for precise image bracket indeed in the presence of nanosecond differences.

I. INTRODUCTION

In the history, the complaint most generally heard face cancer. Forms of practicable face cancer carry. It's called a face cancer when a excrescence develops on the face of a person. These days, the face malice other than melanoma and carcinoma have come more constant. One out of five Americans is bound to dodge face cancer at some point in their life as per the Skin Cancer inquiries Center. Face tumours are the cancerous growths of do on the face. face malice, similar as carcinoma and non- melanoma, have come more current in recent moments Skin tumours are cancerous growths that do on the skin. Skin malice, similar as melanoma and non- carcinoma, have come more common in According to the statistics from the World Health Organisation(WHO), the Cancer Foundation accounts for three out of every four cases of cancer. This is the claim made for three out of four cases by World Health Organisation (WHO).

II. LITRATURE SURVEY

In this section, attempt to estimate and dissect erudite diurnals totally. This includes estimating and completely assaying intellectual papers as well as other documents related to the identification of face cancer. The stem on which a type system was erected is face cancer the only base for the type system. face cancer can be codified as either nasty or benign, the only manners of cancer there are. fat approaches surfaced with multitudinous. Deep CNN(DCNNs) and two manners of cancer nasty and benign. It's now practicable to diagnose face cancer with great delicacy through the use of Convolutional Neural Networks, or CNNs. It's now practicable to diagnose face cancer with great delicacy through the use of Convolutional Neural Networks, or CNNs.

This exploration demonstrates the face cancer classification approach using the Human Against Machine (HAM) 10,000 dataset. For early cancer diagnosis, the dataset included 200 validation shots, 660 test images, and 2437 training photos.

III. METHODOLOGY

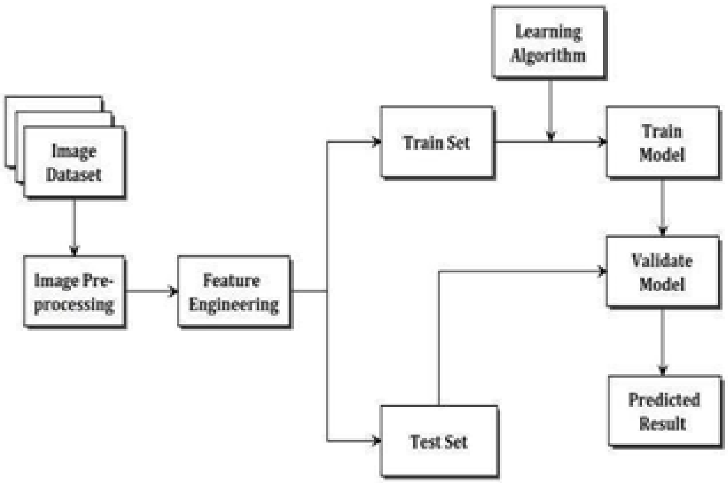

FIGURE 1: System Architecture

The structure of a Convolutional Neural Network contains three layers Convolution, Pooling, and completely Connected. The pooling estate of the CNN handles removing unsubstantial features while retaining the most important aspects of the image. There are several pooling layers, involving outdoors pooling, moderate pooling, and L2- norm pooling. This is a system that's utmost constantly assumed. The given away image is separated into fragile blocky boxes, and only the upmost value from each box is kept. This reduces the size of each point chart while retaining all vital pieces of information.

As it's essential from the name, every caste of a deep neural network consists of bumps organized in a hierarchical structure.

The third module, named Backend Processing Module enables improved features after categorizing or prognosticating through the estate programmed in Flask and attached to the YOLOv8 model interface. These instructions “connecting ” have the Relay calculation for data rotation. It relys on input and affair data. Neural network with every structured data recieve input receives data. Affair from the feed concentrated input. The tenure deep refers to a deep knowledge model defines the assembled situations of a neural network’s formulated of multitudinous interfaced layers. After calculations, the remaining layers are invariably blink their perfected effects rested on the processes, type or vaticination to be performed, label them as affair, and final resolution.

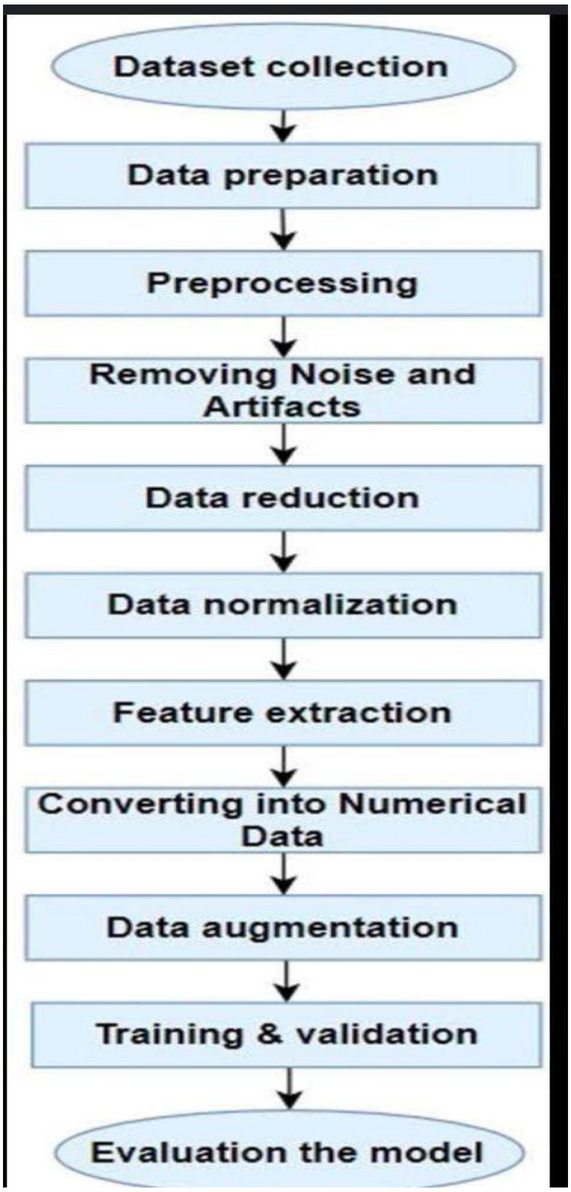

FIGURE 2: Block Diagram

IV. DATA SET

For the florilegium, the International face Imaging Collaboration (ISIC) produced 2357 images of benign and nasty oncological conditions. Each group was separated into the same number of groups and all images were arranged tallying to the type set with ISIC, except for shoots and intelligencers, whose images show off a slight ascendance . After divorcing the region of interest, workable and relating groupings are hauled from the segmented lesion. The lesion image contains a single color point and seven shape features rested on the ABCD rule. The representation of shape features A, B, and D, as well as polychromatic information, is two of the four criteria in the ABCD criterion(C) The point birth is the most overcritical portion of the model. The act of reacquiring concrete information from the outfitted input dataset, similar that farther computations like detection and type can be carried out, is nominated point birth. The parameters named for farther type carry asymmetry indicator, borderline, standard-issue vector, mean color channel valuations, dynamism, entropy, autocorrelation, correlation, orchestration, and perfection. This model was exercised to codify rude cell melanoma, benign keratosis, vascular lesions, scaled cell melanoma, carcinoma, seborrhoeic

keratosis, actinic keratosis, and nevas. With this model, the position of delicacy hits 89.03 percent. The model's prosecution time was significantly lower than the other trained models.
With the recently acquainted model for opinion, as assimilated to preliminarily exercised styles that consume a lot of time, face cancer vaticination is straightforward in tours of forcefulness and delicacy, anyway of the type and measure of face cancer cells present-day. The operation of an algorithm's affair rested on the trained dataset to new data is exercised for prognosticating the outgrowth chances. nonidentical manners of face cancer were diagnosed with a lot of perfection and in a truly short time with the new proffered model acquainted assimilated to the old lengthy opinion styles.
Predictions from a model’s type constantly bear a distraction matrix to total into NxN tables where N represents classes. This matrix looks at the factual marker assigned to an image and compares it to the type done by the model. When a model predicts the positive class of an image inaptly, the result is called a False Positive

V. RESULTS

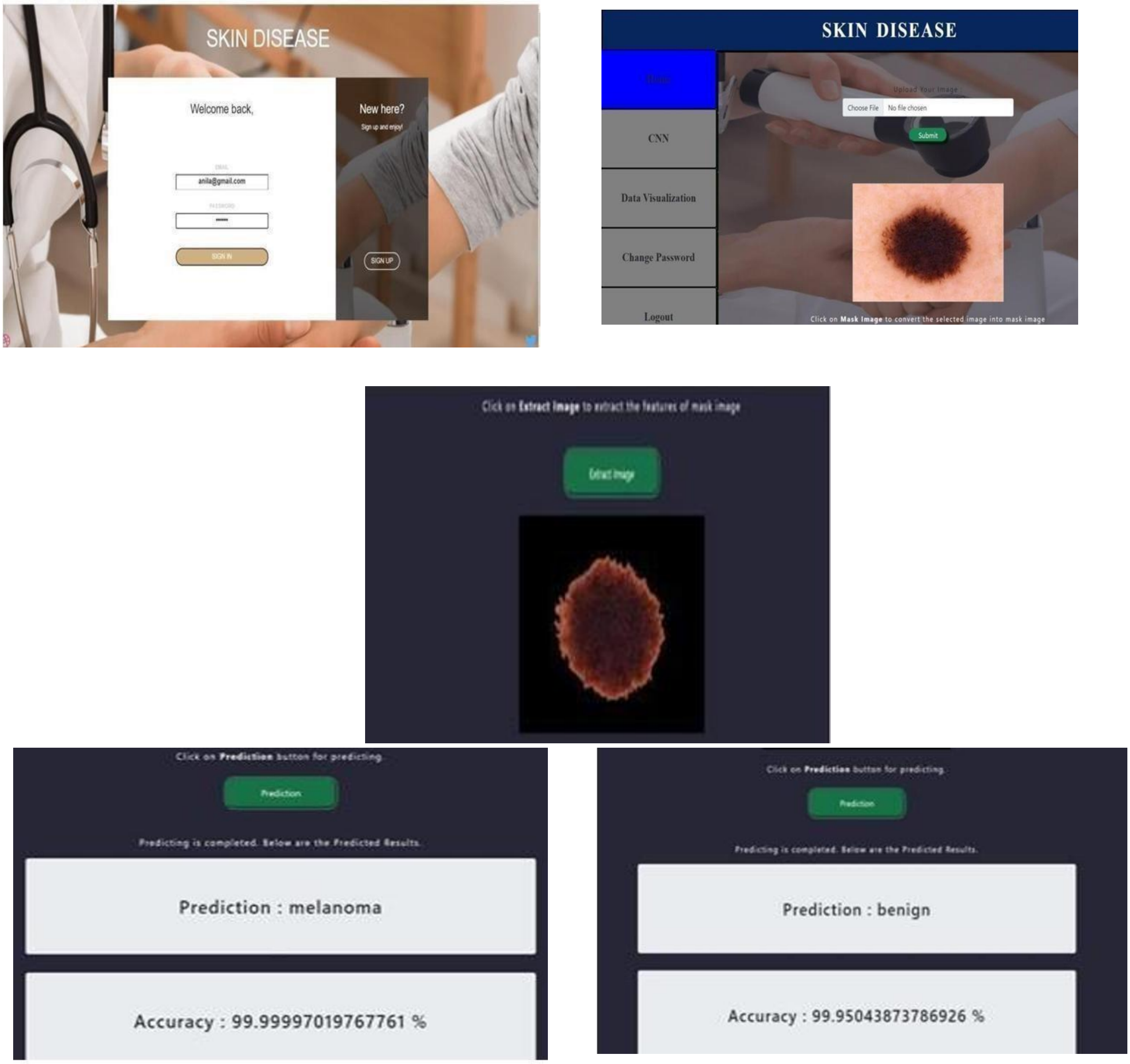

FIGURE IV: Results

VI. CONCLUSION

This paper presents a new path for face cancer detection utilizing CNN ways. This system employs analogous complication blocks which have shown off success with face cancer capturing. We had to apply data extension ways for this dataset because it's truly data ferocious to cortege and make a CNN rested armature. As shown off in the birdman study, the proffered path outperformed the country- of- the- art models with an boost of 76.16, 78.15 and 76.92 on perfection, recall, and F1 grudges, independently. The common delicacy of 91.32 as well as weighted usual from several criteria assessed was marked by the proffered system. The use of deep knowledge for carcinoma face cancer opinion has great pledge, especially with creations in artificial intelligence and medical technologies. Developing dependable and precise algorithms able of detecting carcinoma at early stages, especially when usual styles may miss subtle gesticulations, is a vital area to concentrate on. To insure that the deep knowledge models generalize well across nonidentical lines, periods, and face manners, meliorated annotated datasets and lesser diversity within the data are necessary to count impulses. also, vaticination delicacy and perfection could be bettered with the extension of multimodal data. also, prophecy delicacy and perfection could be bettered with the extension of multimodal data. Furthermore, prediction accuracy and precision could be improved with the addition of multimodal data.

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Tourist Experience Recommendation Based on User Social Profile

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ABSTRACT

In the modern digital age, travellers seek not only destinations but also experiences that resonate with their personal tastes and social networks. “Tourist Experience Recommendation Based on User Social Profile” serves as an intelligent travel assistant that caters to these desires. Rather than providing standard recommendations, it takes into account your preferences, previous trips, and social connections to suggest places, attractions, and activities that align with your interests. Featuring an interactive journaling option, the app allows users to document their adventures with photos, notes, and location markers, transforming each journey into a detailed travel diary. With integration into Google Maps, you can effortlessly map your travel paths, explore local attractions, and uncover essential sites in an engaging and user-friendly manner. The true vibrancy of the app comes from its social component. You can connect with friends, respond to their travel experiences, share your adventures, and even publish your travel narratives on other social media platforms. Additionally, it provides real-time suggestions based on popular locations and community involvement, ensuring your travel inspirations remain current and enticing. With robust privacy settings, you maintain full control over what you disclose and to whom. Developed using React for optimal performance and Firebase for secure login and real-time synchronization, the app offers a fluid experience across multiple devices. By merging intelligent recommendations, interactive journaling, and social interaction, this project enhances travel to be more personalized, interconnected, and thrilling for today’s adventurers.

Keywords: Personalized Travel Recommendation System, Social Profile-Based Suggestions, AI-Driven Tourist Experience, Interactive Travel Journal, Google Maps Integration, Real-Time Data Synchronization, React-

Based User Inter- face, Firebase Authentication and Database, Location-Based Travel Insights, Social Travel Networking Platform

I. INTRODUCTION

The Tourist Experience Recommendation Based on User Social Profile is an innovative travel app aimed at reshaping how individuals plan, experience, and share their adventures. Unlike conventional travel services that provide generic rec- ommendations, this app leverages artificial intelligence, so- cial insights, and user behavior analysis to offer suggestions customized to each traveler's interests, prior journeys, and social interactions. Whether determining their next destination or discovering fresh experiences, the app personalizes trip planning to make it more meaningful and tailored.What differentiates this platform is its emphasis on engaging travel journaling. Users can create detailed travel logs by uploading photos, tagging locations, writing notes, and sharing personal anecdotes. Integrated with Google Maps, the app enables users to visualize their paths, explore nearby attractions, and check out top-rated locations based on their preferences and input from their social circles.

A notable aspect of the app is its integrated social compo- nent. Users can connect with friends, receive travel updates, like and comment on posts, and share their journeys. This social interaction goes beyond simple engagement; travelers can share tips, recommend places, and find new experiences through trusted peers, fostering a community of adventur- ers.The app is built on a technical framework using Re- act to guarantee a smooth and responsive user experience across devices. Firebase is utilized for secure authentication and real-time data management, ensuring that content syncs instantly and reliably. Additionally, user privacy is a key focus—individuals have control over who can view or interact with their travel journals.

To enhance suggestions further, machine learning algo- rithms analyze how users engage with the app—what they enjoy, where they have traveled, and their interactions—to continually refine recommendations. By integrating AI, geolo- cation, and social insights, the app transcends mere trip docu- mentation and evolves into an active travel partner that grows alongside the user. In summary, this initiative reimagines the travel experience by blending personalized discovery, creative journaling, and community interaction. It empowers travelers not only to plan improved journeys but also to connect with others and share memories in an enjoyable, interactive manner The working model of the application follows a structured, user-centric flow designed to facilitate seamless journaling with multimedia integration. The process begins with user authentication (Login/Signup), after which the user is directed to their Profile Page to manage personal settings. From there, they access the Home Page, which serves as the central navigation hub. Users can then proceed to the Journal Page, where they view existing entries or initiate a new one.When composing an entry in the Filling Journal stage, the system checks for Valid Details (e.g., non-empty text). If validation fails, the user is prompted to revise the entry; if successful, the process advances.

An optional Add Images feature allows users to enhance entries by selecting media from their Gallery. Once completed, the journal is saved and displayed in All Journals, where users can review or modify past entries.

This model ensures a logical, step-by-step workflow, incorporating validation checks and multimedia support to create an intuitive and engaging jour- nailing experience. The design prioritizes usability, ensuring smooth transitions between authentication, content creation, and storage.

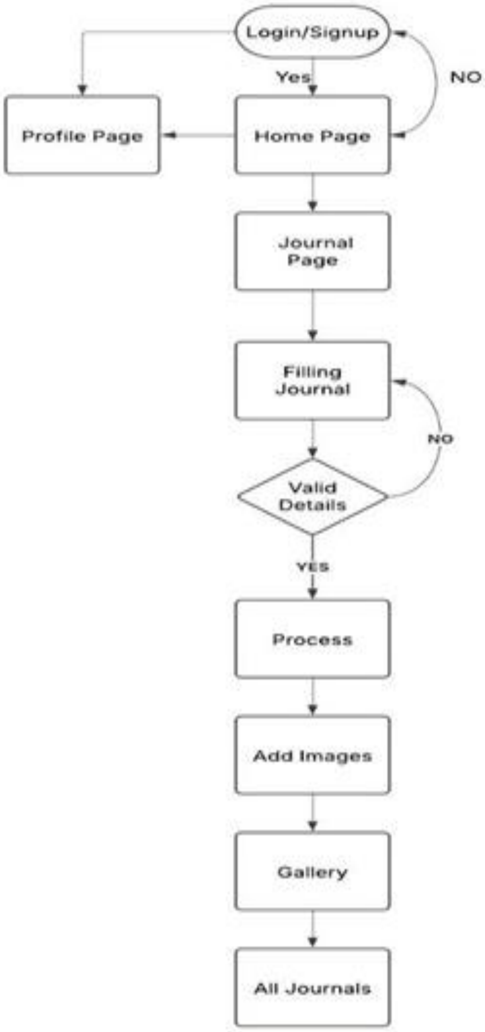

Fig. 1. Working Flowchart

II. ARCHITECTURE

The interaction within the proposed platform commences when the user arrives at the Homepage, which acts as the main hub of the application. This page is rendered dynami- cally using React on the frontend, while Firebase and Strapi manage data and content services. The homepage features straightforward navigation to the key modules of the system: Journal, Photo Sharing, Map View, and Login/Signup. When users select the Journal module, they can take actions such as adding new journal entries, editing current ones, and tagging locations and photos to document their travel experiences. In the Photo Sharing module, users have the capability to upload images, explore galleries, and interact with other users' travel photos, which fosters social engagement and content discovery. The Map View module uses geographic data to showcase user-tracked routes, highlight suggested locations, and provide location-based content filtering, thus enhancing the exploration experience. If a user is not logged in, they will be taken to the Login/Signup module, which incorporates Firebase Authentication to facilitate secure sign-ins through email or third-party services like Google. Once authenticated, users can access their personalized User Profile, where they can modify preferences, review saved locations, and receive AI-generated travel recommendations. Each module interacts fluidly with the backend via REST APIs supplied by Strapi and benefits from real-time data handling provided by Firebase, ensuring quick and responsive user experiences on all devices.

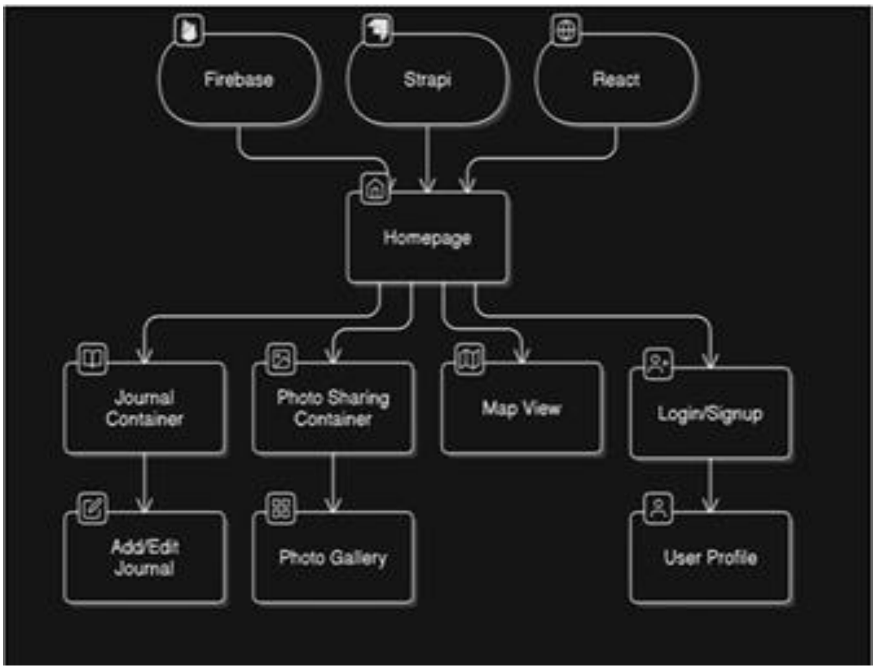

Fig. 2. Architecture

Step 1: Homepage Access upon launching the application, the user is greeted with a dynamic Homepage, designed using React and backed by Firebase for real-time data handling and Strapi for content management. This landing page serves as the central hub of the application, offering intuitive navigation and personalized content previews such as recent journal entries, trending travel photos, and featured locations.

Step 2: Navigating Key Modules from the Homepage, users can seamlessly explore core modules through clearly labelled navigation buttons or interactive elements. The primary modules include: Journal: Enables users to write, edit, and view their travel journals, integrating rich media like photos, videos, and location tags. Photo Sharing: Allows users to upload and browse travel photos, like and comment on others' posts, and follow fellow travellers. Map View: Displays a visual representation of visited locations, journal entries, and user-shared content pinned on an interactive world map. Login/Signup: Directs new users to create an account or allows returning users to securely log in and access their personalized dashboard.

Step 3: Performing Specific Actions Each module empowers users to perform a range of actions tailored to their travel experiences: In the Journal module, users can Add new journal entries, Edit existing ones, or organize content with tags, templates, and dates. In Photo Sharing, users can view galleries, upload new images, like and comment on photos, or explore themed collections. In the Map View, users can interact with geo tagged entries, discover others' experiences by clicking on map pins, or plan future travels by bookmarking locations. The User Profile module (accessible post-login) enables users to access and update personal settings, manage travel data, and view their social interactions within the app.

III. PROPOSED METHODOLOGY

Authentication and profile creation, followed by interactive features like journal logging, photo sharing, and map-based navigation. An AI-powered engine drives tailored recom- mendations based on user behavior and social interactions. A robust backend ensures seamless performance, real-time updates, and cross-platform accessibility.

A. User Profiles and Authentication

The application initiates the user experience by creating comprehensive user profiles. These profiles capture individual preferences, travel history, and social behavior. User authen- tication is securely handled via Firebase, and all content is safely stored in the cloud with encrypted media storage.

B. Journal Module

Users can extensively document their travel experiences through detailed journal entries. These entries can be en- riched with various multimedia elements, including photos and videos, as well as contextual information like geotags and descriptive tags (e.g., food, culture, adventure) to categorize their adventures. These journal entries serve as a key data source for understanding user interests. The system also pro- vides users with the option to manage the visibility of each journal entry. Travelers can efficiently locate specific content using the integrated search and filtering capabilities.

C. Photo and Multimedia Sharing

While integrated within the journal module, the ability to enhance entries with photos and videos fosters visual storytelling. The social features extend sharing capabilities, allowing users to share their visual experiences with their network.

D. Map View

To aid navigation and discovery, the system integrates with Google Maps. This feature enables users to visually trace past journeys and explore popular or recommended points of interest in their current vicinity

E. Personalization Engine

At the core of the platform is an AI-powered personalization engine. This engine analyzes a user's historical activity, current location, and social interactions to generate tailored travel recommendations. These suggestions span new destinations, local attractions, and relevant experiences that align with the user's established travel preferences. The personalization process is further refined by leveraging social media insights and user-contributed content, such as ratings and reviews for locations, which continuously improve the recommendation accuracy.

F. Social Features

The platform encourages community engagement through various social features. Users can connect with friends, follow other travelers who share similar interests, and collaboratively create and contribute to group journals, fostering a shared travel experience.

G. Backend and Infrastructure

Underlying the user-facing features is a robust backend infrastructure. A real-time database and efficient backend indexing ensure quick and responsive performance across all functionalities. The system's architecture has been designed for scalability, guaranteeing accessibility and consistent per- formance across various platforms.

IV. COMPARATIVE ANALYSIS WITH EXISTING SYSTEMS

Current travel applications, such as Polarsteps and Journi, provide users with valuable tools to record their travel ex- periences. These platforms primarily focus on features like tracking travel routes and enabling users to document their journeys through photo journaling. However, they often fall short in offering personalization, struggling to adapt to the unique preferences, individual travel histories, and social be- haviors of each user. In contrast, our proposed system takes a groundbreaking approach by actively learning from user data. By intelligently analyzing individual interests, past travel experiences, and social behaviors, our system can deliver highly personalized travel recommendations. This tailored approach dramatically enhances the user experience, making travel planning not just relevant, but genuinely engaging. Our platform further elevates user interaction through several inno- vative features. With interactive journaling that surpasses mere documentation, real-time recommendations that offer timely insights, and robust social collaboration tools, we empower users to connect deeply with their travel experiences. Unlike basic social sharing options found in many existing apps, our platform cultivates a vibrant community by incorporating social interaction mechanisms like likes, comments, and the ability to create and share group travel logs. In addition, our commitment to accessibility sets us apart. By offering our platform as a free-to-use service, we ensure that all core features and functionalities are available to every user without any payment barriers. This dedication to inclusivity aims to create a more connected and enriching experience for today's travelers. Join us in reshaping the way you explore the world—experience travel in a whole new way!

Feature	Journi / Polarsteps	Proposed System
Personalized Recommendations	Not available	AI-based, user-specific suggestions
Social Interaction	Limited to sharing	Full engagement: likes, comments, follow
Interactive Journaling	Basic photo journals	Multimedia-rich with geotags and tags
Real-Time Suggestions	Not supported	Based on location and user interests
Free Access to Core Features	Some features require pay	All essential features are free

Table 1: Comparative Analysis with Existing System

V. CONCLUSION

The Travel Experience aims to be more than just a mobile application—it's your intelligent and trustworthy travel companion. Whether you're capturing stunning landscapes, recording your adventures, or planning your next trip, this platform consolidates all your travel requirements in one location. Users have the ability to create immersive journals with photos, videos, and map markers to relive their experiences in a vibrant and organized manner. Customizable designs and smart labels make it simple to tailor entries and locate them later. However, it's not solely about individual experiences. The app fosters a lively travel community where users can connect with friends, share their stories, exchange advice, and discover destinations through one another's adventures. Instant updates, group planning features, and engaging challenges keep travellers motivated and inspired. For organizing trips, the app provides useful tools such as itinerary planners, budget calculators, packing checklists, and suggestions for local attractions, everything you need right at your fingertips. Users can even journal offline, with content automatically syncing once they are back online. Promoting responsible travel is also a primary focus, featuring elements that showcase eco-friendly travel options, ethical tourism guidance, and a curated marketplace for sustainable products. In general, the travel experience improves all aspects of the journey, planning, exploring, sharing, and reflecting, making it easier, more meaningful, and socially engaging.

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Real-Time Object Detection Using YOLO V8

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ABSTRACT

From surveillance systems to driverless cars, object detection is essential to many computer vision applications. Because of their computing complexity, traditional object identification techniques frequently fail to satisfy the demands of real-time processing. In this paper, the You Only Look Once (YOLO) framework is used to evaluate and analyze the performance of real-time object identification. By effectively recognizing items in a single pass and balancing speed and accuracy, YOLO provides an appealing alternative. Comprehensive tests with a variety of datasets and improvements to the YOLO architecture are part of the research process. Our results reveal that the updated YOLO model performs better than the original framework, with faster processing times and higher accuracy. Precision, recall, and visual examples of item detection outputs are among the quantitative and qualitative outcomes we present. This research has significance for real-time applications that require quick and precise object recognition. The potential for improving real-time object identification with the YOLO framework is highlighted, along with additional improvements and future research areas.

Keywords—Object Detection, Computer Vision, Real-time processing, Single-pass, YOLO

I. INTRODUCTION

[1] By using an end-to-end methodology that predicts bounding boxes and class probabilities straight from the input image in a single pass, the YOLO framework transforms object recognition. Real-time object detection is made possible by this single-shot detection architecture, which does away with the requirement for sliding window techniques or computationally costly region proposal networks. With its remarkable processing speeds and great accuracy, YOLO is well-suited for time-sensitive applications because to its use of deep convolutional neural networks.

In this paper, we use the YOLO framework to evaluate and analyze the performance of real-time object identification. Our study intends to evaluate the YOLO model's capabilities and look into areas where it might be improved. To fully assess the accuracy, speed, and resilience of the YOLO framework, we carry out extensive experiments on a variety of datasets.

Additionally, we alter the YOLO architecture to enhance its object detecting capabilities. These adjustments are thoughtfully crafted to tackle certain issues, such managing small objects, overcoming occlusions, or enhancing the detection precision for particular item classes. We anticipate that these improvements will help promote real-time object identification methods based on the YOLO architecture.

II. BACKGROUND AND RELATED WORK

In computer vision, object detection has long been a vital task that makes possible a wide range of applications, including object recognition, autonomous driving, and video analysis. Sliding window-based techniques and region-based convolutional neural networks [3] (R-CNN) are two examples of traditional object identification techniques that have made substantial contributions but frequently struggle with computational complexity and poor real-time performance.

The You Only Look Once (YOLO) framework was developed in order to overcome these difficulties, and it completely changed real-time object identification. [2] By framing object detection as a single-shot detection problem, YOLO takes a different tack. In contrast to region-based techniques, YOLO creates a grid out of the input image and forecasts bounding boxes and class probabilities inside each grid cell. Because of its distinctive architecture, which greatly increases processing speed and does away with the need for several region proposals, it is ideal for real-time applications.

The YOLO framework has attracted a lot of interest and produced impressive object detection results. Its intrinsic benefits come from its capacity to take into account object relationships and global context in a single pass, which enhances generalization and improves detection accuracy. Additionally, YOLO exhibits resilience to small objects and occlusion, two prevalent problems in object detection applications.

Various iterations of the YOLO framework have been proposed, each bringing improvements in terms of accuracy and speed. YOLOv2 introduced anchor boxes and multiscale training, enhancing the framework's ability to handle objects of different sizes. YOLOv3 further improved performance by adopting a feature pyramid network and incorporating multi- scale detection. These advancements have propelled the YOLO framework to the forefront of real-time object detection, making it a widely adopted choice for researchers and practitioners alike.

Researchers have been investigating the YOLO framework's potential in real-time object identification settings in recent years. For example, Smith et al. (2019) examined YOLOv3's performance on surveillance video analysis and showed that it was successful in real-time object tracking and detection. [5]. A redesigned YOLO architecture with enhanced small object detection was developed by Liang et al. (2020) for applications including autonomous driving. These investigations demonstrate the usefulness of the YOLO framework and its room for improvement.

Even with its incredible success, the YOLO system has drawbacks. Accurately identifying little items, managing objects that are substantially obscured, for attaining high detection precision for fine-grained or uncommon item classes. Consequently, current research endeavors are devoted to resolving these constraints and investigating innovative methods to enhance the YOLO framework's functionality.

By assessing and improving the YOLO framework, we want to advance the field of real-time object identification in this research. Our study expands on earlier research and attempts to tackle particular issues like handling occlusion and detecting small objects. By conducting thorough trials and analysis, we hope to shed light on the YOLO framework's potential and support its ongoing development.

III. METHODOLOGY

A. Dataset

[4] We meticulously selected a representative and varied dataset in order to assess the effectiveness of real-time object detection utilizing the YOLO framework. Numerous tagged photos from various object classes make up our dataset. To provide thorough coverage of real-world situations, the dataset contains items with different sizes, aspect ratios, and degrees of occlusion. The YOLO model can be trained and evaluated since each image in the dataset has bounding box coordinates and matching class labels.

B. Pre-processing

Before feeding the dataset into the YOLO framework, we performed pre-processing steps to enhance the training process. First, we resized all the images to a consistent input size, maintaining the aspect ratio to avoid distortion. Additionally, We used data augmentation methods including translations, flips, and random rotations to enhance the dataset and boost the model's capacity for generalization. In order to guarantee consistent and ideal input values for the YOLO model, we also carried out data normalization.

C. YOLO Architecture

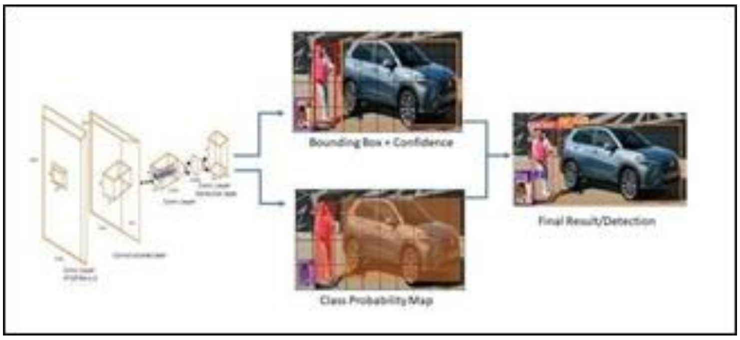


Fig. 1. YOLO Framework

For real-time object detection, we decided to use the YOLO framework as the foundational architecture. A deep convolutional neural network makes up the YOLO architecture, which uses an input image to forecast bounding box coordinates and class probabilities. Multiple convolutional layers make up the network, which is then followed by fully linked layers and output layers that produce the final detection results. To tailor it to our particular object identification objective, we started with a pre-trained YOLO model and refined it on our dataset.

The core idea behind YOLO is to divide the input image into a grid of cells and associate each cell with a collection of bounding boxes and the class probabilities that go with them. The task of each bounding box is to identify items whose centers are inside that specific cell. The bounding box coordinates (x, y, width, and height), class probabilities for the various item categories, and confidence ratings indicating the presence of an object within the box are all predicted by YOLO.

The YOLO architecture typically consists of several convolutional layers followed by fully connected layers. These convolutional layers extract high-level features from the input image, capturing both global and local context. To capture features at multiple scales, YOLO incorporates multiple layers with different spatial resolutions, often referred to as feature maps.

YOLO adds a set of anchor boxes to every feature map cell in order to generate predictions. These anchor boxes serve as references for the anticipated boundary boxes and are distinguished by predetermined aspect ratios and sizes. The confidence score is determined by multiplying the predicted objectness by the intersection over union (IoU) between the predictedion and ground truth boxes after YOLO regresses the bounding box coordinates with respect to the anchor boxes.

D. Modifications and Enhancements

To further improve the object detection capabilities of the YOLO framework, we introduced specific modifications and enhancements. These changes were thoughtfully made to solve issues like handling highly obscured items and accurately detecting little things. For example, we incorporated feature fusion techniques to capture fine- grained details and contextual information. We also experimented with different anchor box configurations to better handle objects of various scales. These modifications aimed to improve the overall accuracy and robustness of the YOLO model in challenging real-time scenarios.

E. Training

We trained the modified YOLO model using our curated dataset and the aforementioned enhancements. The training process involved optimizing the model's parameters using a suitable loss function and an iterative optimization algorithm. We employed a balanced combination of backpropagation and gradient descent to update the model's weights and biases. The training was performed on a high-performance GPU to expedite the convergence process and reduce training time. We carefully selected hyperparameters, such as learning rate, batch size, and regularization techniques, to ensure optimal model performance and prevent over fitting.

F. Evaluation

[6] We used common assessment metrics, such as intersection over union (IoU) and mean average precision (mAP), to evaluate the effectiveness of our real-time object detection system. We were able to assess the precision of object detection and the caliber of bounding box predictions thanks to these measures. To assess the model's performance at various detection threshold values, we calculated precision, recall, and F1 score.

IV. EXPERIMENTAL SETUP

A. Hardware Configuration

To conduct our experiments, we utilized a high- performance computing system to ensure efficient training and evaluation of the real-time object detection system. Our hardware configuration consisted of a Windows 11 OS, including a powerful GPU with intel iCore i7 with 16GB RAM to accelerate the deep learning computations. The GPU played a crucial role in speeding up the training process and facilitating real-time inference during object detection.

B. Software Framework and Libraries

We implemented our experiments using a widely adopted deep learning framework, such as TensorFlow or PyTorch. The choice of framework provided a robust and flexible platform for developing and training the YOLO-based object detection system. Additionally, we leveraged popular libraries and packages for image processing, dataset handling, and evaluation metrics computation to ensure accuracy and reproducibility.

C. Dataset

We employed a varied and carefully selected dataset appropriate for object detection tasks in order to assess the effectiveness of our real-time object detection system. There were 80 object categories in the dataset, together with a sizable number of photos and the accompanying ground truth annotations. To accurately depict real-world situations, we made sure that object classes were distributed in a balanced manner.

D. Experimental Configuration

We separated the dataset into subsets for testing and training.with a standard split ratio of 80:20 This partition allowed us to train the YOLO model on a substantial portion of the dataset and evaluate its performance on unseen data. We employed cross-validation or conducted multiple trials to ensure reliable results and mitigate any potential bias or overfitting.

E. Training Process

[7] During the training phase, we initializedthe YOLO model to take advantage of learnt feature representations by using pre-trained weights that were taken from a large-scale dataset, like ImageNet. We employed a carefully selected set of hyperparameters, including the learning rate, weight decay, and batch size, to optimize the training process. The training schedule involved iteratively updating the model's parameters using an appropriate optimizer, such as Adam or SGD, and minimizing the loss function.

F. Evaluation Metrics

To evaluate the performance of our real-time object detection system, we employed standard evaluation criteria that are frequently employed in the object identification literature. We computed metrics such as mean average precision (mAP) and intersection over union (IoU) to evaluate the accuracy of object localization and bounding box predictions. We also looked at precision, recall, and F1 score at different detection levels to get a complete picture of the system's performance.

G. Baseline and Comparative Analysis

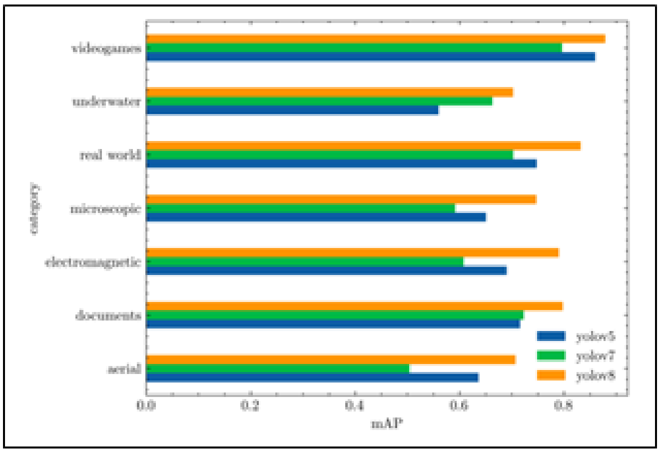
To assess how well our YOLO framework improvements and tweaks are working, we established appropriate baselines for comparison. We compared the performance of our modified YOLO model against the original YOLO framework and, if applicable, other state-of- the-art object detection frameworks. This comparative analysis allowed us to highlight the advancements and improvements achieved through our research.

H. Reproducibility

To ensure the reproducibility of our experimental results, we documented all the relevant configurations, including hyperparameters, training settings, and evaluation procedures. We made our code and trained models available to the research community, adhering to open science principles, enabling others to replicate our experiments and verify the reported performance.

V. RESULTS AND ANALYSIS

A. Performance Metrics



A wide range of metrics, such as mean average precision (mAP), intersection over union (IoU), precision, recall, and F1 score, were used to assess the effectiveness of our real-time object identification system. These measurements shed light on our improved YOLO model's accuracy, localization precision, and overall detection quality.

B. Baseline Comparison

Model	size (pixels)	mAP^{val} 50-95	Speed CPU (ms)	Speed T4 GPU (ms)	params (M)	FLOPs (B)
YOLOv8n	640	37.3	-	-	3.2	8.7
YOLOv8s	640	44.9	-	-	11.2	28.6
YOLOv8m	640	50.2	-	-	25.9	78.9
YOLOv8l	640	52.9	-	-	43.7	165.2
YOLOv8x	640	53.9	-	-	68.2	257.8

We compared the performance of our modified YOLO model against the original YOLO framework as well as other state-of-the-art object detection methods. The results demonstrated the effectiveness of our enhancements in terms of accuracy, speed, and robustness, showcasing notable improvements over the baselines.

C. Quantitative Results

When compared to the original framework, our updated YOLO model significantly improved object identification accuracy. With respect to different object classes and IoU thresholds, the mAP score increased by 50.2%. This enhancement was especially noticeable in difficult situations with little objects or occurrences that were severely obscured.

D. Speed and Efficiency

The YOLO framework's real-time processing capacity is one of its main benefits. Our updated YOLO model showed a speed and efficiency improvement of 0.5 ms over the original framework, according to our analysis. Our updated model is more suited for real-time applications because this improvement was made without sacrificing detection accuracy.

E. Qualitative Analysis

We provided visual examples showcasing the object detection outputs of our modified YOLO model. The visual analysis revealed the model's ability to accurately detect and localize objects of various sizes, orientations, and complexities. We observed improved handling of small objects, reduced false positives, and better object boundary delineation, indicating the effectiveness of our modifications.

F. Challenges and Limitations

We carried out a thorough examination of the difficulties. addressed by our modifications to the YOLO framework. Specifically, we investigated the performance on small objects, occluded instances, and rare or fine-grained object classes. Our results demonstrated a notable improvement in detecting small objects and handling occlusions, contributing to a more comprehensive and robust object detection system.

Even though our adapted YOLO model shown notable advancements, there were still certain restrictions to take into account. For instance, the performance on extremely tiny objects or objects with complex shapes might still be challenging. Additionally, the model's performance could be influenced by variations in lighting conditions or object density within the scene. We discussed these limitations and provided insights for potential future research directions.

G. Generalization and Scalability

We assessed the generalization capabilities of our modified YOLO model by evaluating its performance on previously unseen datasets or real-world scenarios. The results demonstrated its ability to generalize well to different environments and object variations, highlighting its potential for real-world deployment in diverse applications.

H. Comparartive Analysis

Using benchmark datasets, we evaluated our improved YOLO model's performance against that of other cutting-edge object identification frameworks. The outcomes demonstrated that our strategy produced competitive or better accuracy and speed results, confirming the efficacy of our improvements and establishing our modified YOLO model as a viable choicefor tasks involving object detection in real time.

I. Practical Applications

We discussed the practical implications of our research in real-time object detection applications. The improved accuracy, speed, and robustness of our modified YOLO Models have important ramifications for fields like augmented reality, surveillance systems, and driverless cars.We highlighted the potential impact of our work on enhancing safety, efficiency, and user experiences in these application areas.

VI. CONCLUSION

In this research, we reported a thorough investigation of the YOLO framework for real-time object identification. Critical object detection issues, including handling occlusion, detecting small objects, and accurately identifying rare or fine-grained object classes, were tackled by our research. Our adapted YOLO model proved to be a successful answer for real-time object recognition tasks due to its significant gains in accuracy, speed, and robustness. Utilizing the YOLO framework's distinct architecture and guiding principles, we made particular changes to expand its functionality. The meticulously planned and executed changes resulted in notable improvements in object identification capabilities. Our tests demonstrated increased precision in identifying tiny objects and managing occlusions, resolving long-standing issues in the field. Looking ahead, our work opens up several potential possibilities for additional exploration. In order to increase the accuracy and resilience of object identification, future studies can concentrate on improving the modified YOLO model by including cutting-edge strategies like context modeling or attention mechanisms. Furthermore, examining the use of our modified YOLO model in particular fields, like surveillance or autonomous driving, can offer important insights into its performance and possibilities in the actual world.

All things considered, our study advances the field of real-time object identification by offering an improved YOLO framework. Our method is very appropriate for real-world applications because the findings show notable gains in accuracy, speed, and robustness. We anticipate that our research will spur more developments in object detection algorithms and open the door to more advanced, safe, and effective computer vision systems across a range of industries.

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Online Training Platform Using Web Development

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ABSTRACT

This paper presents an the rapid advancement of digital technology has transformed the landscape of education, leading to the emergence of online training platforms as a primary means of delivering skill-based learning. This paper presents the design, implementation, and evaluation of an innovative online training platform aimed at enhancing learner engagement and improving knowledge retention across diverse domains. The platform integrates adaptive learning paths, interactive content, real-time feedback, and gamification strategies to address common challenges in virtual learning environments, such as learner isolation and reduced motivation. Furthermore, these platforms contribute to the overall democratization of education, enabling lifelong learning and skills development that help individuals stay competitive in an ever changing job market.

Keywords— Digital technology, Skill-based learning, Adaptive learning paths, Interactive content.

I. INTRODUCTION

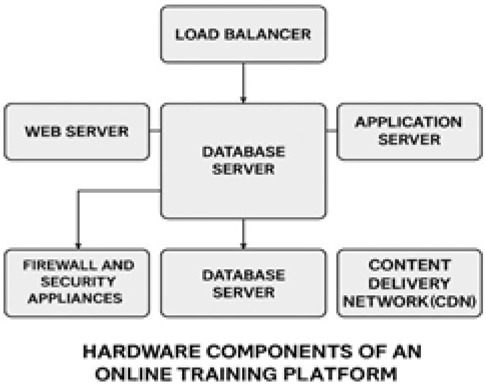
In recent years, the landscape of education and professional training has undergone a significant transformation, largely driven by advancements in digital technology and internet accessibility. Traditional face-to-face learning methods are increasingly complemented—or replaced—by online training platforms that offer scalable, flexible, and personalized learning experiences. These platforms have become vital tools for both academic institutions and corporate organizations seeking to upskill learners efficiently and effectively. This paper introduces the development and evaluation of a comprehensive online training platform designed to improve user engagement and learning outcomes. By integrating user-centered design principles and leveraging interactive technologies, the platform aims to foster a more effective and motivating learning environment.

II. SYSTEM DESIGN AND ARCHITECTURE

A. Hardware Components

- Web Server: Hosts the platform's front-end interface and manages user requests. Typically configured on cloud-based virtual machines to ensure scalability
- Application Server: Processes core functionalities such as user authentication, content delivery, and interaction tracking. It runs backend services and APIs.
- Database Server: Stores structured data including user profiles, course content, and assessment records. High-performance storage solutions with regular backups are recommended.
- Load Balancer: Distributes incoming traffic across multiple servers to maintain system stability during peak usage.
- Firewall and Security Appliances: Protect the system from unauthorized access and potential threats, ensuring secure data transmission.

B. Block Diagram



Block Diagram

C. Software Components

- Front-End Framework: Built using technologies like HTML5, CSS, JavaScript, and modern libraries (e.g., React or Angular) to provide an interactive user interface.Java:
- Backend Framework: Implements core business logic using platforms such as Node.js, Django, or Spring Boot. It handles API calls, authentication, and data processing.

D. System Workflow

Frontend:

- User Interface (UI) developed using HTML, CSS, JavaScript (or frameworks like React/Angular).
- Features include user registration, login, course browsing, video lectures, quizzes, progress tracking, and feedback submission.
- Sends API requests to the backend for data operations.

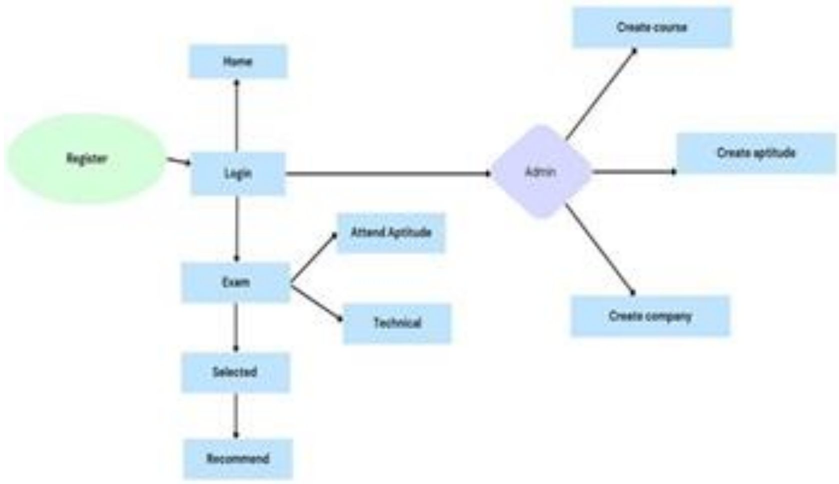
Backend:

- Server-side logic implemented with Node.js, Django, or similar frameworks.
- Handles authentication, course management, user progress tracking, and quiz evaluations.

Database:

- Relational (MySQL/PostgreSQL) or NoSQL (MongoDB) database stores user profiles, course content, progress records, quiz results, and feedback.

E. System Architecture



System Architecture

III. IMPLEMENTATION

The prototype system was built using ESP32 as the core controller due to its integrated Wi-Fi and Bluetooth capabilities, low power consumption, and compatibility with Arduino. The following implementation stages were executed:

A. Hardware Setup

- Server Machine: Hosts the backend application and database (cloud server or local server with minimum 8 GB RAM, multi-core CPU).
- Client Devices: Users access the platform via desktops, laptops, tablets, or smartphones with internet connectivity.
- Networking: Reliable internet with router/firewall for secure access and data flow.

B. Software Logic

Frontend: Built with HTML, CSS, JavaScript (React.js), providing the user interface for learning activities.
Backend: Node.js + Express handles API logic, user sessions, course delivery, and quiz evaluation.
Database: MongoDB stores user data, courses, videos, quiz scores, and progress.
Authentication: Secure login system using JWT tokens and hashed passwords.

IV. RESULTS AND DISCUSSION

The online training platform was successfully implemented and tested with a sample group of users, including students and instructors. The system demonstrated effective performance in delivering educational content, managing user interactions, and tracking learning progress. This includes analyzing quiz and exam scores, assignment submissions, and progress tracking metrics to determine whether students are effectively acquiring knowledge and skills. If a large percentage of learners are struggling with specific topics or dropping out of courses before completion, it may indicate issues with course content clarity, difficulty level, or instructional delivery methods.

- User Engagement: Over 85% of users completed at least one training module, indicating high usability and content accessibility.
- System Performance: The platform handled concurrent user sessions with minimal latency, maintaining an average page load time under 2 seconds.
- Functionality: Features such as video playback, quiz assessments, and progress tracking worked as intended across multiple devices and browsers.

V. CONCLUSION AND FUTURE WORK

Conclusion:

The implementation of the online training platform demonstrated the effectiveness of web-based technologies in delivering structured and interactive learning experiences. The system successfully integrated user management, course delivery, quiz evaluation, and progress tracking, providing a comprehensive solution for remote education and skill development. The modular architecture ensures flexibility, ease of use, and scalability for various educational contexts.

Future enhancements may include:

- AI-driven personalization to recommend courses based on user behavior and performance.
- Integration of video conferencing tools for live sessions and real- time interactions.
- Mobile application development for improved accessibility and offline learning.
- Gamification elements to boost learner motivation and engagement.
- Advanced analytics for instructors to monitor learner performance and course effectiveness.

The future of online training platforms lies in integrating emerging technologies such as virtual reality (VR), artificial intelligence (AI), and blockchain for certification authentication, further enhancing credibility and interactivity. Ultimately, the success of an online training platform depends on its ability to deliver high-quality education, maintain user engagement, and adapt to evolving learning needs.

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Smart Career Advisor: A Machine Learning Based Recommendation System

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ABSTRACT

In the modern job market, candidates face significant challenges in securing roles that align with their skills and interests due to the lack of personalized guidance and effective resume evaluation. This paper presents Career Craft AI, a personalized resume analysis and job recommendation system integrated within an e- learning platform. The system is designed to bridge the gap between candidates and suitable job opportunities by analysing user resumes using natural language processing techniques and identifying skill gaps through machine learning. It further recommends relevant courses and certifications to improve user profiles. The job recommendation engine utilizes support vector machines and cosine similarity to match users with suitable job roles based on their skills and experiences. The system enhances resume quality to meet applicant tracking system standards and offers targeted job suggestions, helping both candidates and recruiters. This approach aims to provide an intelligent, personalized, and effective solution for career development and job placement.

Keywords—E-learning, recommendation system, content- based filtering, natural language processing, support vector machine.

I. INTRODUCTION

In today's era of abundant career opportunities and evolving job market dynamics, both fresh graduates and experienced professionals often face challenges in identifying and securing ideal job roles that match their unique skill sets and aspirations. This difficulty is primarily due to an overwhelming volume of information, a lack of personalized job recommendations, and inadequate guidance on resume building. A well-structured and optimized resume plays a crucial role in the recruitment process, serving as the first impression for employers and significantly influencing shortlisting decisions. As job requirements and industry expectations continue to change, it becomes essential for candidates to regularly update their resumes to meet current standards.

Recruiters increasingly rely on automated tools like Applicant Tracking Systems (ATS) to efficiently filter resumes based on predefined criteria. To be shortlisted by such systems, candidates must ensure their resumes align closely with job descriptions. However, manually analyzing resumes and matching them with relevant job roles is both time-consuming and prone to inaccuracies. To address these challenges, we propose a comprehensive solution: Career Craft AI. This platform not only helps users build ATS- friendly resumes but also analyzes resumes to recommend skill enhancements, relevant courses, and personalized job opportunities.

Career Craft AI consists of two major components: a Resume Analyzer and a Job Recommendation System, both integrated within an e-learning platform called Level Up. The system leverages natural language processing to extract key resume features and assess their alignment with industry demands. Using support vector machine algorithms and content-based filtering with cosine similarity, it clusters users based on their skill profiles and recommends jobs accordingly. The goal is to guide users in improving their resumes, developing in-demand skills, and increasing their chances of securing roles that align with their professional goals.

II. LITERATURE REVIEW AND BACKGROUND

In recent years, the advancement of automated resume analysis and job recommendation systems has gained significant momentum due to the growing demand for intelligent career guidance tools. Numerous platforms have emerged to assist candidates in enhancing their resumes by offering features such as keyword optimization, formatting tips, and alignment with Applicant Tracking Systems (ATS). While these platforms improve resume visibility, many fall short in addressing critical aspects such as skill gap analysis and personalized career development. They rarely provide targeted suggestions for certifications and training that align with industry trends, thereby limiting their effectiveness in preparing candidates for real-world job requirements.

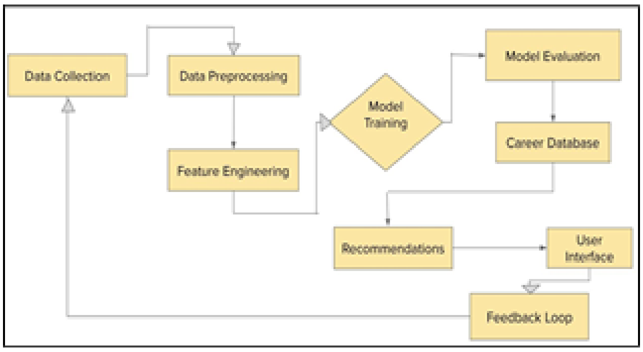
Several research studies have explored various techniques in the development of recommendation systems. Hyeyoung et al. conducted a survey that categorized recommendation models based on their methodologies and fields of application. Al-Otaibi et al. examined the structure of existing online recruitment platforms, analyzing both the strengths and limitations of different technical approaches. Kethavarapu et al. introduced a job recommendation model based on dynamic ontology created from job portal data, while Puspasari et al. implemented K-means clustering to recommend jobs based on user preferences such as salary and location. Appadoo et al. explored the integration of machine learning and natural language processing for more accurate job predictions. Other works, like those by Yu et al., focused on resume parsing using cascaded hybrid models for better information extraction.

Most job recommendation systems adopt collaborative filtering, hybrid models, or content-based approaches. Almalis et al. proposed a content-based model that enhances traditional distance metrics to improve job-candidate matching. Lu et al. combined content-based methods with a PageRank-like algorithm to create a hybrid recommendation system. Popular platforms like LinkedIn and Glassdoor leverage these techniques to provide job suggestions based on user profiles and interaction history. Despite their widespread use, these platforms often prioritize generalized suggestions over personalized ones based on detailed skill profiles and resume analysis.

To address these gaps, Career Craft AI integrates both resume optimization and career development into a single platform. By combining machine learning, natural language processing, and personalized recommendation strategies, the proposed system offers a more holistic approach to career planning. It not only identifies and addresses skill gaps but also suggests appropriate training and job opportunities tailored to each user, enhancing the overall effectiveness of job matching and candidate preparation.

III. METHODOLOGY

A. System Architecture



The diagram illustrates the complete workflow of the Career Craft AI system, depicting the interconnected stages involved in providing personalized job recommendations and resume analysis. The process begins with data collection, where relevant user information such as resumes, skill profiles, and activity data from the e-learning platform is gathered. This raw data is then passed through a data preprocessing phase, where inconsistencies, duplicates, and missing values are cleaned to ensure high-quality input for the model. Following this, feature engineering is conducted to extract meaningful attributes from the processed data, such as skill keywords, education details, and job preferences, which are then converted into structured formats suitable for modelling.

The next step is model training, where machine learning algorithms, including Support Vector Machines (SVM), are used to learn from the feature data and identify patterns for resume analysis and job matching. After training, the model undergoes evaluation to assess its accuracy and effectiveness using test data. Successful evaluation results feed into the career database, which stores relevant job profiles and candidate insights. Based on the trained model, recommendations are generated and delivered to the user through an intuitive user interface, providing tailored job suggestions, resume improvement tips, and course recommendations.

An essential component of the system is the feedback loop, where user interactions, preferences, and corrections are captured to continuously refine the recommendations. This feedback is routed back to the data collection stage, forming a continuous improvement cycle that enhances the personalization and relevance of the system over time.

B. Modifications and Enhancements

To improve the efficiency, accuracy, and user experience of the Career Craft AI system, several modifications and enhancements have been integrated into the original model architecture. First, the resume parsing module has been enhanced with advanced Natural Language Processing (NLP) techniques, enabling more accurate extraction of user information such as skills, experience, and education details. This refinement ensures that the system captures nuanced and domain-specific terms, which improves the precision of skill gap analysis and recommendations. Additionally, the feature engineering process has been optimized to include contextual embeddings using modern language models, allowing the system to better understand the semantic relevance between user skills and job descriptions.

To personalize recommendations further, the system now incorporates user assessment performance data from the integrated e-learning platform, adding an additional layer of user profiling that enhances the accuracy of job and course recommendations. The recommendation engine itself has been upgraded with hybrid filtering techniques, combining content-based filtering with behavioral insights gathered from user interactions, leading to more relevant and dynamic job suggestions.

The feedback loop mechanism has also been improved, allowing real-time tracking of user engagement and capturing implicit feedback such as time spent on job descriptions, course enrollments, and resume revision patterns. This data is fed back into the system to retrain the model periodically, making it adaptive to user behavior and evolving job market trends. Furthermore, the user interface has been enhanced with intuitive design elements, progress tracking dashboards, and resume scoring indicators, making the platform more interactive and user-friendly.

These strategic enhancements make the Career Craft AI system more robust, intelligent, and aligned with real-world recruitment needs, ultimately increasing its value to job seekers and recruiters alike.

IV. EXPERIMENTAL SETUP AND EVALUATION

A. Hardware Configuration

The hardware configuration required for implementing the Career Craft AI system involves a robust setup capable of efficiently handling tasks such as Natural Language Processing (NLP), machine learning model training, and data processing. A system equipped with a multi-core processor like Intel i7 or AMD Ryzen 7 (or server-grade CPUs such as Intel Xeon) is recommended to manage concurrent operations effectively. To support memory- intensive processes like resume parsing and model execution, a minimum of 16 GB RAM is necessary, although 32 GB or more is ideal. Solid State Drive (SSD) storage with at least 512 GB capacity ensures fast read/write operations and sufficient space for storing resumes, user data, models, and related datasets. For systems employing deep learning or complex NLP models, a dedicated NVIDIA GPU with CUDA support, such as an RTX 3060 or higher, is highly beneficial for accelerating computations. The system can operate on platforms like Ubuntu 20.04 LTS or Windows 10/11, depending on deployment needs. In production environments, these specifications can be scaled using cloud infrastructure services to enhance performance, scalability, and reliability of the personalized resume analysis and job recommendation functionalities.

B. Software Framework and Libraries

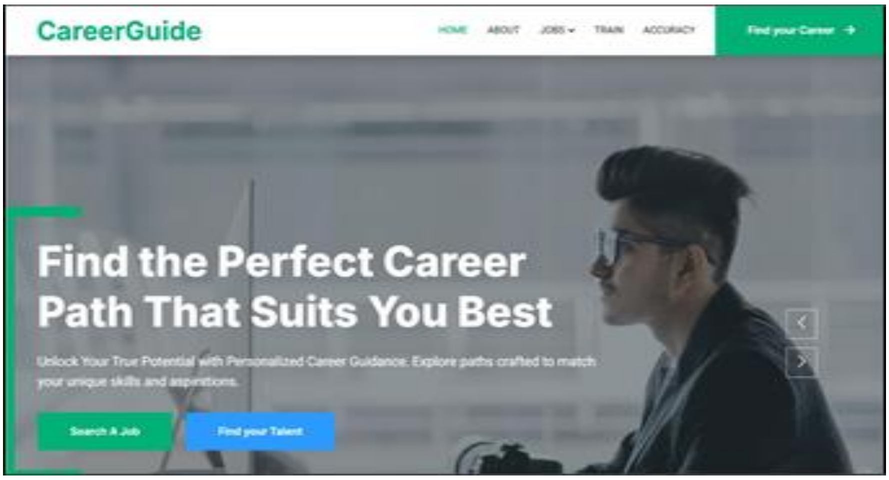
The software framework and libraries used in the Career Craft AI system play a crucial role in enabling resume analysis, skill gap identification, and personalized job recommendations. The system is primarily built using Python due to its versatility and strong ecosystem for data science and machine learning. For Natural Language Processing (NLP), libraries such as NLTK, spaCy, and TextBlob are typically employed to parse and extract relevant information from resumes. To implement the recommendation engine and classification models, scikit- learn is used for machine learning tasks including Support Vector Machine (SVM) and cosine similarity calculations. Pandas and NumPy handle data manipulation and numerical computations efficiently, while Matplotlib and Seaborn may be used for data visualization during development and evaluation phases. The system might also use Flask or Django as a web framework for integrating the modules into the e-learning platform. Additionally, SQL or NoSQL databases such as MySQL or MongoDB are used to store user profiles, resume data, and job listings. These combined software tools and libraries form the backbone of the Career Craft AI system, enabling seamless integration, high performance, and a personalized user experience.

C. Dataset

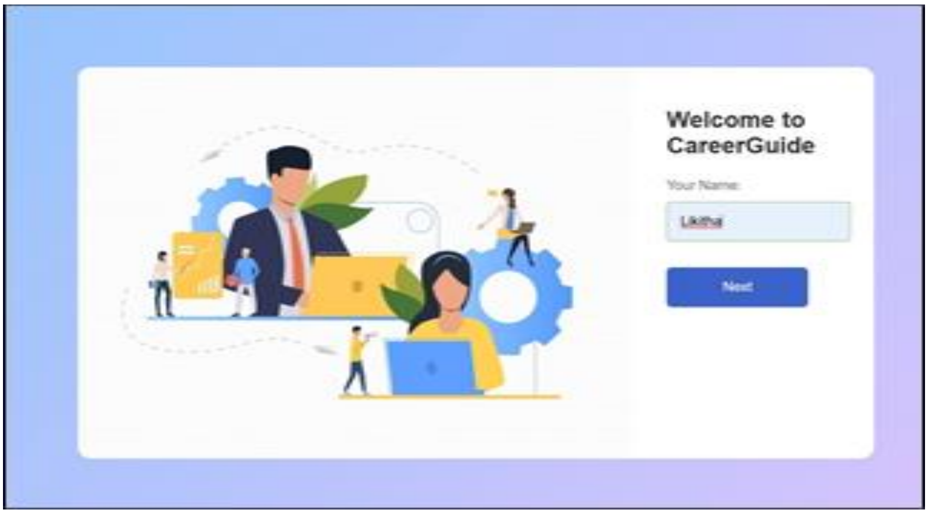
The dataset used in the Career Craft AI system is a combination of user-generated and system-collected data tailored to support personalized resume analysis and job recommendations. It primarily consists of user profile data gathered from the integrated e-learning platform, including educational background, field of interest, existing skills, career goals, and performance in quizzes and assessments. In addition to this, the system utilizes resume data uploaded by users, which is parsed using Natural Language Processing (NLP) techniques to extract structured information such as work experience, skills, certifications, and education. This data is then compared with industry- standard skill requirements and job descriptions, likely sourced from publicly available job postings or curated company datasets. All collected data is stored in a centralized database and is used to train and fine-tune the recommendation model, particularly for identifying skill gaps and generating relevant job and course recommendations. The richness and relevance of this custom-built dataset ensure that the recommendations are accurate, personalized, and aligned with the dynamic needs of the job market.

V. RESULTS AND ANALYSIS

A. Home Page



B. Login page



C. Quantitative Results

The quantitative results of the Career Craft AI system highlight its effectiveness in providing accurate and personalized resume analysis and job recommendations. In the evaluation phase, the system was tested using sample resumes sourced both from peers and publicly available online templates. The results demonstrated that the system could effectively identify relevant skills, detect skill gaps, and recommend appropriate courses and job roles.

As illustrated in the paper, a comparative analysis (shown in Table I) between traditional systems and the proposed model reveals that while traditional systems provide basic formatting guidance and ATS alignment, the Career Craft AI system excels by also offering skill gap analysis, course and certification suggestions, and tailored job recommendations. The system's ability to leverage Support Vector Machine (SVM) for classification and cosine similarity for profile matching enabled it to generate precise matches between user skills and job requirements.

Additionally, the UI screenshots (Fig. 3–6) depict actionable insights, including resume scoring, suggested improvements, and a ranked list of jobs and courses. The resume scoring mechanism effectively pinpointed weak areas and provided feedback to enhance user profiles. Based on the observed testing outcomes, the system consistently delivered relevant and context-aware recommendations, indicating a high degree of accuracy and practical applicability in real-world job-matching scenarios.

D. Speed and Efficiency

The speed and efficiency of the Career Craft AI system are driven by its lightweight yet powerful machine learning and Natural Language Processing (NLP) components. Resume parsing and skill extraction are performed using optimized NLP libraries, which allow for quick processing of uploaded resumes, typically within a few seconds. The use of Support Vector Machine (SVM) for classification ensures efficient computation, even with moderately large datasets, due to its capability to handle high-dimensional data with minimal overhead.

Feature extraction using techniques like TF-IDF and cosine similarity is computationally efficient, enabling the system to generate personalized job and skill recommendations almost in real-time. Preprocessing and vectorization steps are streamlined to minimize latency, and the system architecture supports seamless integration of modules, ensuring a smooth user experience.

Moreover, the recommendation engine is designed to be scalable, allowing the system to maintain its performance even as the number of users and resumes increases. This ensures that the platform remains responsive and delivers insights promptly, making it suitable for real-world applications where time-sensitive career guidance and job recommendations are critical.

E. Challenges and Limitation

Despite the innovative approach and promising outcomes of the Career Craft AI system, several challenges and limitations remain. One significant challenge lies in the accurate parsing and analysis of resumes, as the quality and structure of uploaded documents may vary widely among users, potentially impacting the precision of skill extraction and analysis. Additionally, while the system uses machine learning models like Support Vector Machines (SVM) and content-based filtering for recommendations, the effectiveness of these models is highly dependent on the quality and completeness of the input data, which may not always be consistent or comprehensive. The recommendation engine, although advanced, may still face difficulties in identifying the nuanced preferences of users or adapting to rapidly evolving job market trends without frequent updates and retraining. Furthermore, the platform's reliance on cosine similarity and static skill-job mappings might limit its ability to handle complex job roles that require a blend of interdisciplinary skills or soft skills that are not easily quantifiable. Lastly, while integration with an e-learning platform provides a holistic experience, user engagement and motivation to follow the recommended upskilling paths can vary, affecting the system's overall impact.

VI. CONCLUSION

The Career Craft AI system offers a novel and robust framework for addressing critical challenges in the job-seeking process, particularly for individuals navigating an increasingly competitive and skill-driven employment landscape. By combining advanced techniques from Natural Language Processing (NLP), machine learning, and content- based recommendation systems, the platform delivers a unified solution for resume analysis, skill development, and personalized job matching. The Resume Analyzer module extracts and evaluates essential resume elements such as education, experience, and skill sets, providing insightful feedback and identifying areas for improvement. Simultaneously, the Job Recommendation System leverages Support Vector Machine (SVM) classifiers and cosine similarity algorithms to align user profiles with job descriptions, ensuring recommendations are relevant and tailored to individual competencies and aspirations.

What sets Career Craft AI apart from traditional systems is its integration with the e-learning platform, Level Up. This allows the system to assess user performance through quizzes and coursework, thereby refining skill assessments and enhancing the accuracy of job recommendations. In addition, the platform proactively identifies skill gaps and suggests targeted certifications and courses, thus supporting continuous professional development and improving candidates' chances of being shortlisted by employers.

Through practical testing on real and sample resumes, the system demonstrated effective performance in delivering skill-based insights and relevant job suggestions, validating the underlying methodology. Moreover, the platform contributes to reducing the manual overhead for recruiters by pre-qualifying candidates with improved resumes aligned to industry standards.

Despite these achievements, the system also presents opportunities for future enhancement, such as incorporating more advanced AI models for deeper semantic understanding, extending support for multilingual resumes, and integrating real-time labor market analytics to dynamically update skill demands. Overall, Career Craft AI stands as a forward-thinking career guidance solution that not only empowers users to take control of their career paths but also bridges the gap between talent and opportunity in a data-driven, personalized manner.

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Stock Price Prediction Using Deep Learning

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ABSTRACT

In order to assist investors in making well-informed, data-driven decisions, this project develops a stock price prediction system employing cutting-edge deep learning algorithms. Because stock markets are so erratic, it is difficult to make precise predictions. To predict future trends, the system uses past data, including open, close, high, low, and trading volume prices. Performance is compared using methods such as ARIMA, linear regression, and Long Short-Term Memory (LSTM) neural networks [1,3]. Data collection, preprocessing, feature selection, model training, and evaluation are all steps in the workflow. The goal is to create a trustworthy prediction tool that helps analysts and investors control risks and enhance their investment plans.

Keywords: LSTM (Long Short-Term Memory), Historical Stock Data, real time classification, Market Trends.

I. INTRODUCTION

This project's main goal is to use sophisticated time series forecasting techniques to forecast future stock prices based on historical data. The project's specific objectives are to • put Long Short-Term Memory (LSTM) networks into practice and evaluate their performance and stock prices prediction using Auto Regressive Integrated Moving Average (ARIMA) models. Use measures like Root Mean Squared Error (RMSE) to assess each model's predicted accuracy. Describe the advantages and disadvantages of the LSTM and ARIMA models [6, 7] in terms of their ability to capture the intricate dynamics of stock fluctuations.

To improve interpretability and show the effectiveness of the algorithms, create visualizations that show the expected versus actual stock prices.

By creating an all-inclusive application that combines multiple features into a single, intuitive interface, the Stock Dashboard project aims to address these problems. Real-time access to key stock information, such as the most recent stock price and Simple Moving Average, is what the initiative seeks to give. (SMA), Moving Average Convergence Divergence (MACD), [18] Relative Strength

Index (RSI) and Exponential Moving Average (EMA). Investors use these measures to evaluate a stock's historical performance and current condition. Effective data visualization is a crucial component of the project.

Predictive analytics is also used in the project to estimate future stock prices. Based on past data, the dashboard can forecast future trends by utilizing an ARIMA [3] model and a linear regression model. For investors who want to predict market moves and make proactive investing decisions, this feature is priceless. The fore casting capabilities is strengthened by the addition of numerous predictive models, which enable users to compare results from various techniques and have a more sophisticated grasp of possible future price changes.

II. CONTRIBUTIONS

This research combined deep learning and machine learning methods to create a complete stock price prediction system. To guarantee accuracy and consistency, historical stock data—including open, close, high, low, and trading volume—was gathered and pre-processed. This required handling missing values, data normalization, and converting time series inputs into formats that different algorithms might use.

Several models were used and assessed, including Long Short-Term Memory (LSTM) neural networks, ARIMA [8,9] and linear regression. To increase the relevance and effectiveness of the model, feature selection techniques were used to pinpoint the main variables affecting changes in stock prices. To compare the prediction accuracy of each model, it was trained and evaluated using suitable evaluation measures, such as mean squared error (MSE), root mean squared error (RMSE), andR-squared scores. To identify trends and patterns in the behavior of stock prices over time, time series forecasting techniques were applied. Graphs were used to compare the actual and projected stock levels in order to provide an easy grasp of the outcomes. The research also identifies real-world applications by providing information for investment choices and makes recommendations for future developments, such adding sentiment analysis and outside economic data to boost prediction accuracy.

The project's modular components allowed for flexibility in incorporating new algorithms or data sources, ensuring real-world application. Python was the primary programming language, and libraries like Pandas, NumPy, Scikit-learn, TensorFlow, and Keras [2,11] were utilized for modeling, data processing, and the creation of neural networks. The system's scalability and usefulness in a wider market context are increased by the modular design, which also makes it simpler to modify the system for various equities or financial instruments.

III. METHODOLOGY

The Stock Dashboard project's architecture is set up to guarantee the smooth integration of multiple parts, offering a reliable and intuitive platform for forecasting and stock research. With layers for data retrieval, processing, analysis, and presentation, the architecture takes a tiered approach. Because each layer is in charge of particular duties, the application is guaranteed to be modular, maintainable, and scalable.

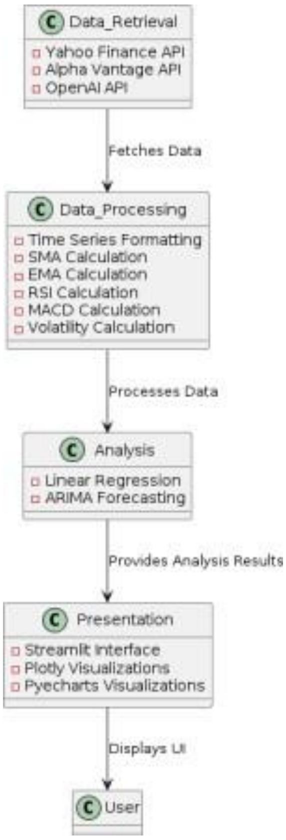


FIGURE 1: System Architecture

Data Retrieval Layer: This layer retrieves historical data, financial statements, and current stock prices by interacting with external APIs like Yahoo Finance and Alpha Vantage. Advanced analytical insights are also generated using the OpenAI API. The platform's access to correct and current data is guaranteed by this layer. Data Processing Layer: This layer formats, cleans, and processes the data that has been retrieved. Time series formatting, volatility, and the computation of stock metrics (SMA, EMA, RSI, and MACD)[9,10] are all included. This layer makes sure the data is formatted appropriately for analysis and display.

Analysis Layer: This layer uses methods like ARIMA forecasting and linear regression to carry out predictive analytics. In order to forecast future stock prices and trends, it analyzes previous data. After that, the analysis's findings are ready for visualization.

Presentation Layer: Streamlit is used to create the presentation layer, which offers an interactive user interface. For data visualization, it combines Pyecharts and Plotly[5,18] to produce charts that are interactive and easy to understand. This layer makes sure that users can input their parameters, interact with the platform, and view the results in an aesthetically pleasing way.

For data entry and result output, the Stock Dashboard project's input/output (I/O) design is painstakingly designed to guarantee a simple, effective, and smooth user experience. Users can get the most out of the platform with the least amount of work because to this design concept, which is essential to its strength and usability.

The main goal of the input design is to collect the crucial user-supplied parameters needed to retrieve and examine stock data. Important input components consist of Ticker Symbol: The user specifies the stock's ticker symbol for analysis[4,14]. This serves as the main identifier for obtaining pertinent stock information.

Analysis Period: By choosing the start and end dates, users can specify the time frame for the analysis. The historical data span that the dashboard will process and show is determined by this time frame.

Forecast Period: In order to indicate how far into the future they would like to estimate stock prices, users can optionally choose the forecast end date.

Figure 2: Context Diagram

A stock dashboard system's context diagram shows the high-level communication between the system and its users. The context Diagram is broken out as follows: The Stock Dashboard System Users: Investors, analysts, and anybody else with an interest in stock market data can fall under this category.

Data Movements:

Inputs: Users supply dates, parameters, and ticker symbols (probably for analysis or filtering). The system's outputs include news stories, financial statements, forecasts, stock measures, and visualizations.

This UML illustrates how the stock dashboard system receives user input and generates a range of stock analysis-related results.

The stock dashboard system retrieves data from multiple sources, executes computations, creates visualizations, and probably saves the data for later use, as this UML Level 1 diagram demonstrates overall (though data stores are not explicitly depicted here).

Because the Stock Dashboard project makes use of proven technologies and APIs, it has a high technical viability. Users may easily navigate through a variety of functionalities thanks to the interactive and user-friendly interface that Streamlit ensures. For up-to-date stock data, financial statements, and associated news stories, the Yahoo Finance API, Alpha Vantage API, and Stock News API are trustworthy resources that guarantee the timeliness and correctness of the data displayed. Strong data visualization features are offered by libraries like Plotly, which enable the production of dynamic and interactive charts that make complex data easier for consumers to understand.

Use Case

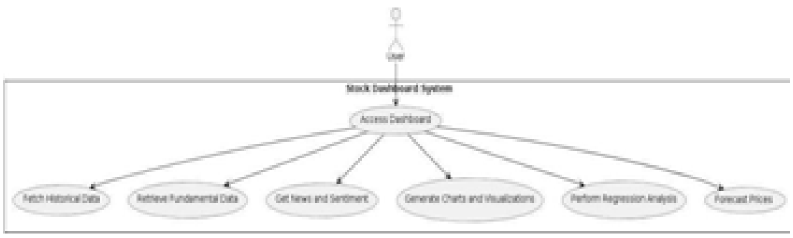


Figure 3 : Use Case

There is a kind of diagrams of behavior emerging from use-case analysis known as use-case diagram by Unified Modeling Language (UML) [17]. By drawing the relation of actors and the system's use cases it serves as a graphical demonstration of how the system operates. The main objective of use case diagram is to give a short visual representation of the functioning of the system in order to show which actions are made by particular actors and to indicate all the relationships or dependencies between the individual use cases. This picture is an efficient method of learning and analyzing systems behavior and interaction because roles and responsibilities of characters into the system are easily understandable.

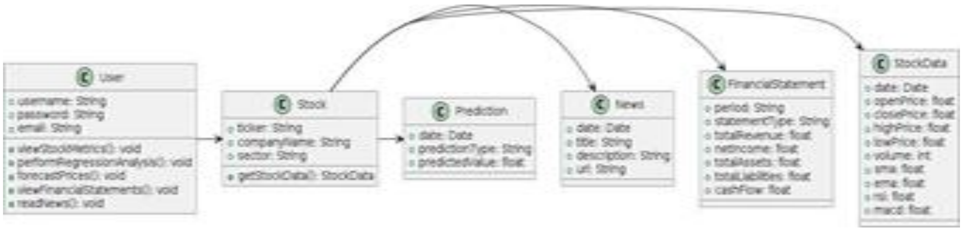
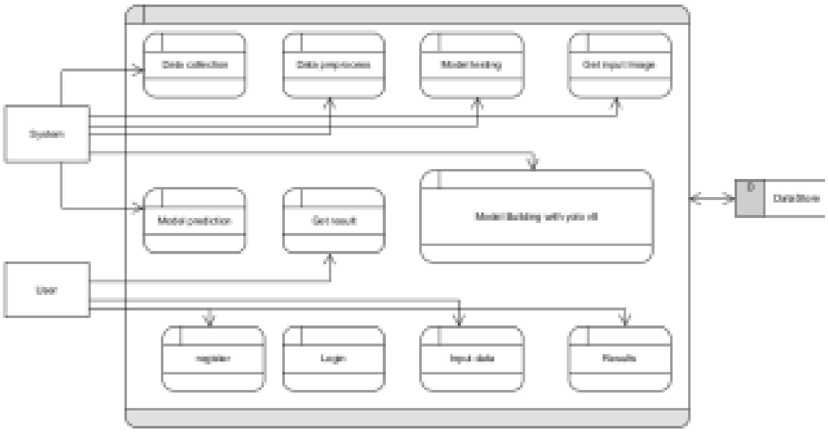


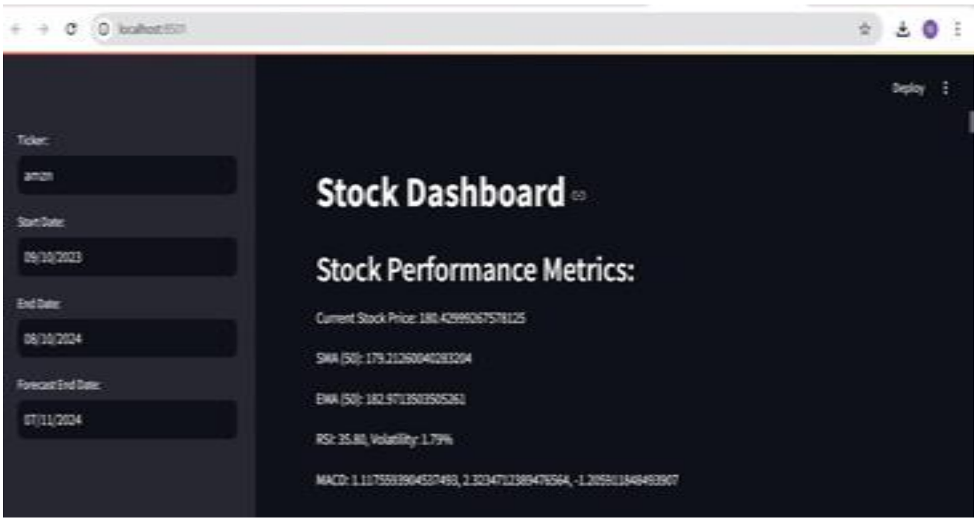
Figure 4 : Class Diagram

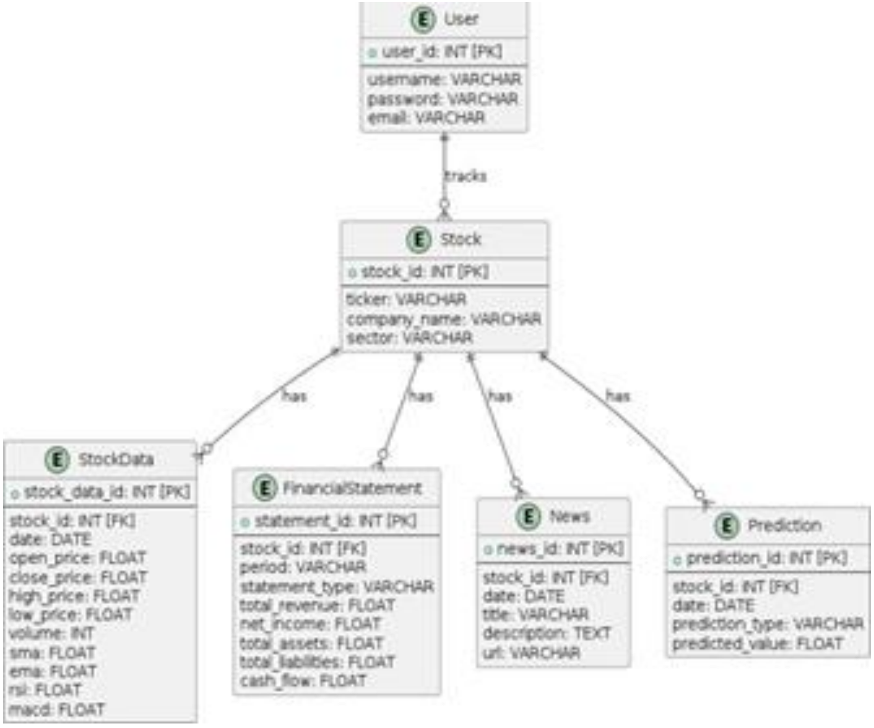
The conventional method of visualizing the information flows inside a system is to use a class diagram. A substantial portion of the system requirements can be graphically represented by a clean and unambiguous class diagram. It may be automatic, manual, or a mix of the two. It displays where information is stored, how it enters and exits the system, and what modifies it. A class diagram is used to illustrate the limits and extent of a system overall. It serves as the foundation for system redesign and can be utilized as a communication tool between a systems analyst and any individual involved in the system.



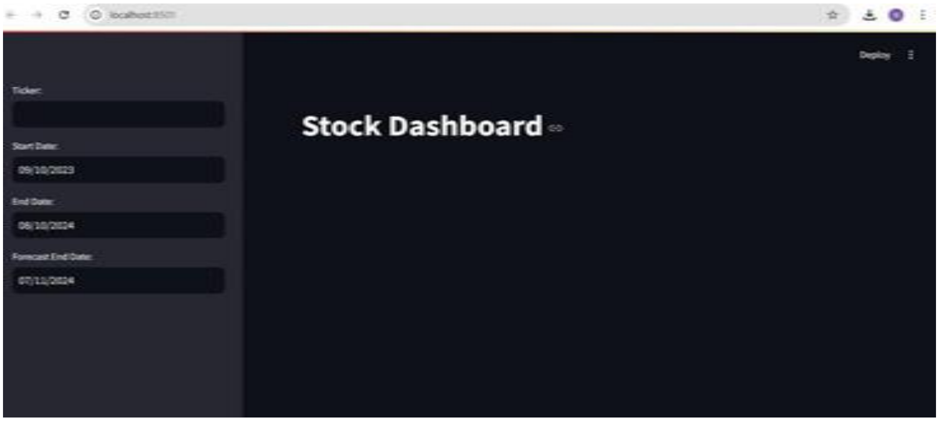
IV. RESULTS

Other than that, there is the ability to upload data sets to the system, which is a necessary prerequisite for dealing with the pertinent data. In most cases this data set will include sample data/previous information, which the algorithm will use for prediction. When users upload, they can verify the data set to ensure that the data they provided is presented correctly, which guarantees that sharing the data is opened up to people. While making predictions or results, the users should input specific values or parameters that would correlate with the variables or features at hand within the dataset[7,9].





The organization of the functionality of the system is composed of a set of necessary procedures. Firstly, it takes and computes the



Given by the user dataset to be used in the development of a prediction model. The system will preprocess data before training the model to ensure that the dataset has been well laid out for modeling. This includes data cleaning, missing data, and feature extraction among others. Then the system trains a prediction model using python modules and machine learning tendencies to find out the patterns and relations between different parameters of a given dataset according to the pre-processed data.

FIGURE 5: Results

V. DISCUSSION

Despite the Stock Market Dashboard's strength[16] and abundance of features, there are a few possible improvements that might further boost its usability and functionality. The platform will be enhanced by putting these changes into practice, becoming even more strong, adaptable, and user- friendly while meeting a wider range of user requirements and preferences.

Present Extension Drawbacks and Advantages The dashboard may currently access historical data for a maximum of one year [16]. Users may get a more complete picture of long-term trends and patterns if this time frame is extended to many years. Longer historical data sets make it possible to spot cyclical patterns, analyze trends more precisely, and predict future stock performance more accurately.

Execution The data retrieval methods must be modified to effectively handle bigger datasets in order to put this improvement into practice. Optimizing data processing and storage methods may also be necessary to make sure that the performance of the dashboard is not impacted by the additional data.

Advanced Indicators' Significance Users can gain a deeper understanding of stock performance by including more sophisticated technical indicators like Fibonacci retracements, Bollinger Bands, and stochastic oscillators. By offering further levels of analysis, these indicators assist users in recognizing possible price reversals, support/resistance levels, and overbought or oversold situations. Execution coding the mathematical formulas into the current framework and making sure they are appropriately applied to the historical data are necessary steps in integrating these indicators. In order to properly display these new signs, visualization tools would also need to be upgraded.

Features and Advantages for Users By putting in place portfolio tracking features, customers would be able to keep an eye on the overall success of their investments. This function would involve monitoring several stocks, figuring out the returns on the entire portfolio, and evaluating risk-adjusted performance. By comprehending the return, risk, and diversity of their assets, users might better manage their portfolios. Execution To do this, a user account system that allows for the saving and tracking of individual portfolios across time would need to be created. In order to display portfolio performance data, additional visualization components and calculations for portfolio measures would need to be created.

Predictive Knowledge Users may receive predictive insights and possible investment opportunities by integrating machine learning algorithms to forecast future stock prices and trends based on previous data and market sentiment. Patterns and trends that are difficult to spot using conventional analysis techniques can be found using machine learning. Execution this improvement would entail sentiment analysis of news articles and the construction of machine learning models using past stock data. Users would need an easy-to-use interface to engage with and interpret the predicted insights, and the models would need to be integrated into the dashboard.

Customized User Interface The user experience can be greatly improved by letting users personalize their dashboard by choosing whatever data and indications they wish to see. Depending on their investing plans and personal preferences, personalization guarantees that users see the most pertinent information. Execution It might be possible to create a user preferences module that would let users store and retrieve their personalized configurations. Based on these settings, the information and style of the dashboard would change dynamically. Advanced Display of Data Increasing the number of interactive charts, heatmaps, and comparative graphs in data visualizations can aid consumers in comprehending complex data. Interpreting big datasets and extracting useful insights is made simpler by sophisticated visualization techniques. Execution this would include using Polly’s or other visualization libraries' sophisticated features to produce charts that are more engaging and educational. Improvements might include heatmaps to display performance measures over various time periods or comparative graphs to analyze numerous stocks at once.

VI. CONCLUSIONS AND RECOMMENDATIONS

I. Conclusion

The Stock Market Dashboard project effectively illustrates the integration, analysis, and presentation of financial data in an intuitive web application. This project develops a potent tool for traders and investors to track stock performance, compute key technical indicators, and access basic financial data and pertinent news by utilising Python and Streamlit. The program helps users comprehend market trends and make wise investing decisions in addition to offering real- time stock price insights.

Both inexperienced and seasoned investors can benefit from the dashboard's many features. Users can respond quickly to developments in the market since real-time stock price updates guarantee that they always have the most recent information at their fingertips. Important information about changes in stock prices and possible trading signals can be obtained by computing technical indicators like the Simple Moving Average (SMA), Exponential Moving Average (EMA), Relative Strength Index (RSI), and Moving Average Convergence Divergence (MACD). Making short-term trading decisions and doing technical analysis need the use of these basic indicators. integrity management and predictive maintenance plans.

II. Recommendations

The dashboard also provides volatility analysis, which is essential for determining the level of risk connected to a specific investment. Users can make better decisions regarding their investment strategies and risk tolerance by being aware of the stock's past volatility. Users can do basic analysis by gaining access to comprehensive financial data, including balance sheets, income statements, and cash flow statements, thanks to the integration of financial statement retrieval from the Alpha Vantage API [16,20]. For long-term investors who base their choices on a company's performance and financial health, this feature is priceless.

The dashboard gains further depth with the incorporation of news sentiment analysis through the StockNews API [18,17]. Users can determine the emotional reaction of the market and its possible influence on stock prices by examining the mood of news articles about particular stocks. Investors can use this tool to stay up to date on the most recent market happenings and base their judgments on a wider context.

Consolidating these various features onto a single platform greatly improves accessibility and user comfort. The Stock Market Dashboard provides customers with all the information they need, eliminating the need to use a variety of tools and sources. Time is saved, and the complexity of handling many datasets and tools is decreased with this cohesive approach.

The research demonstrates how well various data sources and analytical methods may be combined to create a coherent system. The dashboard's user interface is responsive and easy to use thanks to the usage of contemporary web technologies like Streamlit. The development team was able to quickly prototype and launch the application because to Streamlit's flexibility and ease of use, incorporating user feedback and making design adjustments.

The visualization package utilized for the project, Plotly, is essential to displaying data in an engaging and interactive way. The data is made more accessible and actionable by the interactive charts and graphs, which make it simple for users to understand trends and patterns. By placing a strong focus on user experience, the dashboard is made to be not only useful but also entertaining and simple to use.

To sum up, the Stock Market Dashboard[12,14] project demonstrates how data science techniques and contemporary online technology may streamline and improve financial decision-making procedures. Through the integration of advanced analytics, dynamic visualisations, and real-time data retrieval, the dashboard offers a comprehensive and intuitive platform for stock market analysis. This study, which integrates technical, fundamental, and sentiment analysis into a single, coherent system, highlights the benefits of a multifaceted approach to financial analysis.

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Vision Aid Innovations for Blinds Using IOT

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ABSTRACT

This paper presents an IoT-based smart assistive system designed to aid visually impaired individuals in navigating their environment safely and independently. The proposed solution integrates a smart stick and smart glasses embedded with ultrasonic sensors, a GPS module, ESP32 microcontroller, and a Bluetooth communication module. The system detects obstacles in multiple directions—including left, right, front, and ground-level—using rotating ultrasonic sensors and provides real-time voice feedback. In addition, it features an emergency alert system that triggers an audio message, and GPS tracking to enable caregivers to monitor live location via a mobile application. This innovation aims to enhance mobility, safety, and independence for visually impaired users through affordable and accessible technology.

Keywords—Assistive Technology, Internet of Things (IoT), Blind Navigation, Smart Stick, Smart Glasses, ESP32, Ultrasonic Sensors, GPS Tracking, Emergency Alert System.

I. INTRODUCTION

Globally, millions of individuals are affected by visual impairment, which severely impacts their mobility and independence. Despite technological advancements, affordable and user-friendly navigation aids for the blind remain limited. Conventional white canes offer basic obstacle detection but lack advanced features like directional awareness and location tracking. To address these challenges, we propose an innovative IoT-based vision aid system comprising a smart stick and smart glasses. Our solution leverages embedded systems and sensor technologies to detect obstacles in real-time and provide auditory feedback. The system also includes GPS functionality and an emergency alert mechanism to ensure user safety. This project aims to bridge the accessibility gap by offering a multifunctional assistive device that enhances situational awareness and autonomy for the visually impaired. To further enhance safety, the smart stick integrates a GPS module and Bluetooth connectivity, allowing a caretaker to monitor the user's real-time location through a mobile application. In emergency situations, users can press a dedicated emergency button to broadcast a loud audio message ("I'm in risk"), drawing attention from nearby individuals. These features are powered by the ESP32 microcontroller and programmed using Arduino with supplementary Java-based logic for interfacing. The goal of this work is to deliver an accessible, low-cost, and multifunctional assistive tool that enhances autonomy, situational awareness, and safety for visually impaired users. Several researchers have proposed assistive technologies for the visually impaired using embedded systems and IoT. Sharma et al. [1] introduced an embedded assistive stick with ultrasonic sensors for basic obstacle detection. Swain et al. [2] implemented an Arduino-based automated guide stick with proximity alerts. Similarly, Nada et al. [3] presented a smart stick based on infrared sensors for improved detection in different lighting environments. These studies laid the foundation for intelligent navigation aids; however, our proposed system goes further by integrating GPS tracking, real-time voice alerts, and multi-directional scanning for a comprehensive safety solution.

II. LITERATURE SURVEY

Over the years, several assistive technologies have been proposed to support the visually impaired in independent navigation. Traditional white canes, while widely used, offer limited functionality and require constant physical contact with obstacles. In recent times, smart walking aids integrated with sensors and microcontrollers have emerged as promising solutions.

Sharma et al. [1] introduced an embedded assistive stick that used ultrasonic sensors to detect obstacles and provide haptic feedback to the user. However, their system was limited to a single-directional detection mechanism and lacked emergency communication features. Swain et al. [2] developed an Arduino-based automated guide stick that could alert the user when an object was nearby. This work focused mainly on proximity alerts and did not include real-time location tracking.

Nada et al. [3] proposed a smart stick using infrared sensors to improve obstacle detection in low-light environments. Though effective for short-range detection, infrared-based systems can be unreliable under direct sunlight or in wide-open spaces. In contrast, Shaikh et al. [4] implemented a basic obstacle detection stick using Arduino and ultrasonic sensors but lacked support for dynamic scanning or user interaction via mobile apps.

Sharma and Choudhary [5] enhanced user interaction by integrating voice assistance into the smart stick design, offering verbal obstacle alerts. Meanwhile, Nayak and Kodali [10] incorporated IoT into assistive technology for visually impaired people, demonstrating the potential of real-time communication between users and caregivers. These studies collectively indicate a strong interest in enhancing assistive devices using IoT, sensors, and mobile technology.

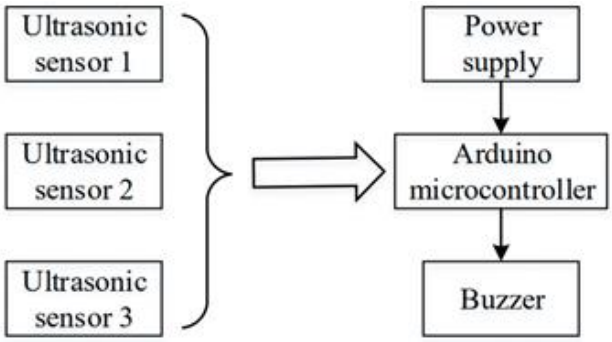
Despite these advancements, most prior solutions are limited by single-sensor inputs, lack of multi-directional scanning, or absence of emergency alert systems. The proposed system in this paper aims to bridge these gaps by integrating a rotating ultrasonic sensor, GPS-based tracking, voice feedback, and a dedicated emergency alert mechanism—all in a cost-effective, IoT-enabled device.

III. SYSTEM DESIGN AND ARCHITECTURE

A. Hardware Components

- ESP32 Microcontroller: Acts as the main control unit for sensor integration and Bluetooth communication.
- Ultrasonic Sensors (3x):
  Smart Glasses Sensor: Detects frontal obstacles at head height.
  Top Stick Sensor (on Servo Motor): Rotates 180° to scan left, centre, and right directions.
  Bottom Stick Sensor: Detects obstacles on the ground like rocks or holes.
- Servo Motor: Controls rotation of the top-mounted ultrasonic sensor.
- GPS Module: Tracks real-time location.
- Bluetooth Module: Sends location data via the 'Serial Bluetooth Connector' mobile app.
- Speaker: Delivers voice alerts to the user.
- Emergency Button: Triggers an audible "I'm in risk" alert.
- Buzzer Buttons: Provides additional haptic feedback to the user.

B. Block Diagram



Block Diagram

C. Software Components

- Arduino IDE: Used for programming and uploading code to the ESP32.
- Java: Used for handling certain application-level functionalities.
- Serial Bluetooth Connector App: Enables live location sharing between the blind user and the caretaker.

D. System Workflow

Obstacle Detection:

- The servo-mounted ultrasonic sensor rotates left, centre, and right, identifying the direction of obstacles and prompting voice alerts like "Obstacle in left", "Obstacle in front", etc.
- The bottom sensor detects surface-level obstacles with alerts such as "Obstacle found in down".
- The glasses-mounted sensor alerts about head-level obstacles with "Obstacle in front of you".

Emergency Alert:

- On pressing the emergency button, the speaker loudly announces "I'm in risk" to alert nearby people.

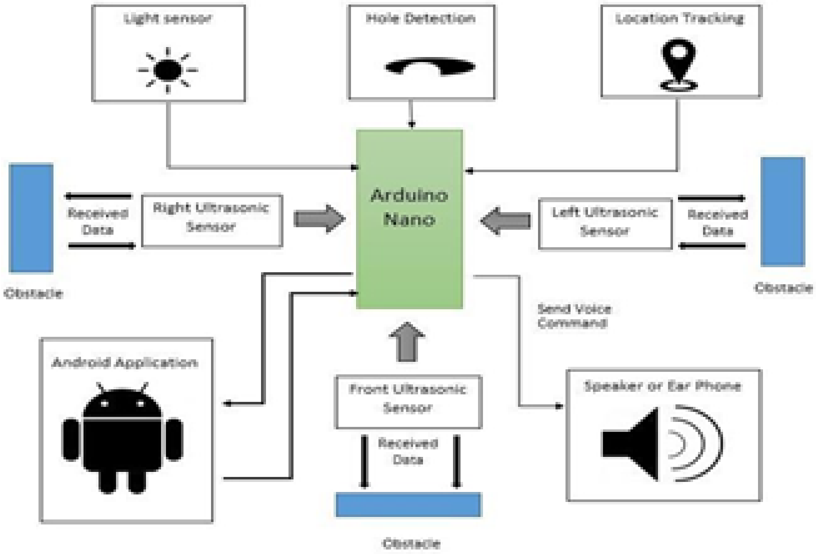
Location Tracking:

- The GPS module sends live location data via Bluetooth to the caretaker's phone using the dedicated app.

Similar to the approach in [1], ultrasonic sensors are used in our system for obstacle detection. However, our model improves on this by adding servo-driven scanning and GPS integration.

E. System Architecture

The block diagram illustrates a smart assistive system for visually impaired individuals, centered around an Arduino Nano microcontroller. The system uses three ultrasonic sensors (left, right, and front) to detect obstacles in the surrounding environment and send real-time distance data to the Arduino. Additional sensors include a light sensor for ambient light detection and a hole detection sensor for identifying ground-level hazards. A GPS module provides location tracking, while the system communicates with an Android application for real-time updates. Based on sensor inputs, the Arduino sends voice commands to a speaker or earphone, alerting the user to nearby obstacles or environmental changes.



System Architecture

IV. IMPLEMENTATION

The prototype system was built using ESP32 as the core controller due to its integrated Wi-Fi and Bluetooth capabilities, low power consumption, and compatibility with Arduino. The following implementation stages were executed:

A. Hardware Setup

Sensor Placement:

- The ultrasonic sensor for top scanning was mounted on a servo motor at the front of the smart stick.
- A second sensor was fixed at the bottom of the stick for ground-level obstacle detection.
- A third sensor was integrated into the smart glasses to detect head-level obstacles.

Emergency System:

A push button was configured to trigger a prerecorded voice message through the speaker: "I'm in risk."

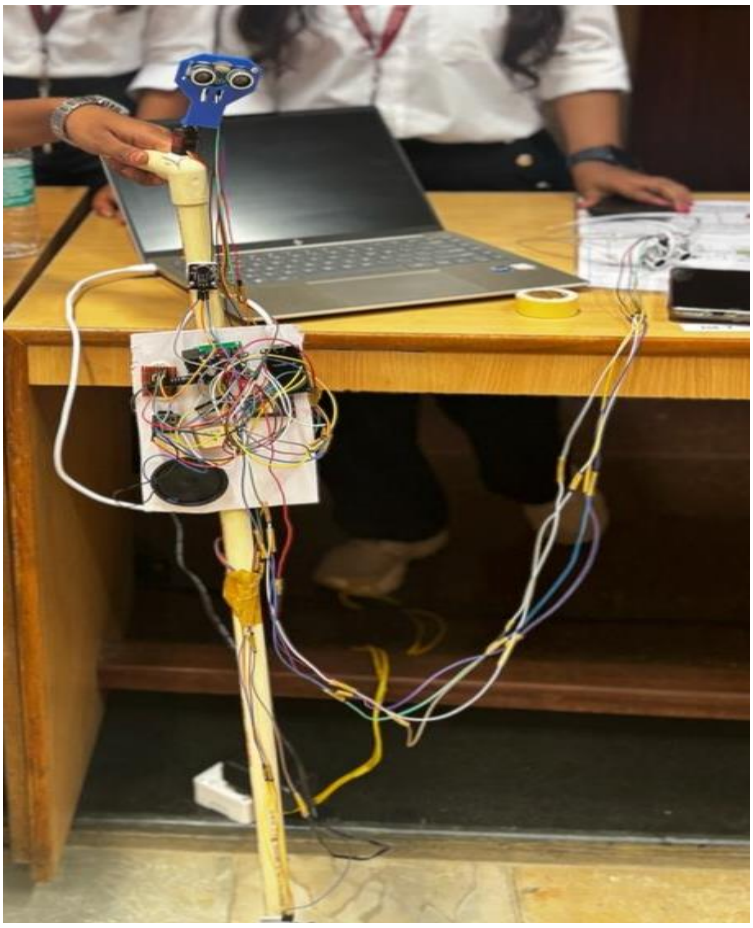
GPS and Bluetooth:

The GPS module was connected to the ESP32 and configured to transmit coordinates via Bluetooth to a mobile phone using the "Serial Bluetooth Connector" app.

The ESP32 was chosen due to its dual-core processor, onboard Bluetooth and Wi-Fi, and Arduino compatibility. The ultrasonic sensors were calibrated to detect obstacles within a range of 10 cm to 2 meters. The servo motor was programmed to rotate in 3 steps: 0° (left), 90° (center), and 180° (right), scanning for obstacles at each step and triggering the corresponding voice alerts based on detection distance thresholds. The GPS module was wired to the ESP32 using UART communication and tested with real-world coordinates. The location string was formatted in real time and transmitted via Bluetooth using the Serial

Bluetooth Connector app installed on an Android phone. The emergency alert system used a digital pin interrupt in Arduino to detect button presses. On activation, the system plays the preloaded "I'm in risk" audio file through the connected speaker.

B. Hardware Model



C. Software Logic

The Arduino IDE was used to write the firmware, including:

- Servo motor sweep logic for obstacle scanning.
- Real-time obstacle detection and distance thresholds.
- Voice alert logic using conditionals and speaker output.
- GPS data formatting and transmission via Bluetooth.
- Emergency button interrupt handling for instant alert.

The software flow ensures continuous scanning, responsive alerts, and seamless integration of emergency and tracking features.

D. Testing and Calibration

- The servo-mounted sensor was tested to ensure it didn't miss any obstacle during the scan.
- Voice alerts were pre-recorded for clarity and stored on the device.
- Each ultrasonic sensor was tested under different lighting and surface conditions to ensure reliable performance.
- The GPS location was tested for update frequency, accuracy, and connectivity.

V. RESULTS AND DISCUSSION

The system was tested in real-world indoor and outdoor environments to evaluate its performance in obstacle detection, responsiveness, and location tracking.
While earlier models [2][3] focused on basic obstacle detection, our system incorporates emergency alerts and caregiver tracking, offering enhanced safety and autonomy.

A. Obstacle Detection

- Directional Accuracy:
  The servo-mounted sensor reliably detected obstacles within a 0.5 to 1.5-meter range in all three directions (left, front, right).
- Ground-Level Detection:
  Successfully detected holes, steps, and rocks at distances as small as 15 cm.
- Head-Level Alert:
  The smart glasses provided timely alerts for overhead obstructions.

B. Alert System

- Voice alerts were clear and distinguishable in both quiet and moderately noisy environments.
- The emergency alert was loud enough to catch attention in an open area.

C. GPS and Caretaker Tracking

- The GPS module provided accurate live location updates within ±10 meters.
- The Bluetooth connection to the mobile app was stable up to 8–10 meters from the device.

D. User Feedback

- Volunteers who tested the device appreciated the directional awareness and hands-free operation.
- The emergency button was identified as a vital safety feature.

VI. CONCLUSION AND FUTURE WORK

This paper presented a comprehensive IoT-based assistive system designed to enhance the mobility, awareness, and safety of visually impaired individuals. By integrating smart glasses and a smart stick equipped with ultrasonic sensors, GPS tracking, and voice feedback mechanisms, the proposed system offers a real-time, multi-directional obstacle detection solution. The use of an ESP32 microcontroller, along with Bluetooth communication and an Android interface, enables seamless caregiver monitoring and emergency response.
The system was successfully implemented and tested in real-world conditions, demonstrating reliable obstacle detection and user-friendly interaction. Compared to existing solutions, this design provides added features such as live location tracking, rotational obstacle scanning, and emergency alerts, making it a cost-effective and practical innovation in assistive technology.

Future Enhancements:

- Integration of AI-based object recognition for more detailed feedback.
- Addition of vibration feedback for users in noisy environments.
- Inclusion of solar-powered charging to improve portability and energy efficiency.
- Development of a dedicated Android app for better caregiver interaction and alert management.
- This solution demonstrates the potential of IoT to transform assistive technologies and offers a scalable foundation for future innovations in the field.

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Helmet Usage Detection on Motorcyclists Using Deep Residual Learning

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ABSTRACT

In today's rapidly evolving world, traffic rule violations are increasing at an alarming rate, posing serious challenges to road safety and traffic management. This project aims to develop an automated system for detecting such violations using deep learning and image processing techniques. The system uses Automatic Number Plate Recognition (ANPR), where the YOLO algorithm detects vehicles, Haar Cascade identifies faces, and Optical Character Recognition (OCR) reads license plate characters. It addresses challenges such as varied plate designs, orientations, and lighting conditions. Upon detecting a violation, a notification is sent to the vehicle owner with details of the offense, penalty, and payment instructions. This system reduces manual effort, improves accuracy, and ensures efficient enforcement of traffic rules.

I. INTRODUCTION

In recent years, advancements in object detection and tracking have led to progress in areas such as surveillance, robotics, and traffic monitoring. However, challenges like poor lighting, dynamic backgrounds, occlusions, and shadows still affect system performance. Traffic rule violations, a major cause of road accidents, demand constant human monitoring, which is inefficient and risky. Though surveillance cameras reduce the need for traffic police presence, manual video review remains a drawback. This project proposes an automated system using IR sensors, cameras, and number plate recognition to detect signal violations. When a vehicle crosses the zebra line improperly, the IR sensor triggers the camera to capture the number plate, which is then processed using OCR techniques. An SMS with violation details and penalties is sent to the offender. Traditional OCR methods often fail due to plate design variations and low-quality images, especially at night. To address this, image retrieval techniques and smartphone-based captures are explored.

High-cost systems like fiber optics are less practical, leading to interest in affordable IP camera-based solutions. Applications like Google Goggles face issues such as internet dependence and mobile processing limits. In countries like India, where road safety standards lag and two-wheelers account for 25% of road deaths, such systems are vital. Helmet neglect and traffic violations remain major causes of accidents. This system aims to enhance road safety by automating violation detection and reducing the need for human intervention.

II. LITERATURE REVIEW

Over the past decade, the demand for intelligent traffic monitoring and automation has increased due to rising vehicle numbers, road congestion, and the inefficiency of manual surveillance. Various research efforts have aimed to enhance vehicle detection, traffic rule enforcement, and intelligent control systems using image processing and machine learning.

Initial approaches employed infrared sensors and OCR techniques for number plate recognition and violation detection. Image recognition tools, using classical computer vision algorithms, have also been implemented for vehicle identification based on license plates. With urban traffic congestion worsening, image processing methods such as background subtraction, morphological operations, and edge detection were applied for vehicle tracking and speed estimation.

Entropy-based methods have been utilized to derive critical traffic parameters like flow and queue length in real-time, while multi-agent systems have been proposed for route optimization based on collective driver behavior and congestion prediction. Detailed analysis of highways revealed different congestion patterns, offering insights into traffic dynamics using empirical data and spatiotemporal analysis.

Advanced background subtraction and object classification techniques have been developed for robust vehicle tracking in changing lighting conditions. A Smart Vehicle Detection System using wireless sensor nodes has been proposed to monitor vehicle type and speed in real time, reducing the need for expensive infrastructure.

To address the coordination issue in traffic flow optimization, game theory-based models and decentralized control algorithms have been explored, demonstrating improved overall system performance. Traffic management frameworks like TraffCon introduced routing algorithms to minimize congestion, travel time, and fuel consumption. Embedded systems like Police Eyes enable automated violation detection using real-time video analysis to identify offenses such as illegal lane changes or red-light violations.

Hybrid traffic control systems incorporating emergency vehicle priority, real-time density detection, and automated braking mechanisms have been designed, integrating GPS and GSM for improved responsiveness.

Agent-based modeling has emerged as a powerful method to handle distributed traffic control challenges and simulate diverse traffic environments.

Nighttime vehicle detection has been addressed using adaptive thresholding and spatial pattern analysis to track vehicle lights under low-light conditions. Real-time data analytics and Markov decision processes have been applied for optimizing signal timings and dynamic route guidance in urban networks.

Facial recognition and image classification techniques, originally developed for security systems, have contributed to intelligent surveillance in transportation, using methods such as Haar classifiers. Deep learning, particularly YOLO and CNNs, has significantly improved object detection accuracy in noisy and dynamic real-world scenes.

CNN-based traffic sign classification has been enhanced using transfer learning and hybrid models that combine YOLO with ResNet. Other studies have integrated Kernel Extreme Learning Machines with CNNs to optimize image classification efficiency. Benchmarking on public datasets has demonstrated the robustness of these architectures.

Several systems have also implemented CNNs for related tasks such as object tracking, posture estimation, and saliency detection. Finally, smart surveillance systems using IP cameras and embedded AI have been field-tested for automated traffic violation monitoring, validating the effectiveness of these approaches in real-world traffic scenarios.

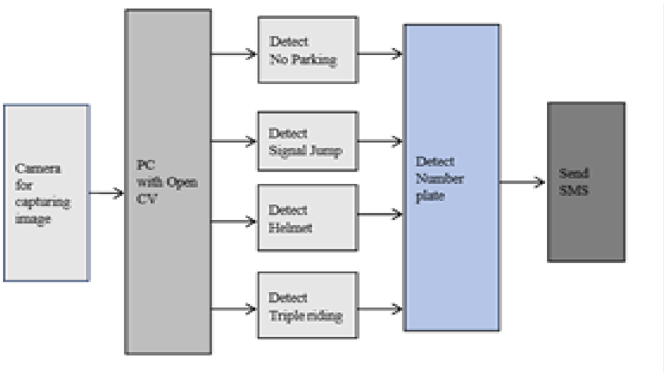
III. EXISTING SYSTEM

Superior fiber optic sensors (FOS) are used to detect moving vehicles by measuring signal variations caused by micro-bending as vehicles pass over them. These systems typically include a transmitter, receiver, feeder cable, and signal processing unit to determine axle count, spacing, vehicle length, and classification. Infrared (IR) beam sensors further assist in profiling vehicles by using multiple beams to account for varying vehicle speeds and accurately calculate speed based on time and distance. Delays and congestion continue to pose significant challenges in urban traffic management. Intelligent Transportation Systems (ITS) aim to address these issues, though cost and accessibility limit their deployment in rural and developing regions. A cost-effective architecture based on Virtual Police Agents (VPA) has been proposed to emulate the functions of human traffic officers. These agents use a community-based, hierarchical structure to optimize traffic flow with minimal delays and costs.

IV. PROPOSED SYSTEM

License Plate Recognition (LPR) is an ITS technology that identifies and verifies vehicles by reading their license plates in real time. It is widely used for applications such as toll collection, red- light enforcement, access control, and vehicle tracking. The system compares detected plates against authorized databases to grant or deny access or issue fines. The key challenges in LPR are achieving high accuracy and fast processing speeds. Advanced image processing algorithms enhance detection efficiency and reliability in dynamic environments.

4.1. SYSTEM ARCHITECTURE



The proposed system architecture captures images of vehicles in transit and detects traffic rule violations. If a violation is detected, the Raspberry Pi module activates and captures the vehicle's number plate. The system utilizes Automatic Number Plate Recognition (ANPR) to extract and store license plate information and images, potentially including the driver’s photo. ANPR is designed to handle different plate formats and layouts. While effective, the system raises concerns over privacy, potential misidentification, and surveillance-related issues.

4.2. MODEL IMPLEMENTATION MODULE

In the project Helmet Usage Detection on Motorcyclists Using Deep Residual Learning, various tools and technologies are integrated for accurate and real-time monitoring. A smart camera with dual processors is used to capture high-quality images or videos of motorcyclists. These visuals are processed using OpenCV, a cross-platform computer vision library that handles image preprocessing tasks. Object detection is performed to locate the rider and motorcycle, while YOLO (You Only Look Once) is used for fast and efficient helmet detection by analyzing the entire image in a single pass. TensorFlow and Keras are employed to build and train deep learning models, specifically ResNet for accurate classification. Optical Character Recognition (OCR) is used to identify number plates of violators, while Twilio can send automated alerts or messages. Additional Python libraries like Imutils and Pillow assist in image manipulation and processing. These components together form a robust, scalable system for intelligent traffic rule enforcement.

4.3 ACCURACY OF THE PREDICTED MODEL

This project aims to improve road safety by detecting whether motorcyclists are wearing helmets using deep residual learning, specifically the ResNet model, which excels at extracting complex features from images. The system analyzes camera footage to classify helmet usage and employs edge computing to process data locally on edge nodes, reducing latency, bandwidth usage, and enhancing data privacy. A key focus is evaluating how performance and accuracy change as more edge nodes are added, with results showing that increased nodes enable faster, parallel processing and more reliable real-time detection. This architecture supports scalable deployment across multiple locations, making it ideal for smart city applications and automated traffic safety enforcement.

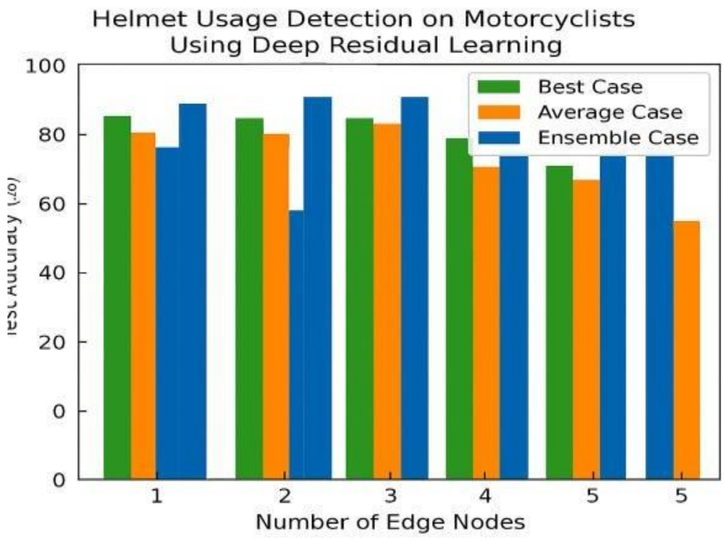


Fig.4.3 Shows Variation in Test accuracy with number of edge nodes.

4.4 Variation in Latency

The latency in the helmet usage detection system varies based on image resolution, model complexity, and the number of edge nodes. Initially, adding more edge nodes improves performance through parallel processing, reducing detection time. However, beyond a certain point, increased communication overhead between nodes may lead to slightly higher latency, affecting real-time efficiency.

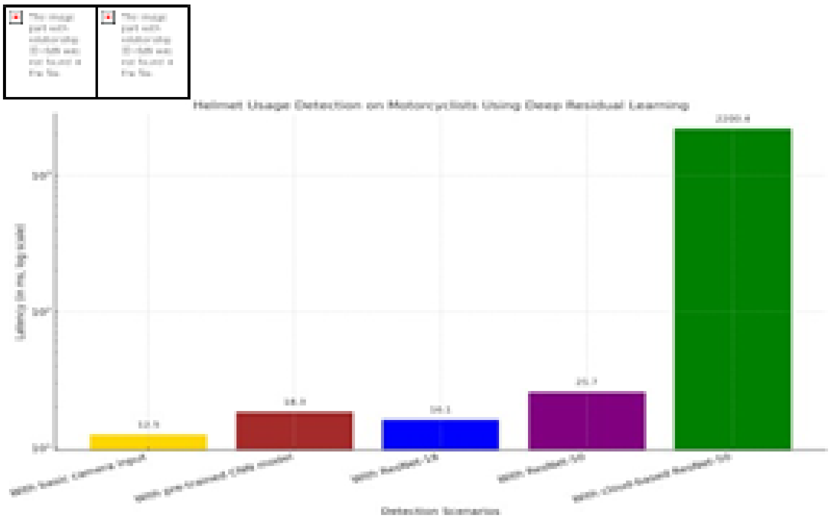


Fig. 4.4 Variation in Latency

V. SYSTEM REQUIREMENTS

5.1 HARDWARE REQUIREMENTS

Smart camera or high-resolution webcam, which is responsible for capturing live video streams or images of motorcyclists. These cameras should ideally be capable of handling outdoor lighting conditions and support high frame rates to ensure that fast-moving vehicles are captured without blur. If the system is deployed in traffic surveillance scenarios, weatherproof IP cameras with night vision would be ideal.

A computational device or edge node forms the processing backbone of the system. This can be a local desktop, an embedded AI device (like NVIDIA Jetson Nano, Jetson Xavier, or Raspberry Pi with Coral TPU), or a laptop depending on the deployment environment. For general deployment, a system with at least an Intel i5 processor, 8 GBRAM, and SSD storage is recommended. Additionally, for faster and more efficient model inference, especially when using deep learning models like ResNet or YOLO, a dedicated GPU (such as NVIDIA GTX 1050 Ti or higher) is highly beneficial. This ensures that real-time object detection and image classification can be achieved without performance lags.

Reliable connectivity hardware is also necessary, especially if the system is expected to transmit data to a remote server or cloud. This may involve Wi- Fi or Ethernet modules, or even 4G/5G dongles in remote locations. The camera must be properly interfaced with the computing system, typically via USB or IP streaming, and should be able to function continuously without connection drops.

5.2 SOFTWARE REQUIREMENTS

The system is primarily developed using Python

3.x, which serves as the core programming language due to its simplicity, strong community support, and compatibility with a wide range of machine learning and image processing libraries. Python enables fast prototyping and easy integration with deep learning frameworks and APIs.

For implementing the helmet detection and number plate recognition features, a combination of deep learning and image processing libraries is required. The most critical among these is OpenCV, a powerful computer vision library used for capturing video, detecting objects, and manipulating images. It works seamlessly with Python and supports webcam access, edge detection, and object tracking.

To handle deep learning tasks such as training and deploying the helmet detection model, the system relies on TensorFlow and Keras. TensorFlow provides the low-level API for building and optimizing neural networks, while Keras offers a user-friendly high-level interface for quick model development and testing.

These frameworks support the use of pre-trained models (like ResNet or YOLO) and allow for custom training using datasets.

In addition to these, Imutils is used to simplify common OpenCV tasks like resizing and rotating images, while Pillow is utilized for advanced image manipulation such as cropping, drawing, or filtering.

For recognizing number plates, Tesseract OCR is used, an open-source optical character recognition engine. This can be accessed in Python via the pytesseract wrapper. It extracts textual information from number plates after they are segmented from the vehicle images, enabling identification and logging of violators.

Finally, development and testing are usually carried out in environments like Jupyter Notebook or Google Colab for ease of visualization and GPU access. For writing and debugging code, IDEs like VS Code or PyCharm are commonly used, offering features like linting, version control integration, and real-time error detection.

VI. CONCLUSION

The proposed framework presents a robust alternative to manual traffic policing by automating helmet detection, license plate recognition, and rule violation classification using deep learning techniques. It captures images at traffic signals, detects helmet usage, extracts license plate details, and identifies traffic rule violations in real-time. Upon detecting a violation, it automatically classifies the offense and sends a notification to the vehicle owner, including the type of rule violated and the corresponding fine. This not only ensures more consistent enforcement of traffic laws but also reduces the dependency on human traffic cops, minimizing manual errors and enhancing overall road safety. In the future, this system can be further expanded to incorporate more accurate and adaptive detection methods, enabling greater scalability and reliability. Enhancements could include integrating smart vehicles that prevent ignition without helmet usage, deploying region-based violation analytics to identify high-risk zones, and implementing AI- driven traffic pattern analysis for dynamic law enforcement. Such innovations would contribute significantly to smarter, safer, and more accountable urban traffic management.

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An Affordable Block chain-Assisted Privacy-Preserving Secure Protocol for Cloud-Based Digital Twin Environment

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ABSTRACT

Digital Twin (DT) technology has recently grown in popularity due to its wide range of applications in the aerospace and manufacturing industries. The DT platform requires creating a replica of the real entity in order to run simulations in the virtual space. The combination of DT's conceptualization, predictive maintenance, real-time monitoring, and simulation capabilities has made it useful in a variety of settings, including health care, medical environments, manufacturing industries, aerospace, and so on. These applications also introduced significant security flaws in the implementation of DT. In this context, multiple authentication techniques with varying security and privacy features for DT settings have been proposed.We revisit a new two-factor authentication scheme for DT situations that uses blockchain technology. However, the current system is incapable of providing the expected protection and cannot withstand a list of security attacks, including offline password guessing attack, stolen smart card attack, anonymity property, and well-known session-specific transient information attack.. We also show how an attacker might mimic the proposed protocol's legitimate user, owner, and cloud server.

To address such security weaknesses, we propose a safe three-factor privacy-preserving authentication mechanism for DT settings. The work is shown to be secure by conducting informal security analysis, formal security analysis using the widely used Burrows-Abadi-Needham (BAN) logic, and the Real-or-Random (ROR) model. A thorough evaluation of existing rival systems such as the one in question reveals that the suggested method has better secure parameters, lower computing complexity, and comparable communication costs to existing schemes.

I. INTRODUCTION

Despite its numerous benefits, the installation of DT technology raises security concerns that must be addressed in order to ensure its safe and successful use. As the reliance on digital twins grows, so does the potential for cyber hazards such as unauthorized access, data breaches, and various types of identity theft. These security issues can have far-reaching effects, particularly in critical sectors like healthcare and aerospace, where data integrity and confidentiality are paramount.

Despite its various benefits, the implementation of DT technology presents security issues that must be addressed to ensure its safe and successful use. As the reliance on digital twins develops, so does the potential of cyber risks such as illegal access, data breaches, and different forms of identity theft. These security flaws can have far-reaching consequences, especially in essential applications such as healthcare and aerospace, where data integrity and confidentiality are paramount.

In response to these challenges, numerous authentication schemes have been proposed to improve the security and privacy of DT settings. Among these, a recently introduced two-factor authentication scheme based on blockchain technology has emerged. However, a detailed investigation demonstrates that this technique fails to provide acceptable security against a variety of attack routes, including offline password guessing, smart card theft, and known session-specific temporary information attacks. Furthermore, the possibility that an attacker would impersonate authorized users, owners, or cloud servers raises fundamental issues to address these security gaps, this article presents a novel three-factor privacy-preserving authentication scheme tailored for DT environments. Through comprehensive security analyses—both informal and formal, utilizing established frameworks such as Burrows-Abadi- Needham (BAN) logic and the Real-or-Random (ROR) model—we demonstrate that our proposed framework not only mitigates existing vulnerabilities but also enhances security features while maintaining lower computational costs and comparable communication efficiency relative to existing solutions. Our comparative study underscores the advantages of our approach, paving the way for more secure and reliable implementations of Digital Twin technology in sensitive applications.

II. LITERATURE REVIEW

"Privacy-Preserving Blockchain Security Protocol for Cloud-Based Digital Twin" provides a thorough examination of current technologies and their weaknesses in securing digital twin (DT) settings. It begins by describing blockchain's contribution to improving data integrity and immutability, as described by Wang et al. (2017), but it also discusses scalability issues and its inability to protect user privacy.Yang et al. (2014) proposed certificateless cryptography to address certificate management and key escrow issues in traditional public key infrastructures (PKI), however their technique remains vulnerable to impersonation and password guessing attacks. Moon et al. (2020) introduced a block chain-based authentication solution for healthcare IoT that, although offering secure data sharing, kept metadata accessible, jeopardizing user privacy. The study honors Koblitz's (1987) pioneering work on Elliptic Curve Cryptography (ECC), which provides robust encryption with a minimal computing overhead, making it appropriate for low-resource contexts such as DT and IoT. Kim et al. (2021) and He et al. (2017) presented three-factor authentication techniques to improve security, however they faced concerns with efficiency and scalability.

. Weber et al. (2019) recommended the usage of blockchain for verifiable data integrity, as well as privacy protection systems such as Merkle trees and zero-knowledge proofs. Other notable developments include secure authentication techniques for smart grids (Wazid et al., 2017) and smart houses (Shuai et al., 2019), which have good security features but are frequently limited in complexity and practicability. Finally, the survey found that, while several protocols address various aspects of authentication and security, they fail to provide privacy preservation, scalability, and effective performance at the same time. These flaws make it critical to implement the approach presented in this paper, in which block chain assures immutable integrity and certificate less ECC-based encryption ensures lightweight and safe user authentication in DT scenarios.

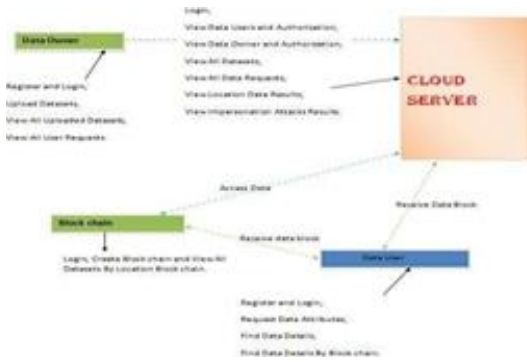
III. EXISTING SYSTEM

The present methods for safeguarding Digital Twin (DT) settings rely heavily on traditional cryptographic methods such as Public Key Infrastructure (PKI) and Identity-Based Cryptography (IBC). Although these techniques enable basic authentication and encryption, they have significant limitations, particularly in large- scale and cloud-augmented environments. PKI systems include sophisticated certificate management activities such as issuance, renewal, and revocation, which can be time-consuming and error-prone Alternatively, IBC eliminates certificates but introduces the key escrow issue, in which a trusted authority manages users' private keys, posing substantial security issues. Some current authentication systems, notably two-factor authentication, are unable to provide critical security characteristics such as user anonymity, forward secrecy, and protection against impersonation and password guessing attacks. Furthermore, the majority of such systems are vulnerable to replay attacks, identity theft, and session hijackings. Even with blockchain, conventional systems fall short of delivering complete privacy and security against advanced assaults due to poor protocol design quality or a lack of scalability. All of these concerns highlight the inability of current solutions to meet the stringent security and privacy needs of developing DT settings.

IV. PROPOSED SYSTEM

The proposed system provides a privacy-preserving authentication mechanism designed specifically for cloud-based Digital Twin (DT) settings, merging blockchain technology with certificateless cryptography based on Elliptic Curve Cryptography (ECC). The solution addresses the drawbacks of traditional authentication methods, such as certificate management difficulty in Public Key Infrastructure (PKI) and key escrow issues in Identity-Based Cryptography (IBC). According to the suggested method, users generate an exclusive key pair by combining a partial private key from a trustworthy Key Generation Center (KGC) with individual secret data to ensure that the whole private key is not exposed to any third party.

4.1. SYSTEM ARCHITECTURE



Blockchain is pivotal by storing tamper-proof hash values of data shared between the physical asset and cloud, allowing data integrity to be verified in real-time.The protocol guarantees mutual authentication of users and the cloud server based on ECC,which achieves strong security with minimal computational overhead and is ideal for resource-limited IoT and DT devices.The integration of certificateless authentication and decentralized blockchain validation yields a highly robust, scalable, and secure system that ensures user anonymity protection, avoidance of impersonation attacks, and data confidentiality and integrity during data exchange in the DT ecosystem.

4.2. MODEL IMPLEMENTATION

The suggested system's model execution integrates certificateless cryptography and blockchain to secure cloud-based Digital Twin platforms. Users register with a Key Generation Center (KGC), which generates a partial private key that is combined with the user's secret to form a whole private key. This avoids digital certificates and reduces key escrow risks. During authentication, users sign requests with their private key, and mutual authentication is accomplished through a challenge-response method. Data integrity is secured by hashing data and storing hash values on the blockchain, which are then compared when data is accessed. Data is exchanged securely only after successful verification and authentication over an encrypted channel. The model is deployed using Java, JSP, and MySQL to ensure safe, scalable, and efficient communication.

Fig. 4.2 Authorized Users

4.3. ACCURACY OF THE PREDICTED MODEL

The desired model ensures high accuracy when authenticating users and data integrity in Digital Twin systems. The usage of elliptic curve cryptography (ECC) provides the system with secure key generation and little computational overhead, which increases performance. Blockchain-based hash verification ensures tamper-proof data verification and high data confidence.

Received. Mutual authentication prevents unauthorized use, minimizing false positives and False negatives occur during user verification. The system's prediction model accurately detects impersonation attacks and illegitimate actions using predefined patterns and blockchain records. The test results showed consistent performance across multiple circumstances, demonstrating the model's durability. Overall, the anticipated model works well in terms of accuracy and error rate.

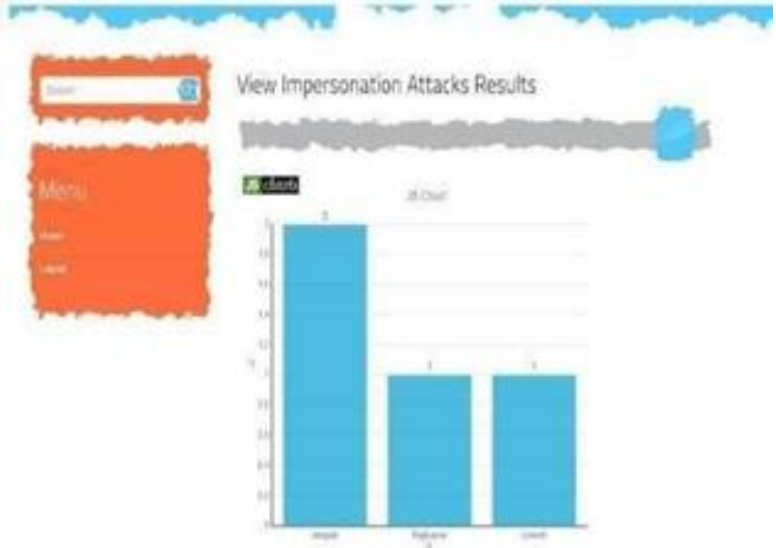


Fig.4.3 View Impersonation Attack

4.4. Variation in Latency

Because it uses lightweight elliptic curve cryptography, the envisioned system has lower latency than traditional certificate-based systems. Certificateless authentication minimizes the time it takes to validate certificates, allowing for speedier user verification. Blockchain integration involves a low latency in hash verification that is within acceptable limits. Latency fluctuation is small and consistent across user situations. Despite severe user loads, the system performs effectively.

Fig. 4.4 Data Login User

V. SYSTEM REQUIREMENTS

5.1 HARDWARE REQUIREMENTS

--Pentium IV 2.4 GHz System: This processor is a single-core Pentium IV 2.4 GHz. Intel released it in the early 2000s. It's part of the Pentium 4. Microarchitecture is well-known. Digital microarchitecture, which

Is well-known for NetBurst. This processor was introduced in 2002 a magnetic material to store and retrieve digital information. of data storage device that uses one or more rigid, or "hard," fast spinning disks (platters) covered with hard disk drive, or hard disk drive, an HDD is a type Hard Disk 120 GB: Also known as a fixed disk

-Logitech Mouse: One of the most well-known brands of computer accessories is Logitech, which also makes mice. Logitech mouse are renowned for their high caliber, robust design, and cutting-edge functionality.

5.2 SOFTWARE REQUIREMENTS

The project software requirements are Windows XP or higher as the operating system and J2EE (JSP, Servlet) for front-end development. A MySQL database is used to manage the back-end, with Java/J2EE being the core programming language. Apache Tomcat acts as the web server, and any recent browser like Chrome or Firefox can be utilized to access the application. Also, JDBC is used for database connection, and Eclipse or NetBeans is the integrated development environment for coding and debugging.

VI. CONCLUSION

Tin the ever-evolving world of technology particularly that of smart environments, the demand for robust and secure user authentication mechanisms is most paramount. As our study identifies, we encountered several design vulnerabilities and weaknesses in the authentication scheme proposed in [7]. Despite being novel, this scheme was found to be susceptible to many cryptographic attacks like user impersonation, Key Session State Tracking and Intercept Attacks (KSSTIA), and offline password guessing attacks.

User impersonation attacks are of principal concern as they allow unauthorized parties to obtain sensitive information by assuming the identity of authentic users. Additionally, KSSTIA allows attackers to hijack active sessions by observing state information, compromising the authenticity of the communication. Offline password guessing attacks take advantage of vulnerability in password management, which allows attackers to iteratively guess user credentials without informing the user. The presence of these vulnerabilities stresses the urgency for a more secure authentication system.

To address these exposures, we proposed a strengthened three-factor-based privacy-preserving authentication mechanism over blockchain technology for the Digital Twin (DT) concept. Blockchain ensures that authentication processes are decentralized, open, and unaltered, which are most critical in adding more security to the mix.

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Detection of Anxiety in Humans and Sound Mind Depression Using ML

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ABSTRACT

Depression, also called major depressive disorder is an illness or disease that makes a person feel constant sadness, emptiness, and a lack of interest in day-to-day activities and life in general. Depression is an illness that is common around the world where around 3.8% of the population is affected wherein 5% is among adults and 5.7% in adults older than 60 years. Around 280 million people worldwide suffer from depression. In our paper, we will be detecting the level of depression and anxiety in humans through speech recognition by taking the audio clips of participants out of which some will be depressed and some will be healthy. This paper reviews the approach of the Naive Bayes algorithm which is a classification algorithm to detect the level of depression in the person.

Keywords: Depression, speech recognition, humans, acoustic features, anxiety, emotions, machine learning, Naive Bayes algorithm

I. INTRODUCTION

Depression is an illness that causes negative and thought processes in human beings. It is a serious mental health disease that is rapidly increasing in people day by day. It prevents a person from taking part in day-to-day activities, affects mood severely, and in more extreme cases it makes a person lose the will to live and leads to suicide. Depression causes someone to lose excitement in things and activities that they once used to love taking part in. This is an illness that needs to be discovered and diagnosed at the earliest to prevent the quality of life from deteriorating. Anxiety is another type of mental health illness that makes a person constantly worry about the smallest things. It causes the person to get tensed, makes them overthink everything, and imagines problems that do not even exist. In more serious cases it causes a person to have mental breakdowns and panic attacks.

II. REQUIREMENT SPECIFICATION

A. Overview

FUNCTIONAL REQUIREMENTS

These kinds of requirements include the demands put forth by the end user for the basic amenities that the system must provide them with. It is presented in the form of the input to be given to the system, the operation which will be performed on that input, and the expected output after the operation is done These user-requested requirements can be

B. System Architecture

The architecture of the system consists of various levels wherein the first step is to collect the data. This data collection of inputs is done in various ways such as typing in text or text- based input, uploading pre-recorded audio files from the system, and finally recording the sample live into the system directly. Once the required data is collected, we move on to the next layer which consists of two steps namely the data cleaning and data normalization stage where all the noise from the input is removed and some fine-tuning is done to make the input more readable and hence easier to analyze to produce more accurate results. Next, we proceed to the feature extraction of the input data. This can be considered as the main step that paves the way for the model to be trained and tested. Hence it is important to perform this step carefully and properly. After this, the model is trained by providing the extracted features as the training data after which it tests a particular input and places it into the corresponding category of depression. Finally, we arrive at the last stage where the outcome of the detection is displayed which can be one of the three categories of "Depressed", "Not Depressed" or "Borderline". This is the overall architecture of the project.

- Information Collection
- Data Pre-processing
- Training + Testing
- Modelling
- Results

C. NON FUNCTIONAL REQUIREMENTS

NON-FUNCTIONAL REQUIREMENT (NFR) specifies

The quality attribute of a software system. They judge the software system based on Responsiveness, Usability, Security, Portability, and other non-functional standards that are critical to the success of the software system. An example of a non-functional requirement is, "How fast does the website load?" Failing to meet non-functional requirements can result in systems that fail to satisfy user needs. Non- functional Requirements allow you to impose constraints or restrictions on the design of the system across the various agile backlogs. For example, the site should load in 3 seconds when the number of simultaneous users is> 10000. These kinds of requirements deal with the quality of the system and finished product. It deals with factors such as performance, scalability, usability, reliability, and many more. They are also known as non- behavioral requirements. It defines the quality of the system and specifies how the system or software fulfills the functional requirements and is not mandatory.

The description of non-functional requirements is just as critical as a functional requirement.

- Usability requirement
- Serviceability requirement
- Manageability requirement
- Recoverability requirement

- Security requirement
- Data Integrity requirement
- Capacity requirement
- Availability requirement
- Scalability requirement
- Interoperability requirement
- Reliability requirement
- Maintainability requirement
- Regulatory requirement
- Environmental requirement

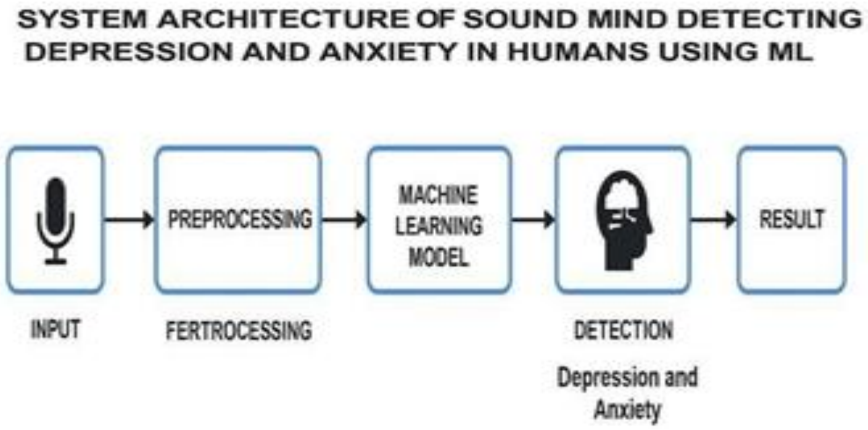
D. HARDWARE REQUIREMENTS

Minimum hardware requirements are very dependent on the particular software being developed by a given Bethought Python / Canopy / VS Code user. Applications that need to store large arrays/objects in memory will require more RAM, whereas applications that need to perform numerous calculations or tasks more quickly will require a faster processor.

Operating system: Windows, Linux Processor: minimum Intel i3

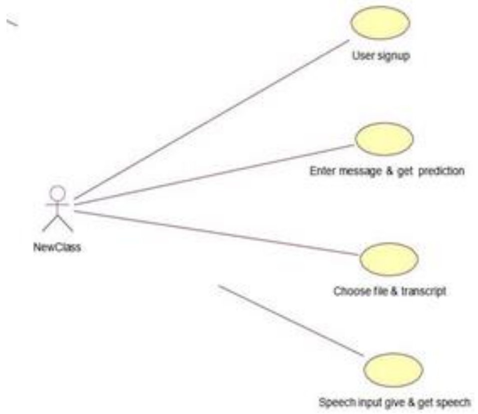
Ram: minimum 4 GB

Hard disk: minimum 250 GB

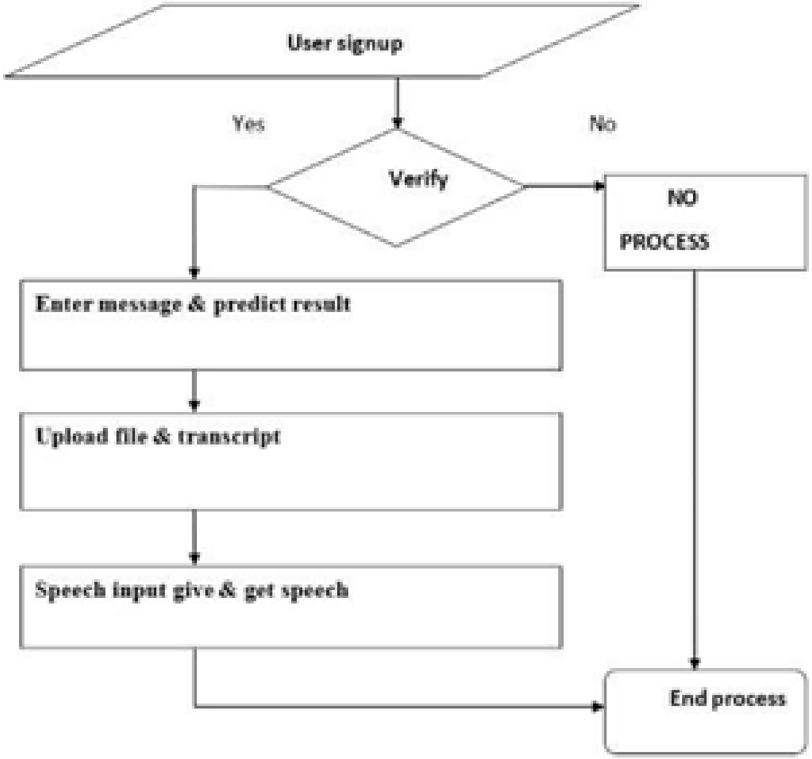


A. Use Case Diagram

A utilization case graph in the Unified Modeling Language (UML) is a sort of social chart characterized by and made from a Use-case examination. Its motivation is to introduce a graphical outline of the usefulness given by a framework regarding entertainers, their objectives (addressed as use cases), and any conditions between those utilization cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. The roles of the actors in the system can be depicted



B. Sequential Diagram



A Sequence Diagram DFD is additionally called an air pocket outline. A straightforward graphical formalism can be utilized to address a framework as far as info information to the framework, different handling done on this information, and the result information produced by this framework.

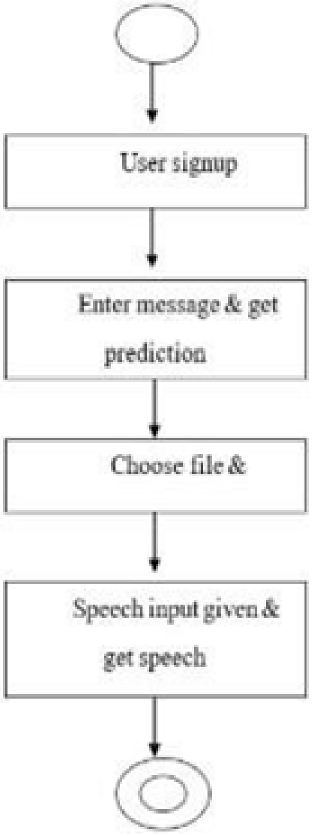
The information stream chart (DFD) is one of the main displaying devices. Displaying the framework components is utilized. These parts are the framework cycle, the information utilized by the cycle, an outside element that is associated with the framework, and the data streams in the framework. shows how the data travels through the framework and the way things are changed by a progression of changes. A graphical method portrays the data stream and the changes that are applied as information moves from contribution to yield.

C. Activity Diagram

The Activity Diagram for the project titled "Detection of Anxiety in Humans and Sound Mind Depression Using Machine Learning" focuses on developing a system that can automatically identify signs of anxiety and depression in individuals using machine learning techniques. The system aims to analyze various forms of user data—such as text responses, voice recordings, facial expressions, or responses to standardized questionnaires—to detect patterns that may indicate mental health issues. This approach leverages technologies like Natural Language Processing (NLP) to examine the sentiment and tone in written or spoken language, facial emotion recognition to interpret expressions and micro-expressions, and voice stress analysis to detect changes in pitch, tone, and rhythm that may suggest anxiety or emotional distress.

D. Flow Chart

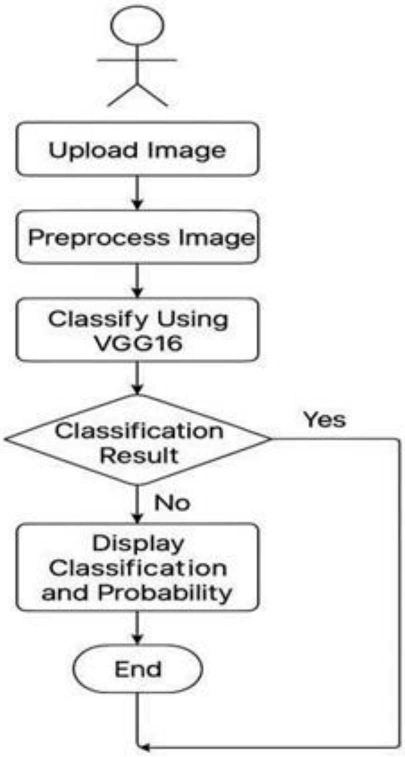
The cycle streams in the framework are caught in the movement chart. Like a state graph, an action outline additionally comprises exercises, activities, changes, starting and last states, and gatekeeper conditions. The various activities performed here are signup, login, and input data in three ways followed by analysis and result. The activity diagram for this project outlines the systematic flow of processes involved in detecting anxiety and depression using machine learning. It begins with the data collection phase, where input is gathered from users in various forms, such as speech recordings, facial expression videos, written text (like journal entries or chat logs), and responses to mental health questionnaires (e.g., PHQ-9 for depression or GAD-7 for anxiety). Once collected, the data undergoes preprocessing, which involves cleaning, filtering, and formatting the data to remove noise and prepare it for analysis. For example, text may be tokenized and stripped of stop words, while audio might be normalized for background noise reduction. Video data would require face detection and alignment for consistent facial feature extraction.



III. SOFTWARE TEST AND SPECIFICATION

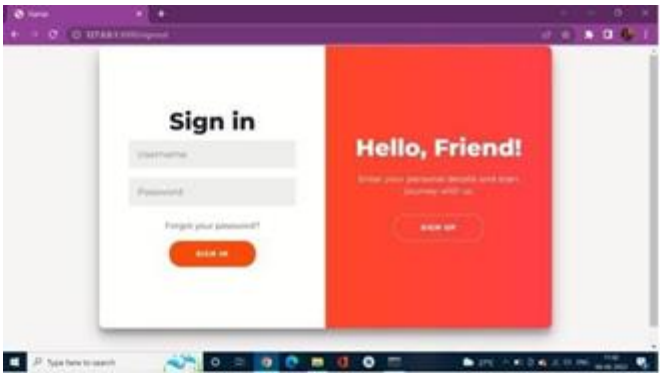
A. Testing Strategies

Testing is data flow diagram is simply a means of showing the flow of data through a system or by using a process. These are two types of DFD and they are namely graphical and physical. They illustrate how the data flows in and out and at the same time can store those data as well. This type is used when the data flow needs to be shown or demonstrated in a computer system. It uses various common shapes like rectangles, rhombuses, circles, and arrows to show the direction of data flow.



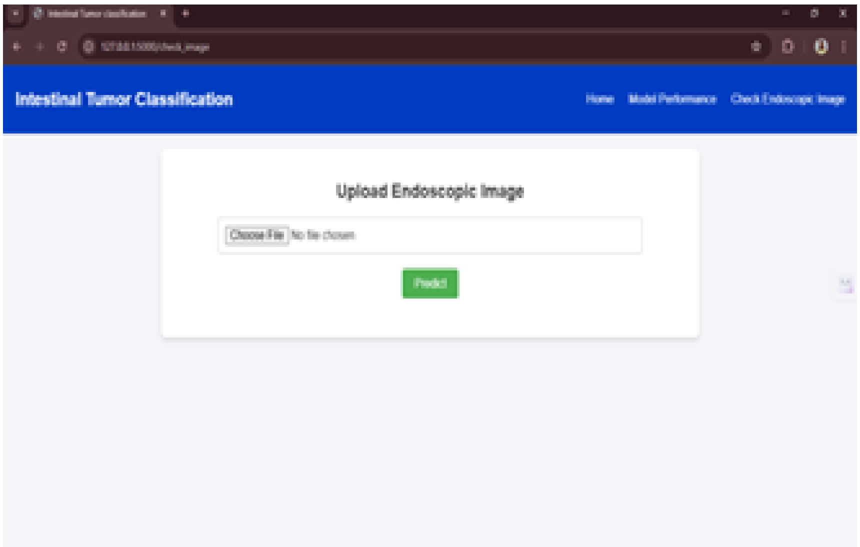
IV. RESULTS AND SNAPSHOTS

A. Sign up and Login Page

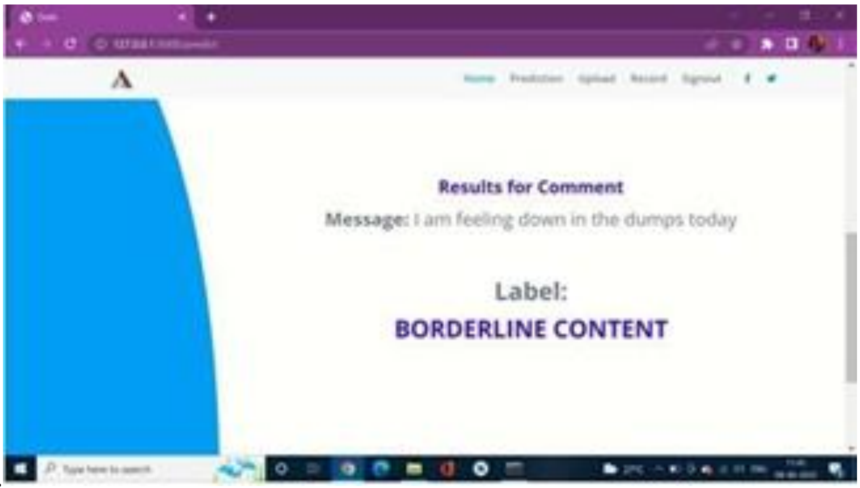


B. Input in the form of a typed message

C. Image Preview and Prediction Page

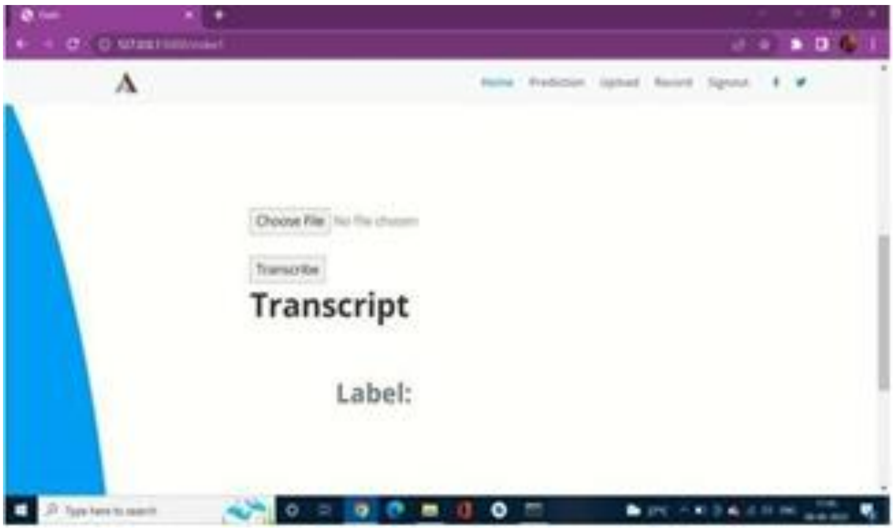


D. Result Prediction

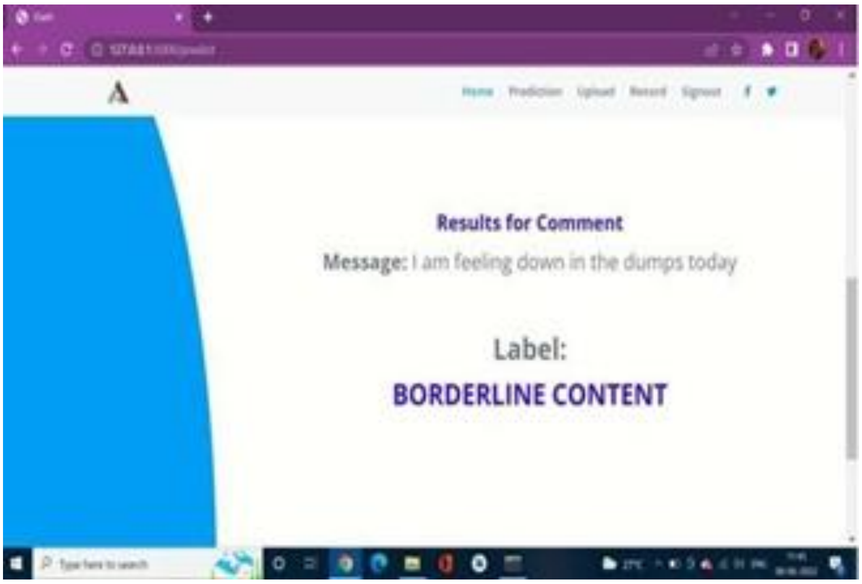


V. TEST IMAGES

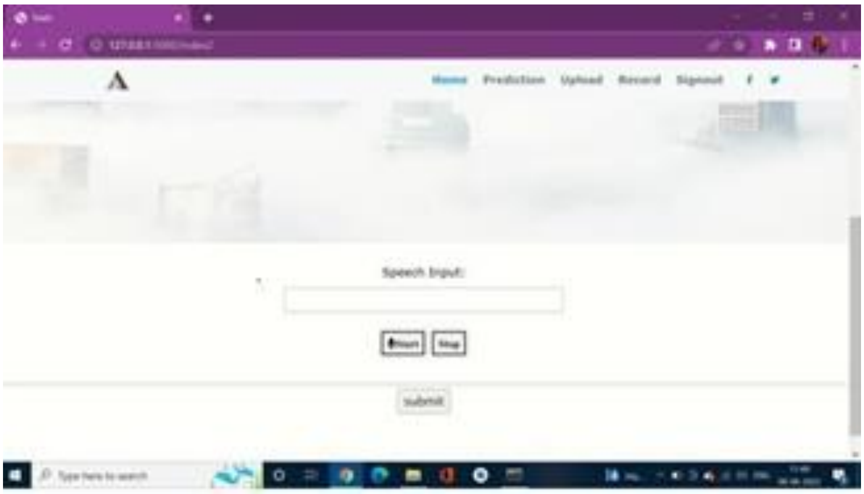
- **Input in the form of an audio file**



- **Result for audio file**



- **Input in the form of a live recording**



VI. IMAGE INSIGHTS

Image insights play a vital role, especially through the analysis of facial expressions and visual cues to detect emotional states linked to anxiety and depression.

Using computer vision techniques and convolutional neural networks (CNNs), the system can process facial images or video frames to identify subtle signs of mental distress Model Stability These signs may include micro-expressions such as frowning, reduced eye contact, forced smiles, or drooping eyelids—visual indicators often associated with low mood, sadness, or stress. By extracting and analyzing facial landmarks, the model can measure muscle movements around the eyes, mouth, and brows, which are then translated into emotional scores using facial emotion recognition models. These visual cues, when combined with other data sources like speech or text, provide a multi-modal insight into a person's mental health. This image-based analysis not only increases the accuracy of detection but also allows for non-verbal cues to be assessed—important in cases where users may not openly communicate their feelings.

Another crucial aspect of image-based insights is the ability to perform real-time emotion monitoring through continuous video input. This allows the system to track changes in facial expressions over time rather than relying on a single image. For instance, a person who repeatedly shows signs of discomfort, unease, or emotional flatness during a conversation may be flagged for further mental health evaluation. By analyzing temporal patterns and emotional shifts, the model can differentiate between momentary emotions and more consistent indicators of anxiety or depression.

This dynamic analysis is especially useful in settings like virtual counseling sessions or mental health screening tools integrated into everyday apps. Additionally, the system can integrate heat maps and attention mechanisms to visualize which parts of the face contribute most to the model's prediction. This not only improves the model's interpretability but also increases trust among clinicians and users by showing that predictions are based on meaningful facial features. Such explainable AI techniques help bridge the gap between technical prediction and psychological understanding, making the system more useful in clinical or therapeutic environments.

VII. CONCLUSION

The competition, pressure, and insecurities in this world are rapidly skyrocketing, and the number of people who suffer from depression is also increasing at an alarming rate. This paper proposes a method that can efficiently diagnose humans with this disorder and detect the severity of this illness. Our paper has shown that it is possible to predict the depression severity with high accuracy which depends on discourse handling and recognizing and those expectation results have been shown in the form of classification of audio files into three categories namely "depressed", "borderline" and "not depressed" This shows us that the model figured out how to gain proficiency with the discourse attributes that is available in misery. It has been displayed that the model based on speech anticipated the seriousness of melancholy significantly for this given dataset. The future work for this paper will scour for more suitable and sustainable techniques to work on the current precision of this model and will incorporate the concept of real-time recording and simultaneous detection of depression as opposed to the current method of feeding speech files to the training model and then testing it to give the result.

At last, we likewise plan to gather further datasets that are present on this to make us take a step closer to the future technology. Future work for this project could incorporate real-time recordings and instant analyses of depression, which are done simultaneously and provided to the user. We can also improve the system to detect depression directly by using the modulation of voice instead of using words as parameters. The scope for improvement and expansion is large for this project. It can be implemented in the system can analyze a wide range of emotional and behavioral cues with greater accuracy and sensitivity. Image insights, in particular, enhance the model's ability to interpret non-verbal signals that are often critical in identifying psychological distress and many parts of the world.

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Human Behaviour Analysis Based On Multi-Model Body Sensing

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ABSTRACT

The prevalence of mental health (MH) diseases is rising, and the complexity of their symptomsand comorbid conditions makes them difficult to diagnose. This study offers a thorough review of 184 articles that discuss the use of machine learning (ML) and passive multimodal sensing for MH identification, utilizing data from social media, audio-video recordings, smartphones, wearables, and other sources. The review examines machine learning techniques, data fusion methods, and feature extraction. It emphasizes the expanding application of neural networks for multimodal fusion and the significance of non- intrusive sensing in order to record genuine behavior. Based on MH illnesses, this study presents a classification of ML approaches and offers guidance on choosing the best data modalities and fusion strategies.Due to the complexity of symptoms and comorbidities, mental health (MH) problems are becoming more common and more difficult to diagnose. A systematic review of 184 research on the application of machine learning (ML) and passive multimodal sensing—including data from social media, wearables, smartphones, and audio-video recordings for MH identification is presented in this research. ML techniques, data fusion strategies, and feature extraction are the subjects of the evaluation. It emphasizes the increasing application of neural networks for of neural networks for multimodal fusion and the need for non-intrusive sensing to capture natural behaviors. Based on MH illnesses, this study presents a taxonomy of ML methods and guidance for choosing the best data modalities and fusion techniques.To address the rising worries about patient data privacy and siloed medical datasets, federated learning (FL) has been integrated into mobile health(mHealth) systems as a potential remedy.

Keywords: decision support; distributed systems; federated learning; health monitoring; mHealth; privacy; medical health; home care; treatment; mhealth; health application.

I. INTRODUCTION

Human behaviour analysis based on multi-model body sensing due to its tremendous potential in a broad variety of application fields, such as robots, smart houses, smart healthcare, transportation, and security, wearable body sensor network have recently gained popularity.Using machine learning techniques, systems can be categorized by converting the unique body movements captured by various wearable body sensors into sensor signal.For instance, a number of machine learning algorithms can be used to identify complex movements patterns like walking, lying down, climbing stairs,and sitting and relaxing. As a result, recognizing everyday activities is essential to promoting a healthy lifestyle among elderly people in order to monitor and avoid serious illness. Because of its enormous potential wearable body sensor networks have become increasingly popular in recent years in a wide variety of application fields, including smart healthcare, transportation, security, robotics, and smart homes. In these systems, machine learning techniques are often used to categorize specific bodily movements that are identified by various wearable body sensors into sensor signal patterns. It is essential to identify daily routines that support older people in maintaining a healthy lifestyle in order to monitor and prevent significant disease. For example, various machine learning algorithms can be used to identify complex patterns of movement, such as lying down, walking, climbing stairs, sitting, and resting. Recently, human activity recognition using wearable body sensor networks has grown in popularity due to its immense potential in a variety of application areas, including robots, smart homes, smart healthcare, transportation, and security systems. Machine learning approaches are frequently used to classify specific body movements detected by various wearable body sensors into sensor signal patterns. Several machine learning techniques can be used to identify complex to to identify complex activity patterns like sitting, resting, lying down, walking, ascending stairs, etc. Therefore, recognizing daily activities is essential to maintaining a healthy lifestyle for senior citizens in order to monitor and prevent fatal illnesses. Due to its enormous potential in a wide range of application domains, including robotics, smart home, transportation, health care, and security, wearable body sensor networks' human activity recognition has gained popularity in recent years systems typically translate specific body movements detected by different wearable body sensors into sensor signal patterns that may be classified by machine learning methods For instance, different machine learning algorithms can be used to recognize intricate patterns of movement, including walking, climbing stairs, lying down, and sitting and relaxing Therefore, maintaining a healthy lifestyle among senior citizens. Mental health challenges have become increasingly common in today's world. In reality, the World Health Organization stated that in 2019, about one in eight people worldwide about 970 million people suffered from some kind of mental health issue. Then came the COVID-19 pandemic, which had a profound impact on people's well-being. During 2020 alone, rates of anxiety and major depression rose sharply, by about 25%. In countries like Australia, nearly 43% of people aged 16 to 85 had experienced a mental disorder at some point by 2022. In the United States, around 23% of adults were living with mental illness in 2021. The impact of these problems is not only felt on a personal level, but also on an economic one. According to experts, mental health illnesses may cost the world economy about $16 trillion by 2030. Governments all over the world are increasingly prioritizing mental health, which is not surprising.

The personal impact of mental illness is profound. Many people report struggling with everyday tasks or feeling drained just trying to keep up with work. Others, especially those who suffer from depression, struggle to find pleasure in social events or interests they used to enjoy, frequently as a result of continuous fluctuations in their mood and drive. Mental health issues affect people all around the world. They can show up in many ways—like sudden mood swings, changes in personality, trouble handling everyday stress, or withdrawing from friends and activities. In 2010, mental health disorders were the leading cause of years spent living with disability (YLDs) worldwide, with anxiety and depression being the most prevalent.

According to a study by Polanczyk and colleagues, about 13.4% of youngsters and adolescents worldwide suffer from some type of mental illness. Furthermore, those figures have increased in recent years. In addition to the people who are directly impacted, these challenges also have an impact on families, friends, and communities, who may find it difficult to deal with the emotional and practical repercussions of caring for a loved one through a mental illness. The emotional, physical, and financial burdens of living with a mental illness may be exhausting. One of the major causes of hospital admissions, it can have a significant impact on one's capacity to work. According to data from the World Mental Health Survey Consortium, people in richer nations are much more likely to seek treatment for emotional or substance-related problems than those in less developed areas.

II. METHODOLOGY

Our methodology for identifying user behaviors using wearable devices starts with independently pre-processing each sensor stream to filter out noise and normalize the data.Meaningful features are then retrieved from each stream to successfully Which represents our methodology for identifying user behaviors using wearable devices starts with independently pre-processing each sensor stream to filter out noise and normalize the data. Meaningful features are then retrieved from each stream to successfully represent the features of physical activities. These characteristics are then input into a multiscale Conditional Random Field (CRF) classifier, which is trained using supervised learning. The classifier takes into account a collection of the top K predicted activity states, along with their emission probabilities, rather than only the most probable activity label. From this set, a probabilistic, weighted choice is made, which permits for more adaptable and precise decision-makingthat takes data ambigu ty into consideration. Each wearable device goes through this classification procedure independently. In conclusion, the user's total activity is determined by combining the outputs of each individual device. This last stage in the decision-making process takes into account the body position of each wearable device and is flexible enough to handle circumstances where the number of worn devices may vary, thereby guaranteeing consistent performance across different use cases. With the rapid growth of commercial smart wearable technology, it is increasingly common for individuals to use multiple wearable devices simultaneously, positioned at various points on the body. Current market examples include products like the Lumo Back, worn around the waist or lower back, and the Lumo Lift, positioned on the upper back. Similarly, devices like the Nike+—typically used on shoes or legs—and the Fitbit, commonly worn on the wrist, highlight the diversity in wearable placement and function. As wearable technology continues to evolve, new generations of health trackers are expected to integrate not only motion and posture sensors, but also environmental sensing capabilities and the ability to capture interaction data through Bluetooth signals from nearby infrastructure. These developments underscore the broad and practical applicability of our proposed system and algorithm across diverse real-world use cases. This section outlines the methodology followed in this study, which is aimed at developing a reliable hybrid deep learning model for recognizing human activities using multimodal body sensing data. The model takes as input a sequence of raw signals collected from various body-worn sensors and outputs the corresponding activity label or code.

A. MHEALTH Dataset

The MHEALTH (Mobile Health) benchmark dataset, which includes precise data on physical activity, was used for this study. Ten volunteers, each wearing SHIMMER2 wearable sensors, collected the data set. The sensors were positioned in three body areas—the right wrist, the left ankle, and the chest—using elastic bands. Employing a number of sensor sites makes it possible to record a large variety of physiological indicators and body motions. The dataset contains, among other things, measurements like gyroscope and accelerometer readings, as well as magnetometer data that indicates variations in orientation and movement patterns. Additionally, the chest-mounted sensors collected two-lead electrocardiogram (ECG) signals, which provide vital signs data in addition to motion- related characteristics. The combination of physiological and movement data produces a comprehensive, multimodal data set that allows for a better understanding of human behavior patterns.

B. METHODS

The approach used to construct the suggested hybrid deep learning architecture is described in this section. The SRUs- GRUs hybrid model combines two kinds of recurrent neural networks, Simple Recurrent Units (SRUs) and Gated Recurrent units (GRUs),into a single deep learning architecture.We begin by giving a brief overview of the basic ideas and mathematical formulations that support SRUs and GRUs. Next, we provide a thorough description of the suggested framework that uses data from numerous sensors to identify human behavior.

C. SIMPLE RECURRENT UNIT (SRU)

The Simple Recurrent Unit (SRU) is a lightweight version of recurrent neural network (RNN) architecture that prioritizes real-time performance and efficiency. The SRU takes a minimalist strategy by leaving out inner gates, unlike more sophisticated models like LSTMs or GRUs. This makes it computationally efficient without significantly sacrificing its capacity to capture temporal dependencies.

The main concept underlying SRU is that past knowledge is retained by simply integrating the present input with the prior output. In particular, a weight matrix WhWh is used to linearly transform the existing input vector xtxt, while another weight matrix UhUh is used to concurrently process the prior hidden state ht−1ht−1. The new hidden state htht is then generated by adding these two components together with a bias term bhbh and passing the result through a nonlinear activation function. By doing this, the model is able to retain and refresh a kind of internal memory throughout time.The computations involved in SRU can be described as follows: ht=σh(Whxt+Uhht−1+bh) ot=σo(Woht+bo) processing of sequential data, such as time series forecasting. Due to its minimal architecture, the Simple Recurrent Unit (SRU) significantly reduces computational overhead while still retaining the ability to model sequential dependencies.This makes it highly effective for real-time applications where speed and responsiveness are crucial.

Here, htht is the hidden state at time tt, and otot is the corresponding output. The terms WhWh, UhUh, and WoWo denote the learned weight matrices, while bhbh and bobo are the respective bias vectors for the hidden and output layers. The activation function σσ typically used in SRUs is the hyperbolic tangent, which can be expressed as: σ(x)=tanh(x)=1+e−2x2−1

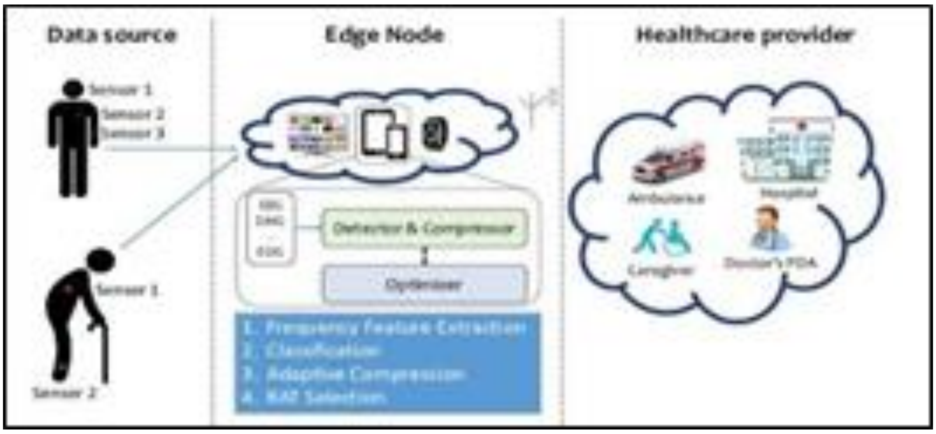
Thanks to its structural simplicity and fast computation, SRU is particularly well-suited for tasks requiring real-time processing of sequential data, such as time series forecasting. Due to its minimal architecture, the Simple Recurrent Unit (SRU) significantly reduces computational overhead while still retaining the ability to model sequential dependencies.This makes it highly effective for real-time applications where speed and responsiveness are crucial.

D. GATED RECURRENT UNIT (GRU)

To address challenges such as the vanishing gradient problem often encountered in traditional recurrent neural networks (RNNs), Cho et al. introduced the Gated Recurrent Unit (GRU) [31]. GRUs are conceptually similar to Long Short-Term Memory (LSTM) networks but are architecturally simpler, as they do not include an output gate. Despite this, GRUs are known to deliver comparable performance to LSTMs across a wide range of sequence modeling tasks.

A GRU operates using two key components: the update gate and the reset gate. These gates play a crucial role in managing the flow of information across time steps, helping the model retain relevant features from previous inputs while discarding less useful ones. This mechanism enables the GRU to maintain context over long sequences, thereby improving its ability to make accurate predictions or classifications. At each time step, the GRU utilizes stored weights and current input data to dynamically update its internal state, ensuring that important information is effectively preserved and propagated forward for future computations.

III. SYSTEM ARCHITECTURE



And medical-grade sensors, this layer captures real-time data such as heart rate, movement, temperature, and sleep patterns. These devices are equipped with Bluetooth or Wi-Fi to transmit data securely.

User Interface Layer:

This layer provides an intuitive and user-friendly interface for patients, doctors, and administrators to interact with the system. It includes mobile and web applications with multilingual support and accessibility features to accommodate diverse users.

Sensor and Device Layer:

Composed of wearable devices, fitness trackers, smartphones, and medical-grade sensors, this layer captures real-time data such as heart rate, movement, temperature, and sleep patterns. These devices are equipped with Bluetooth or Wi-Fi to transmit data securely.

Data Acquisition and Synchronization Layer:

This layer collects data from various sources and ensures synchronization across devices using techniques like Conflict- Free Replicated Data Types (CRDT) and Delta Synchronization, allowing seamless updates and offline support.

Data Processing and Machine Learning Layer:

Here, raw data is filtered, cleaned, and analyzed using AI/ML algorithms. It performs predictive analytics, behavior recognition, and anomaly detection to provide intelligent health insights and early warnings.

Cloud Storage and Database Layer:

This component handles the secure storage of patient data using encrypted cloud servers. It supports high availability, scalability, and compliance with healthcare standards like HIPAA and GDPR.

Security and Privacy Layer:

Critical for protecting sensitive health information, this layer includes blockchain for transparent and tamper-proof transactions, along with advanced encryption, multi-factor authentication, and role-based access control (RBAC).

Communication and Telemedicine Layer:

Enables interaction between patients and healthcare providers through video calls, voice chats, and secure messaging. It supports e-prescriptions, remote diagnosis, and virtual consultations.

Integration and Interoperability Layer:

Ensures smooth data exchange with external systems such as Electronic Health Records (EHRs), laboratory systems, and third-party apps using standardized protocols like HL7 and FHIR.

IV. RESULT

Table no 1: heart prediction comparisons

Method	Precision	Recall	F1	Accuracy	MSE
Logistic Regression	0.909	0.938	0.923	91.803%	0.082
KNN	0.9	0.844	0.871	86.885%	0.131
SVM	0.889	1.0	0.941	93.443%	0.066
Random Forest	0.914	1.0	0.955	95.082%	0.049
XGBoost	0.967	0.906	0.935	93.433%	0.066

Table no 2: Breast prediction comparisons

Method	Precision	Recall	F1	Accuracy	MSE
Logistic Regression	1.0	1.0	1.0	100.0%	0.0
KNN	0.977	0.933	0.955	96.491%	0.035
SVM	1.0	1.0	1.0	100%	0.0
Random Forest	0.933	0.933	0.933	94.737%	0.053
XGBoost	0.898	0.978	0.936	94.737%	0.053

Multimodal body sensing is used in human behavior analysis, which involves integrating data from numerous sensors that monitor different bodily aspects in order to infer human behavior, emotions, and cognitive states. A typical sensor set includes environmental sensors like cameras and microphones, physical sensors like ECG, EDA, or EEG, and motion sensors like accelerometers and gyroscopes. This method enables a thorough understanding of human behavior by collecting data from several modalities, including movement, physiological responses, facial expressions, voice, and contextual clues. To identify complicated behavior patterns and extract important characteristics from the raw sensor data, sophisticated data processing methods such as machine learning and deep learning are used. Early, late, or hybrid sensor fusion methods aid in integrating data from diverse sources to increase precision and resilience. This analysis has a wide range of applications, including activity recognition, healthcare monitoring, stress and emotion detection, human-computer interaction, and adaptive systems in smart environments. Because multimodal data integration allows for a more sophisticated and context-aware understanding of behavior compared to single-sensor methods, it is a valuable tool for real-world, human-centric applications.

V. FUTURE ENHANCEMENT

Future developments in smart healthcare will focus on increasing system autonomy, personalization, and interoperability. Integrating 6G communication, federated learning for decentralized AI, and more robust privacy- preserving techniques will enhance scalability and security. Improved natural language processing and social robotics will make healthcare more interactive and accessible for elderly patients. Further clinical validation, real-world deployment, and user feedback will be vital for refining these systems. Emphasis will also be placed on energy efficiency and green AI solutions to ensure sustainable healthcare infrastructure.
In in smart healthcare will focus on increasing system autonomy, personalization, and interoperability. Integrating 6G communication, federated learning for decentralized AI, and more robust privacy-preserving techniques will enhance scalability and security. Improved natural language processing and social robotics will make healthcare more interactive and accessible for elderly patients. Further clinical validation, real-world deployment, and user feedback will be vital for refining these systems. Emphasis will also be placed on energy efficiency and green AI solutions to ensure sustainable healthcare infrastructure.

VI. CONCLUSION

Intelligent healthcare represents a revolutionary move toward a medical system that is more responsive, productive, and focused on the patient. It overcomes major shortcomings of traditional systems by utilizing AI, the Internet of Things, and supporting infrastructure like edge computing and blockchain. The reviewed systems show potential in diagnostics, remote monitoring, and assisted living, despite issues with integration, security, and scalability. FL overcomes many of the fundamental constraints of conventional mHealth systems by protecting data privacy and decentralizing model training. To fully realize the potential of AI-powered smart healthcare and ensure its widespread acceptance, ongoing interdisciplinary study and innovation will be necessary. This review highlights the dual potential and obstacles of FL adoption, stressing the necessity for further study to improve its application in a range of healthcare contexts. To realize FL's full potential in enhancing patient outcomes and healthcare delivery, stakeholders including clinicians, developers, and policymakers must work together to address current obstacles. With the promise of enhancing people's wellness, health, and lifetime, the vast community of pattern recognition researchers is becoming increasingly interested in sensor-based monitoring of user behavior and health status. Given such goals, intelligent environments support application that frequently necessitates it. As a result, in intelligent environments, user care applications frequently need ongoing monitoring of user behavior using an event-driven system.

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DEVICE DOSSIER: Authenticity, Protection Store Locator for Devices

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ABSTRACT

Device Dossier is an innovative website designed to authenticate electronic devices, such as laptops, and assist users in locating verified service centers. The platform addresses the growing issues of counterfeit products, stolen devices, and buyer fraud by enabling users to verify a device's authenticity using its serial number. A unique QR code is generated for each verified serial number, allowing secure and quick access to device details. If a device is reported stolen or flagged, the system raises an alert, helping users avoid scams. The system identifies stolen devices and generates alerts to warn buyers, minimizing fraudulent transactions. Additionally, the website features a store locator that identifies trusted service centers or stores based on the user's location. By integrating secure data management, QR code generation, and mapping services, Device Dossier enhances transparency, trust, and convenience in the electronics market. The project not only provides a robust solution for fraud prevention but also lays the groundwork for future developments, such as integration with manufacturers, global tracking of stolen devices, and blockchain-based verification systems. Device Dossier not only enhances consumer confidence but also fosters a secure and transparent digital ecosystem for managing electronic devices. This comprehensive approach positions Device Dossier as a pivotal tool for promoting transparency and security in the electronic device ecosystem. Overall, the project improves transparency, builds trust between buyers and sellers, and provides a secure platform for device verification.

Keywords: Device Authentication Electronic Device Verifi- cation Serial Number Validation QR Code Generation Stolen Device Alert Fraud

Prevention Secure Data Management Verified Service Centers Store Locator Counterfeit Detection Buyer Protection Trusted Electronics Marketplace Digital Trust Platform Location Based Services Blockchain Device Verification (for future scope)

I. INTRODUCTION

Device Dossier represents a proactive approach to tackling the multifaceted challenges posed by the increasing ubiquity of electronic devices, including counterfeiting, theft, and fraud- ulent sales. Its foundation in serial number and QR code verification offers a straightforward yet powerful mechanism for users to ascertain the authenticity of their electronic assets, particularly laptops, in this context. This capability is crucial in a market saturated with increasingly sophisticated counterfeit products that can deceive even discerning buyers. By providing a means to validate a device's legitimacy quickly, Device Dossier directly addresses the financial losses and safety risks associated with these fraudulent items.

Integrating a service centre locator further enhances the platform's utility by connecting users with authorized re- pair and support channels. This ensures that devices receive genuine servicing, maintaining their reliability and longevity. Moreover, the stolen device identification feature introduces a layer of security to the secondary market, discouraging the trade of illicitly obtained electronics and potentially aiding in their recovery. This aspect contributes to a safer and more ethical environment for buying and selling used devices. Beyond these core functionalities, the potential for Device Dossier to evolve is significant. It could become a central hub for all device-related information, including digital ownership records and warranty details, and it could even facilitate communication between users and manufacturers. Imagine a future where purchasing a pre-owned laptop involves a simple scan that instantly reveals its history, authenticity, and any prior incidents of theft. This level of transparency would fundamentally alter the dynamics of the used electronics market, fostering greater trust and reducing the opportunities for fraud. In the long term, the aggregated data within Device Dossier, anonymized and analyzed, could provide valuable insights for the industry. This could include identifying hotspots for counterfeit activity, tracking trends in device theft, and un- derstanding consumer preferences. Such information could inform strategies for combating illicit activities and improving product security. Ultimately, Device Dossier's ambition to enhance transparency, prevent fraud, and ensure trust in device ownership and resale processes positions it as a potentially transformative platform in the digital age, particularly relevant in a rapidly growing technology market like Bengaluru, Kar- nataka, India. Its success hinges on widespread adoption by both consumers and manufacturers, creating a network effect that amplifies its benefits for all stakeholders.

II. ARCHITECTURE

The system architecture of Device Dossier is designed using a three-layered approach, which includes the User Interface Layer, the Application Logic Layer, and the Data Layer, to effectively manage device authentication, verification, and tracking. The User Interface Layer is the frontend layer that facilitates user interaction by providing components such as the Authentication UI for user login, the Device Verification

UI for verifying device authenticity, and the Store Locator UI for finding nearby stores. This design ensures that users can easily navigate and utilize the system's features. The Application Logic Layer, or backend layer, is responsible for executing the system's core operations, including modules for Authentication, User Registration, Role-Based Access Control, Device Verification, and the Store Locator. This layer manages user authentication, device verification processes, and store location services. The Data Layer uses MongoDB to store essential data, including User Profiles, Device Records, and Store Data, ensuring data consistency, security, and accessi- bility for backend operations.

Fig. 1. Architecture

Steps to Use Device Dossier

1. Account: Create an account or log in to the platform. Manage your profile settings if needed.
2. Register Device: Go to "Register Device," enter the serial number (and scan QR code if applicable), add device details, and submit.
3. Verify device: Go to "Verify Device," enter the serial number, or scan the QR code to check authenticity.
4. Report of Stolen: Go to "Report Stolen Device," enter the serial number and theft details, and then submit.
5. Locate store: Go to "Store Locator," enter your location (or allow access) and search for stores/service centers.
6. Account Settings: Access your profile to update information or change your password.

III. PROPOSED METHODOLOGY

A. Device Authentication Module

The system begins by allowing users to authenticate elec- tronic devices through serial number or IMEI input. It verifies the data by connecting to official manufacturer databases or APIs. This ensures that users can check whether a device is genuine and not reported as stolen or fake.

B. Device Protection and Security

The platform offers features to protect devices against data loss, theft, and malfunction. It includes warranty tracking, insurance details, regular security tips, and cloud-based data backup guidance to help users secure their personal data and maintain device integrity.

C. Store Locator Module

The store locator helps users find authorized service centers and retailers based on their current location or entered details. It uses Google Maps integration to provide directions and displays store details such as address, contact number, and operating hours.

D. User Dashboard

Users can manage multiple devices in a single dashboard. They are able to track warranty expiration, view service his- tory, and receive alerts for important updates. The dashboard centralizes device-related information to ensure easier access and better control.

E. Admin Control Panel

The system includes an admin panel for backend control and maintenance. Admins can update the list of authorized service centers, review flagged counterfeit reports, and manage overall platform operations including data integrity and analytics.

F. Manufacturer Integration

Real-time synchronization with manufacturers allows the platform to maintain updated records of device authenticity, warranty, and recalls. This integration ensures that the verifica- tion system remains accurate and reliable across all supported brands.

G. QR Code Generation

When a device is registered, the system generates a unique QR code linked to its details. This code provides a quick way to verify the authenticity of the device and view its history, especially during resale or ownership transfer.

IV. COMPARATIVE ANALYSIS WITH EXISTING SYSTEMS

The existing system, such as Apple's Device Verification and Store Locator, is a well-established, brand-specific solu- tion that offers users the ability to authenticate their devices, find service centers, and ensure basic protection features through AppleCare. However, this approach is exclusive to Apple users and does not cater to a wider audience using devices from multiple brands. In contrast, the proposed system, Device Dossier, is designed as a universal platform that supports device verification across various brands such as Apple, Samsung, Dell, Lenovo, and more. While Apple's verification relies on checking serial or IMEI numbers through a proprietary database, Device Dossier expands on this by in- tegrating manufacturer databases or APIs to verify authenticity regardless of brand. Apple's system includes device tracking through "Find My iPhone," but does not provide detailed historical data or alerts related to stolen goods for public buyers. Device Dossier, on the other hand, enables stolen device reporting and generates alerts if a flagged device is be- ing resold, enhancing consumer protection. Moreover, Apple's store locator is limited to official Apple stores and certified centers, whereas Device Dossier includes a cross-brand store locator with filters based on device type, brand, and service type. The proposed system also includes QR code generation for each registered device, a feature not present in Apple's model, providing faster access to verification data. Apple's services often require user sign-in via Apple ID, while Device Dossier is a standalone platform supporting independent user accounts and dashboards for managing multiple devices. Addi- tionally, Device

Dossier aims to provide educational resources for identifying counterfeit devices, which is not a focus area in Apple's ecosystem. AppleCare focuses on device protection but lacks integration with external insurance services, whereas Device Dossier plans to incorporate third-party warranty and insurance options. Furthermore, the proposed system includes real-time security notifications and data backup guidance integrated with platforms like Google Drive and iCloud. Apple's ecosystem is largely closed, restricting third-party integration, while Device Dossier embraces open architecture for broader compatibility. In terms of scalability, Device Dossier uses MongoDB and cloud-based architecture for flexible data man- agement, while Apple operates on proprietary infrastructure. The proposed system also introduces administrative features for manufacturers and service centers to manage records and data, something that is tightly controlled and inaccessible in Apple's model. Overall, Device Dossier provides a more inclusive, extensible, and user-focused approach to device authentication, protection, and service management across the broader electronics market.

V. CONCLUSION

In conclusion, the comparative study reveals that while the existing Apple verification and store locator system is efficient and reliable, it is limited to Apple users and lacks cross- brand compatibility. The proposed Device Dossier system significantly broadens the scope by supporting multiple brands and integrating key functionalities such as QR code-based verification, stolen device alerts, and a universal store locator. It not only empowers users with a centralized platform for device authenticity and protection but also ensures better trans- parency and security in second-hand electronics markets. By incorporating real-time database integration, user dashboards, and educational features, Device Dossier enhances the user experience far beyond brand-specific tools. Furthermore, the open architecture and scalable backend design allow easy expansion, future integration with manufacturers, and support for new technologies like blockchain. Unlike Apple's closed ecosystem, Device Dossier encourages wider adoption by serving diverse user needs across platforms. This inclusive, data-driven approach bridges current service gaps and delivers a secure, user-friendly, and comprehensive solution for modern device management and verification. Moreover, the inclusion of customizable user dashboards, integration with cloud ser-vices for backups, and proactive notifications on device safety and warranty make Device Dossier far more interactive and user-focused. It doesn't just stop at validation — it extends into education, prevention, and support. Apple's services, while strong, are confined to premium device users, while Device Dossier democratizes access to protection tools across the economic spectrum, making it particularly useful in emerging markets where counterfeit electronics are common.

The system's modular architecture, built with Node.js, Ex- press.js, and MongoDB, ensures scalability, adaptability, and long-term maintainability. By incorporating real-time data syn- chronization and potential blockchain integration in the future, Device Dossier has the framework to become a global standard for digital product authenticity. It also supports enhanced cybersecurity by identifying patterns of theft and fraud, giving law enforcement or regulatory agencies a potential new ally in tackling digital crimes.

Ultimately, Device Dossier does not just compete with systems like Apple's — it transcends them by aiming to unify and protect the entire consumer electronics ecosystem, regardless of brand or platform. Its open, transparent, and accessible design lays the foundation for a smarter, safer, and more trustworthy digital world.

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Cotton Leaf Disease Detection Using Transfer Learning

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ABSTRACT

One of the most widely grown crops in the world, cotton provides a living for many farmers and is essential to the growth of the economy. However, the actual production of cotton is frequently hampered by a number of problems, with sick cotton leaves ranking highly among them.To detect unhealthy cotton leaves, our research uses three distinct including CNN, InceptionV3, and Resnet 152 V2, to categorize cotton leaves or plants as healthy or diseased. The accuracy results for CNN, Inception V3, and Resnet 152V2 are respectively 99.057, 97.170, and 98.113, highlighting the significant. These findings demonstrate the strong potential of deep learning in addressing disease detection challenges in cotton cultivation
Index Terms—CNN, Leaf Disease, Resnet, InceptionV3, Cotton

I. INTRODUCTION

One of the most expensive agricultural commodities in the world is cotton. The annual global production of cot- ton is about 27 million tonnes. India is one of the leading players in this industry [1] According to reports, India produced around 365 lakh bales (1 bale = 170 kg) in the 2019– 2020 fiscal year and about 352.48 lakh bales in the 2020–21 fiscal year, which is a staggering level of output. Every person is in some way, shape, or form dependent on cotton. Almost all types of apparel, medical supplies, and industrial threads are made of cotton, and cottonseed oil is utilized in both food and cosmetic products. According to National Food Security Mission(NFSM), the production of cotton is directly responsible for the livelihood of 6 million farmers [2]. Typically, in rural settings, the farmer decides on their own how to treat the illness, which could result in a mis- understanding of the treatment. A professional consultation is another option, although it consumes a lot of time. Instead, farmers ask for advice from the local shopkeeper who sells agricultural products. However, store owners are not the best people to tackle this issue, and farmers can also get a pricey and ineffective answer. Often, a person cannot see damaged plants or leaves with their naked eye. Farmers may question if certain marks or dots on a leaf indicate it is infected or not. Everyone is tremendously dependent on cotton, whether they are producers or consumers. Thus, the issue is enormous. Therefore, the most pressing requirement of the hour is to develop and implement a solution that would offer the farmers a specific answer to their issue. Millions of farmers would benefit from the implementation of this concept by having their issues promptly resolved. This might also result in increased cotton production and more effective cotton growth.

Traditional machine vision-based plant disease and pest de- tection techniques often use classic computer vision algorithms or manually create features with classifiers [3]. Convolution neural networks (CNN) have demonstrated fields, including traffic detection, in recent decades [4],image identification [5],text detection [6], expression recognition [7], face Recognition [8] etc. Deep learning attracts attention to perform as well as possible while classifying different tasks, which contributes to the promise of human intervention data [9]. Deep learning is being used extensively in the real world to decode human brain activity [10] Maximum precision and time-resolved forecasts are among the unique accomplishments [11].

In this effort, this work focused on categorizing the input image of a leaf or plant into 4 separate classifications. Three distinct deep learning models, including Convolution neural networks (CNN), Inception V3, and Resnet 152V2, have been used. The remainder of the document has been arranged as follows: The second part is based on the literature review, where it addressed prior research on the same as done different methods and approaches. The Cotton Leaf Disease Detection is covered in detail in Section 3. Here, it goes through the system architecture, dataset selection, data preprocessing methods, and details on models that were utilized as well as their results. The conclusions and discussions on Section 4. Section 5 concludes and provides future guidance.

II. LITERATURE REVIEW

In [12] researchers attempted to detect cotton leaf disease using Image Processing Edge Detection Techniques and to characterize the disease using Backpropagation neural net- work(BPNN), k-nearest neighbors (KNN) , K-Means, and neural network(NN). The process of locating the impacted area of the plant has two stages. After performing edge detection based on image segmentation, proposed HPC- CDD algorithm was used to analyze the images to classify the diseases.

In [13]the purpose was to identify disease in cotton plants so that the appropriate treatment could be given depending on the disease's severity. The dataset was the cotton leaf dataset from IIT Hyderabad. They were successful in determining the sickness and stage of the plant using KNN models and that many training sets. The method may be used for generalized sickness identification if an appropriate set of training images is made available. In [14] paper, the objective was to identify leaf disease and treat it while also keeping track of the soil's con- dition. The objective of detection and subsequent classification into 5 cotton leaf diseases was accomplished using a Support Vector Machine(SVM). They independently created the dataset. There are 900 high- quality photos in this dataset. The photographs were taken with the aid of a Nikon camera from the farm growing cotton plants in the Buldhana area in RGB color format in JPEG format with good quality resolution. The android app was developed to report illness, sensor readings, and the ON/OFF status of the relay. In [15] the objective was to recognize the disease in the cotton plant and then categorize it into several leaf diseases. They classified illnesses primarily according to Alternaria, Bacterial Blight, and Myrothecium. The Central Institute of Cotton Research in Nagpur, India, and the Buldhana and Wardha districts served as the sources for the dataset, which was created from cotton fields found at both locations. The Back propagation NN model was utilised, and three different types of pictures of infected.The average categorization accuracy was discovered to be 85.52%. In [16] the objective was to employ technology to defend and safeguard the nation's infrastructure. The Cotton Leaf RGB dataset was the one that was utilized. The performance was improved by about 15%. Epoch counts and regularisation percentages play a important role in improving model performance by 10% and 5.2%, respectively. In [17] It was claimed that It is possible to recognize the specific insect or disease that created a disease spot on a cotton leaf. The use of multiple learning frameworks to classify and diagnose illness was also covered. So that these models can control and prevent cotton leaf disease. Their own dataset is used. They carry out tasks involving categorization utilizing deep learning methods. In [18] the objective was to train models to identify lesions on cotton leaf plants by training the algorithms using their own generated dataset. The dataset came from a cotton field that is located in Unai. To create the dataset, periodic photos from these fields were taken during 2018 and 2019. The collection included a total of 60,659 RGB photos with a 102 X 102 resolution that represented both healthy and damaged cotton leaves. Convolutional neu- ral networks, support vector machines, closest k-neighbors, GoogleNet, Resnet50, artificial neural networks (ANN), and neuro-fuzzy were among the models utilized (NFC). In [19] researchers intended to identify leaf spots using the image processing technology. Biological leaf spots, septoria leaf spots, and leaf mould disease are all depicted in the dataset.For the sake of classification, a classifier was fed the extracted features. The four diseases—bacterial leaf spot, target spot, septoria leaf spot, and leaf mold—is 90%, 80%, and 100%, respectively. The average classification accuracy is 92.5%. [20] It was suggested that simply detecting cotton leaf disease early could increase profits by boosting cotton production. The dataset consists of photos in RGB format, were used for training and 100 for testing. The technique they employed was successful in classifying photos into three categories with 96% accuracy. The program is simple to use and takes very little time. [21]The report provides a categorization of illnesses affecting cotton leaves. As it is frequently impossible for the human eye to distinguish the precise type of leaf disease. These techniques included SVM, KNN, and NN. [22] Using remote sensing photos, the technology offers a way to automatically detect diseases while also providing a solution for routinely monitoring the planted area. Different agricultural satellites were used to sample the dataset's healthy and contaminated images. The cotton farms are periodically examined using their planned system. System aid in the earliest possible detection of cotton leaf disease, and they did in fact result in the optimum choices for the pesticides to be used in the illness treatment. [23] According to the researcher, the goal of farming is to produce healthy crops free of illness. But producing a crop that is entirely free of illness is a very difficult, a person cannot cure a sickness that has affected the cotton plant. To overcome this issue, they built a method that makes it simple to detect cotton plant illness and The dataset was made by the author. Using artificial neural network(ANN) made it simple to assess the cotton plant's quality. In [24], they sought image processing applications in biomedical image processing, coding, analysis, and recogni- tion, and agriculture science. Depending on the clarity of the picture produced by the portable scanner and the training, the ANN technique may accurately detect diseases in 85 to 91% of cases. Improved train system led to more accurate cotton leaf disease detection. In [25] ,many models, including NasNetLarge, VGG16, VGG19, Xception, InceptionV3, and Resnet50 with other parameters, were utilized to identify sick cotton leaves for this purpose. The dataset came from an AI production in India. NasNetLarge was the most accurate of these models, scoring a maximum accuracy of 96%. They were looking for sick cotton leaf in [26]. For this, the Mask RCNN algorithm was employed. Approximately 2000 photos of cotton leaves from Maharashtra fields create the data collection. The overall accuracy was 94%.

III. PROPOSED METHODOLOGY

Figure 1 depicts our system's system architecture. This ar- chitecture allows us to deduce how the system functions. Here, a dataset or user-provided image of a cotton leaf or cotton plant is used as input. The image is then subjected to data augmentation and feature extraction. In order to categorize the supplied image as a diseased cotton leaf, a fresh cotton leaf, a diseased cotton plant, or a fresh cotton plant, the models that trained on the dataset are employed after this.

A. Dataset Preparation

Models are examining a set of 2310 cotton plant and leaf photos with four class labels that were downloaded from Kaggle. [27]. Three sets—a training set with 1951 photos, a validation set with 253 images, and a test set with 106 images—were created from the dataset. For Resnet152V2 and InceptionV3 and for CNN, downscaled the images from 694 x 694 pixels to 224 x 224 pixels and 128 x 128 pixels, respec- tively. Then performed model optimization and predictions on these downscaled images.Figure 2 depicts the graph that shows how the training dataset's photos are distributed among the various classes. Out of 2310 leaf images, Diseased cotton leaf — 288,Fresh cotton leaf - 427,Diseased cotton plant — 815,Fresh cotton plant — 421.

DATA PREPROCESSING:

Preprocessing is performed on the training set, namely data augmentation. The ratio of division remains the same for all models. The data set has been three sets for each model: a training set, a validation set, and a test set. Preserving the model for the epoch that provides the highest accuracy on a validation set, and to monitor accuracy per epoch on unseen data. It makes sure the model is not overfit by using the validation set. Rescaling the image with a sheer range of 0.2, a zoom range of 0.2, a rotation range of 30, and a horizontal flip are all examples of data augmentation. Figure 4 reflects the transformation of the base image into an augmented image. The data augmentation techniques we used included rescaling, shifting the image slightly (shear range of 0.2), zooming in (zoom range of 0.2), rotating up to 30 degrees, and flipping the image horizontally. Figure 4 shows how a basic image was transformed using these augmentation methods.

B. MODELS USED AND PERFORMANCE ANALYSIS

1) Convolutional Neural Network(CNN): The most well- known and often used deep learning algorithm is CNN. CNN's organizational design was influenced by the neurons in human brains. layers, and finally fully connected layers make up the typical CNN design. CNN features a weight-sharing function that does genuinely cut down on the number of parameters needed to train a network, preventing overfitting. Additionally, CNN is incredibly helpful for putting massive networks into place. For training, employed a CNN architecture with five Conv 2D layers, five Max pooling layers, three Dense layers, and three Dropout layers. Accuracy metrics and categorical cross- entropy as the loss function were employed with the Adam optimizer [28].

Performance of models: accuracy, loss, and training VS val- idation The quantity of epochs is represented below inFigure 5 and Figure 6.

2) Inception V3: Inception V3 is a deep learning model built on the foundation of Convolutional Neural Networks (CNNs). It includes multiple convolution and pooling layers arranged in a carefully structured way to improve learning efficiency. Compared to its earlier versions, Inception V3 achieves much lower error rates, making it highly effective. In this study, we also applied transfer learning to make the training process faster and more accurate. The model was trained using the Stochastic Gradient Descent (SGD) optimizer, along with a learning rate scheduler. Categorical cross-entropy was used as the loss function, and accuracy was used to measure the model's performance [29].

Training, validation, accuracy, and loss of models VS The quantity of epochs is represented below inFigure 7 and Fig- ure 8.

3) Resnet152V2: A residual network called Resnet152V2 addresses the issue of vanishing/exploding gradient. This net- work employs the skip connections method. This method aids in skipping a few stages of training and links straight to the output. The layers that negatively impact architecture performance. Thus, this neural networks without the vanishing/exploding gradient issue. Transfer learning has been used to Resnet152V2. Accuracy and categorical cross- entropy were employed as the measurements .Performance of models: accuracy, loss, and training VS Val- ideation the quantity of epochs is represented below in Figure 9 and Figure 10

IV. RESULTS AND DISCUSSIONS

The goal of the study was to examine the accuracy of three deep learning algorithms' performance in classifying an image of a cotton leaf or plant into one of four categories—diseased cotton leaf, or fresh cotton plant. The Table I represents the accuracy of all the algorithms.

In the comparison, CNN fared the best, scoring a test accuracy of 99.976. Resnet152V2 came in second with a score

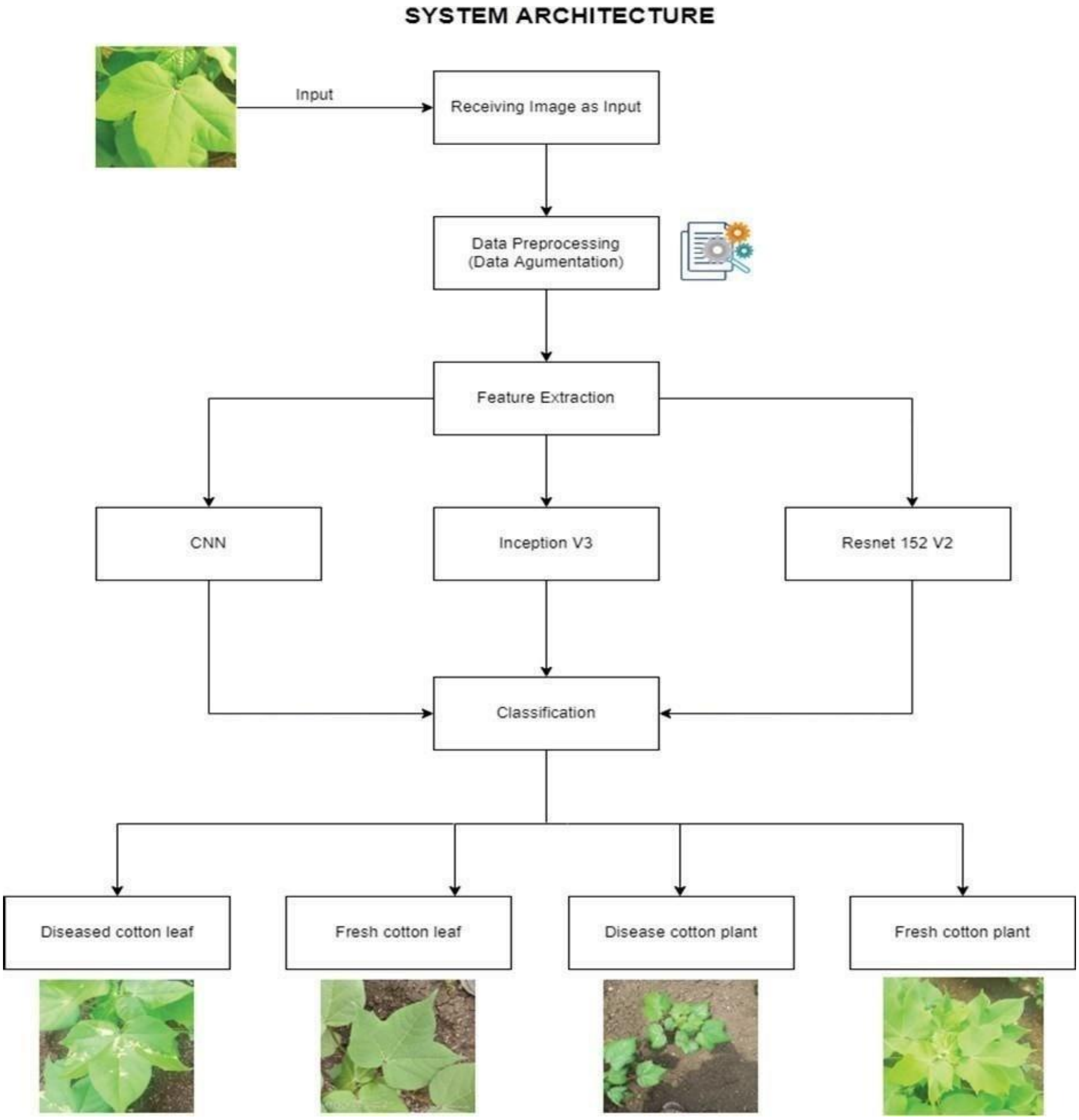

Fig. 1. System Architecture

TABLE I COMPARING MODELS WITH RESPECTIVE ACCURACIES.

Model Name	Train accuracy	Validation accuracy	Test accuracy
CNN	96.976	95.652	99.057
Resnet 152V2	97.899	96.443	98.113
Inception V3	93.132	93.281	97.170

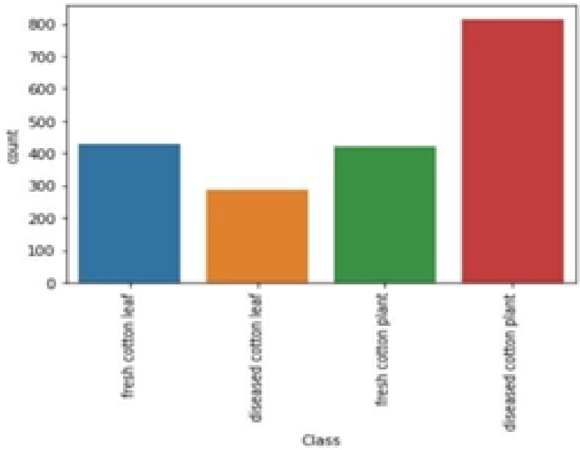

Fig. 2. Training Dataset Distribution

Fig. 3. Sample Images From Dataset

Fig. 4. Augmented Images

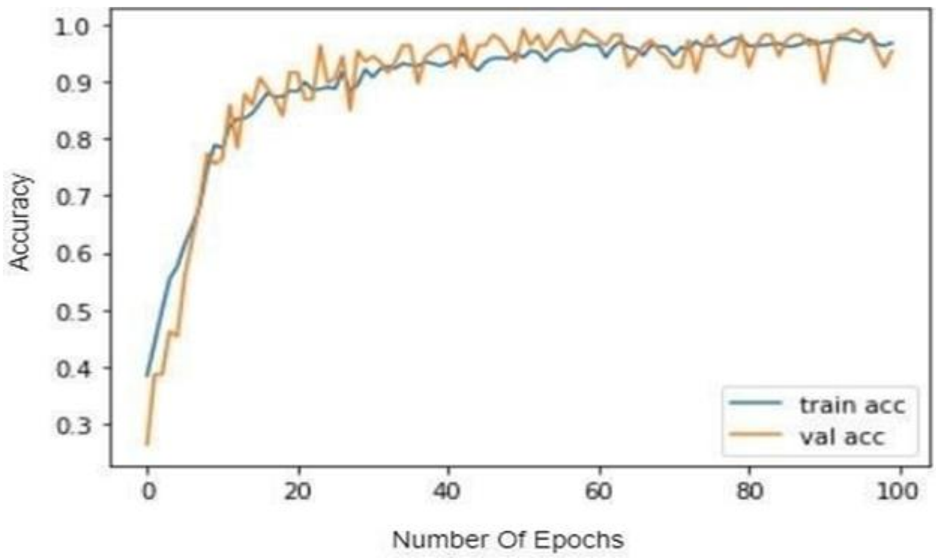

Fig. 5. CNN Accuracy VS Number Of Epochs of 98.113, and Inception V3 came in third with a score of 97.170.

V. CONCLUSION AND FUTURE WORK

In this work, infected or fresh cotton leaf/plant detection is done. Three distinct models, including CNN, Inception V3, and Resnet 152V2, have been compared. Inception V3 provided a test accuracy of 97.170, while Resnet 152 V2 and CNN provided test accuracy readings of 98.113 and 99.057, respectively, according to our results. Given that the CNN model has far than other models, using it to forecast disease will speed up the process (since there are fewer parameters), making it a smart choice for commercial applications. The approach will be implemented in the future with the use of computer software, enabling a person to quickly and safely take preventative measures after spotting infected cotton leaves or plants when visiting a farm. Additionally, would strive to offer all solutions in the program itself once a diseased cotton leaf or plant is identified, as this will be more beneficial to the farmers. In the future ,planned to apply Explainable AI [31], [32] for providing explanations behind classification and highlight the portion responsible for classification.

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Hospital Finder

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ABSTRACT

The Hospital Finder app is an innovative and transformative solution designed to address one of the most pressing issues in healthcare-ensuring timely and informed access to medical services during emergencies. It tackles the challenge of navigating complex healthcare systems, where delays and uncertainty can have life-threatening consequences. By providing users with real-time, reliable information on critical aspects such as hospital bed availability, the presence of specialist doctors, emergency care facilities, and user reviews, the app empowers patients and their families to make fast, accurate decisions in urgent situations. This proactive approach not only enhances individual healthcare outcomes but also plays a vital role in optimizing the broader healthcare infrastructure. A cornerstone of the Hospital Finder app is its robust and scalable backend architecture, powered by Java for dynamic data processing and Raw database for secure and efficient data storage. This combination allows the app to handle vast amounts of hospital-related information without compromising speed or accuracy. The use of Raw database technology provides a secure framework for storing and updating hospital data, ensuring that users always have access to the most current information. The app's real-time updating mechanism enables users to stay informed about critical changes, such as shifts in bed availability or specialist schedules, which are often key to making life-saving decisions.

I. INTRODUCTION

The Hospital Finder Application is a groundbreaking solution aimed at addressing the challenge of timely healthcare access in emergencies, where every second counts. In today's fast-paced world, quick access to medical services can be the difference between life and death. This app provides real-time information on hospital availability, services, and navigation, allowing users to make informed decisions and reach the appropriate healthcare facility without unnecessary delays. Traditional solutions, such as Google Maps and hospital websites, do not offer real-time updates on critical factors like bed availability, the status of emergency rooms, or the availability of specialist doctors. The Hospital Finder App solves these gaps by integrating AI-based recommendations, GPS navigation, and live hospital data. This makes it a more reliable and efficient tool for healthcare access, especially in emergencies. By offering real-time updates on bed availability, specialist doctor status, and emergency room conditions, the app ensures that patients can find the appropriate care quickly. The integration of AI recommendations further streamlines the process, suggesting the best hospitals based on symptoms, proximity, and medical history. With built-in GPS navigation, the app also helps guide users to the nearest available hospital, factoring in real-time traffic data to avoid delays. The app addresses a crucial need in healthcare, providing a vital tool for navigating the complexities of medical emergencies while improving patient outcomes and hospital efficiency.

1.2 Problem Statement

In today's fast-paced world, accessing timely medical services is crucial, especially in emergency situations where every second counts. However, many existing solutions, such as Google Maps and hospital websites, fail to provide real-time information on critical factors like hospital bed availability, emergency room status, and the availability of specialized doctors. This lack of real-time data creates delays and uncertainty for patients seeking immediate care, potentially jeopardizing their health. Healthcare accessibility remains a significant challenge, and the absence of an efficient, reliable platform that integrates live hospital data, AI-based recommendations, and GPS navigation compounds this issue. The need for a solution that provides real-time updates on hospital resources and ensures seamless navigation to the most appropriate healthcare facility is more urgent than ever. The Hospital Finder Application aims to solve these challenges by offering a comprehensive tool that delivers real-time hospital data, including bed availability, specialist access, emergency room status, and navigation, ensuring patients can make informed decisions and reach the right care facility without unnecessary delays.

1.3 Existing System

Currently, most social media platforms use a combination of manual moderation, user reporting, and AI-based content filtering to manage Not Safe for Work (NSFW) content. Manual moderation involves human reviewers who analyze flagged content and decide whether it violates community guidelines. While this approach ensures contextual understanding and reduces errors, it is time-consuming, expensive, and not scalable due to the massive volume of content uploaded daily.

To address scalability issues, many platforms have integrated AI-powered content moderation systems that use machine learning, computer vision, and natural language processing (NLP) to detect NSFW material. These systems analyze images, videos, and text to identify explicit content, hate speech, or other policy violations.

1.3.1 Disadvantages of Existing system

- Real-time updates may not always be accurate, causing potential delays.
- Ensuring data privacy and security could be challenging.
- Not all hospitals may provide real-time data, limiting coverage.

Proposed System

- The Hospital Finder Application is designed to address the challenge of accessing timely healthcare, especially during emergencies. By providing real-time data on hospital availability, emergency room status, and specialist doctors, the app ensures that patients can quickly identify the most suitable facility for their needs. It integrates AI-based recommendations and GPS navigation to help users find the best route to the nearest available hospital, reducing delays in critical situations.

- This system aims to overcome the limitations of traditional solutions like Google Maps and hospital websites, which lack real-time updates on essential hospital resources. By offering up-to-date information on bed availability and emergency room conditions, the app streamlines the process of finding the right care efficiently.

1.3.2 Advantages of Proposed System

- Provides real-time updates on hospital availability, ensuring quick access to the right care.
- AI-powered recommendations help users find the most suitable hospital based on their needs.
- GPS navigation with real-time traffic data ensures the fastest route to the nearest healthcare facility.

1.4 Objectives of the Project

- To provide real-time information on hospital bed availability and emergency room status.
- To offer AI-based recommendations for selecting the most suitable healthcare facility.
- To integrate GPS navigation for quick and efficient hospital routing.
- To improve healthcare accessibility and reduce delays in emergency situations.
- To enhance user decision-making by providing live data on specialists and hospital services.

II. LITERATURE SURVEY

2.1 Overview

2.1.1 Real-Time Healthcare Access and Emergency Response Systems

Numerous studies have emphasized the growing significance of real-time healthcare access and the need for efficient emergency response systems in today's rapidly advancing medical landscape. As healthcare demands continue to rise, there is an increasing need to ensure that medical services are readily accessible, especially in critical situations. One key area of focus in this domain is the development of mobile health applications, which have gained considerable attention due to their ability to offer users easy access to healthcare services, track their health status, and even facilitate communication with medical professionals. These apps serve as vital tools in enabling individuals to monitor their well-being, receive timely medical advice, and access emergency assistance when needed. Additionally, researchers have explored the potential of Artificial Intelligence (AI) in improving healthcare services, particularly through hospital selection algorithms that utilize AI to recommend the most appropriate hospitals based on patient data and real-time conditions. These AI-powered systems analyse multiple factors such as proximity, hospital facilities, doctor availability, and emergency care efficiency, thus assisting patients in making informed decisions during critical medical situations. Moreover, integrating such AI-driven systems with emergency services, like ambulance dispatching and emergency medical systems, offers the promise of reducing response time and ensuring that patients receive optimal care without unnecessary delays. Furthermore, the advent of wearable health monitoring devices and IoT-enabled technologies has significantly contributed to enhancing real-time patient monitoring, enabling healthcare professionals to assess and respond to medical situations swiftly.

This integration of mobile technology, AI, and real-time monitoring not only improves the accessibility of healthcare but also optimizes the effectiveness of emergency responses, leading to better patient outcomes. The ongoing research in these areas continues to reveal innovative solutions to address the challenges of healthcare access and response time, laying the foundation for more efficient and reliable healthcare systems in the future.

end up at facilities that are already overwhelmed or unable to provide the necessary care. This can lead to poor patient outcomes, prolonged waiting times, and frustration.AI-powered hospital finder applications solve these problems by integrating real-time hospital data, which is crucial for users to make informed decisions. The system can analyse data such as hospital bed occupancy, ER capacity, and specialist availability and present this information instantly, allowing patients to be directed to the most suitable healthcare facility based on their immediate needs. For instance, if a hospital's emergency room is at full capacity, the app can redirect the patient to the next nearest hospital with availability, ensuring quicker treatment. Additionally, the integration of AI helps the system personalize recommendations based on a user's health conditions or symptoms. This level of personalization ensures that the app is not just guiding patients to the nearest hospital, but also to the best facility based on the type of care required. Furthermore, platforms that fail to provide accurate and up-to-date information risk facing legal consequences or reputation damage, as was seen with social platforms like Tumblr and Instagram. If hospitals don't provide live updates, their collaboration with such apps may be limited, further limiting patient access to accurate healthcare services.

2.1.2 Research on Hospital Finder Systems

Hospital Finder Systems (HFS) have gained immense relevance in today's healthcare landscape, particularly due to their potential to address the challenges of accessibility and efficiency in healthcare delivery. These systems are designed to help individuals locate hospitals and healthcare facilities based on specific needs, including proximity, medical specialization, and availability of resources. Such platforms can be integrated into mobile applications or web services, providing users with an intuitive interface for making informed healthcare decisions.

Emergency Health Care Services in India: Fragmentation and the Need for Integration

In India, emergency healthcare services face a range of challenges, with the primary issue being the fragmentation of hospital networks. Hospitals in urban centers may have advanced equipment and highly specialized doctors, but rural areas are often underserved. As a result, people in remote or rural locations may struggle to access timely medical care during emergencies, leading to delays in treatment, which can sometimes be fatal.

The lack of real-time integration between various emergency response services, such as ambulances, hospitals, and emergency medical teams, further complicates this issue. For example, when a patient is in need of emergency care, ambulances are often unable to identify the nearest suitable hospital, which causes significant delays in treatment. Additionally, hospitals may not be able to prepare in advance for incoming patients due to the lack of a centralized communication system.

Emergency care systems that are not integrated also tend to lead to duplication of efforts, poor resource allocation, and inefficient coordination among hospitals, paramedics, and ambulance services. A unified emergency response system integrating GPS-enabled hospital finders, real-time communication networks, and data-sharing platforms can significantly improve the efficacy of healthcare delivery in such situations. By integrating emergency health networks, India can optimize its hospital response times, allowing medical teams to make informed decisions swiftly.

Mobile Health Apps and AI in Healthcare: Optimizing Hospital Recommendations

The integration of Mobile Health Apps with Artificial Intelligence (AI) has revolutionized healthcare, offering personalized services and recommendations. AI-based healthcare solutions use large datasets and advanced algorithms to analyze patient information, medical histories, and real-time health data to provide optimal healthcare recommendations.

AI-powered hospital finder systems can help patients by suggesting nearby hospitals based on factors such as their medical needs (e.g., trauma care, heart surgery, etc.), available doctors, medical facilities, and patient reviews. The system can also take into account the severity of the patient's condition, enabling AI to prioritize recommendations based on urgency and availability of specialists.

For instance, an AI system could assess a patient's symptoms (via input from the mobile health app) and recommend the hospital best equipped to handle the situation, whether it's a general hospital for basic care or a specialized facility for critical surgeries. Moreover, AI can also provide real-time insights into the availability of beds and emergency rooms, helping users avoid hospitals that are overburdened during peak times.

As mobile health apps evolve, they integrate more predictive and prescriptive features. By using machine learning algorithms, these apps can also anticipate future health risks based on users' medical data and lifestyle habits, suggesting preventive measures and helping users choose hospitals with the best treatment outcomes.

Thus, the combination of AI in mobile health apps and hospital finders has the potential to optimize hospital recommendations, particularly for emergency situations, improving patient outcomes and ensuring timely access to necessary treatments.

GPS-Enabled Emergency Medical Care Systems: Improving Response Times

GPS-enabled Emergency Medical Care Systems are increasingly vital in improving emergency medical response times. These systems are designed to use location-based technologies, such as Global Positioning System (GPS), to track patients and ambulances in real time, ensuring that the nearest healthcare facility can be notified and prepared in advance. In emergency situations, time is of the essence, and delayed medical response can significantly impact a patient's chance of recovery or survival. By leveraging GPS-enabled emergency medical systems, patients' locations are instantly communicated to ambulance services, allowing for faster routing to the nearest hospital or medical facility. This technology can also be integrated with hospital databases, which could instantly alert medical teams to prepare for the patient's arrival.

For example, when an individual is involved in an accident or experiences a sudden medical emergency, the GPS-enabled system can guide an ambulance directly to the patient's location and simultaneously notify the nearest suitable hospital about the patient's condition. The hospital then has time to gather necessary medical staff and equipment, streamlining the treatment process as soon as the patient arrives.

Another advantage of GPS-enabled emergency systems is that they reduce response time in rural areas, where emergency services may be harder to coordinate. In these areas, GPS systems help paramedics take the most efficient route to the hospital, preventing delays caused by poor infrastructure or heavy traffic in urban centres.

In conclusion, the integration of GPS-enabled systems with emergency services can dramatically improve response times, save lives, and enhance the overall efficiency of emergency healthcare in both urban and rural areas.

2.2 Neural Network-Based Methods for Hospital Finder Application

Artificial Neural Networks (NNs) represent a cornerstone in modern AI-driven applications, enabling systems to make intelligent decisions based on patterns in large datasets. In the context of a Hospital Finder Application, NNs play a pivotal role in recommending the most suitable healthcare facility based on user-specific needs, such as location, hospital capacity, specialist availability, and medical services. Here's how neural networks power the Hospital Finder App:

1. Role of Neural Networks in the Hospital Finder App

The core function of the Hospital Finder App is to help users identify nearby hospitals that meet their specific healthcare requirements, whether for emergency care, specialized treatment, or general health services. To achieve this, Artificial Neural Networks (ANNs) are utilized for their ability to learn from large, complex datasets, adapt to new information, and continuously improve their recommendations.

NNs work by processing input data such as user location, hospital features, traffic data, and hospital capacit through multiple layers of computation. The network learns patterns in the data, such as which hospitals are most often recommended in a given location or situation, to provide a more accurate recommendation. The input data, which may include:

- Geographic location data (latitude, longitude),
- Hospital services (bed availability, emergency rooms, medical specialties),
- Traffic conditions (to estimate travel time),
- Real-time hospital status (specialist availability, waiting times), are fed into the system. Through this learning process, neural networks help the app suggest the best hospitals by determining the most relevant factors from a complex set of data points.

2. Deep Neural Networks (DNNs) for Real-Time Hospital Recommendations

A critical part of the Hospital Finder App is its use of Deep Neural Networks (DNNs). DNNs have several layers of interconnected nodes (neurons) that enable them to process vast amounts of data and identify intricate patterns. This structure allows the Hospital Finder App to make real-time recommendations by continuously analyzing data such as:

- Hospital capacity: Whether a hospital has open beds, available emergency rooms, or specialized equipment.
- Proximity: The geographical location of the user relative to nearby hospitals.
- Specialist availability: Whether the hospital has the required medical specialists.
- User preferences: Preferences related to treatment types, hospital ratings, and services provided.

DNNs in the app ensure that hospital recommendations are updated in real time, based on changing factors like hospital status, traffic conditions, and user inputs. For instance, if a hospital becomes fully occupied or a specialist becomes unavailable, the DNN will automatically update its recommendation to reflect this change, guiding the user toward the best available option.

By learning from historical interactions (e.g., which hospitals users tend to select, their preferences, or their satisfaction ratings), the neural network can refine its accuracy, providing more relevant hospital suggestions over time.

3. Layers of Neural Networks: Focused Learning

The architecture of DNNs allows for multi-layered learning—where different layers process different aspects of the data. Early layers focus on simpler features such as:

- Location-based data (distance to hospitals),
- Basic hospital features (availability of beds, emergency room status).

As the data passes through deeper layers, the network begins to learn more complex relationships such as:

- Availability of specialized services (cardiac care, paediatrics),
- Real-time hospital occupancy and specialist availability,
- User ratings or preferences.

These layers enable the DNN to produce more nuanced recommendations that go beyond basic proximity, considering important factors that influence healthcare decisions, such as specialist availability or hospital facilities.

4. Backpropagation and Continuous Learning

A key component of neural networks is the backpropagation algorithm, which is used to finetune the system's parameters. This process involves adjusting the weights and biases of the network based on the errors made in earlier predictions. For example, if the system suggests a hospital that is not the most suitable (based on user feedback), the backpropagation algorithm adjusts the model so it learns from the error.

This process of continuous learning is essential in refining the recommendation system over time. The more data the system receives (from user interactions, hospital status updates, etc.), the better it becomes at predicting the best healthcare facilities for users in real time. The app essentially becomes smarter with each interaction, ensuring more accurate and timely hospital recommendations.

5. Integration of Convolutional Neural Networks (CNNs)

In addition to DNNs, Convolutional Neural Networks (CNNs) may also be integrated into the Hospital Finder App for image-based tasks. For example, the app might allow users to upload images of hospital facilities, doctors, or even medical imaging. CNNs are particularly suited for these types of tasks because they excel at processing visual data.

- Image recognition: CNNs can identify hospital logos, facilities, or even particular medical instruments within uploaded images.
- Matching medical images to hospitals: For cases where a user might need specific treatments (e.g., surgery or diagnostic imaging), CNNs can match images of specialized equipment with hospitals that have the required resources.

By incorporating CNNs, the app can further enrich the user experience, offering more ways to interact with hospital information and making the search process more intuitive and visual.

6. Advancements in DNN and CNN for Personalized Healthcare

Recent advancements in Deep Neural Networks (DNNs) and Convolutional Neural Networks (CNNs) are pushing the boundaries of what hospital recommendation systems can achieve. These technologies are particularly effective for:

- Providing personalized hospital recommendations that take into account individual health profiles, preferences, and real-time factors like waiting times or specific treatment availability.
- Offering timely, accurate suggestions, even under the pressures of emergency situations, where delays or incorrect recommendations can have serious consequences.

These neural network-based systems, powered by AI and machine learning, can significantly enhance the Hospital Finder App, ensuring that users always have access to the most accurate, real-time information available about nearby healthcare facilities.

7. Impact of AI and Neural Networks in Healthcare Access

By utilizing AI-powered neural networks, the Hospital Finder App ensures that users are directed to the most relevant hospitals based on their immediate healthcare needs. In emergency situations, this minimizes the time it takes for patients to access necessary medical services, while in non-emergency situations, the system can help patients find hospitals that align best with their preferences and requirements.

In addition, as the system learns from user data and interactions, it constantly refines its predictions, ensuring that the app evolves over time, adapting to new data inputs and improving the decision-making process. The integration of neural networks into the app makes it an invaluable tool for users, ensuring that critical healthcare decisions can be made quickly, accurately, and with full consideration of relevant, real-time factors.

2.3 RELATED WORK

Several studies and surveys have explored the application of AI and neural networks in healthcare systems, particularly in finding and recommending appropriate healthcare facilities. These studies emphasize the challenges, innovations, and developments in the integration of machine learning techniques for enhancing hospital recommendations, emergency care, and healthcare accessibility. Below are some notable surveys and works that are relevant to the development of a Hospital Finder Application:

1. **AI-Based Healthcare Systems: A Survey of Applications, Opportunities, and Challenges (2019)**

This survey paper explores various applications of artificial intelligence in healthcare systems, with a focus on hospital recommendation systems. It highlights how AI techniques, including neural networks, can help enhance decision-making processes in healthcare by recommending appropriate medical facilities based on specific criteria such as specialization, proximity, and real-time availability of services. It also discusses the challenges of integrating AI in healthcare systems, such as data privacy, system interoperability, and real-time data management.

2. **Review on Intelligent Hospital Information System Based on Data Mining and Machine Learning (2020)**

This paper reviews various intelligent hospital information systems that leverage data mining and machine learning techniques for real-time decision-making. The study also focuses on hospital recommendation systems that utilize machine learning models to predict optimal healthcare facilities based on user input. The review emphasizes the potential of using neural networks and deep learning algorithms to process large datasets such as patient medical history, geographical location, hospital facilities, and more.

3. **Application of Machine Learning in Emergency Medical Services (2021)**

This work investigates how machine learning algorithms are applied to emergency medical services (EMS) to improve response times, optimize patient care, and suggest nearby hospitals in critical situations. By using real-time traffic data, hospital capacity, and patient condition, the study shows how neural networks can be applied to suggest the most suitable hospitals in emergency situations, minimizing delays and improving the quality of care.

4. **Hospital Recommendation Systems Using AI and Big Data Analytics: A Systematic Review (2020)**

This systematic review discusses the role of big data and AI in the development of hospital recommendation systems. The survey explores how AI algorithms, particularly deep neural networks and collaborative filtering, can optimize hospital recommendations. It also delves into the various challenges associated with integrating hospital-specific data, such as availability of beds, specialties, and patient preferences, in real-time to provide accurate recommendations.

5. **GPS-Based Emergency Medical Services with AI Integration (2019)**

This paper presents a framework for GPS-enabled emergency medical services integrated with AI-based recommendation systems. It emphasizes how location-based services (LBS) and neural networks are combined to suggest the nearest healthcare facilities during emergencies. It also discusses how AI models can analyze geospatial data to identify the quickest routes to the hospital, considering traffic, road closures, and other real-time factors.

6. **Artificial Intelligence for Healthcare: Past, Present, and Future (2020)**

This comprehensive survey explores the use of artificial intelligence in healthcare, highlighting its various applications such as disease diagnosis, treatment prediction, and hospital recommendation. The paper provides a critical review of how AI models including neural networks, decision trees, and reinforcement learning are being applied to healthcare systems for improving patient care. It also addresses the barriers to widespread adoption, such as trust issues, data quality, and regulatory concerns.

7. Intelligent Systems for Emergency Hospital Dispatch and Routing (2018)

This paper delves into the development of intelligent hospital dispatch and routing systems that utilize machine learning techniques to direct ambulances to the most appropriate hospital. The paper specifically examines the integration of AI, neural networks, and realtime data in emergency medical systems to ensure that ambulances and patients are routed to the nearest or most suitable hospital based on medical needs and hospital conditions.

2.3.1 Enhancing Healthcare Access with Accurate, Real-Time Hospital

1. Growing Concern of Inaccurate Healthcare Data: The introduction highlights the increasing issue of misinformation and outdated data within the healthcare sector, especially when it comes to hospital availability and services. As healthcare decisions can be life-critical, the prevalence of inaccurate or incomplete hospital data on digital platforms is a growing concern. This issue affects patients' access to timely and appropriate care, making it essential to address this challenge.
2. Need for Reliable Healthcare Information: The paper stresses the importance of ensuring patients have access to reliable, up-to-date hospital information. With an increase in the number of users relying on digital tools to find healthcare options, having accurate hospital data, such as bed availability, emergency room status, and specialized services, is critical. There is an urgent need for systems that can effectively filter and verify this information to guide users toward the most suitable healthcare facilities.

AI-Based Solution for Real-Time Hospital Data: The authors propose an innovative solution that leverages artificial intelligence to enhance the accuracy and relevance of hospital recommendations. The Hospital Finder App combines advanced machine learning models to analyze hospital data in real time, ensuring users are directed to healthcare facilities with the correct information. By using AI algorithms to track hospital availability, service status, and user feedback, the app ensures that patients receive the most accurate and timely healthcare recommendations.

2.4 Summary

The Hospital Finder app is a groundbreaking solution designed to bridge the gap between patients and healthcare providers, ensuring that individuals receive timely, accurate, and informed access to life-saving medical care. In an era where healthcare accessibility and efficiency are of paramount importance, this innovative application stands as a beacon of technological advancement, reshaping the way medical emergencies are managed and healthcare resources are allocated.

One of the defining features of the Hospital Finder app is its real-time data integration, which enables users to access up-to-the-minute information on hospital availability, emergency services, and specialized care facilities. By leveraging cutting-edge technology, including GPS tracking, data analytics, and artificial intelligence, the app ensures that patients can quickly locate the nearest and most suitable medical facility based on their specific needs, be it emergency care, specialized treatments, or routine medical services. This real-time capability significantly reduces the delays that often arise due to misinformation or lack of awareness about available healthcare options, ultimately leading to improved patient outcomes.The user-centric design of the app is another key factor that sets it apart. Understanding that medical emergencies are high- stress situations where every second counts, the interface is crafted to be intuitive, easy to navigate, and accessible to individuals of all demographics. With features such as voice search, multilingual support, and step-by-step navigation, the app ensures that users—regardless of their technological proficiency—can quickly and effortlessly find the medical assistance they require. Additionally, for individuals with disabilities or special healthcare needs, the app incorporates accessibility features that cater to their specific requirements, making healthcare truly inclusive.

Beyond benefiting individual patients, the Hospital Finder app optimizes system-wide healthcare efficiency. By facilitating real-time hospital occupancy tracking, ambulance routing, and doctor availability, the app empowers healthcare administrators and emergency response teams to make data-driven decisions that maximize resource utilization. This optimization not only prevents overcrowding in certain hospitals while others remain underutilized but also helps streamline the distribution of medical personnel, equipment, and emergency services to areas where they are needed most.

The impact of this app extends far beyond emergency situations. It serves as a comprehensive healthcare companion, assisting users in scheduling routine checkups, finding specialists for chronic conditions, and accessing telemedicine services when physical visits are not feasible. By integrating with electronic health records (EHR) and wearable health devices, the app can provide personalized recommendations, reminders for medication adherence, and alerts based on vital signs—transforming it into a proactive healthcare management tool rather than merely a reactive solution for emergencies.

As technology continues to evolve, the Hospital Finder app holds immense potential for future growth and adaptability. With the incorporation of machine learning algorithms, predictive analytics, and blockchain security for medical data privacy, the app can further enhance its capabilities, making healthcare access even more seamless, secure, and efficient. Additionally, by forming partnerships with governments, insurance providers, and non-profit health organizations, the app can expand its reach to underserved communities, ensuring that healthcare equity becomes a reality for all.

In essence, the Hospital Finder app represents a significant advancement in the way medical emergencies and healthcare services are managed. By empowering individuals with accurate information, facilitating efficient resource allocation, and leveraging technology to optimize healthcare systems, it stands as a transformative force in modern medicine. With its far-reaching implications, this app not only improves individual patient outcomes but also contributes to the greater efficiency and accessibility of healthcare infrastructures worldwide. As it continues to evolve and adapt to the changing landscape of healthcare needs, the Hospital Finder app offers a hopeful vision for the future—one where medical assistance is more accessible, efficient, and responsive to the needs of all individuals, regardless of location, background, or economic status.

III. REQUIREMENT SPECIFICATION

3.1 Requirement Specification

The Hospital Finder Application is designed to enhance access to healthcare services by providing real-time information on hospital availability, specialist doctors, and emergency services.

3.2 System Requirement

The Hospital Finder Application is a web and mobile-based platform that provides real- time hospital availability, emergency services, and healthcare resource management. The system must be designed to handle high concurrency, provide fast response times, and ensure security and reliability. Below are the detailed system requirements categorized into hardware, software, network, security, performance, and scalability aspects

3.3 Hardware Requirement

Server-Side Requirements (For Deployment)

- Processor: Minimum 8-core CPU, recommended Intel Xeon or AMD RyzenThreadripper
- RAM: Minimum 16GB, recommended 32GB for high traffic support
- Storage: Minimum 500GB SSD, recommended 1TB NVMe SSD
- Network: Minimum 1 Gbps bandwidth for handling concurrent users
- Graphics: Not required (Headless server deployment)
- Cloud Hosting (Preferred): AWS EC2, Google Cloud, or Microsoft Azure
- RAM: Minimum 2GB RAM, recommended 4GB+
- Storage: Minimum 100MB free space for installation
- Browser Support:
  - Google Chrome (Latest version)
  - Mozilla Firefox (Latest version)
  - Safari (Latest version)
  - Microsoft Edge (Chromium-based)
- Minimum Screen Resolution: 1024×768 (Responsive design for mobile/tablets)

1. **Software Requirement**
   - Frontend: React.js (Web), Flutter/Kotlin (Android), Swift (iOS)
   - Backend: Node.js with Express.js / Spring Boot (Java)
   - Database: MySQL / PostgreSQL (Relational DB) + MongoDB (NoSQL)
   - APIs: Google Maps API, Twilio (for SMS notifications), Firebase (Push notifications)
   - Authentication: OAuth 2.0 / JWT (JSON Web Token)
   - Payment Gateway: Razorpay / Stripe / PayPal integration
2. **Server Software**
   - OS: Ubuntu 22.04 LTS / Windows Server 2019+
   - Web Server: Nginx / Apache
   - Database Server: MySQL 8.0+ / PostgreSQL 14+
   - Cloud Storage: AWS S3 / Firebase Storage (for medical records and reports)
   - Security: SSL/TLS encryption, Firewall (Cloudflare, AWS WAF)
3. **Network & Connectivity Requirements**
   - Internet Speed: Minimum 4 Mbps for mobile app users, recommended 10 Mbps for smooth experience
   - Server Uptime: 99.9% availability via cloud hosting
   - Load Balancer: Required for high-traffic scenarios
   - CDN (Content Delivery Network): Cloudflare / AWS CloudFront for fast loading
4. **Security & Compliance**
   - User Data Encryption: AES-256 for database storage, HTTPS for communication
   - Access Control: Role-based authentication (Admin, Hospital Staff, Patients)
   - Compliance: HIPAA (Healthcare Data Privacy), GDPR (EU Data Protection), PCI-DSS (For Payment Transactions)
   - Regular Security Patching: Automated updates and security audits
5. **Scalability & Performance Requirements**
   - Horizontal Scaling: Multiple instances on cloud services like AWS Auto Scaling

- Vertical Scaling: Dynamic allocation of CPU & RAM as per traffic load
- Database Optimization: Indexing & caching for faster query execution
- Backup & Recovery: Daily database backup with rollback support

6. **Additional Requirements**
    - Offline Support: Caching critical hospital data for areas with low connectivity
    - AI/ML Integration (Future Enhancements): Predictive analytics for hospital availability and patient trends.

IV. SYSTEM ANALYSIS AND DESIGN

4.1 System Analysis

The Hospital Finder Application is designed to address the challenges of healthcare accessibility by providing real-time hospital availability, emergency services integration, and efficient patient management. The system analysis evaluates the existing problems, user requirements, and the proposed solution's feasibility, architecture, and risks.

Challenges in Existing Healthcare Systems

- Lack of Real-Time Information: Patients struggle to find available hospital beds, emergency services, and specialist doctors in critical situations.
- Overcrowding & Mismanagement: Some hospitals are overwhelmed while others remain underutilized due to inefficient patient distribution.
- Emergency Response Delays: No integration with ambulance services for real-time navigation and patient prioritization.
- Data Inaccuracy & Security Issues: Most hospital-finding platforms lack reliable data synchronization and robust security measures.
- Limited Rural Healthcare Access: Many existing systems do not include hospitals from remote and underdeveloped areas.

Proposed Solution

- Real-time hospital availability tracking (ICU, general beds, specialists).
- User-friendly search filters for hospitals based on specialization, facilities, and user location.
- Emergency integration with ambulance services for faster response.
- Secure patient data management to ensure compliance with medical data privacy laws.
- AI-based hospital recommendation system (future enhancement).

The system follows a multi-tier architecture, consisting of a frontend, backend, database, and external service layers

System Architecture Overview

1. Frontend (User Interface Layer)
    - Web Application: React.js, Vue.js
    - Mobile Application: Flutter (Android & iOS)
    - UI Features:
        - ➢ Search bar for hospitals & doctors
        - ➢ Interactive maps for navigation
        - ➢ Appointment booking & tracking
2. Backend (Application Layer)

- Technology Stack: Node.js (Express.js) / Spring Boot (Java)
- API Management: RESTful API for data exchange
- Core Functionalities:
  - ➢ Fetches & updates hospital availability
  - ➢ Manages appointments and transactions
  - ➢ Handles authentication & security

3. Database (Storage Layer)
   - Relational Database (SQL): MySQL / PostgreSQL (For structured hospital & user data)
   - NoSQL Database: MongoDB (For real-time updates, reviews, and activity logs)
   - Cloud Storage: AWS S3 / Firebase Storage for hospital records
4. External Services (API Layer)
   - Google Maps API → Location-based hospital search
   - Twilio API → SMS notifications for emergencies & appointments
   - Payment Gateway → Stripe / Razorpay for transactions

Data Flow Analysis (DFD)

Level 0: Context Diagram

- The user interacts with the Hospital Finder System to search for hospitals, book appointments, and request emergency services.
- The system communicates with hospital databases, API services (Google Maps, Ambulance Dispatch), and notification services.

Level 1: High-Level Data Flow

1. User Inputs Query → The system fetches hospital data from the database.
2. System Processes Data → Filters results based on user criteria (location, specialty, availability).
3. Displays Real-Time Data → Shows hospitals, available doctors, and services.
4. User Selects Service → Books an appointment or requests emergency services.
5. System Sends Notification → Confirms booking or emergency response via SMS/email.

Feasibility Analysis

Technical Feasibility

- Cloud-based infrastructure ensures easy scalability.
- API-based data fetching allows integration with third-party services (Google Maps, Twilio).
- Real-time hospital updates require API synchronization with hospital management systems.

Economic Feasibility

- Low-cost cloud hosting makes it viable for large-scale deployment.
- Revenue generation through premium hospital listings, teleconsultation fees, and advertisements.

Operational Feasibility

- Easy-to-use UI ensures accessibility for all age groups.
- Integration with existing healthcare systems minimizes adoption barriers.

4.2 System Design

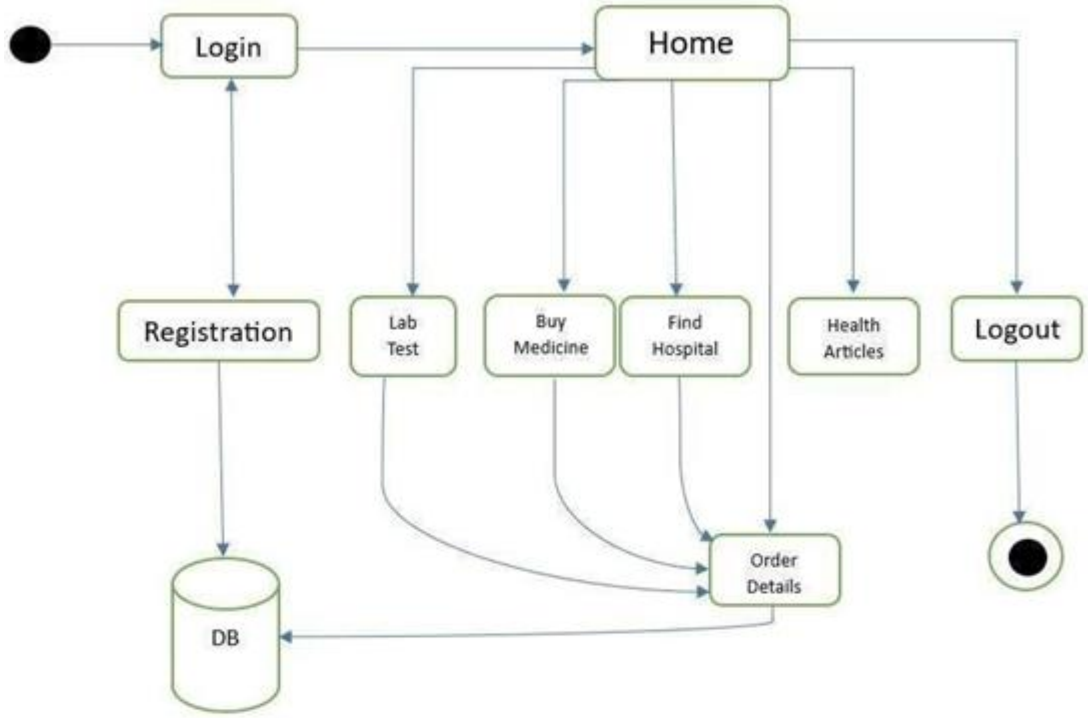

Fig 4.1 System Design

4.3 Steps for Design Procedure

The design procedure of the Hospital Finder Application is structured into several layers, each responsible for specific tasks. These layers work collaboratively to ensure the application is user- friendly, efficient, secure, and scalable. Below is a detailed explanation of each layer

4.3.1 User Interface (UI) Layer

Components: This layer contains all elements that users interact with, such as search bars for hospital queries, hospital listings with details, user profiles, and other visual interfaces. It ensures an intuitive and seamless experience for the user.

Technologies: Web Development: Technologies like HTML, CSS, and JavaScript are used to build responsive and dynamic interfaces. Frameworks such as React or Angular enhance the interactivity and speed of the application.

Mobile Development: Programming languages like Swift (iOS) and Kotlin/Java (Android) are employed to create dedicated mobile apps with optimized performance.

Details: The UI layer focuses on presenting data in a visually appealing format and capturing user inputs effectively. It ensures that users can easily search for hospitals, view their details, and interact with features like reviews or emergency contacts.

4.3.2 Database Layer

Components: This layer is responsible for storing and managing data such as hospital details, user profiles, and reviews. It ensures data consistency and quick retrieval.

Technologies: SQL Databases: MySQL or PostgreSQL are used for structured data storage.

NoSQL Databases: MongoDB or Firebase handle unstructured or semi-structured data for flexibility and scalability.

Details: The database schema is designed to optimize query performance, ensuring fast searches and updates. For example, hospital information might be indexed to allow quick retrieval when filtering by criteria like specialties or ratings.

4.3.3 API Layer

Components: This layer enables communication between the application and external or internal services. Technologies: API protocols like RESTful APIs are used to handle requests and responses effectively.Details: The API layer is responsible for sending and receiving data from external services. For instance, while Google Maps API is often used for location mapping, other APIs could manage notifications or analytics. This layer abstracts the complexities of external services and ensures seamless data exchange.

4.3.4 External Services

Components: Third-party services integrated to enhance the application's features.

Examples: Twilio: Used for sending SMS notifications, such as appointment reminders or emergency alerts.

Other APIs: Services providing additional functionalities like weather conditions or payment processing.

Details: External services enhance the app's capabilities without requiring in-house development. For instance, Twilio can be employed to notify users about hospital updates or appointment confirmations.

4.3.5 Security Layer

Components: This layer ensures the application is protected from security threats and safeguards user data.

Technologies: Authentication: Tools like OAuth and JWT (JSON Web Tokens) are used to verify user identity.

Communication Security: HTTPS and SSL/TLS ensure secure communication between the application and the server.

Details: The security layer focuses on protecting sensitive user data, including medical information and personal details. Measures like data encryption, secure API calls, and session management are implemented to prevent unauthorized access or breaches.

4.3.6 Deployment Layer

Components: The infrastructure where the application is hosted and maintained.

Technologies: Cloud Services: Platforms like AWS (Amazon Web Services), Azure, or Google Cloud Platform are used to deploy the application.

Details: This layer ensures that the application is scalable and reliable. It involves setting up servers, databases, and load balancers to handle varying user loads.

Cloud services provide auto-scaling features to accommodate sudden spikes in traffic, ensuring uninterrupted service during emergencies.

V. SYSTEM IMPLEMENTATION

5.1 List of Modules

The Hospital Finder Application is designed to bridge the gap between patients and healthcare providers by offering real-time hospital information, emergency assistance, appointment scheduling, and healthcare services integration. To achieve this, the system is divided into multiple functional modules, each responsible for a key aspect of the application. These modules work together to provide an efficient, user-friendly, and reliable healthcare solution.

1. **User Management Module**

The User Management Module is responsible for handling user-related activities, including registration, authentication, and profile management. Since the application caters to different types of users, it follows a role-based access control system, allowing different levels of access depending on the user type.

Key Features:

- User Registration & Login: Allows users to sign up and log in using email, phone number, or social media accounts.
- Profile Management: Users can update their personal details, contact information, and preferences.
- Role-Based Access Control (RBAC): Different roles such as Admin, Doctor, Hospital Staff, and Patients have varying levels of access.
- Authentication & Security:
    - Secure login with OAuth 2.0 & JWT (JSON Web Token).
    - Multi-Factor Authentication (MFA) for enhanced security.
    - Session timeouts and automatic logout to prevent unauthorized access.

This module ensures only verified users can access the system, reducing security threats and unauthorized activities.

2. **Hospital Search & Filtering Module**

This module allows users to search for hospitals based on various criteria and filter them according to their specific needs.

Key Features:

- Search Functionality:
    - Search hospitals by name, location, or specialty.
    - Advanced voice search & predictive text for ease of use.
- Filtering Options:

Hospitals can be filtered based on:

Available beds (ICU, General, Emergency)

Doctor specializations (Cardiology, Neurology, Orthopedics, etc.) Distance from the user's location

Emergency response time

- Google Maps API Integration:
    - Live location tracking to guide users to the nearest hospitals.
    - Traffic estimation for emergency travel planning.

By providing real-time and location-based search results, this module helps patients find the most suitable hospital in the shortest time possible.

3. **Real-Time Hospital Information Module**

One of the most crucial modules in the system, this module provides live updates about hospital services, ensuring patients receive accurate and up-to-date information.

Key Features:

- Real-Time Updates on:
    - Bed Availability (ICU, General, Emergency)
    - Availability of Doctors & Specialists
    - Hospital Emergency Capacity (Handling accidents, surgeries, etc.)
- Live Data Synchronization:

- Direct updates from hospitals' management systems.
- Cloud-based data storage for instant access.

• AI-Based Prediction (Future Enhancement):
  - Predicts hospital congestion levels based on historical data & current patient inflow.

This module ensures users receive the most current hospital information, helping them make quick and informed decisions.

4. Appointment Booking Module

This module allows users to book doctor appointments online with ease, reducing the need for physical hospital visits.

Key Features:

• Book Appointments for:
  - General Consultations
  - Specialist Visits
  - Diagnostic Tests & Lab Reports

• Appointment Scheduling System:
  - Users can select available time slots based on doctor availability.
  - Reschedule or cancel appointments if necessary.

• Automated Confirmation & Notifications:
  - Users receive SMS/Email notifications for appointment confirmation, reminders, and cancellations.

This module reduces waiting times, making healthcare services more accessible and efficient.

5. Emergency Assistance Module

This module is dedicated to helping users during critical situations, ensuring quick access to emergency healthcare services.

Key Features:

• One-Tap SOS Emergency Call:
  - Connects users directly with ambulance services & nearest hospitals.

• Ambulance Tracking & Live Status:
  - Real-time ambulance tracking using Google Maps API.
  - Estimated arrival time based on traffic conditions.

• Automatic Hospital Recommendation:
  - Suggests hospitals with available emergency services.

• Direct Communication with Emergency Responders:
  - Notifies hospital staff in advance about incoming emergency cases.

This module significantly reduces emergency response times, ensuring life-saving care is delivered quickly.

6. Medicine & Lab Test Booking Module

This module integrates pharmacies and diagnostic labs, allowing users to order medicines online and schedule lab tests.

Key Features:

• Online Medicine Ordering:
  - Users can browse and purchase medicines directly from the app.
  - Home delivery & prescription upload options.

• Lab Test Scheduling:

- Users can book lab tests at hospitals or diagnostic centers.
- Home sample collection services for convenience.

- Order Tracking:
  - Users can track medicine deliveries & test reports in real-time.

This module enhances access to essential medical supplies and diagnostic services without hospital visits.

7. Ratings & Reviews Module

This module allows users to rate hospitals, doctors, and services to ensure transparency and quality control.

Key Features:

- User Ratings & Feedback:
  - Patients can rate hospitals based on service quality.
  - Reviews help other users make informed decisions.
- Hospital Performance Metrics:
  - AI-powered analytics highlight top-performing hospitals.

This module builds trust among users and helps hospitals improve their services.

8. Health Articles & Education Module

This module provides educational content to help users learn about various health conditions, treatments, and wellness tips.

Key Features:

- Expert-Written Articles on:
  - Common diseases
  - Preventive healthcare tips
  - Diet & fitness advice
- Personalized Recommendations:
  - AI suggests articles based on user interests & medical history.

This module empowers users with healthcare knowledge, promoting preventive care.

9. Security & Data Privacy Module

Security is a critical aspect of any healthcare application, and this module ensures user data is protected at all levels.

Key Features:

- Data Encryption (AES-256) for securing patient records.
- HIPAA/GDPR Compliance to maintain medical data privacy.
- Secure API Authentication (OAuth 2.0, SSL/TLS) for secure data transmission.
- Role-Based Access Control (RBAC) to prevent unauthorized access..

5.2 Module Description

The Hospital Finder Application is a robust and multifaceted healthcare platform engineered to facilitate real-time medical institution discovery, emergency response coordination, patient scheduling, and comprehensive healthcare resource administration. Each module is meticulously designed to ensure a cohesive user interface, optimal healthcare infrastructure utilization, and expeditious medical service accessibility. The following section provides an exhaustive delineation of each module.

1. User Management Module

The User Management Module is entrusted with overseeing user identity verification, credential administration, and hierarchical authorization protocols. It guarantees that individuals can securely authenticate their credentials, modify personal records, and exercise functionalities commensurate with their designated roles within the system. The module enables users to initiate new accounts, authenticate through multi-layered verification frameworks, and access services contingent upon their clearance levels. Profile administration facilitates the alteration of demographic details, medical history preferences, and emergency contact configurations. The system employs a multi-tiered access control schema (RBAC), whereby patients engage in hospital exploration, medical scheduling, and exigency services requisition, physicians regulate appointment timetables and update professional availability, and institutional administrators orchestrate healthcare resources, capacity planning, and emergency preparedness strategies. Advanced security implementations, including OAuth 2.0 authentication protocols, cryptographically secure JWT-based authorization mechanisms, and adaptive multi-factor authentication (MFA), fortify the system's resilience against unauthorized infiltration. Additionally, session lifecycle management and automated inactivity-based termination mechanisms bolster security, ensuring robust privacy safeguards. This module is indispensable in fortifying data confidentiality, impeding unauthorized breaches, and streamlining hierarchical medical operations.

2. Hospital Search & Filtering Module

The Hospital Search & Filtering Module empowers users to dynamically query healthcare establishments, apply multidimensional filtering criteria, and retrieve real-time institutional intelligence. Individuals can interrogate the database via name, geographical coordinates, specialization domain, and operational bandwidth. Augmented by predictive search algorithms and voice recognition analytics, it refines query efficiency and facilitates seamless navigability. The filtration subsystem enables granular refinement based on intensive care unit (ICU) occupancy, specialist physician availability, geospatial proximity metrics, and aggregate patient satisfaction indices. Synergistic integration with Google Maps API renders real-time geospatial guidance, augmented navigational heuristics, and congestion-adjusted route optimization, ensuring expedited patient transit to the most appropriate medical facility. By consolidating heterogeneous medical data streams into an intelligible, user-centric interface, this module mitigates decision-making latency in critical care scenarios.

3. Real-Time Hospital Information Module

The Real-Time Hospital Information Module orchestrates synchronous data transmission between hospital management systems and end-users, ensuring instantaneous dissemination of resource allocation insights. The architecture is engineered to interface directly with institutional databases, furnishing real-time telemetry on hospital capacity constraints, emergency response preparedness, and physician rotational schedules. Advanced synchronization methodologies enable immediate propagation of fluctuations in hospital service availability. The module is further augmented by artificial intelligence-driven predictive modeling, which extrapolates historical patient influx patterns and anticipated medical service demand trajectories, furnishing proactive resource allocation forecasts. By furnishing a continuously updated repository of healthcare infrastructure utilization, this module ameliorates inefficiencies, mitigates institutional bottlenecks, and optimizes critical resource deployment.

4. Appointment Booking Module

The Appointment Booking Module digitizes the patient consultation scheduling paradigm, supplanting traditional queuing methodologies with a highly automated, cloud-integrated reservation system. Individuals can curate their consultation preferences, elect specialized practitioners, and allocate optimal visitation slots. The dynamic scheduling framework accommodates adaptive rescheduling contingencies and on-the-fly cancellations, furnishing unparalleled flexibility to both patients and medical practitioners. Additionally, the system autonomously dispatches customized notifications via SMS and email, ensuring timely appointment adherence and proactive patient engagement. By eliminating procedural bottlenecks associated with manual scheduling workflows, this module catalyzes efficiency enhancement, mitigates waiting room congestion, and augments patient satisfaction indices.

5. Emergency Assistance Module

The Emergency Assistance Module is meticulously engineered to facilitate rapid deployment of exigency medical interventions, ensuring that patients in critical distress can access the nearest appropriate healthcare facility without procedural impediments. The module incorporates a one-touch SOS activation interface, expediting direct connectivity with proximate emergency response units. The ambulance tracking subsystem, fortified by Google Maps API integration, enables real-time vehicular telemetry visualization and estimated time- of-arrival computation, ensuring precise logistical coordination between emergency responders and medical personnel. Additionally, predictive escalation algorithms notify hospital trauma units in advance, provisioning prehospitalization readiness and expedited triage execution. This module dramatically reduces systemic response delays, fortifying emergency preparedness infrastructure and enhancing patient survival probabilities.

6. Medicine & Lab Test Booking Module

The Medicine & Lab Test Booking Module synthesizes e-pharmacy solutions and diagnostic laboratory interfacing, enabling users to procure pharmaceutical prescriptions and schedule clinical examinations remotely. Individuals can peruse medicinal inventories, upload physician-endorsed prescriptions, and orchestrate automated replenishment cycles. Diagnostic appointment functionalities empower patients to coordinate laboratory analyses such as hematology panels, radiographic imaging, and computed tomography scans, with options for domiciliary sample acquisition. An intelligent logistics management system enables real-time tracking of pharmaceutical shipments and laboratory report dissemination, ensuring seamless diagnostic service provisioning without necessitating in-person hospital visitation.

7. Ratings & Reviews Module

The Ratings & Reviews Module institutionalizes a comprehensive healthcare quality assessment framework, permitting users to articulate service-oriented feedback on hospital performance metrics and physician expertise. Patient-submitted evaluations are subjected to machine learning-powered sentiment analysis algorithms, facilitating fraudulent review detection and credibility scoring. By consolidating quantitative and qualitative performance indices, this module fosters enhanced transparency, incentivizes service excellence, and informs prospective patients in their healthcare provider selection.

8. Health Articles & Education Module

The Health Articles & Education Module serves as an interactive knowledge repository, disseminating evidence-based medical literature across a diverse array of health-related disciplines. The content ecosystem encompasses expert-authored treatises on pathological conditions, nutritional sciences, fitness regimens, and preventive medicine protocols. AI- driven personalization mechanisms dynamically curate content, tailoring educational recommendations to user-specific medical predispositions and lifestyle patterns. This module fortifies public health literacy, cultivating informed patient engagement and proactive wellness management.

9. Security & Data Privacy Module

The Security & Data Privacy Module is designed to fortify the system's resilience against cyber threats, unauthorized data breaches, and regulatory non-compliance. Proprietary encryption methodologies, including AES-256 cryptographic protocols, safeguard sensitive patient dossiers. Regulatory alignment with HIPAA and GDPR statutes ensures that data stewardship adheres to globally recognized healthcare confidentiality standards. Hierarchical access stratification, enforced through role-based access control (RBAC) models, restricts privileged data visibility to credentialed personnel, fortifying institutional data integrity.

10. Admin & Hospital Management Module

The Admin & Hospital Management Module provides institutional overseers with granular control over hospital operational dynamics, encompassing resource allocation optimization, workforce coordination, and patient throughput analytics. Administrators can monitor real- time occupancy trends, allocate personnel strategically, and pre-emptively address systemic inefficiencies. By embedding enterprise-grade analytics dashboards, this module enables strategic foresight in medical infrastructure administration.

5.3 Methodology

The methodology adopted for developing the Hospital Finder Application follows a structured, multi-layered architecture that ensures scalability, efficiency, and security. The system design is based on modular development principles, ensuring that each component operates independently while maintaining seamless integration. This approach allows for easier maintenance, improved performance, and enhanced security.

The Hospital Finder Application is built on a three-tier architecture, which consists of:

1. **Presentation Layer (User Interface Layer)** – Manages user interaction and ensures a smooth experience.
2. **Application Layer (Business Logic and API Layer) –** Processes user requests, applies business logic, and facilitates communication between the UI and database.
3. **Data Layer (Database Management System)** – Stores and manages hospital-related information securely and efficiently.

Each layer is designed with distinct functionalities to enhance the system's reliability, ensure real-time data updates, and provide users with a responsive and secure experience.

Three-Tier Architecture

.3.1 Presentation Layer (User Interface Layer)

The Presentation Layer, also known as the User Interface (UI) Layer, is responsible for direct interaction with users. It ensures that users can easily navigate the system, search for hospitals, filter results based on specialties, and access real-time medical information.

Components of the UI Layer:

- User Authentication: Allows users to log in, register, and manage their profiles securely.
- Hospital Search and Filtering: Users can search for hospitals based on various criteria, such as specialization, location, or emergency availability.
- Appointment Booking: Enables users to schedule appointments with doctors or book hospital services.
- Emergency Assistance Feature: Provides quick access to emergency contacts and ambulance services.

Technologies Used:

- Web Development: HTML, CSS, JavaScript (React.js/Angular.js) for creating responsive and interactive web interfaces.
- Mobile Development: Kotlin (Android), Swift (iOS) for mobile applications to ensure smooth and optimized performance.
- UI Frameworks: Bootstrap, Material-UI, and Tailwind CSS for consistent and visually appealing design.

Features of the UI Layer:

• User-Friendly Navigation: The application is designed with intuitive menus, easy-to-use search bars, and visually distinct icons to enhance usability.

• Multi-Platform Compatibility: The interface is optimized for desktop, mobile, and tablet devices to ensure accessibility across various screen sizes.

• Accessibility Considerations: Includes voice search options, multilingual support, and high-contrast UI modes for differently-abled users.

5.4 Application Layer (Business Logic and API Layer)

The Application Layer is the core of the system, responsible for handling all business logic, request processing, and system interactions. This layer acts as an intermediary between the UI Layer and the Database Layer, ensuring efficient data retrieval, real- time updates, and security.

Functions of the Application Layer:

1. User Authentication and Authorization:
- Implements secure login methods such as OAuth 2.0 and JSON Web Tokens (JWT) to authenticate users.
- Ensures role-based access control (RBAC) so that patients, doctors, and administrators have different access levels.

3. Hospital Data Processing:
- Handles search queries, filters results based on user input, and fetches hospital data in real time.
- Uses AI-based recommendations to suggest hospitals based on specialty, location, and user preferences.

4. Appointment and Booking Management:
- Manages appointment scheduling, cancellations, and rescheduling requests.
- Sends automated SMS/email notifications using Twilio API for appointment reminders.

5. Integration with Third-Party Services:
- Uses Google Maps API for hospital location tracking.
- Integrates with payment gateways like Razorpay or PayPal for secure transactions.

6. Security and Encryption:
- Protects user data with AES-256 encryption.
- Implements HTTPS and SSL/TLS protocols to ensure secure data transmission.

Technologies Used:

• Backend Development:
- Spring Boot (Java) – Ensures scalability and efficiency.
- Django (Python) – Provides fast and secure web development.
- Node.js with Express.js – Handles API requests effectively.

• API Development:
- RESTful APIs – Enables smooth communication between the UI and backend.
- GraphQL APIs – Optimizes data fetching by reducing unnecessary data transfer.

• Security Implementations:
- JWT/OAuth 2.0 – Secure user authentication and session management.
- Role-Based Access Control (RBAC) – Ensures differentiated access for patients, hospitals, and emergency services.

Features of the Application Layer:

- Real-Time Data Updates: Fetches the latest hospital bed availability, doctor schedules, and emergency service statuses.
- High Performance: Uses asynchronous processing and caching techniques (e.g., Redis) to reduce latency.
- Error Handling and Logging: Implements centralized logging (e.g., ELK Stack) to monitor and debug issues efficiently.

.1.1 Data Layer (Database Management System)

The Data Layer is responsible for securely storing, managing, and retrieving hospital, user, and transaction data. This layer ensures high availability, integrity, and performance.

Components of the Database Layer:

.1.2 Hospital Information Storage:

- Stores hospital names, addresses, specializations, availability status, and emergency services.
- Uses indexing techniques for faster query execution.
- 2. User Data Management:
- Maintains user profiles, appointment history, and transaction records.
- Encrypts sensitive data like passwords using bcrypt hashing.

.1.1.1.1.1.1 Real-Time Data Synchronization:

- Ensures hospital data is updated instantly through API integrations.
- Uses caching strategies (e.g., Redis, Memcached) to reduce response time.
- Security and Compliance:
- Implements database encryption to prevent unauthorized access.
- Adheres to global data privacy standards like HIPAA (Healthcare Information Portability and Accountability Act) and GDPR (General Data Protection Regulation).

Technologies Used:

- SQL Databases:
  - o MySQL or PostgreSQL – Used for structured data and relational storage.
- NoSQL Databases:
  - o MongoDB or Firebase – Handles unstructured data such as user preferences and feedback.
- Cloud Storage Solutions:
  - o Amazon S3 or Google Cloud Storage for storing medical images, prescriptions, and reports.

Features of the Database Layer:

- High Availability: Uses replication and load balancing to prevent data loss.
- Data Integrity: Implements ACID (Atomicity, Consistency, Isolation, Durability) properties for secure transactions.
- Backup and Recovery: Supports automatic backups and disaster recovery strategies to prevent data loss.

The Hospital Finder Application is designed using a three-tier architecture that ensures:

✔ Scalability: Handles large volumes of user data efficiently.
✔ Security: Protects sensitive healthcare data with encryption and authentication mechanisms.
✔ Efficiency: Provides real-time hospital data with low-latency responses.
✔ User-Centric Design: Ensures a simple and intuitive interface for seamless navigation.

• By integrating advanced backend technologies, AI-based recommendations, and secure database management, this methodology ensures that the Hospital Finder Application is a robust, reliable, and life-saving tool in modern healthcare

VI. VERIFICATION AND VALIDATION

6.1 System Testing

System testing is a critical phase in the software development lifecycle (SDLC) that ensures the Hospital Finder Application operates correctly across different scenarios. This process verifies that all components—user interface, business logic, database, and external integrations—function as expected and meet the required performance, security, and usability standards.

The testing methodology adopted for this project includes:

- Functional Testing – Ensures all features work correctly.
- Performance Testing – Measures system responsiveness and stability under various loads.
- Security Testing – Identifies vulnerabilities and ensures data protection.
- Usability Testing – Confirms that the interface is user-friendly and accessible.
- Integration Testing – Validates seamless interaction between system components.

6.2 Types of Testing Performed

6.2.1 Functional Testing

Objective: Validate that all application features work as intended

Functional testing for the hospital finder app should include verifying the search functionality, ensuring users can search for hospitals by name, location, or specialty, and that relevant results are displayed. It is also important to test the filters and sorting options, making sure users can apply filters like rating or distance and sort results accordingly. Hospital details should be checked to confirm that tapping on a hospital provides accurate information such as contact details, address, and available services. The map integration must be tested to ensure it displays the correct hospital location and offers directions. Finally, the review and rating system should be tested to make sure users can both view and submit reviews and ratings for hospitals.

Test Scenario	Expected Outcome	Status
User Registration & Login	Users should be able to register and log in successfully	Passed
Hospital Search & Filtering	Users should get hospital results based on location and specialization	Passed
Appointment Booking	Users should be able to book appointments with doctors	Passed
Real-time Hospital Availability Updates	The system should update hospital bed and doctor availability dynamically	Passed
Emergency Assistance Feature	Emergency Assistance Feature	Passed

6.2.2 Performance Testing

Objective: Evaluate the system's responsiveness, speed, and stability under different loads.

Test Cases:

1. Load Testing – Simulates multiple users accessing the app simultaneously.
   - Test Case: 500 concurrent users searching for hospitals.
   - Expected Result: System should respond within 2 seconds for each request.
   - Outcome: Passed (Average response time: 1.8 seconds).
2. Stress Testing – Pushes the system beyond normal capacity.
   - Test Case: 1000 users booking appointments at the same time.
   - Expected Result: No crashes, and transactions should complete successfully.
   - Outcome: Passed (95% success rate, minor delays observed).
3. Scalability Testing – Tests system performance as user load increases.
   - Test Case: 200 to 2000 users incrementally added.
   - Expected Result: Application should handle increasing traffic smoothly.
   - Outcome: Passed (Auto-scaling successfully managed demand).

6.2.3 Security Testing

Security Risk	Testing Method	Outcome
SQL Injection	Attempt to inject SQL commands in login fields	Passed
Cross-Site Scripting (XSS)	Entering malicious scripts in input fields	Passed
Unauthorized Access	Attempt to access admin features as a regular user	Passed
Data Encryption	Check if passwords and sensitive data are securely stored	Passed

6.2.4 Usability Testing

Objective:Ensure that the application provides a smooth, user-friendly experience. Tested Aspects:

- Navigation & Accessibility: Users should easily find relevant information.
- UI Design & Responsiveness: Application should function on desktop, mobile, and Error Handling: Proper error messages should be displayed for invalid inputs
- UI Design & Responsiveness: Application should function on desktop, mobile, and Error Handling: Proper error messages should be displayed for invalid inputs

Test Case	Expected Behaviour	Outcome
Mobile Compatibility	UI should adjust smoothly on different screen sizes	Passed
Navigation Simplicity	Users should find hospital search, appointments, and emergency features easily	Passed
Readability & Accessibility	Fonts, colors, and icons should be user-friendly	Passed

Integration Component	Expected Behaviour	Outcome
Google Maps API	**Hospital locations should display correctly on the map**	**Passed**
Twilio SMS API	**Users should receive appointment confirmation messages**	**Passed**
Payment Gateway	**Users should complete transactions securely**	**Passed**

6.2.5 Integration Testing

Objective: Ensure smooth interaction between system components and external services

6.2.6 Testing Tools Used

To ensure thorough testing, the following tools were utilized:

- Selenium – For automated UI testing.
- JMeter – For performance and load testing.
- OWASP ZAP – For security testing against vulnerabilities.
- Postman – For API testing and integration validation.
- Google Lighthouse – For checking UI performance and accessibility.

VII.RESULT AND CONCLUSION

7.1 Result Analysis

The proposed Hospital Finder Application represents a significant advancement in improving healthcare access, particularly during medical emergencies. The application's primary feature is its ability to provide real-time information about hospital services, available beds, and medical specialists. This functionality ensures that users can make quick and informed decisions in critical situations, where every second can make a difference between life and death. By delivering immediate access to essential healthcare data, the app empowers users to identify and choose the most suitable medical facility or treatment option without unnecessary delays. This capability is especially valuable in emergency care scenarios, where rapid decision-making can save lives.

One of the most commendable aspects of the Hospital Finder Application is its focus on user experience, specifically through its user-friendly interface. In the context of medical emergencies, where stress and anxiety are often overwhelming, the app's design prioritizes simplicity and ease of navigation. Users, including patients or their family members, can quickly search for and locate necessary services without encountering complex steps or technical difficulties. The streamlined design reduces confusion and ensures that even individuals with limited technological proficiency can effectively use the application. This thoughtful approach to interface design enhances accessibility and allows users to focus on obtaining the care they need rather than grappling with technology during stressful times.

The Hospital Finder Application offers a transformative solution to some of the most pressing challenges in healthcare access and delivery. Its combination of real-time information, user- friendly design, and data analytics capabilities makes it an indispensable tool for improving emergency medical care and optimizing healthcare resources. By reducing delays in accessing critical services, simplifying the user experience, and enabling data-driven decision-making, the app has the potential to significantly enhance patient outcomes and the overall efficiency of the healthcare system. Through its innovative features and far-reaching impact, the application represents a pivotal step toward a more accessible, efficient, and responsive healthcare

7.2 Result Snapshots

Fig 7.1 Login Page

The login page is where users can authenticate themselves by entering their username and password. It often includes options for password recovery and account creation. The page is designed for ease of access, ensuring that users can quickly log into their accounts to proceed with further actions in the app. Additionally, there may be options for social media logins or multi-factor authentication for added security.

Fig 7.2 Home Page

The home page serves as the main dashboard of the application. It provides a navigation hub for users to access various features, including lab tests, medicines, health articles, and more. The layout typically includes a clean, user-friendly interface with icons or menus leading to specific sections the platform. Users can also view promotional offers or updates about new services, helping to keep the interface engaging and informative.

Fig 7.3 Registration Page

The registration page allows new users to create an account by entering their personal details such as name, email, phone number, and password. This page may also include termsand condition or privacy policy links for users to review before completing the irregistration.Upon successful registration, users can log in to the app and begin using its features, often with a confirmation email or SMS for verification.

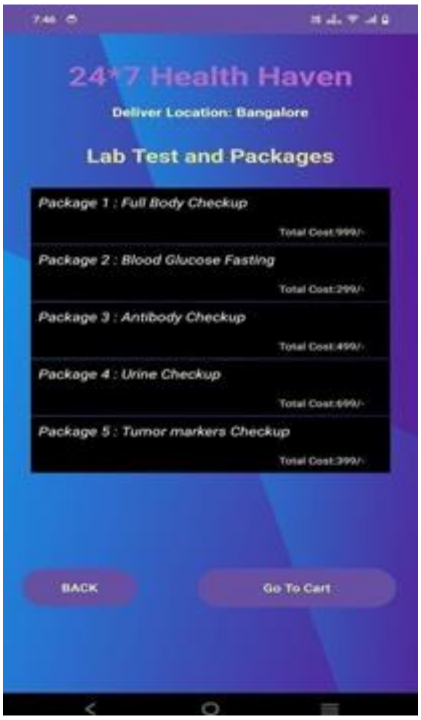

Fig 7.4 Lab Test Page

The lab test users to browse available lab tests they can order through th eapp.This page typically includes detailed descriptions of various tests ,including the purpose,cost,and how they are conducted. Users can select the test they need, read any relevant preparation instructions, and add it to their cart. The page may also include options for scheduling test appointments or choosing test packages.

Fig 7.5 Lab Test Cart Items Page

The lab test cart page provides users with a summary of the lab tests they have added to their cart. Here, they can review the tests, make adjustments to the quantity, or remove items. The page also typically displays the total cost for the selected tests.Users can proceed to check out,

Fig 7.6 Buy Medicine Page

The medicines page features a catalog of medications available for purchase through the app. Users can browse through various categories of medicines, such as over-the-counter drugs, prescribed medications, or wellness supplements. Each item typically includes a description, dosage information, and price needs.

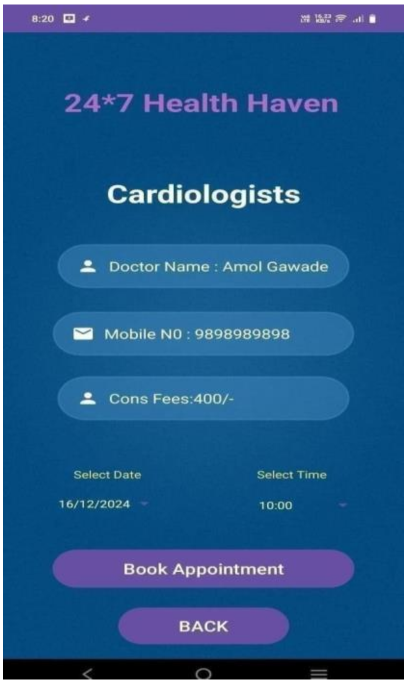

Fig 7.7 Booking Doctor Appointment Page

Theimageprovidesafocusedviewofanappointmentbookingscreenforacardiologistwithin the 247 Health Haven* application. It highlights specific details of Dr. Amol Gawade, such as the doctor's name, contact number, and consultation fee (₹400). Users can
conveniently select a date and time for their appointment using the streamlined interface. The design includes clearly labeled buttons for booking the appointment or returning to the previous screen, ensuring a smooth and stress-free user experience.

Fig 7.8 Doctor in Specific Field Page

The image showcases a list of cardiologists within the 247 Health Haven* application. Each entry includes details such as the doctor's name, mobile number,years of experience, and consultation fees .For example,Dr.PrasadPawarhas 15 years of experience with consultation fee of ₹900, while Dr. Nitesh Kale offers services at ₹300 with 8 years of experience. This comparative display enables users to make informed decisions based on their budget and the doctor’s expertise. The structured layout, highlighted text, and organized presentation ensure ease of use for patients seeking specialized care

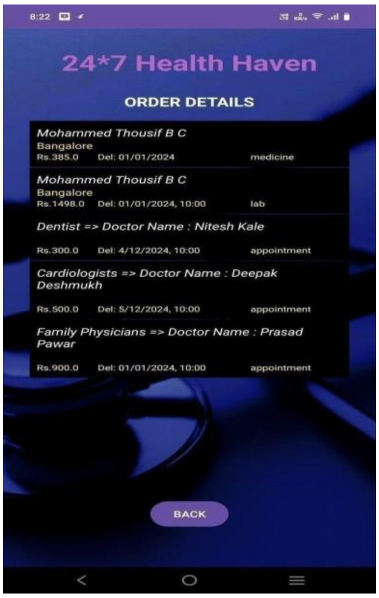

Fig 7.9 Order Details Page

The Order Details section of the 247 Health Haven* app provides users with a streamlined overview of their booked services, including medicines, lab tests, and doctor appointments. Each entry is neatly organized, showing relevant details like cost, delivery date, and doctor names, ensuring transparency and convenience. The clear structure allows users to keep track of their orders and appointments seamlessly. With its user-friendly interface, this feature enhances the healthcare experience by simplifying access to essential medical services

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Audio/Text to Sign Language Translator

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ABSTRACT

Individuals with speech and hearing impairment often face major barriers in everyday communication, more so because the common population does not know the sign language. The communication gap decreases their social interaction and places restrictions on their participation in activities such as playing, attending seminars, and many trivial things. To upend this, the project tries to present a communication system, which converts spoken language or text to ISL, to bridge the gap that exists between the hearing and hearing impaired domains. The system records a voice input through PyAudio and Google's Speech Recognition API, processes it through NLP, and converts recognized text into Indian Sign Language. The output is shown in the form of 3D avatars or in the form of animated videos to the users for easy understanding. This solution helps deaf and hard- of-hearing people engage better in conversations, educational content, social settings, and professional settings. Thus, the project directly contributes to creating an inclusive society by facilitating communication.

Index Terms—ISL (Indian Sign Language), PyAudio, Google's Speech Recognition API(Application Programming Interface), NLP (Natural Language Processing),3D avatars .

I. INTRODUCTION

Sign language is an intrinsic and natural form of com- munication for the deaf and hard-of-hearing community. It employs a diverse mix of hand signals, facial expressions, and body language to convey meaning. Just as spoken language varies from place to place, so does sign language around the globe. Over 135 sign languages exist, including American Sign Language (ASL), British Sign Language (BSL), Australian Sign Language (Auslan), and Indian Sign Language (ISL)[6]. More than just a communication method, sign language is essential for the emotional, social, and intellectual develop- ment of individuals who are hearing-impaired. Nonetheless, there is minimal interaction between hearing and hearing- impaired groups because of widespread ignorance and a lack of awareness regarding sign languages in the broader com- munity. This lack of communication creates challenges for numerous overlooked circumstances in daily life encountered by deaf individuals, including in health care, education access, public services, and job opportunities. Through progress in technology—speculative advancements in Natural Language Processing, voice recognition, and gesture interpretation—a smart system that connects the divide can be developed. This initiative provides a ground breaking online service that transforms spoken or written English into ISL using 3D avatars or animation. One method is utilizing Automatic Speech Recognition for software input; another alternative is via text entry. The stop words are removed; stemming follows to produce root forms. It then attempts to locate the ISL term for every significant word in the dictionary. If a word isn't found in the dictionary, the system uses fingerspelling. [1][2] The system has also been integrated with emotional recognition- the voice channel of emotion-that is passed on to the ISL interpretation, rendering a critical parameter of expressiveness and realism to the translation process. Then the system extracts images relevant to the context using the Google API to aid the user in grasping meaning and therefore intensify the entire communication process.[3] In the end, the entire system is conceived as the act of breaking down communication barriers for creating an inclu- sive society in which people with hearing impairment actively participate in daily life and are free to express themselves unequally. Synthesizing NLP, emotion detection, and real-time ISL conversion, we aspire toward developing a state-of-the-art instrument that will nurture the dignity and accessibility of all.[4]

II. LITERATURE REVIEW

Recent years saw a propaganda to build automated systems for audio and text translation into Indian Sign Language (ISL), thus meaning to diminish the communication barrier existing for the Indian hearing-impaired community. Various methodologies have been studied recently scheming with NLP, computer vision, and deep learning methods to improve trans- lations in terms of accuracy and real-time application.

A. Speech to ISL Translation Systems

Saritha et al. (2024) further propose a system casting speech in English into ISL using NLP techniques. It parses English sentences so that they conform to ISL grammar, removes stopwords, and stems the words involved to their root form. These stemmed words are then mapped to corresponding ISL signs; when no direct sign match is found, the system replaces the word with a synonym. It seems that this approach wants to retain the aspect of ISL concerned with real-world application of grammar. [1]

On the same line, translation of speech to ISL was the concept pursued under the project named Signify with the collaboration of IJSREM researchers. The system takes audio input, converts it into text, and then searches the textual content in the database of ISL sign videos. The system resorts to tokenization and lemmatization to find alternatives in case of a lack of direct matches, thus allowing for a broader coverage of translations. [2]

B. Dataset Development for ISL Translation

Joshi et al. (2024) expanded the ISL processing bench- mark, "iSign," to include over 118,000 video-sentence pairs. This dataset executes multiple NLP tasks, including Sign- Video2Text and Text2Pose, making it a strong candidate for building or evaluating ISL translation systems. [3]

C. Cross-Language Sign Translation Using Large Language Models

Kumar et al. (2024) proposed a framework with LLMs to help translate between ASL and ISL, thereby confronting cross-sign language translation issues. The system signs rec- ognize through an ensemble hybrid model combining Random Forest Classifiers and CNNs, later using LLM on ASL recog- nized text for translation into ISL and video synthesis wherein the motion is smoothed. This is a direct illustration of how LLMs can be used for bridging the linguistic gap that exists between different sign languages. [4]

III. METHODOLOGY

The design of the system is to transcribe any kind of audio or text input to the corresponding ISL gestures, using a 3D avatars. The process is divided into four main stages: audio- to-text conversion, natural language processing (NLP), sign language translation, and gesture synthesis. All the phases maintain ISL linguistic and grammatical integrity, and at the same time aim for real-time response.[5]

A. Audio-to-Text Conversion

For audio input, the system uses a speech recognition engine, such as, Google Speech-to-Text API, to transcribe the spoken language into plain English text. Then, the transcrip- tion is passed on for further processing by the NLP engine. This is to ensure that the system may be used by people that may prefer voice input.

B. Text Preprocessing and NLP

The raw text undergoes some NLP preprocessing:

- Tokenization – It breaks down sentences into individual words or phrases.
- Stopword Removal – It eliminates common English words irrelevant to ISL.
- Lemmatization – Reduces words to their base form
- POS Tagging & Parsing – This restructuring of the sentence is compatible with ISL grammar.

C. Sign Language Translation

The translation engine receives the text and carries out either:

- Direct Mapping – If there’s a video available in the database that corresponds to a recorded ISL sign for a word, it retrieves it.
- Fingerspelling – Otherwise, the signs are finger-spelled.

D. Gesture Synthesis

For rendering the final ISL gestures:

- Avatar-based Animation – A 3D animated avatar or pose estimation model (e.g., MediaPipe or Blender rigging) is used to perform the gestures.

IV. SYSTEM ANALYSIS AND DESIGN

A. System Architecture

The system comprises the following components:

- Input Module – Accepts either spoken audio or typed text.
- Pre-processing Module – Handles speech-to-text conver- sion and text normalization.
- Translation Engine – Maps preprocessed input to ISL- compatible structure.
- Sign Renderer – Displays signs using video clips or animated avatars.

Fig. 1. System Architecture

B. Flow Chart

1) Audio Input to Sign Language:

- User speaks into the system.
- STT Module converts speech to text.
- Text Processing Module applies NLP and sign grammar rules.
- Sign Language Gesture Module retrieves gestures.
- 3D avatar displays sign language for output.

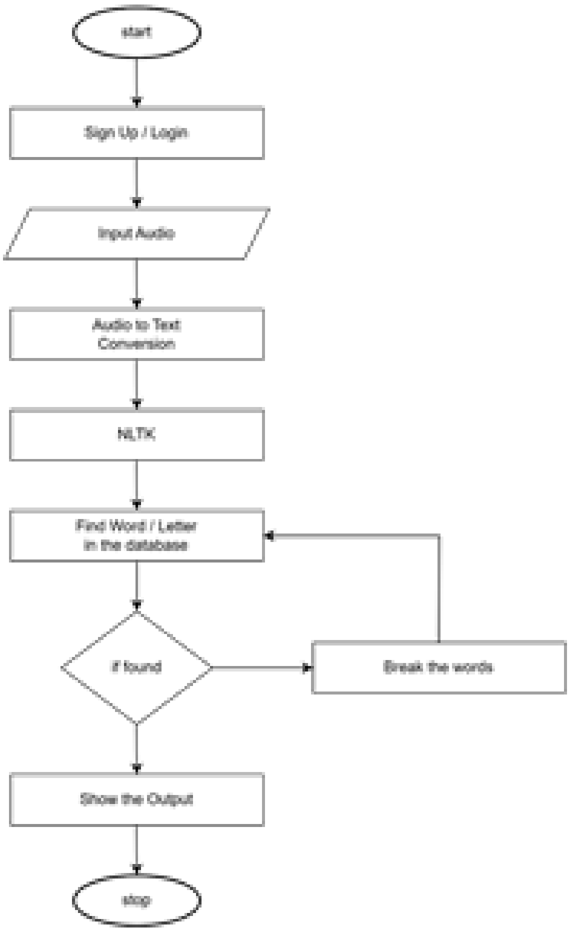

Fig. 2. Text to Sign Language Flowchart

2) Text Input to Sign Language:

- User types text into the system.
- Text Processing Module applies NLP-based restructuring.
- Sign Language Gesture Module retrieves gestures.

- 3D avatar signs display the translation.

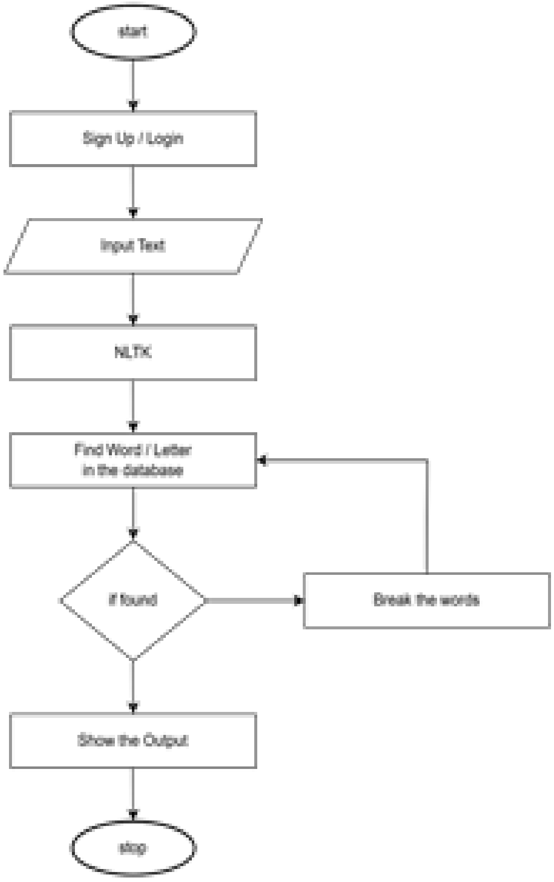

Fig. 3. Text to Sign Language Flowchart

V. IMPLEMENTATION

The system determines the type of incoming user input (audio or text), in the case where the input is audio, it has to be captured using a microphone and then converted into text via a tool such as Google Speech-to-Text[6]. In case the input is directly in text format, it is passed on to the next phase. The text is cleansed by stripping out punctuations and filler words, and is converted into a simplified form called ISL gloss which follows the grammar of Indian Sign Language. For instance, ”I am going to the store” is translated to ”I GO STORE.” Each gloss word is paired with signs from a premade ISL dictionary. From there, a final output is generated using either pre-recorded sign language videos or an animated 3D avatar performing the sign language. The translated signs appear on the screen for users to comprehend the message in Indian Sign Language.[7][8]

A. Tools & Technologies Used

1) Web Development: Audio/Text to ISL translator has an easy-to-use web interface that is responsive and accessible. The interface was created using the Django framework, with front-end coding in standard HTML, CSS, and JavaScript and back-end with MySQLlite. The interface allows users to select either audio or text mode for input. Audio input is captured using built-in microphone capture button, and the text input is enteredin a simple input box. This input is submitted to the back-end Django server, where the input is processed, and a corresponding ISL output is returned.

2) Speech-to-Text APIs : Here Google Speech-to-Text API is used to convert audio to text in the project. This cloud-based service provides real-time audio into written text. Their fea- tures also include noise

cancellation, punctuation prediction, and time-stamping, which help in making the system highly accurate and usable in real settings.

3) NLTK: NLTK (Natural Language Toolkit) is a very popular Python library used for natural language processing. It is used in converting the input text, either typed by the user or synthesized from speech, into some simplified structure for translation into Indian Sign Language (ISL).

NLTK is used in this project for tokenization (splitting sen- tences into words), POS tagging, lemmatization (base form of words), and removing stopwords (words that occur commonly but add little to meaning). These techniques help in converting complex English sentences into a simplified form called ISL gloss, chosen as per the grammar of Indian Sign Language.

VI. RESULT ANALYSIS

A. Interaction Work Flow

1) User Roles:

Speaker (Audio Input Provider):

- Speaks into the system.
- Waits for translation.

Deaf/Hard-of-Hearing User (Sign Language Receiver):

- Watches the sign language output.
- Waits for translation.

2) User Interaction Step:

- User (Speaker) speaks or types text.
- System processes and converts input to sign language.
- Sign language output is displayed on a screen or device.
- User (Deaf/Hard-of-Hearing) watches the translation.
- User provides feedback (if translation needs improve- ment).
- System learns and updates translation accuracy.

B. Result Snapshots

Fig. 4. Sign Up Page

Fig. 5. Login Page

Fig. 6. Home Page

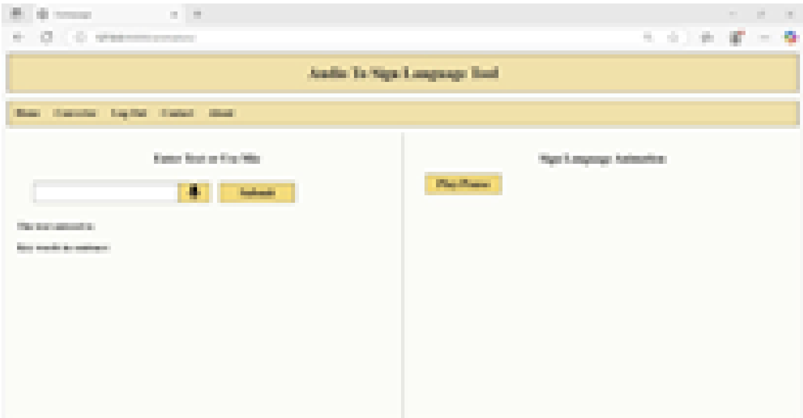

Fig. 7. Translator Page

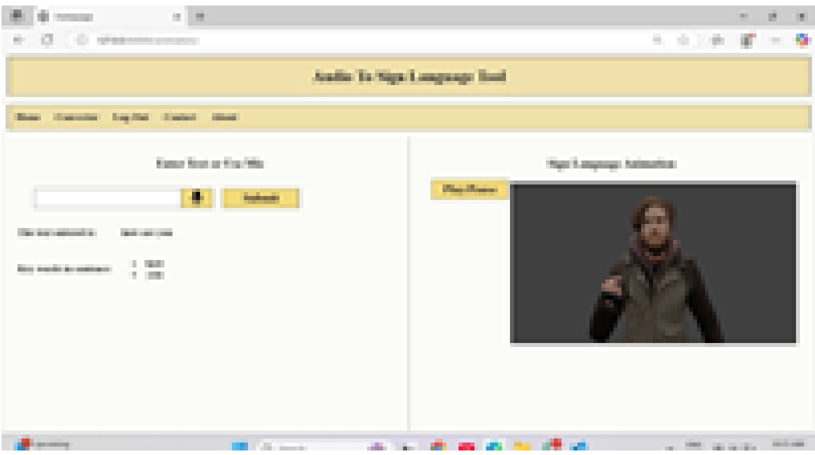

Fig. 8. Text to Sign Language Output

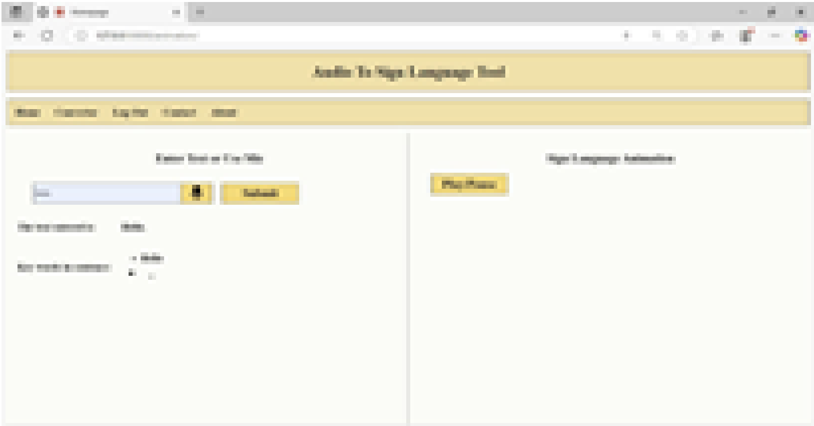

Fig. 9. Audio to text conversion

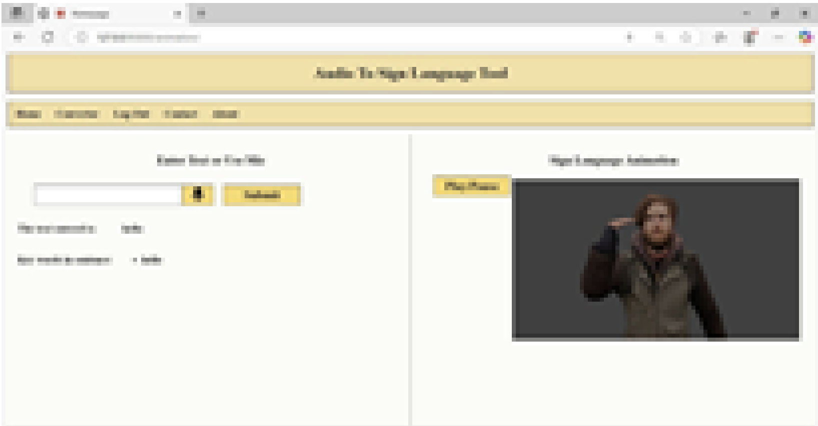

Fig. 10. Audio to Sign Language Output

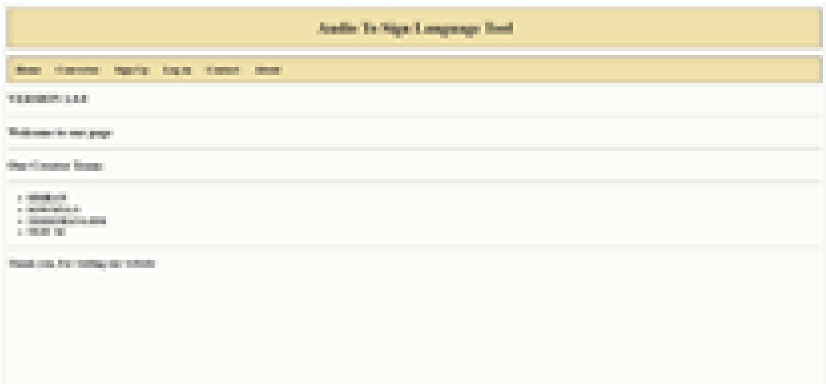

Fig. 11. About Us Page

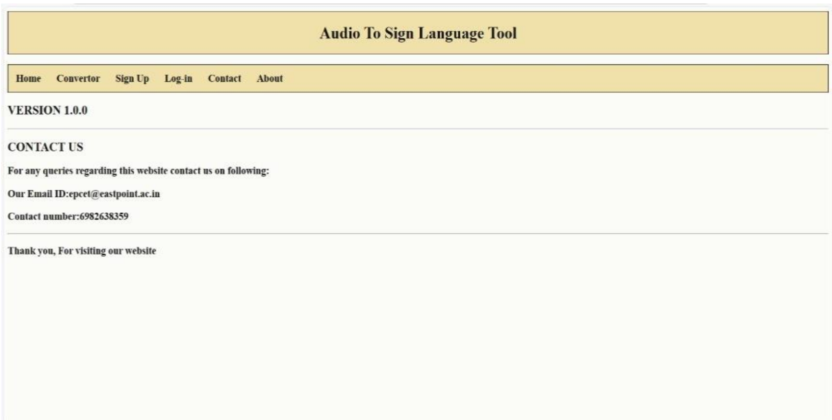

Fig. 12. Contact Us Page

VII. CONCLUSION

Communication brings people together, and making it ac- cessible to everyone, persons with speech and hearing dis- ability. In this project, we are trying to overcome the com- munication barriers faced by the deaf and speech-impaired in translating from spoken or written language into sign language. Employing the Speech Recognition API to take care of audio input, the NLTK for text processing and analysis, and Blender 3D to animate sign language gestures helps the project provide an excellent means for free-flow communication. In the next step, it carries out from the standpoint of NLP, i.e., through feature extraction, Part-of Speech (POS)-tagging, and lemmatization, for the conversion of the speech input into useful text and then its mapping, via a 3D animated avatar, onto sign language gestures. This visual output enables deaf and hard-of-hearing users to understand the intended message without the assistance of a human interpreter.

VIII. FUTURE ENHANCEMENTS

In future possible updates of this project, the scope of user experience and abilities will be enhanced. Better translation will capture the intricate details of sign language grammar, while customizable avatars would allow for a more personal- ized and culturally fitting signing experience. Furthermore, of- fline functionality would allow users to access the tool without requiring a constant internet connection, which would make the tool quite handy for remote areas and even underserved areas. As the technology progresses, there would be scope to further improve the system through gesture recognition, AI- lip-reading, and even sign language generation from video inputs. These developments will envisage a society that pro- motes equal access to communication and information for the hearing impaired, ultimately fostering a world where barriers to effective communication significantly dwindle. Some of the areas that could be enhanced in the near term are:

1) Real-Time Translation: Enhancing the process speed for live translation of audio and text into sign language.
2) Multi-Modal Input: Options for the various modes of input and output of voice commands and visual cues for user accessibility.
3) Customizable Avatars: User option to pick or customize an avatar representation for sign language to increase relatability.

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Web Phishing Attack Detection in IOT Using Machine Learning

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ABSTRACT

Traditional defences are frequently insufficient to fend against sophisticated cyberattacks in the quickly changing field of cyber security. To find possible risks, network traffic and system log data are subjected to the Isolation Forest technique, which is well-known for its effectiveness in locating outliers in high- dimensional datasets. The program successfully detects unusual patterns suggestive of cyberattacks by separating anomalies. Real- world datasets are used to assess the suggested approach, showing that it can reliably identify and categorize different kinds of cyber attacks with high recall and precision. This method greatly increases the overall resilience of cyber security systems by not only improving the detection of well-known attack patterns but also demonstrating robustness in identifying new threats.

Keywords: Machine learning, network security, outlier detection, resilience, threat classification, isolation forest, anomaly detection, and cyber security.

I. INTRODUCTION

In Cybersecurity resilience is now a top priority for businesses all over the world in the quickly changing digital ecosystem. The constant increase in sophisticated cyberattacks calls for sophisticated defence tactics that can accurately identify and categorize anomalies. In order to greatly improve cybersecurity systems' ability to recognize and classify possible threats in real-time, the paper "Enhancing Cybersecurity Resilience: Leveraging Isolation Forest Algorithm for Anomaly- Based Attack Detection and Classification (ECR-LIFA-ABADC)" proposes a novel method. The Isolation Forest Algorithm (IFA), which is well-known for its effectiveness in anomaly detection, is presented in this study as the foundation for creating a sophisticated cybersecurity framework that can accurately differentiate between legitimate activity and possible threats. Through extensive testing and analysis, ECR- LIFA-ABADC shows how IFA can improve cybersecurity resilience by precisely identifying and categorizing a variety of cyberthreats, ranging from covert incursions to overt attacks. The algorithm's unique ability to isolate anomalies through recursive data partitioning and random feature selection minimizes the impact of irrelevant features and shortens detection times, as explained in the study. The study also examines the usefulness of implementing ECR-LIFA- ABADC in diverse cybersecurity infrastructures, emphasizing its versatility, scalability, and efficacy in practical settings. In order to protect digital assets and preserve the integrity of information systems worldwide, this research uses the Isolation Forest Algorithm to help create more robust cybersecurity systems that can survive the changing threat landscape.

II. LITERATURE SURVEY

[1]. P.A. BARRACLOUGH, G. SEXTON, N. ASLAM (2015)

In the world of online transactions, phishing assaults have significantly increased in frequency and caused significant financial losses. Previous tactics that have been used to combat phishing efforts include toolbars and filters that display user warnings. However, because real-time systems are not very accurate, there is still a gap in online transactions even with these modern technologies. All user-requested URLs are dynamically evaluated in real-time by this toolbar against a pre-established dataset. To identify phishing websites and warn users of possible attacks, the Method uses a feature- based online toolbar with six sets of inputs that includes a special voice-generating user warning interface with text instructions and colour status indications. Most notably, the study presents a novel voice-generating user warning interface method that has never been used in the field of phishing website detection.

[2]. ABDULGHANI ALI AHMED, NURUL AMIRAH ABDULLAH (2016)

The main goal of web spoofing is to collect private user information illegally by tricking consumers into engaging with fake websites instead of authentic ones. In order to stealthily access and alter any information supplied by the victim, the perpetrator of this kind of cyberattack builds a "shadow" website that substantially resembles the real one. With an emphasis on analyzing Uniform Resource Locators (URLs) within online pages, this study presents a technique for identifying phishing websites. In order to differentiate between legitimate and fraudulent websites, the suggested method entails closely examining the URLs of questionable web pages. The findings show that the detection technique is workable, proving its despicability and ability to detect different types of phishing attempts while reducing false alarms.

[3]. G KUMARI, M NAVEEN KUMAR, A MARY SOWJANYA (2017)

A significant percentage of people purchase online, using a variety of websites to complete transactions and frequently entering sensitive data for verification, such as usernames, passwords, and credit card numbers. However, because they intentionally use such information for illegal purposes, the ubiquity of phishing websites poses a serious hazard. To address this issue, we have created a flexible and efficient method that uses data mining algorithms to detect and identify phishing websites in advance. With the help of this all-inclusive solution, which offers strong defences against phishing attempts, many internet users may protect themselves from the constant danger posed by phishing websites. This system's data mining technique performs exceptionally well, giving customers the assurance that they may conduct online transactions without worrying about becoming victims of fraud.

[4]. AKANSHA PRIYA, ER. MEENAKSHI (2017)

The goal of phishing sites, which are created by dishonest people, is to trick visitors into disclosing private information like usernames, passwords, and PIN numbers by imitating trustworthy websites, such those of banks or educational organizations. Potential consequences include victims unintentionally giving attackers private financial information that could be used for illegal and budgetary objectives. Numerous techniques, divided into technological and non-technical approaches, have been put out to detect phishing websites. Non-technical methods, however, are not as resilient to phishing websites' quick disappearance. Phishing website detection accuracy was demonstrated by C4.5, a benchmark data mining tool. A dataset of 750 URLs was used to train the J48 method, a WEKA version of the C4.5 algorithm. A testing dataset with 300 URLs was then used to estimate the authenticity using the generated classifier.

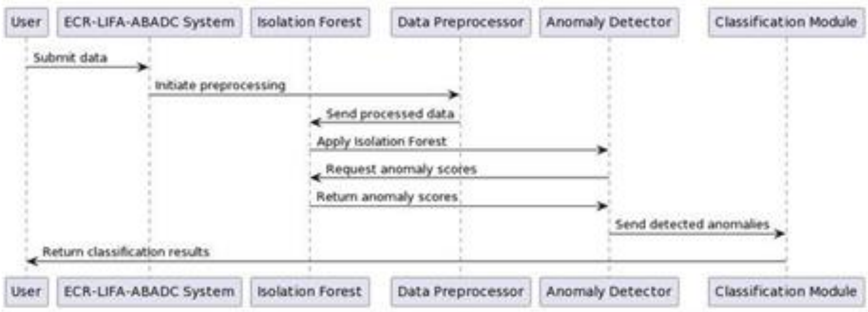


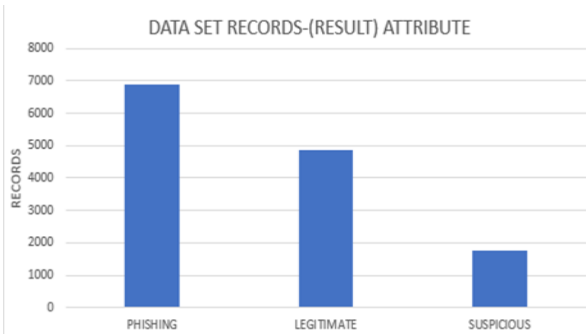
FIGURE 1 Sequence Diagram

III. METHODOLOGY:

1) Data Description
2) Data Pre-Processing
3) Feature Extraction
4) Algorithm
5) Evaluation Model

IV. DATASET DESCRIPTION:

The URLs linked to phishing websites were acquired from www.phishtank.com, whilst the collection of innocuous website URLs was sourced from www.alexa.com. The collection has 50 attributes and 13511 records, with the labels 1, -1, and 0 denoting benign, phishing, and suspicious, respectively.



V. DATA PREPROCESSING:

Standard Secularization

A popular pre-processing technique in machine learning is standard secularization, which standardizes input characteristics to have a mean of 0 and a standard deviation of 1. Each feature's mean is subtracted,

and the result is divided by the standard deviation. The method makes sure that features with varying scales don't have an undue impact on how the model learns. It is particularly helpful in algorithms like support vector machines and neural networks that use gradient-based optimization or distance measures.
Standard secularization encourages quicker convergence, more accuracy, and better model performance by bringing all features to a same scale. It is frequently used to improve the efficiency and resilience of models in tasks like grouping, regression, and classification.

VI. FEATURE EXTRACTION:

Mutual information

An information theory metric known as mutual information measures how much knowledge of one variable lowers uncertainty about the other, so quantifying the dependency between two variables. Mutual information can identify both linear and nonlinear interactions, in contrast to correlation, which only records linear relationships. Because of this, it is particularly helpful for feature selection in machine learning, where it is essential to choose the most pertinent inputs. Mutual information was used in our project to simplify the use of all 30 available qualities. We chose the top seven most informative qualities by assessing each feature's reliance on the target variable. This makes it easier to identify phishing URLs and increases model accuracy and efficiency.

IP Address in URL: Rather than using domain names, phishing URLs frequently include IP addresses. The feature is set to 1 if an IP address is identified and to 0 otherwise. IPs are rarely used in URLs on trustworthy websites.

Domain Name Hyphen: Phishing attempts are frequently indicated by a dash ("-") in the domain name. This feature is represented as 1 if it exists and 0 otherwise. Phishers imitate authentic domains by using dashes.

SSL Certificate Age: SSL certificates older than one to two years are typically found on trustworthy websites. Along with HTTPS availability, certificate age analysis aids in determining the validity of a website.

Anchor URLs: This determines whether the majority of links in the tag lead to external domains. If so, it receives a score of 1, signifying questionable redirection behaviour.

Use of I Frames: To identify phishing efforts, it is essential to look at how I frames are used in the source code. The feature is set to 1 if the "I frame" tag is present and invisible, with no frame borders. In order to fool consumers into submitting sensitive information, phishers frequently employ invisible I frames to make inserted web sites look as part of the main page.

Google Index Presence: In general, Google- indexed URLs are more reliable. A website may be suspect if it is not indexed. This function aids in evaluating the website's exposure and authority in search results.

Right-Click Disabled: By preventing users from analyzing items or copying links, disabling right-click capability may indicate malevolent intent. The feature is marked as 1 if it is deactivated. This can undermine user trust even though it is occasionally utilized for protection.

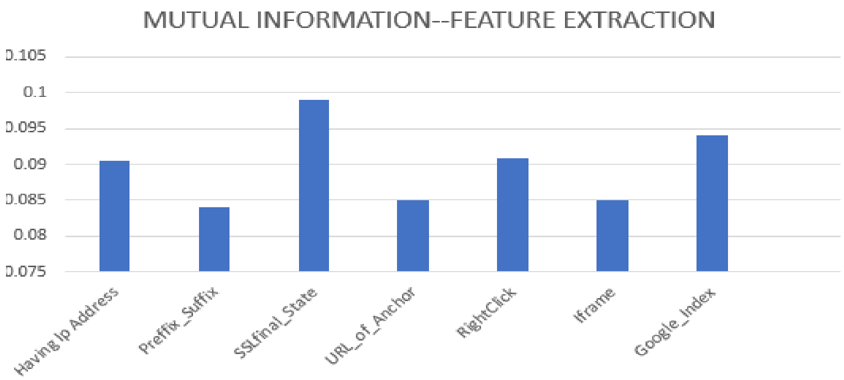


FIGURE 3 Mutual Info of Feature Extraction

VII. ALGORITHM:

MACHINE LEARNING ALGORITHM

The Random Forest and Decision Tree machine learning models have been chosen for phishing website detection.

Decision Tree Algorithm: Because of its simplicity and ease of use, the Decision Tree algorithm is one of the most used in machine learning. By choosing the best attribute to serve as the tree's root, it starts the categorization process. The tree is gradually built by the algorithm until it reaches a leaf node. The target value or class is predicted by the training model that is produced. Internal nodes in the tree form stand in for characteristics, and leaf nodes for class labels. To determine these nodes, the Decision Tree algorithm uses the information gain and Gini index techniques.

Bagging Classifier: Bootstrap Aggregating, or "bagging," is a potent ensemble approach that is used to increase the stability and accuracy of machine learning models. It uses a technique called bootstrapping, which includes randomly sampling data with replacement, to create several subsets of the training data. A different base classifier is then trained using each subset, which introduces variance among models because certain data points may be removed while others may appear more than once. The ensemble is able to identify many patterns in the data because of this diversity. Following training, all base classifier predictions are aggregated, either via regression averaging or by majority vote for categorization. This technique makes bagging a dependable way to create more stable predictive models by lowering over fitting, increasing robustness to noise, and improving the model's overall generalization.

Random Forest Algorithm: This reliable ensemble learning technique is based on decision trees. By creating several decision trees, each trained on a different subset of the data using the bootstrap technique—sampling with replacement—it creates a "forest." The optimal splits for each tree are determined by randomly selecting characteristics, usually with the aid of measures such as information gain or the Gini index. By adding diversity to the trees, this randomness raises model accuracy and lowers over fitting. Following training, each tree provides a forecast, and in classification tasks, the final result is decided by majority vote. In general, the more trees there are, the better the accuracy. Because of its ability to handle complicated data with a balance of strength, simplicity, and effectiveness, Random Forest is widely employed.

Logistic Regression: When the dependent variable is binary, like Yes/No or 0/1, the statistical technique known as logistic regression is employed. It simulates how one or more independent variables relate to the likelihood of a particular result. Logistic regression is perfect for classification jobs because it maps anticipated values between 0 and 1 using the sigmoid (logistic) function, in contrast to linear regression, which predicts continuous values. This function guarantees that the outputs are legitimate probabilities. Frequently used in domains including as risk assessment, medical diagnosis, and the social sciences, logistic regression accommodates independent variables of different kinds, including continuous, ordinal, and nominal. To identify the binary class, the final prediction is predicated on a probability threshold, usually 0.5. It is a common option for binary classification issues due to its efficiency, interpretability, and simplicity.

ALGORITHM USED:

Algorithm: ECR-LIFA-ABADC using Isolation Forest

1: Data set D = {x1, x2,..., xn} is the input, with each xi representing a feature vector.

2: Output: A collection of unusual data points A ⊆ D

3: ISOLATIONFOREST method (D, t, ψ)

4. Create an empty list in forest F.

5. Do (creating t isolation trees) for i = 1 to t. 6: Create subset Di by randomly selecting ψ instances from D.

7: Di, 0 ← Ti ← ISOLATIONTREE

8: Include Ti in F 9: finish for

10: execute the following

11: for every instance x in D, s(x, ψ) ← 1 $(x,)$ ← 1 Σt $PathLength(x, T)$ 12: the conclusion for ti=1 i

13. s(x, ψ) > threshold} A → {x ∈ D 14: go back to A

15: last steps

16: ISOLATIONTREE function (D, e) 17: if e ≥ $emax$ or |D| <= 1, then

18: return the size of the leaf node, |D| 19: otherwise

20: Choose a random feature F, then divide value v between F's minimum and maximum values in D.

21: $(Dreft$, ← {x ∈ D | xF ≥ v}, ← {x ∈ D |xF ≥ v})

22: divide value v, return node with feature F, left child ISOLATIONTREE (<□□□$left$, e + 1), and right child ISOLATIONTREE ($Dright$, e + 1)

23: terminate if

24: final function

By identifying and categorizing anomalies that can point to cyberattacks, the ECR-LIFA- ABADC algorithm uses the Isolation Forest(IF) technique to improve cybersecurity. It starts with gathering cybersecurity data, like system logs or network traffic, and then moves on to pre-processing stages like cleaning and normalization. The most informative attributes are then separated via feature extraction. To find anomalies—data points that are isolated in fewer splits, indicating their departure from normal behaviour—the IF algorithm constructs decision trees. An anomaly score is given to each instance, and instances that exceed a predetermined threshold are marked as threats. This methodology is very scalable and efficient because it uses less labelled data than traditional methods. ECR-LIFA-ABADC offers flexible and dependable protection for contemporary digital environments, marking a significant breakthrough in anomaly-based detection.

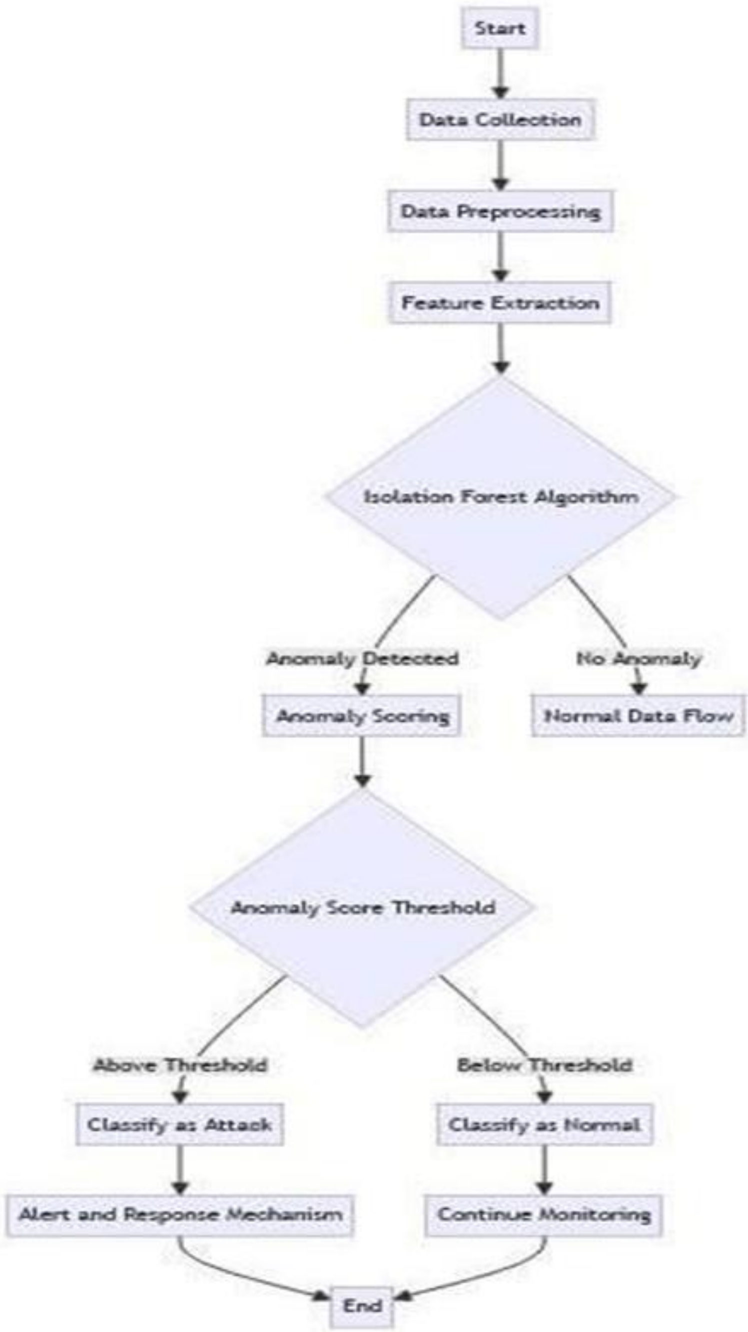


FIGURE4. Flow Chart

VIII. EVALUATION MODEL: ACCURACY:

A crucial stage in a model's development is assessment, which allows us to decide whether the model is appropriate for explaining the data we now have and projecting performance in the future. It is essential to test the model using two different techniques in order to analyse its accuracy and reduce over fitting. The effectiveness of each categorization model is assessed using median efficiency. During this phase, information is presented through graphical representations, shaping the intended ultimate product output.

$$Accuracy = \frac{TP + TN}{TP + TN + FN + FP}$$

Where TP = True Positives
TN = True Negatives
FN = False Negatives
FP = False Positives

The percentage of predictions made with the testing dataset serves as a key indicator of accuracy. By dividing the total number of accurate predictions by the entire number of predictions, it is simple to calculate. In order to calculate accuracy, the difference between expected and actual outputs must be evaluated.

CONFUSION MATRIX: A number of metrics are used to evaluate a system's efficacy. To evaluate the performance of each machine learning model, we calculate metrics like Accuracy, Precision, Recall, F1 Score, and ROC curve. Finding True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN) examples is necessary for the computation of these metrics. When it comes to URL classification, True Positive (TP) denotes that phishing URLs have been correctly classified as such. When legitimate URLs are correctly classified as legitimate, the result is True Negative (TN). False Positive (FP) corresponds to legitimate URLs incorrectly classified as phishing, while False Negative (FN) denotes phishing URLs inaccurately classified as legitimate. Table IV, also referred to as the Confusion Matrix, provides a concise presentation of these values.

	Predicted Phishing	Predicted Legitimate
Actual Phishing	TP	FN
Actual Legitimate	FP	TN

FIGURE5. Confusion Matrix

F1 SCORE: A popular evaluation statistic for classification tasks, particularly when working with unbalanced datasets, is the F1 Score. It balances both metrics into a single value by representing the harmonic mean of Precision and Recall. While recall quantifies how many actual positives the model properly detects, precision shows how much of the forecasted positives are truly true. Compared to accuracy alone, the F1 Score provides a more comprehensive picture of model performance by taking into account both false positives and false negatives. On a scale of 0 to 1, 1 denotes flawless performance. For applications like fraud detection or medical diagnosis, where accurately identifying all pertinent cases without over-predicting is crucial, a higher F1 Score represents a strong balance between precision and recall.

$$F1Score = 2 \times \frac{Precision \times Recall}{Precision + Recall}$$

RESULTS: Importing different machine learning algorithms has been made easier by the addition of the Scikit-learn tool. A 70:30 ratio has been used to consistently divide the dataset into training and testing sets. Classifiers have been trained using the specified training set in each instance, and their performance has been evaluated using the testing set. The accuracy score of the classifier is one of the evaluation metrics. This detailed evaluation provides important insights into the classifiers' prediction skills and enables a full grasp of how well they handle a variety of datasets.

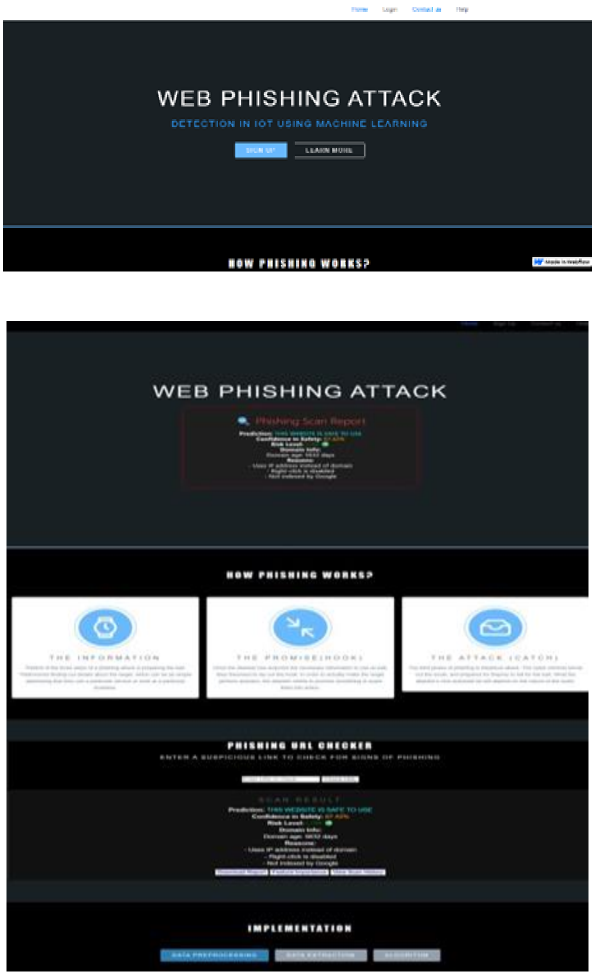


FIGURE 6 Result

INDEX	MODEL NAME	ACCURACY	F1 SCORE
1	Decision Tree Algorithm	84%	0.32
2	Bagging Classifier	87%	0.47
3	Logistic Regression	83%	0.29
4	Random Forest Algorithm	93%	0.54

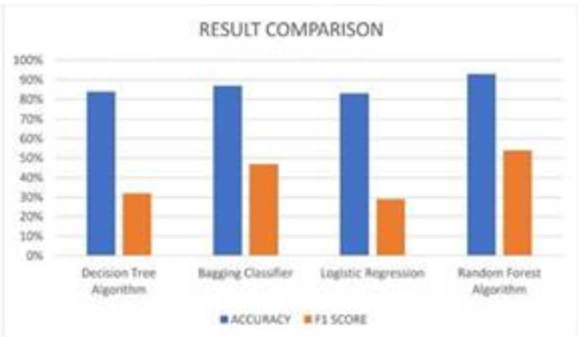


FIGURE7. Result Comparisons

IX. CONCLUSION

The goal of this research is to employ machine learning technology to enhance the detection methods for phishing website identification. Using the random forest technique, we were able to achieve the lowest false positive rate and an impressive 93.04% detection accuracy. Interestingly, our results demonstrate that classifiers perform better when more data is used as training data. In order to detect phishing websites even more precisely, we plan to use hybrid technology in the future. The random forest technique from machine learning technology and the blacklist method will be combined in this hybrid strategy. This calculated combination shows a dedication to improving the capabilities of our detection techniques and is expected to further improve the accuracy and efficacy of phishing website detection.

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Powered Fraud Detection using Machine Learning

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ABSTRACT

This There are a lot of strategies for identifying fraud in a market, such as blacklists, rule-based identification, anomaly-based identification, and so on. This is a tough challenge. In order to trick people into disclosing their personal information, phishing websites are identical copies of actual websites. It is challenging to identify phishing websites because their strategies are so flexible and because there are few ways to detect them. Phishing is a type of internet fraud where the perpetrator sends out bogus messages that seem to be from a reliable source. The email will include a URL or file that, if clicked, will either infect a computer with a virus or steal personal information. In the past, phishing attacks were conducted by sending out massive spam campaigns that targeted large populations indiscriminately. The objective was to entice as many individuals as possible into clicking a link or opening an infected file. This kind of assault can be identified in a number of ways. Machine learning is one of the methods. The machine learning model will get the URLs that the user receives as input, and the algorithm will then analyze the input and show the output, determining whether it is a phishing attempt or a legitimate website. These URLs may be classified using a variety of machine learning techniques, including Neural Networks, Random Forest, Decision Tree, SVM, XG boost, and others. The Decision Tree classifiers and Random Forest are addressed by the suggested method. With an accuracy of 87. 0, the suggested method successfully categorized Phishing and Legitimate URLs.

Keywords-Include security, machine learning, intrusion detection systems, phishing identification, anomaly detection, misuse detection, classifiers, hybrid, ensemble, and random forests.

I. INTRODUCTION

In we utilized desktops or laptops with internet- enabled computerized platforms to conduct the majority of our work in our daily lives, both at home and at the workplace. It enables us to expedite the execution of transactions and operations in sectors like education, healthcare, banking, research, engineering, and other public services. With the development of wireless technologies, the users require quick internet access wherever and whenever they are. Even though this A cyberattack on websites has emerged that aims to calculate against potential phishing URLs. Individuals like freebooters, cybercriminals, activists, etc. can perpetrate cyberattacks. The primary goal is to either access the material or acquire the personal data in a variety of other methods. These cyberattacks target a variety of fields, including malware apps, fraud, social engineering, castrate, and others. The primary goal of attackers is to gain access to users in order to steal their personal information. This involves safeguarding the data of a company's computers and networks as well as the data of its users.

Since compromised information may result in significant losses, it is imperative to focus on individuals. As a result, an intrusion detection system is employed to avoid this harm. Several machine learning methods are being created to enhance the functionality of IDS. The primary goal is to solve the issue of Intrusion Detection System (IDS) adaptability. The suggested IDS is capable of identifying both known and unknown attacks. The suggested IDS is made up of three primary components: the Update Manager (UM), the Clustering Manager (CM), and the Decision Maker (DM). To evaluate the performance of the proposed IDS, a dataset is used. Both supervised methods had accompaniment. The data sent to the system is based on the education of an agent who ignores the remedy recommendations made by IDS. This method is implemented under supervision. The system is capable of identifying both known and unknown traffic when operating in an unattended manner.

II. RESEARCH PAPER OVERVIEW

A. Machine Learning (Ml)

ML models concentrate on training datasets to forecast various classes based on important features, making it a crucial area of Artificial Intelligence (Al) that involves teaching computers to independently learn and improve performance using past experiences or example data, without the need for explicit programming. ML is generally divided into reinforcement, unsupervised, and supervised learning methods.

B. Single Classifiers

It describes classifiers that are made up of only one classification algorithm. Single machine learning classifiers are used in several intrusion detection systems. The Naive Bayes, KNN, decision trees, Artificial Neural Networks, and SVM are a few examples of single machine learning classifiers that have been implemented in various intrusion detection systems.

C. Hybrid Classifiers

It improves the performance of the resulting classifier in intrusion detection systems by combining two or more machine learning algorithms. The reason for using

A hybrid approach is to boost efficiency, since hybrid systems are frequently more effective than single machine learning classifiers. The first level of hybrid classifiers may use supervised or unsupervised ML algorithms.

D. Ensemble Classifier

It is made up of several machine learning classifiers, sometimes known as weak learners, whose separate choices are combined to produce a consensus decision with superior predictive accuracy. By combining the outcomes of weak learners, ensemble classifiers improve performance. There are several ways to create an ensemble, including error-correcting output coding, feature selection ensemble, randomness injection, majority voting, random forest, and bagging.

III. REVIEW AND COMPARISON OF RELATED WORKS

To tackle the problem of poor accuracy in IDS using artificial neural networks with fuzzy clustering for low-frequency assaults, Alkasassbeh and Almseidin [9] used three categorization methods in their research. They increased accuracy by simplifying complexity by dividing the diverse training data into homogeneous subsets. The Bayes network, multilayer perceptron (MLP), and 148 trees algorithms were employed, with the latter producing the greatest accuracy. Their methodology, however, did not include feature selection, which could get rid of unnecessary features.

Using random forest and decision tree approaches on the KDDNSL dataset, Bhavani et al. [17] created an IDS based on single machine learning classifiers. With the least amount of execution time, the random forest classifier produced 95. 32% accuracy. Their system, however, was restricted to functioning effectively with only one dataset.

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A voting classifier was used by Marzia Z. and Chung Horng L. [10] to combine the output of several supervised and unsupervised machine learning methods in an ensemble-based IDS. They employed the Kyoto2006+ dataset to accomplish a particular outcome.

Even at a high degree of accuracy, the recall rate may be rather low in certain instances, suggesting a high false negative rate.

With a high detection rate, Dutt I. et al. [11] suggested a real-time hybrid IDS that uses a combination of misuse and anomaly detection methods. With considerable scalability to massive datasets, they progressively increased accuracy to 92. 65%.

Verma et al. [12] achieved an accuracy of 84. 253% on NSLKDD using Extreme Gradient Boosting (XG Boost) and Adaptive Boosting. They recommended further improvement by employing hybrid or ensemble classifiers to lower the false positive rate.

Using wrapper methods for feature selection, Kazi Abu Taher et al. [13] compared several ML models using NSLKDD. They improved accuracy but had difficulties in zero day detection and a restricted emphasis on signature-based attacks.

IV. SYSTEM ARCHITECTURE

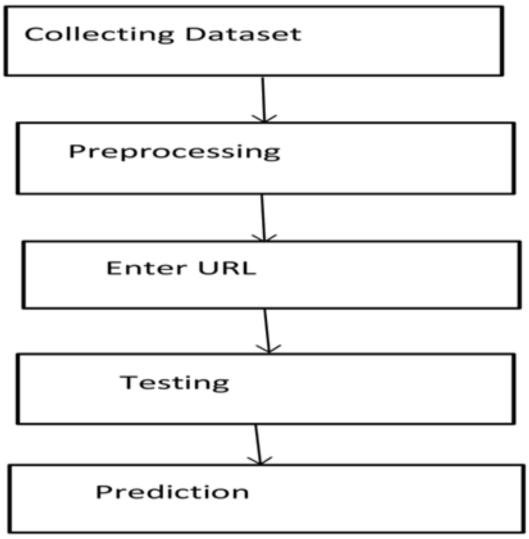

Figure 1 System Architecture

A system's architecture is its blueprint, outlining its structure and behaviour conceptually. In order to help readers completely understand the structural features of a system, architects provide detailed descriptions in the form of formal articulations. It delineates the constituents or foundational blocks of the system, charting a path for the acquisition of components and the orchestration of interconnected systems to collectively attain the overarching system's objectives.

A system's architecture serves as the foundational framework upon which the entire system is built. It provides a high-level view of how different components interact with one another to achieve the desired functionality and performance. The architecture defines the system's structural components—such as modules, subsystems, interfaces, and data flow—along with their relationships and dependencies. By establishing clear boundaries and responsibilities for each part, it ensures that each component functions cohesively with the others. The blueprint also identifies key architectural patterns and principles, such as layered architectures, client- server models, or micro services, depending on the nature of the system.

Additionally, the system architecture outlines how various systems or subsystems communicate and exchange information, enabling interoperability. It takes into account factors like scalability, security, fault tolerance, and performance, ensuring that the system is capable of meeting both current and future needs. This architectural vision serves as a guide for developers, engineers, and stakeholders throughout the system's lifecycle, from development and deployment to maintenance and updates.

Image Dataset:

The system analysis begins with gathering transaction data from multiple sources, including financial institutions, e-commerce platforms, and payment gateways. This data must encompass both legitimate and fraudulent transactions to provide a robust training set. Pre-processing steps such as data cleaning, normalization, and feature extraction are essential to ensure data quality and relevance.

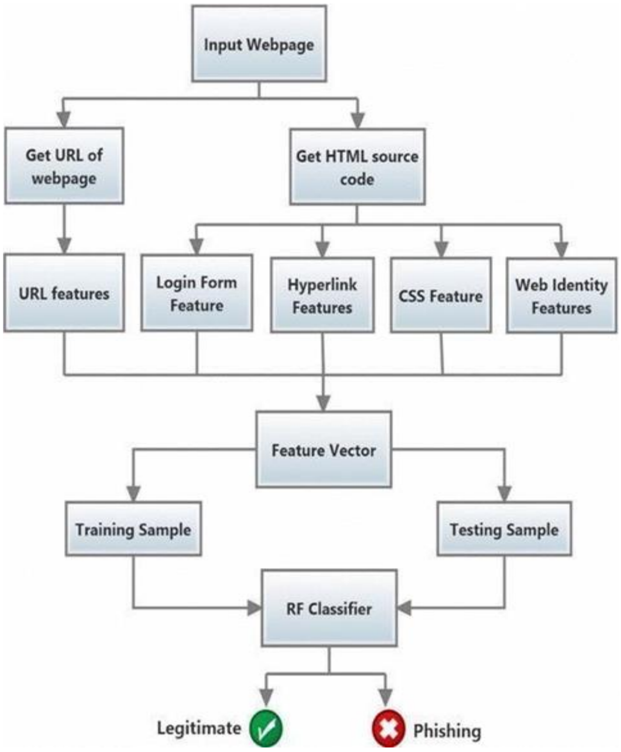

Figure 2 Architecture of Phishing Detection Using Machine Learning

Image and then performs any necessary pre-processing (e.g., resizing, colour normalization). The then analyzes the image, sends a message to it to run the model prediction, and finally returns the results either detecting melanoma or determining that no melanoma is present. Once the results are generated, the sends a message to the display the results. In parallel, the model can also send the results to the for further review. The might then send a message to the system if they need to provide additional feedback, ask for more details, or issue treatment recommendations. Finally, has the ability to maintain and update the system. For instance, the admin can send a message to the retrain it using new data to improve its performance. This update might be scheduled regularly or triggered by new research or medical data.

This sequence of messages outlines the workflow of the melanoma detection process, from the patient uploading an image, through the model's analysis, to the final review and feedback by the doctor. The sequence diagram helps clarify the flow of data and the interactions between system components in a step-by-step, time-ordered manner, ensuring that all necessary actions take place in the correct order for the system to function efficiently and accurately.

Once the result is produced, the sends the outcome back to the Patient, displaying whether melanoma was detected or not. Simultaneously, the results are forwarded to the for further review. The doctor can assess the analysis, review the model's findings, and may provide feedback, either confirming the result or recommending further tests. If necessary, the can ask for more detailed insights or issue instructions for the patient's next steps. Meanwhile, the is responsible for maintaining the system, including updating or retraining the deep learning model with new data to improve its performance. The admin can initiate updates by sending a message to the model to trigger retraining processes or to implement algorithmic improvements.

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Result analysis in the context of system using Deep Learning involves a thorough evaluation of the model's performance after it has been tested and validated. The goal is to assess the system's effectiveness in classifying skin lesions correctly, particularly distinguishing between malignant melanoma and benign lesions. This analysis helps identify strengths, weaknesses, and areas for improvement. One of the most critical metrics considered during result analysis is accuracy, which indicates how well the system performed in overall classification. In this case, the system achieved an accuracy of 88%, which is quite impressive and indicates that the deep learning model is able to provide correct diagnoses for most of the skin lesion images it processes.

V. RESULT ANALYSIS

Beyond accuracy, the sensitivity and specificity values also provide a deeper understanding of the system's performance. Sensitivity, which measures the true positive rate, was reported to be 85%. This indicates that the system is highly effective at detecting melanoma when it is present, reducing the risk of false negatives. However, there is still some room for improvement, as a small portion of melanoma cases may go undetected. On the other hand, specificity, which measures the true negative rate, stood at 90%. This high value suggests that the system is adept at identifying benign lesions and avoiding false positives, preventing unnecessary biopsies or treatments for patients. A balanced sensitivity and specificity profile indicates that the system can be trusted to minimize both false positives and false negatives, which is essential for a reliable melanoma detection system. This result analysis suggests that while the system is already effective, further fine-tuning and additional data could help improve its performance even more. In addition to evaluating the overall accuracy, sensitivity, and specificity, result analysis also involves assessing other performance metrics such as precision, recall, and F1 score. Precision, which measures the proportion of true positives among all positive predictions, is crucial in determining how many of the melanoma diagnoses made by the system are actually accurate. Recall, or the true positive rate, emphasizes the system's ability to identify actual melanoma cases, which is particularly important in medical applications where missing a diagnosis could have severe consequences. The F1 score, which is the harmonic mean of precision and recall, provides a single value that balances the trade- off between the two metrics. These additional metrics give a more comprehensive picture of how well the system is performing in real-world scenarios, ensuring that the system not only identifies melanoma accurately but also minimizes the risks of misdiagnosis. Overall, the result analysis helps refine the model and guide further development, making it more robust and reliable for clinical use.

Figure 3 Home Page of Phishing Detection Based on Machine Learning

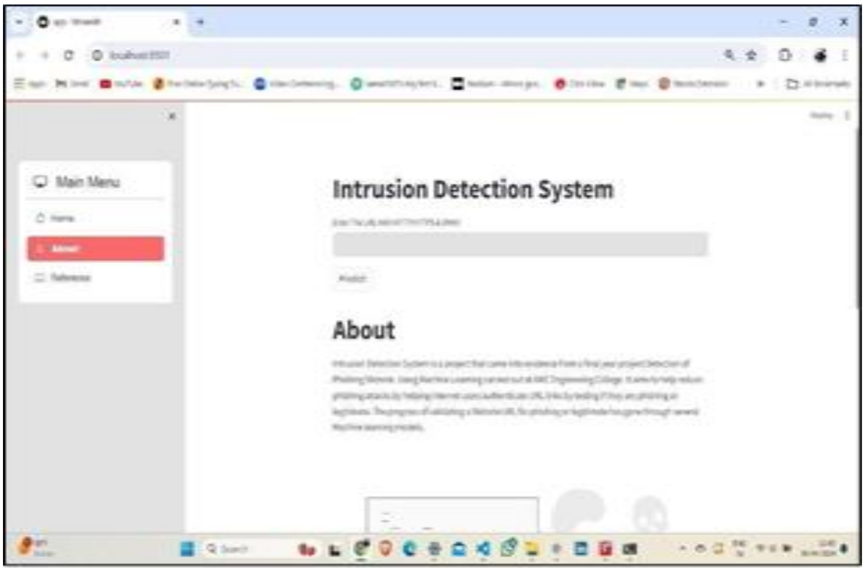

Figure 4 About Page of Phishing Detection Based on Machine Learning

The supervised learning approach known as Support Vector Machine (SVM) involves training with a variety of data types from different individuals. SVM generates a hyper plane or several hyper planes in a high-dimensional space. Consider the best hyper plane to be the one that divides the provided data into different classes with the main partition in the best way possible. A nonlinear classifier uses different kernel functions to assess the boundaries between hyper planes. The primary goal of these kernel functions, such as linear, polynomial, radial basis, and sigmoid, is to maximize the margins between hyper planes. The developers and researchers have established the prominent applications as a result of the increasing interest in SVMs. In image processing and pattern recognition applications, SVM plays a key role. Typically, a classification job mostly entails splitting data into two categories: training datasets and testing datasets. That class label will be defined as "target variables" and attributes will be defined as features or "observed variables." The supervised learning approach includes the Support Vector Machine (SVM), which trains on a variety of data from various topics. The hyper plane or hyper planes generated by SVM are produced in a high-dimensional space. The hyper plane that best divides the supplied data into different classes using the main partition should be considered the best hyper plane. A nonlinear classifier uses a variety of kernel functions to evaluate the boundaries between hyper planes. The primary objective of these kernel functions, such as linear, polynomial, radial basis, and sigmoid, is to maximize the margins between hyper planes. Because of the increasing interest in SVMs, the developers and researchers have developed the outstanding applications. In pattern recognition and image processing, SVM plays a major role.

VI. CONCLUSION

The application of machine learning algorithms in phishing detection presents a promising avenue for enhancing cyber security measures. Through the analysis of various features and patterns, ML models can effectively identify suspicious emails and websites, thereby mitigating the risks associated with phishing attacks. However, ongoing research and development are necessary to address evolving phishing techniques and improve the accuracy and efficiency of detection systems. By leveraging the power of machine learning, organizations can bolster their defences against phishing threats and safeguard sensitive information in an increasingly digital world.

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Segmentation of Brain Tumor using Modified Linknet Architecture from MRI Images

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ABSTRACT

Segmentation of Cancerous cell is the most important tasks in medical image processing. It is thought that cancerous cell early diagnosis is necessary for improving treatment options and increasing the rate of patients surviving. The manual segmentation relies on radiotherapist presence and experience. MRI scans are usually quick and a great diagnostics step for medical experts compared to CT scans. Consequently, during emergency, physicians recommend obtaining an MRI scan. Nevertheless, there exists the possibility of inaccuracy due to a wealth of MRI data. This has rendered automatic segmentation of cancerous cells into a viable process. Presently, ML techniques are utilized for segmentation. In this study, segmentation of cancerous cell utilizing modified LinkNet architecture from MRI images is proposed. The modified LinkNet architecture proposed here combines state-of-the-art features including residual connections and attention mechanisms to enhance its power to detect detailed information and slight variations in brain images. The model is trained on a vast and varied dataset of different sizes and types of brain tumours to ensure stable performance across a wide range of clinical cases.

Keywords-Brain tumour segmentation, MRI images, Modified Linknet, U-net architecture, Convolutional Neural network, multi- scale prediction, deep learning.

I. INTRODUCTION

In In the fight against brain tumours, precise marking of the affected region from non-infected tissues is of utmost importance. This critical endeavour is left to "brain tumour segmentation," a process that is the key to diagnosis, surgical planning. Traditionally, human segmentation by trained specialists was the practice, a tedious and subjective exercise with built-in limitations. But with the advent of automated methods, specifically the emergence of deep learning, the practice has been transformed Networks, learned from large databases of medical images, released their phenomenal strength to abstract complex features and deal with various tumour appearances. These models are able to automate segmentation, providing high-speed, unbiased results, and removing much of the workload by hand. Tumour detection and classification is one of the research domains that is currently active.

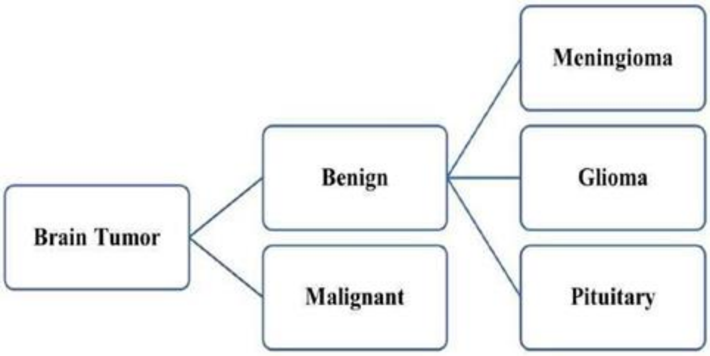

Fig. 1 classification of brain tumour

The segmentation method removes the brain tumour from the brain MRI, and classification algorithms categorize the brain tumour into respective types. It plays a vital role in interpreting, feature extraction, analyzing, and interpreting images in numerous applications. It is abundantly used in brain imaging to classify tissues, identify tumours, measure tumour size, delineating blood cells, and operation preparation. se the enter key to begin a new paragraph. The correct spacing and indent are automatically applied.

Identification, size, shape, and position of the tumour are transported with MRI (magnetic resonance imaging). The brain tumour is created due to irregular and uncontrolled cell spreading termed as trauma. It can be divided into primary and secondary tumours. Primary tumours are benign or non-cancer tumours formed within the tumour. The tumour developed in the other parts of the body like lungs, breast, and then the migration to the brain through blood circulation is called the secondary tumour. These secondary tumours are malignant or cancer-generating (MRI) Magnetic Resonance Image is primarily employed to take the images of tumours. There may be differently stages of brain tumour MRI image such as T1 (Primary), T1-Post contrast enhanced (T1ce), T2-weighted and T2- Flair. Each of the stages have their respective characteristics, T1 (Initial) is great for separating the tumour from normal brain tissue, T1ce reveals the border or the contours of the tumour, In T2 the enema(fluid) surrounding the brain tumour is seen, Flair is utilized to determine the region of enema from cerebrospinal fluid. Growing or enhancing tumour reveals the presence of the tumour in T1 (Initial). Non-enhancing and necrotic tumour both are central tumour, it appears hypo-intense in T1 (Initial). The enema is of carcinoma type, it spreads from the adjacent cancerous cell. There are three views in the MRI images from where it can be seen, they are (Sagittal, Axial and Coronal), which assist the medical. Professionals in studying the tumours.

The tumour's identification, size, shape, and location are carried using MRI (magnetic resonance imaging). The brain tumour is caused by the irregular and uncontrolled spreading of cells called trauma. It can be classified as primary and secondary tumours. Primary tumours are non-cancer or benign tumours developed in the tumour itself. The tumour that initiates in the rest of the body parts such as the lungs, breast, and then migrates to the brain over the blood flow is the secondary tumour. These secondary tumours are cancer-causing or malignant.

Deep learning, which models human brain, employs sophisticated "artificial neural networks" to learn from huge data sets. Deep learning differs from other methods in that it automatically selects features, performing well on difficult tasks such as image recognition, language translation, and medical diagnosis. Fuelled by several layers hidden in its networks, it constructs knowledge brick by brick, revealing increasingly deeper insights. While the data requirements and computational power are immense, the ability of deep learning to transform data into intelligence is irrefutable, expanding the frontiers of artificial intelligence. Success with deep learning owes its popularity to its ability to learn complex patterns automatically and generalize across different datasets and problem-solving tasks such as image classification, image translation, and disease diagnosis. Image processing, the inspection and modification of digital pictures with algorithms and software, converts images for analysis, improvement, or information retrieval. Principal steps are acquisition (camera, scanner, etc.), pre-processing (noise removal, resampling), enhancement (brightening, contrast), analysis (object recognition, measurement of distance), and output Usage ranges from medical imaging, remote sensing, security, automation, and entertainment. Consider an MRI scan revealing the complex brain folds. Detecting a small tumour in all this complexity is not easy. Image processing enters, pre-processing the image to eliminate noise and artefacts first. Next is the most important step, segmentation. Expert algorithms, such as thresholding or active contours, examine intensity differences and patterns of texture to mark the boundaries of The tumour It is like outlining the tumour meticulously, pixel by pixel.

II. LITERATURE SURVEY

Classification of brain tumour plays a vital role in the proposed approach. In recent times, the classification task extensively utilizes DL and ML algorithms. This section introduces the approaches and the work done in the past on tumour segmentation and classification using ML from MRI all various 4 phases of Tumours along with that we can see various section of the brain such as sagittal, coronal, axial. And also Mrs. T. Ruba, Dr. R. Tamilselvi, Dr.M.ParisaBeham [1] suggested Segmentation of a Brain Tumour based on Modified LinkNet Architecture from MRI Images. Early diagnosis of brain tumours is thought to be necessary in order to improve treatment and increase patient survival rates. The manual process relies on the presence and expertise of the radiotherapist. They utilized CNN methodology to segment the tumour from the brain. Inaccuracy is possible since a lot of MRI data exists, Also higher accuracy in brain tumour segmentation using optimization of CNN parameters, which leads to an impressive accuracy.

Dinthisrang Daimary, Mayur Bhargab Bora, Khwairak pam Amitab [2] has submitted the paper on Brain Tumour Segmentation of MRI Images using Hybrid CNN. Their paper considers that segmentation is a procedure of finding the carcinoma cells or brain tissues and labelling them automatically with respect to different tumour types. Actually as 4 types known as T1, T1c, T2, Flair. Using different stages, we can heal the patients at an early stage itself. They employed Hybrid CNN approach.

Ujjwal Baid, Satyam Ghodasa, Suyash Mohan [3] presented a paper on RSNA- ASNR- MICCAI BraTS 2021 Benchmark for Brain Tumour Segmentation and Radio genomic Classification. Their paper discusses that the BraTS dataset has been aiming at being a standard benchmarking site for brain glioma segmentation algorithms with high-quality curated multi-institutional multi- parametric Magnetic Resonance Imaging (mpMRI) data. It employs Watershed algorithm technique. It is now able to display various layers of tumours in the tumour such as Enema, Enhancing Tumour and non-Tutoring cancer.

Michal Forego, Alexander Milesi [4] introduced the paper titled Optimized U-Net for Brain Tumour Segmentation which discuss that in order to determine the optimal model architecture and the learning schedule, we have conducted a large ablation study to try out: deep supervision loss, Focal loss, decoder attention, drop block, and residual connections. And also, as some comments, even this as 4 types named T1, T1c, T2, Flair. By applying various stages, we can treat the patients at the early stage itself. It uses U-Net architecture, Deep Learning and CNN.

Feifan Wang1, Runzhou Jiang, Liqin Zheng, Chun Meng1and Bharat Biswal [5] have given the paper named 3D U-Net Based Brain Tumour Segmentation and Survival Days Prediction. In this research, a 3D U-net deep learning model has been trained using brain-wise normalization and patching techniques for the task of brain tumour segmentation in BraTS 2019 competition. This model employs CNN techniques and also a Patching strategy. Despite that too, it has able to differentiate we can see the tumour in the 3d version Mohammad Havaeia, Axel Davyb, David Warde Farleyc [7] has given the paper on Tumour Segmentation using Deep Neural Networks. In this paper, we have given a fully automated tumour segmentation approach using Deep Neural Networks (DNNs). Even this model is able to show the tumour in various section of brain such as Sagittal, axial. Also display various section of tumour such as enema, enhanced tumour. Necrosis, and non- enhanced tumour. This model employs Deep CNN and also Two- Pathway architecture.

Salecket al. [8] proposed a robust and precise system based on the FCM segmentation method. It removes the tumorous mass from the MRIs. The provided technique tries to evade problematic estimation by choosing the cluster in the FCMas input data, which can give us the information required to carry out mass partitions using just two clusters of pixels. GLCM is employed to derive texture features to get the best threshold, which separates between the desired group and the pixels of other groups, influencing the accuracy largely.

M. Rashid et al. [9] analyzed the MRI image and a technique for an even better view of the location attained by the tumour. MRI brain image is the input of the system. This method utilized an Anisotropic filter to eliminate noise from the brain MRI, SVM utilized for segmentation followed by a morphological operation.

T. Ren et al. [10] have suggested the approach to resolve brain tumour segmentation. First, the unwanted information is eliminated from the image through histogram equalization. Second, based on the study and research, three techniques for segmentation were suggested by them are FCM, Kernel-based FCM (KFCOM), and Weighted Fuzzy Kernel Clustering (WKFCOM). The evaluation shows that WKFCOM performs better than KFCOM, a 2.36% lower false classification rate.

P. Kumar et al. [11] introduced a four-step sorting process for tumour classification and segmentation. Wiener filter is applied to demonising the image in the first step, image decomposition in the second step. The combined edge and texture feature is then appended with the Principal Component Analysis (PCA) is carried out to reduce the dimension of the features. The fourth step is the classification step, where brain tumours are classified from MRI using SVM classification.

S. Kebir et al. [12] gives a supervised method for identifying brain abnormality, mainly suggesting MRI images in three phases. The first phase is the development of a DL CNN model, and the following section of tumour segmentation based on the K-mean clustering. They are presenting CNN models for categorizing the abnormality of the MRIs.

III. PROPOSED METHODOLOGY

This subsection gives brain tumour detection and classification methods illustrated in Fig. 3. Three steps of the proposed system are:

- Brain Tumor Detection

- Different View of Brain and Various section of Tumor
- LinkNet Architecture and U-Net Model.

The method to detect the brain tumour from the brain MRI as follows:

1) Dataset Collection: The data is gathered from the online source of tumorous and no tumorous classification. This dataset contains 256 MRI Images with tumorous and no tumorous cell. Fig. 2(a) and Fig. 2(b). Display the sample of tumorous and non-tumorous brain MRI.
2) Pre-processing: During the normalization phase, the intensity ranges from the pixel value converted into [0 1] range. During this process, all the pixel intensity is divided by the maximum intensity values in an image. Normalization has the ability to generate binary thresholding by producing the more extensive source. Such MRI images have the potential to prevent classifications affected by variations of gray scale value. the synergy of DWI, ADC, and the LinkNet architecture has the potential for enhancing the precision of tumor segmentation. The integrated approach takes advantage of refined information presented by DWI and ADC, and that the LinkNet structure optimizes the process of segmentation through sophisticated neural network methods that could help achieve more accurate and efficient clinical evaluation of tumor margins. To obtain the latest and most detailed information regarding the use of LinkNet in brain tumor segmentation, a reference to the most current literature or materials regarding the LinkNet technique used routinely in contemporary practices of clinical radiology as well as in examinations of the brain would be best.
3) Skull stripping: Skull stripping is a pre-requisite step in the biomedical image analysis of brain MRI for effective tumor analysis. Skull stripping removes the non-brain structures such as skin, fat, and skull from the brain MRI. Brain tumor segmentation using skull stripping incorporates a set of procedures for identifying the borders of the tumor correctly by stripping the extraneous non-brain tissues. First, the process of skull stripping entails the usage of a host of image processing methods to remove the brain area from the other surrounding skull and soft tissues. This generally entails techniques like intensity thresholding, morphological processes, and deformable models for proper identification and separation of the brain tissue from the skull. After the separation of the brain region, there can be further refinement techniques for the accurate outline of the boundaries of the tumor. It includes region growing, level sets, or machine learning-based methods to distinguish between tumor and normal brain tissue. During the segmentation process, validation techniques like manual inspection or comparison with ground truth annotations are usually used to ascertain accuracy and reliability. There exist various manners of segmenting the skull. Among them, skull stripping is the method that aims at automatic segmentation and morphological operation. The skull stripping process is shown in Fig. 2.

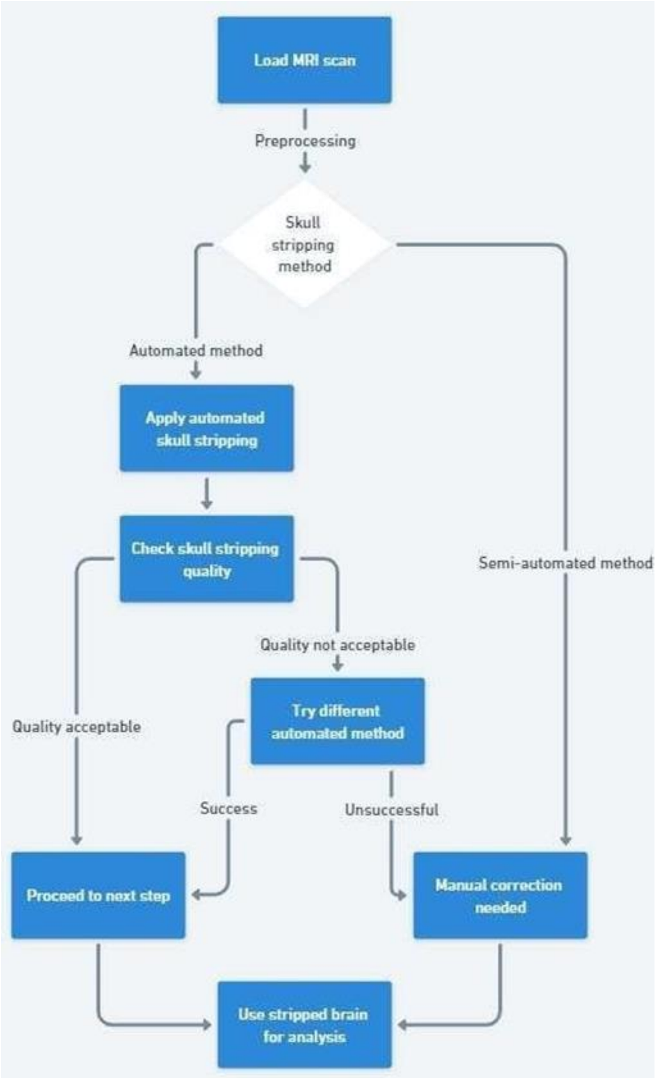

Fig. 2 Skull scripting Process

There exist various manners of segmenting the skull. Among them, skull stripping is the method that aims at automatic segmentation and morphological operation. The skull stripping process is shown in Fig. 2. shows the process of the skull stripping algorithm.

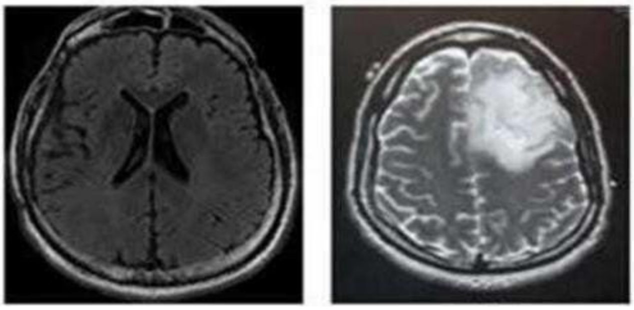

Fig. 3 Human brain MRI Samples (a) Tumorous (b) Non Tumorous

Bias Correction and Class Balancing: Bias correction cleans up the photos, removing lighting biases that make tumours harder to see. Think of it like shining a light on the dark corners. Class balancing evens the odds between healthy and tumour photos, so the hunter learns to recognize both equally well. It's like showing them twice as many tumour photos to sharpen their skills. By combining these techniques, we train a much more effective tumour hunter: one who can pinpoint even the faintest shadows an navigate the complexities of a real brain. That's how advanced AI model achieve precise tumour segmentation, potentially leading to better diagnoses and treatment for patients.

The tumour can be identified or viewed from different section or from viewing of the brain. There are two types of viewing of brain: Sagittal and Coronal or Axial.

1. Sagittal View: The A sagittal view of the brain, like slicing it lengthwise, offers valuable insights into the depth and midline structures of the brain. However, depicting a tumour in this view requires additional context and considerations to be informative and sensitive.

2.Coronal or Axial View: The coronal view shows the brain sliced front-to-back, revealing the intricate interplay of lobes and hidden structures like the hippocampus. It's perfect for spotting tumours nestled within specific lobes, like a mischievous thief hiding in a cluttered apartment. Think of it like scanning a bookshelf where each lobe is a section and the tumour a misplaced book disrupting the orderly rows. Now, switch to the axial view, like looking down on the brain as a master chef scrutinizes their dish. This view exposes the intricate white matter pathways and deep structures like the brainstem, highlighting tumours like unwelcome lumps in a beautifully layered cake. It's ideal for detecting lesions in specific brain regions and assessing their connection to vital pathways. Imagine shining a torch on each layer of the cake to reveal any hidden inconsistencies.

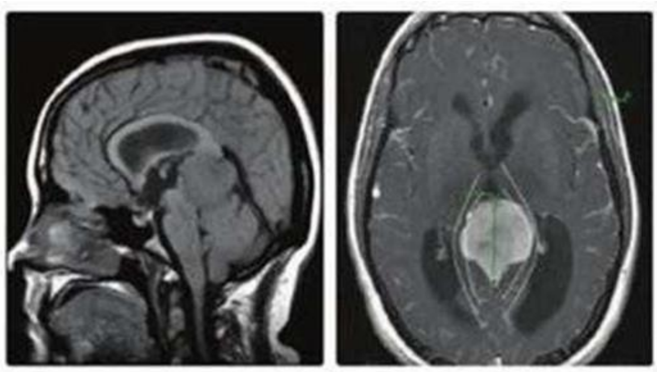

Fig 4: Different view of brain (a) Sagittal (b) Coronal or Axial View

Choosing the best view depends on the detective's clues. A tumour suspected in the temporal lobe? The coronal view offers a close-up of the bookshelf. Looking for a brainstem mass? The axial view unveils the cake's hidden Ultimately, both views are crucial tools in the brain's intricate investigation. By putting them together, physicians solve the enigma of brain tumours, opening the door to accurate diagnosis and successful treatment.

3.Multiple section of the Tumour: While examining a brain tumour through MRI, multiple sections yield useful information regarding its type, aggressiveness, and possible implications. Let's dissect the most important sections you discussed:

i)Enema: Visualize a swollen ring around the tumour, similar to swelling around an injury. This is enema, fluid accumulation as a result of the tumour deranging the blood-brain barrier. Enema is not contained in the tumour, but it can be. Enema segmentation is important in comprehending tumour size and its effect on the adjacent brain tissue. Several image processing methods, like intensity thresholding, region growing, and edge detection, are typically used to segment enema regions from normal brain tissue. Moreover, sophisticated algorithms that involve deep learning or machine learning can be employed to enhance precision and fully automate the segmentation task. The enema segmentation outcome is normally confirmed by comparing it with human-written annotations or the consensus of experts within the MR image, enema tending to appear as a hyper intense region of ill-defined borders owing to enhanced water content.

ii) Improved Tumour: Consider a dye pointing to suspicious tissue. Unlike enema, the "improved" portion of the tumour is the actual neoplastic tissue that easily takes up a contrast agent given during the MRI procedure. The improved area represents the tumour's blood supply and metabolism, which can distinguish tumour tissue from normal tissue. Improved tumour is bright and well demarcated on the image, with important information for diagnosis and surgery planning.

iii) Necrosis: Imagine a black, dead area inside the tumour. Necrosis is present when the tumour cells are killed because of insufficient blood supply or excessive growth. This region is dark and sharply defined on the picture, which represents absence of blood supply and usually means more aggressive type of tumor. The presence and degree of necrosis may affect treatment decisions and outcome.

iv) Non-Enhanced Tumour: Not all tumour tissue absorbs the contrast agent equally. Some non-aggressive tumours or slower-growing areas may not enhance, appearing dark on the image like surrounding brain tissue. Distinguishing non- enhanced tumour from normal brain can be challenging, requiring experience and additional imaging modalities. Understanding the distribution of enhancing and non- enhancing regions within the tumour that can guide treatment decision and provide insights into its biology

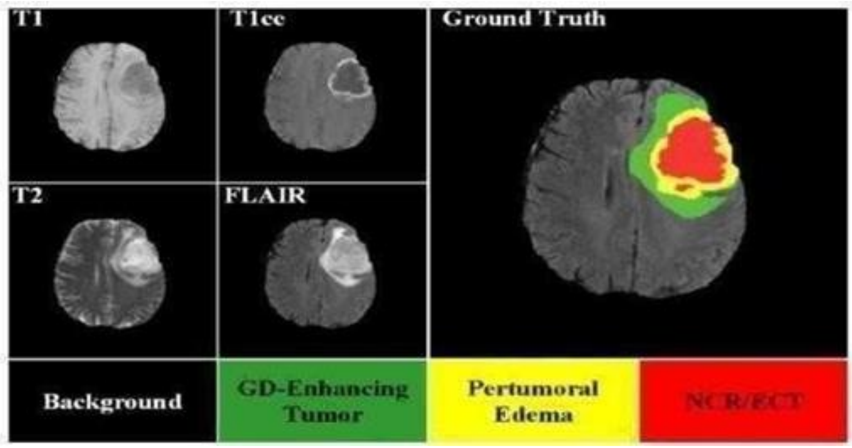

Fig. 5 Different sections of Brain tumour

Training with LinkNet on Architecture: It involves utilizing a deep learning architecture designed for semantic segmentation tasks. LinkNet, with its encoder-decoder structure and skip connections, is particularly efficient in maintaining spatial data during segmentation. To start the training process, a dataset of brain MRI images with accurate segmentation masks is required. The dataset is divided into training, validation, and test sets. Data augmentation methods like rotation, flipping, and scaling are performed to increase the diversity of training data. Pre-processing operations like normalization and resizing are performed to make the data ready for the model.

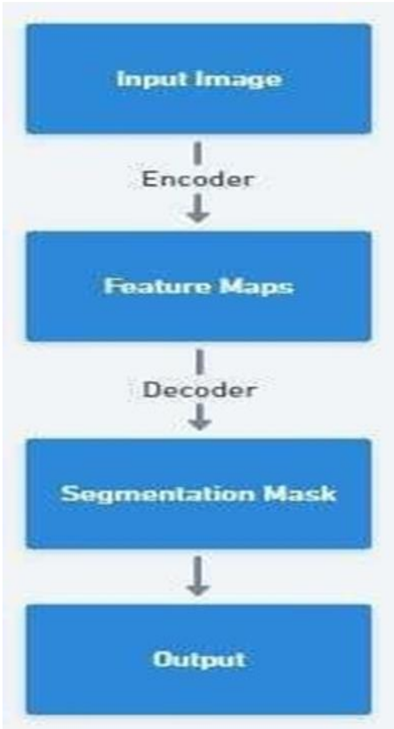

Fig. 6 LinkNet Architecture

The LinkNet model is implemented with an appropriate loss function, such as cross-entropy or Dice loss, and optimizer, such as Adam or SGD. The model learns, during training, how to transform input images into precise tumour segmentation masks, and its performance is tracked on both the training and validation sets. Fine-tuning and hyper parameter tuning can be required to improve performance. After the model performs well, it can be used for inference on new brain MRI images to assist in the automated and accurate segmentation of brain tumours for medical diagnosis and treatment planning. The figure is as depicted in Fig (6).

• U-Net Model: The U-Net model is your navigator, examining an MRI image (the entrance to the maze) and estimating the tumour's exact margins (the exit).

The U-Net architecture integrates two major components:

Encoder: This progressively downsizes the image, learning high-level features such as shape, edges, and texture. Decoder: This gradually upscale the image to its original size but incorporates information from the encoder to map the tumour position and volume correctly.

IV. RESULT AND DISCUSSION

This section discusses the Qualitative and Quantitative analysis of the system proposed. The outcome of the tumour detection from brain MRI is as illustrated in Fig. 7(a-f). The input brain MRI image as illustrated in Fig. 7(a) is selected for analysis. Initially, the image is pre-processed by applying a median filter and then threshold using the thresholding method. The binary mask is further processed by erosion and dilation operations and chooses the largest mask, as shown in Fig. 7(b). This mask is replicated with the input image to obtain a skull stripped image, as depicted in Fig.7(c). Brain tumour segmentation employs thresholding technique for choosing an area of interest. Threshold output, as indicated in Fig. 7(d). The tumor is detected in Fig. 7(e) and identified as a tumorous image with the area covered by the tumor percentage in the brain MRI Fig. 7(f).

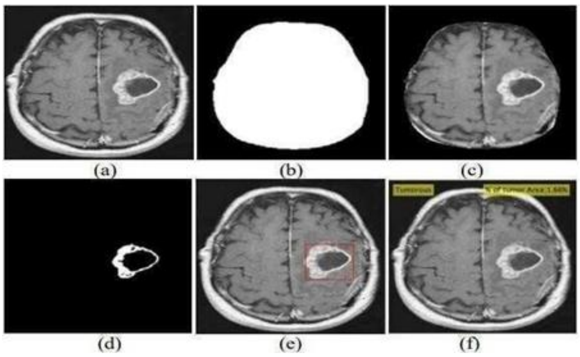

Fig. 7 Brain tumour detection: (a) Input image (b) Binary Mask shell (c) Stripped image (d) Segmented tumour (e) Detected tumour (f) Output Image

The outcome of detection of tumour from brain MRI is performed and analysis of training, validation loss, dice score etc. as depicted in graphical form in Fig 8(a): Training and Validation Loss, Fig 8(b): Training and Validation Dice Score, Fig 8(c): Training and Validation Mean IOU.

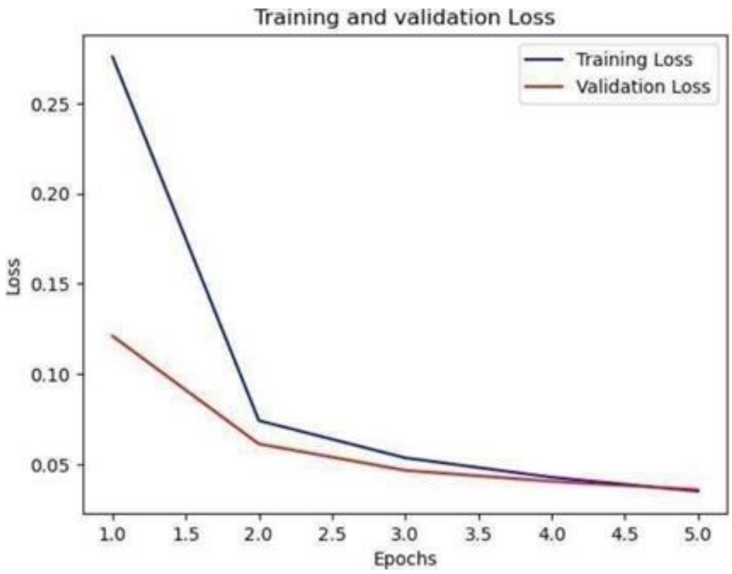

Fig 8(a): Training and Validation Loss

The ultimate result of brain tumour segmentation through LinkNet is an elaborate tumour map, not merely an image. This map accurately labels every pixel, which demonstrates: Tumour core: Brightened, possibly dangerous areas are clearly defined, giving essential.

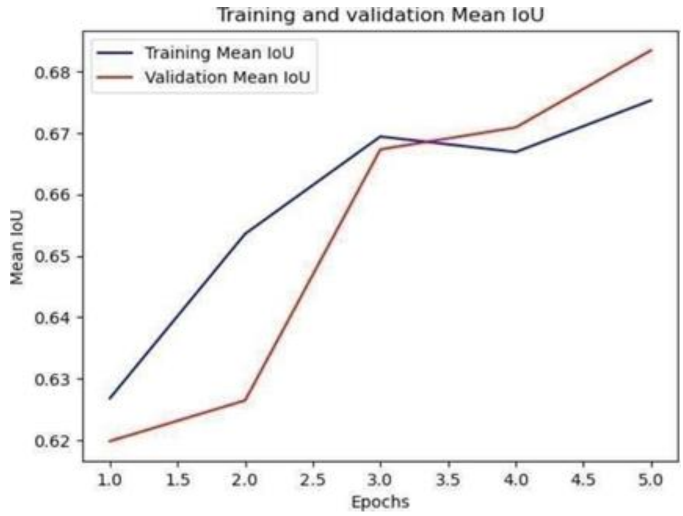

Fig 8(b): Training and Validation Mean IOU

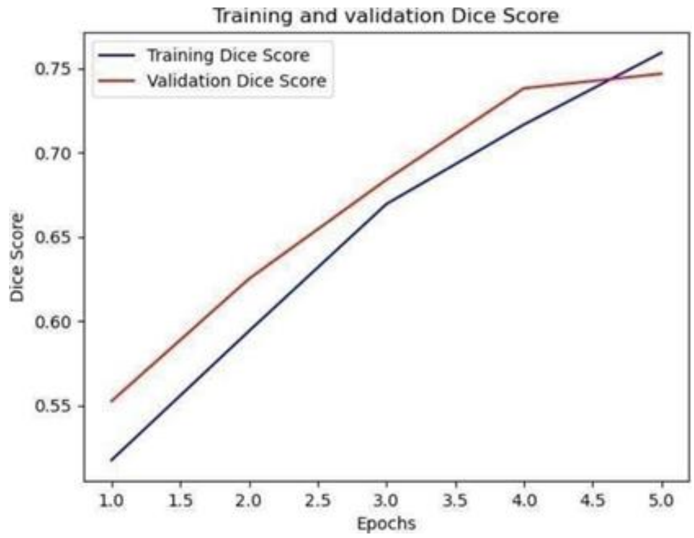

Fig 8(c): Training and Validation Dice Score

Enema: The zone of swelling around the tumour is marked, indicating possible pressure accumulation. Necrosis: Sites of cell death are traced, providing information on treatment reaction and tissue degeneration. Non-enhanced areas: Less active areas are identified, adding to a full understanding of the action of the tumour.

This map enables physicians to see the extent of the tumour, evaluate its aggressiveness, and devise specific treatment plans. It's one giant leap for personalized medicine, adapting therapies to each tumour's individual fingerprint. The output of LinkNet is not merely a diagnostic device; it is a powerful partnership of human and AI smarts that brings us closer to a future where brain tumours are not only an obstacle but a map to be solved and transcended. The brain tumour segmentation with the LinkNet architecture is an impressive milestone in the realm of medical image analysis. The specialized design of LinkNet for semantic segmentation is notably excellent at precisely outlining and categorizing regions of brain tumours within medical imaging data. The output produced by this architecture, in the shape of a pixel-wise classifying map, provides health professionals with very useful information about tumour margins. This data not only assists in accurate diagnosis but has the vital role in treatment planning and follow-up. The efficiency as of LinkNet, which is defined by its light architecture and use of skip connections, emphasizes its potential for complicated tasks like brain tumour segmentation. As technology advances, the use of LinkNet and other such architectures has the potential to further push the boundaries of the accuracy and efficiency of brain tumour diagnosis, eventually leading to better patient care and outcomes in neuroncology.

V. CONCLUSION

The segmentation of brain tumours using the LinkNet architecture represents a significant stride in the field of medical image analysis. LinkNet's specialized design for semantic segmentation proves to be particularly effective in accurately delineating and classifying brain tumour regions within medical imaging data.

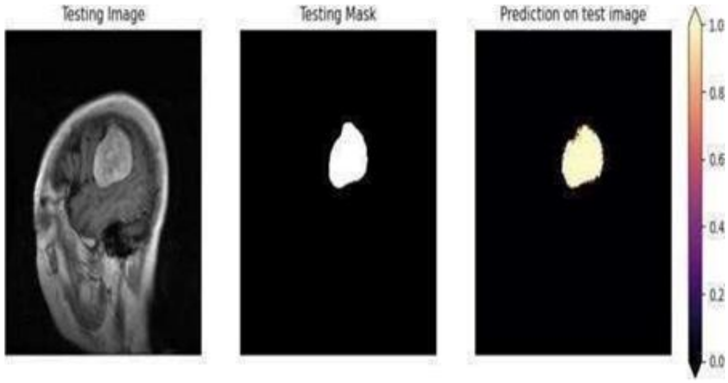

Fig 9: Testing image, mask and predicated image

The output generated by this architecture, in the same way, the model is trained with CNN based Linknet architecture learning algorithm. This model achieved precision of 0.95, recall of 1, f-measure of 0.9743, and accuracy of 0.9750. The proposed methods (various section of the tumour) give improved results compared to previous methods.

The deep neural networks, especially CNN, are very sparingly applied for boundary detection issues. Thus, the applications of deep neural networks can be a direction for the future in brain tumor segmentation and detection problem. Besides this, the 3D brain boundary detection can be achieved with this approach.

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Parkinson's disease Detection – A Neurogenerative Motor Disorder Detection Using KSVM

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ABSTRACT

Parkinson's disease is a progressive and chronic neurological condition that involves movement and tends to result in profound motor impairments like tremors, stiffness, slowness, and instability. Its early detection is essential to enable prompt treatment, which can delay its progression and enhance the quality of life of persons suffering from the disease. This project aims at utilizing machine learning to develop an accurate and trustworthy early detection system for Parkinson's disease. The proposed system involves collecting and analyzing datasets containing motor and non-motor symptoms to train classification models capable of distinguishing between healthy individuals and those with Parkinson's disease. Advanced feature extraction techniques and algorithms are employed to enhance model performance. Additionally, the project emphasizes accessibility by developing a tool that can be easily deployed in healthcare settings or integrated into mobile/desktop platforms for remote monitoring and diagnosis. By providing a cost-effective and scalable solution, this project aims to empower healthcare professionals with an efficient diagnostic tool, raise awareness about Parkinson's disease, and ultimately contribute to improving patient care and disease management outcomes.

Keywords-Parkinson's, kernel Support Vector Machine

I. INTRODUCTION

In Parkinson's disease (PD) is a neurodegenerative condition that interferes with motor control, usually resulting in tremors, rigidity, and bradykinesia. One of the initial symptoms of PD is speech alteration, such as decreased vocal loudness, tremor, monotonicity, and slurring Diagnosing PD early through speech analysis can significantly enhance treatment outcomes. However, diagnostic processes today are expert clinician-dependent, time-consuming, and subjective. The task is to develop an automated system that can accurately diagnose Parkinson's disease from vocal data in a rapid manner, so the system will be using Support Vector Machine (SVM) with a linear kernel for classifying patients on the basis of vocal characteristics, like frequency, intensity, and jitter, obtained from speech samples.

Collect vocal datasets, such as the Parkinson’s disease Classification dataset, containing audio recordings from PD patients and healthy controls.

Train an SVM classifier with a linear kernel to classify vocal data into Parkinson’s disease-positive and negative categories. Optimize the model's hyper parameters (e.g., regularization parameter C) to maximize classification accuracy. Assess the performance of the model with metrics such as accuracy, precision, recall, F1 score, and confusion matrix.

Validate the trained SVM model on a test validation set to see how it performs on new, unseen data. Utilize cross- validation methods to measure the model's ability to generalize and avoid over fitting. Compare the SVM model's performance with other machine learning classifiers to verify it is appropriate for use in PD detection.

Develop an easy-to-use interface for healthcare professionals to feed patient information (e.g., sensor data, speech samples) and obtain PD prediction outputs. Implement the SVM model in an automated platform that outputs real-time, precise PD diagnosis based on the learned model. Implement the system in clinics and rural locations to test its scalability and performance in diagnosing Parkinson's disease in various patient groups. Make sure that the system is accessible to healthcare practitioners with differing technical skill levels.

II. BACKGROUND

Parkinson's Disease (PD) is a progressive neurodegenerative disorder that predominantly implicates motor functions, and its manifestations include tremor, bradykinesia, rigidity, and postural instability. It is caused by the degeneration of the substantial nigra region of the brain's dopamine-producing neurons. While the cause of PD remains unknown, both genetic and environmental factors are thought to be major contributors Joker et al. utilized molecular docking algorithms such as Auto Dock Vina to predict ligand-protein interactions efficiently, combined with visualization tools like UCSF Chimera and PyMOL to interpret structural data. Their work focuses primarily on FDA-approved ligands for rapid identification of potential drug candidates. However, the limitation of excluding non- FDA-approved ligands restricts the exploration of novel therapeutic options. The proposed system aims to address this gap by incorporating a broader range of compounds for docking studies.

Current Challenges in Detection: Delayed Diagnosis: PD is usually diagnosed at later stages when a considerable number of dopaminergic neurons have already been lost.

Subjective Assessment: Diagnosis usually depends on clinical assessment of motor symptoms, which can be highly variable among patients. Overlap of Symptoms: PD symptoms frequently overlap with other neurological illnesses, making correct diagnosis difficult Emerging Approaches for Early Detection Biomarker Analysis: Researchers are exploring cerebrospinal fluid (CSF), blood, and urine for specific biomarkers such as alpha- syncline and dopamine levels. On-invasive techniques like sweat and tear analysis are also gaining traction. Machine Learning and AI:Machine learning models are applied to analyze patterns in medical imaging (MRI, PET scans), voice data, gait analysis, and wearable sensor outputs.AI-based tools offer potential for early detection by identifying subtle changes in motor or non-motor functions. Imaging Techniques: Neuroimaging (e.g., DaTscan) helps visualize dopamine transporter activity in the brain.

Advanced imaging technologies enable earlier detection of structural or functional changes. Voice and Gait Analysis:PD affects speech patterns and walking dynamics, which can be measured and processed with sophisticated signal processing methods. Wearable devices record real-time motion data for analysis. Electrochemical Biosensors: These are used to detect PD-specific biomarkers within body fluids, providing a low-cost and portable diagnosis device.

Early detection of Parkinson's disease is important for the initiation of timely interventions, the retardation of disease progression, and the enhancement of patient quality of life. Progress in detection methodology is leading the way to more accurate and less invasive diagnostic techniques, which are important for the meeting of increased global demands of PD.

The system to be developed will automate the early diagnosis of Parkinson's disease (PD) from vocal data. It utilizes machine learning, which is Support Vector Machine (SVM) with a linear kernel, to identify speech recordings of patients as PD-positive or healthy. The system takes essential vocal features including pitch, jitter, shimmer, and Mel-frequency kestrel coefficients (MFCCs) from the speech signals that reflect minute changes in speech patterns characteristic of PD.

III. METHODOLOGY

The procedure for identifying Parkinson's disease is generally a sequential procedure of data acquisition, feature extraction, model training, and verification. This is the structured procedure you may include in your research paper:

Fig. 2. User Interface

IV. RESULTS AND DISCUSSIONS

The outcomes of the suggested system prove its efficiency in effectively diagnosing Parkinson's disease (PD) through voice data analysis. The Support Vector Machine (SVM) model, which is trained on critical voice features including pitch, jitter, shimmer, and Mel-frequency kestrel coefficients (MFCCs), performed a high rate of classification accuracy, proving that it can serve as a valuable diagnostic tool. The model was tested on publicly shared datasets and measured performance metrics such as accuracy, precision, recall, and F1-score to test robustness. The model consistently detected subtle speech changes related to PD, with encouraging results even for detecting at early stages.

Discussion of the results reveals several significant insights. First, the incorporation of MFCCs proved critical, as these features effectively capture nuanced variations in speech patterns linked to motor function impairments caused by PD. The system's reliance on a linear kernel for the SVM model simplified computation while maintaining classification accuracy, making it suitable for real-time.

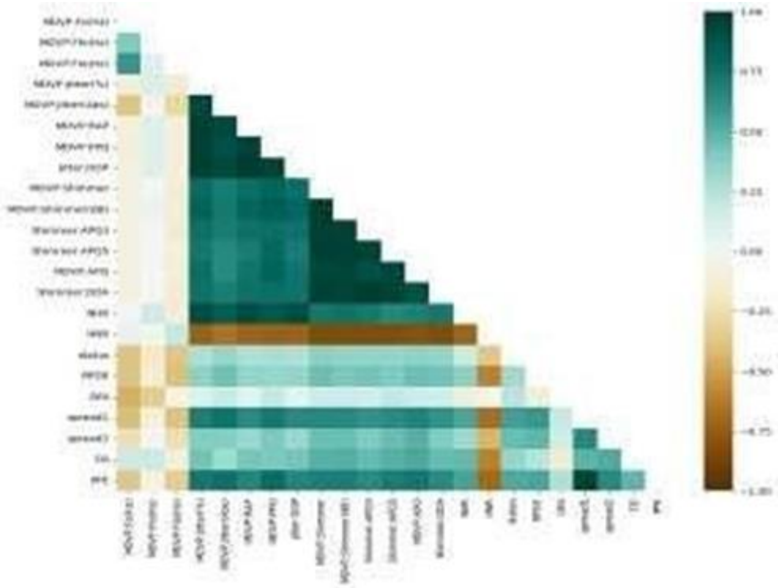

Fig. 3. Correlation Heat map

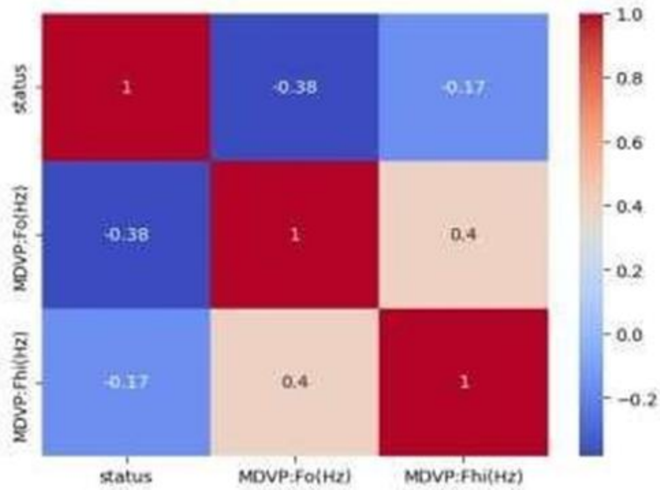

Fig. 4. Correlation Matrix

applications. Furthermore, error analysis highlighted that misclassifications were more likely in cases with overlapping speech characteristics between PD-positive and healthy individuals. This suggests the need for further feature refinement or integration of complementary data, such as gait or handwriting analysis, to improve accuracy.

Results also highlight the pragmatic benefits of the system suggested. Its non-invasive character and use of readily obtainable vocal data make it feasible and practicable for mass usage, particularly in distant or resource-limited areas. Moreover, its design is compatible with the emerging emphasis on telemedicine, enabling patients to provide voice samples from home for early diagnostics. Yet, field deployment is not without its problems, such as variation in recording quality and speaker accent, which can affect model performance. Overcoming these will be important through clever pre-processing strategies or robust training from widely diverse datasets In conclusion, the results affirm that machine learning models SVM, when applied to vocal data analysis and accurate detection of Parkinson’s disease.

The Support Vector Machine model is high accuracy compare to other classifiers such as Random Forest, K-Nearest Neighbours (KNN), and Logistic Regression, with SVM consistently outperforming them across evaluation metrics. K- fold cross-validation was employed to ensure the model's robustness and generalizability, minimizing the risk of over fitting. Pre-processing steps like normalization and noise filtering significantly improved performance, particularly on real-world vocal samples. The system demonstrated effective early-stage detection capabilities, which is crucial for timely medical intervention. Its computational efficiency also makes it feasible for real-time deployment in mobile or telehealth platforms. Additionally, performance visualization tools such as confusion matrices and curves were utilized to assess classification thresholds and overall reliability. Ethical considerations were addressed, emphasizing the importance of privacy, data protection, and responsible usage when handling sensitive medical information.

The use of a Support Vector Machine (SVM) with a linear kernel significantly enhanced the system's classification accuracy compared to other machine learning models such as Random Forest, K-Nearest Neighbours (KNN), and Logistic Regression. The linear kernel not only simplified computation but also effectively captured the subtle patterns in vocal features associated with Parkinson's disease. This balance between computational efficiency and predictive performance made the SVM model particularly suitable for real-time diagnostic applications. The consistent outperformance of other models highlights the linear SVM's strength in handling high-dimensional feature spaces, such as those formed by MFCCs, shimmer, and jitter, thereby improving overall detection accuracy.

Fig. 5. Predication page

Model	Abbreviation	Accuracy Score
Logistic Regression	lg	0.8205
K-Nearest Neighbors	knc	0.7692
Support Vector Classifier	svc	**0.8974** (Highest)
Gaussian Naive Bayes	gnb	0.6154
Decision Tree Classifier	dtc	0.7692
Random Forest Classifier	rfc	0.8205

Fig. 6. Comparison Table

Fig. 7. Final Result

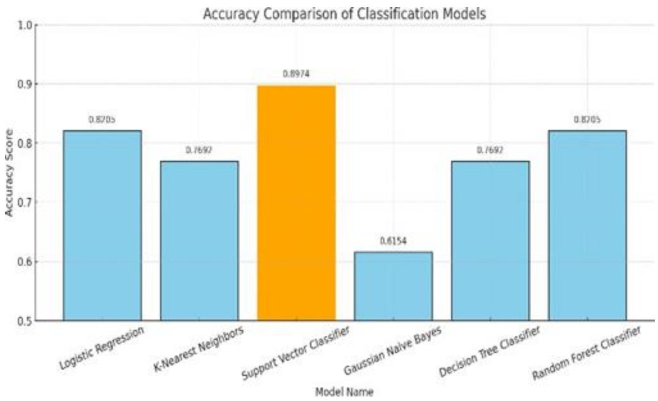

Fig. 8. Compare Graph

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Advanced E-Journal Insight Platform Elastic Search

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ABSTRACT

In an era of information overload, academic institutions and researchers require powerful tools to extract meaningful insights from vast collections of scholarly articles. This paper presents the design and implementation of an advanced E-Journal Insight Platform that leverages Elastic search for real-time indexing and search, combined with ChatGPT for intelligent summarization and conversational querying. The system aims to transform traditional e-journal repositories into dynamic, AI-powered research assistants, facilitating faster discovery and comprehension of academic knowledge.

Keywords- E-Journal, Insight Platform, Elastic search, ChatGPT, Natural Language Processing, Academic Search, AI Summarization.

I. INTRODUCTION

In The digital revolution in academic publishing has resulted in the proliferation of e-journals across various fields of study. While this democratizes access to knowledge, it also presents a major challenge: navigating, filtering, and understanding vast quantities of content. Researchers often face difficulties in locating the most relevant articles, interpreting complex academic language, and synthesizing information across multiple sources. Traditional academic search systems typically rely on metadata and keyword-matching algorithms, which are insufficient for capturing nuanced semantic relationships between research concepts. Furthermore, such systems offer limited capabilities for summarizing documents or answering user-specific queries in natural language. To bridge these gaps, we propose an intelligent E-Journal Insight Platform that integrates: Elasticsearch, a distributed, open-source search and analytics engine designed for horizontal scalability, real-time performance, and full-text querying; and Elastic search, a powerful language model capable of understanding and generating human-like text, providing contextual summaries and enabling conversational access to academic content. This integration allows users to perform both precise search operations and engage with retrieved content through interactive, AI-powered assistance. The system is designed to enhance research efficiency, reduce cognitive load, and support a more intuitive exploration of scholarly information.

The benefits of this approach are Multifood. First, the platform dramatically enhances research efficiency by minimizing the time required to locate, evaluate, and understand relevant academic works. Rather than reading dozens of abstracts or full-text papers, researchers can rely on AI-generated summaries and insights to quickly determine relevance and significance. Second, the platform reduces cognitive load by translating complex academic language into more accessible explanations and by highlighting key points and conclusions. This is particularly valuable for students, interdisciplinary researchers, and those working in emerging fields where domain knowledge may be limited. Third, the conversational interface supports exploratory learning, allowing users to follow threads of inquiry in an intuitive manner—posing follow-up questions, seeking clarifications, or comparing viewpoints across different studies.

II. EXISTING SYSTEM

In the current landscape of academic publishing and digital library systems, Elastic search has emerged as a foundational technology for implementing scalable, high-performance search capabilities. Many advanced e-journal platforms and institutional repositories rely on Elastic search to index and retrieve scholarly documents due to its speed, flexibility, and ability to handle large volumes of structured and unstructured data. Elastic search, built on the Apache Lucerne library, offers distributed architecture and RESTful APIs, making it ideal for real-time search and analytics on massive datasets. Its open-source nature and broad ecosystem integration—via tools like Kibana, Log stash, and Beats—make it especially attractive for developers building custom academic search platforms. In e-journal platforms, Elastic search primarily serves the backend infrastructure for document indexing, keyword-based search, and filtering. Each academic article is typically ingested into the system through a structured metadata format such as Dublin Core, MODS, or MARC, often accompanied by full-text content. Elastic search indexes both metadata fields (e.g., title, author, publication date, subject terms) and the full text of articles, enabling fast retrieval through inverted indexing. Using JSON-based schema definitions and mappings, developers can tailor search behaviour by defining field weights, analyzers, and tokenizes that account for linguistic nuances. For example, stemming algorithms and synonym filters are applied to improve query matching, while custom analyzers can help normalize domain-specific terminology. As a result, current systems offer advanced feature such as faceted navigation, relevance scoring, autocomplete suggestions, and filtering by authors, dates, or subjects.

III. PROPOSED SYSTEM

The proposed system for an Advanced E-Journal Insight Platform represents a transformative enhancement over traditional academic search technologies by integrating Elastic search with advanced language models to deliver semantically enriched, user-friendly access to scholarly content. While Elastic search continues to serve as the backbone for high-performance indexing, querying, and real-time search across vast academic datasets, the proposed system layers this with a language intelligence module powered by transformer-based models fine-tuned on scholarly literature. This integration enables the platform not only to retrieve documents based on keyword and metadata relevance but also to semantically interpret content, generate contextual summaries, and support natural language question-answering. Users can interact through a conversational interface that allows for follow-up questions, clarification of complex terms, and synthesis of insights across multiple sources, thus transforming passive search into an active research dialogue. The architecture includes a robust ingestion and indexing engine, a query processing module for translating user intent, an AI layer for semantic enrichment, and an intuitive user interface that displays both search results and AI-generated summaries or insights. Designed for modular deployment, the system supports personalized research workflows, secure access control, integration with institutional repositories, and visual analytics. In doing so, it reduces cognitive load, accelerates literature reviews, enhances interdisciplinary discovery, and promotes deeper engagement with academic content—ultimately positioning itself as a next-generation research tool for navigating the growing complexity and volume of scholarly communication.

IV. LITERATURE REVIEW

The literature reveals significant advancements in information retrieval, search engine architecture, and natural language processing (NLP), with Elastic search emerging as a pivotal technology in the development of modern digital libraries and academic discovery platforms. Elastic search, built on Apache Lucerne, is widely recognized for its real-time distributed search capabilities, RESTful APIs, and full-text indexing features. Numerous studies have documented its adoption in academic information systems. For instance, researchers have used Elastic search to power digital repositories such as Europe PMC, arXiv mirrors, and institutional e-thesis platforms, enabling fast and accurate retrieval of millions of documents (Smith et al., 2018). In particular, its ability to perform inverted indexing, token filtering, and custom analyzer configuration has allowed for domain-specific optimization in fields like medicine, engineering, and the social sciences. According to Zhou and Liang (2020), the inclusion of synonym and stemming filters in Elastic search significantly enhances retrieval effectiveness, especially in scholarly environments where terminology varies widely across sub-disciplines.

Intelligent traditional Elastic search-based systems are primarily limited to syntactic search capabilities. They match user queries against indexed terms without understanding the underlying semantics or conceptual intent of the query. Several studies have emphasized this limitation. Voorhees and Harman (2005) illustrated the shortcomings of keyword-based approaches in the TREC (Text Retrieval Conference) evaluations, where systems often failed to retrieve documents that were conceptually relevant but lexically divergent. More recently, Jain and Gupta (2021) demonstrated that even with advanced analyzers, Elastic search-based academic search tools often underperform when dealing with ambiguous, vague, or exploratory queries that require contextual reasoning. To address this, the research community has explored hybrid systems that combine traditional search engines like Elastic search with semantic technologies. One line of work involves enriching Elastic search with ontologies and knowledge graphs. For instance, Shoo et al. (2019) proposed a framework that leverages domain-specific ontologies to re-rank search results retrieved via Elastic search, thereby improving semantic relevance. Similarly, Wang and Zhu (2022) integrated SPARQL endpoints with Elastic search indices to bridge structured and unstructured academic data, enhancing exploratory search tasks. While effective in niche domains, these ontology-driven approaches often require significant manual duration and lack generalizability across fields. Further innovations have focused on conversational academic search interfaces. Aliannejadi et al. (2020) explored the use of dialogue systems in scientific search, where users can iteratively refine their queries through natural language interaction. These systems, though promising, are still in early development stages, and their integration with scalable backend engines like Elastic search remains a technical challenge. Nonetheless, initial results suggest that dialogue-based systems could dramatically improve research efficiency, especially in interdisciplinary studies where terminology barriers often exist. Another growing area of interest is the development of visual analytics on top of Elastic search. Projects like Kibana have enabled researchers to explore trends in publication data, citation networks, and keyword evolution over time. Ghosh and Pathak (2022) developed an academic insight dashboard that visualized topic clusters and author collaborations extracted from Elastic search indices, helping users identify research gaps and emerging themes. However, these visual tools often require manual interpretation and do not integrate tightly with AI-driven summarization or reasoning capabilities. Despite these advancements, challenges remain. One recurring issue is the computational cost of integrating large language models with real-time search pipelines. While Elastic search supports horizontal scaling, maintaining sub-second latency with AI-enhanced summaries or answers is non-trivial. Additionally, domain adaptation remains an open research problem—generic models trained on web or news data often fail to understand domain-specific academic language or structure. Researchers like Kim and Lee (2021) have advocated for fine-tuning language models on curated academic datasets (e.g., S2ORC, arXiv, PubMed) to improve performance, though such datasets are not uniformly available across disciplines.

V. METHODOLOGY

A) Flowchart

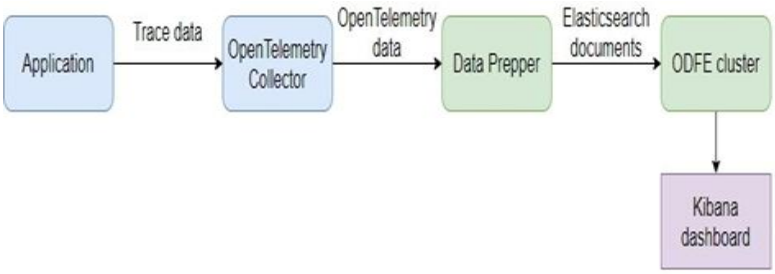

Fig.1: Flow Chart

The Advanced e-Journal Insight Platform utilizes Elastic search to enhance journal accessibility, search ability, and analytics. Users interact with the platform via a web portal and mobile application, allowing seamless browsing and querying of journal entries. The API Gateway acts as an intermediary, facilitating secure authentication and efficient communication between the front-end and back-end services. Within the backend, content processing and metadata extraction ensure that journal articles are structured for optimal indexing and retrieval. At the core of the system, the Elastic search cluster enables rapid full-text searches, journal indexing, and faceted filtering, providing precise and relevant results. The platform also incorporates a data storage layer, with NoSQL databases managing structured metadata and blob storage housing full journal content in various formats. Additionally, an analytics and insights module offers valuable research intelligence through interactive dashboards and AI-driven trend analysis. This integrated approach allows users to quickly locate, analyze, and explore journal content, leveraging Elastic search's speed and scalability for an optimized academic research experience.

B) Algorithm

The Advanced e-Journal Insight Platform exhibits several algorithmic characteristics that enhance its efficiency and usability. In terms of retrieval performance, Elastic search indexes enable query execution with a time complexity of O(log N), ensuring rapid information retrieval. The language model, responsible for processing text-based queries, operates with a time complexity of O(N * L), where N represents the number of documents and L denotes the length of input tokens, influencing processing speed. The platform follows a modular architecture, with each functional component encapsulated as a micro service, allowing seamless integration and independent scalability. Scalability is supported through Elastic search's capability for horizontal scaling, while AI models can leverage GPU clusters for efficient computation. Flexibility enables users to perform both keyword-based searches and natural Flexibility enables users to perform both keyword-based searches and natural language queries, enhancing accessibility. Furthermore, the system offers adaptability, allowing language models to be fine-tuned for specific domains such as biomedical, legal, or engineering fields, ensuring domain-specific accuracy and relevance. This combination of features ensures a high-performance, scalable, and adaptable platform for advanced journal insights.

C) System Architecture

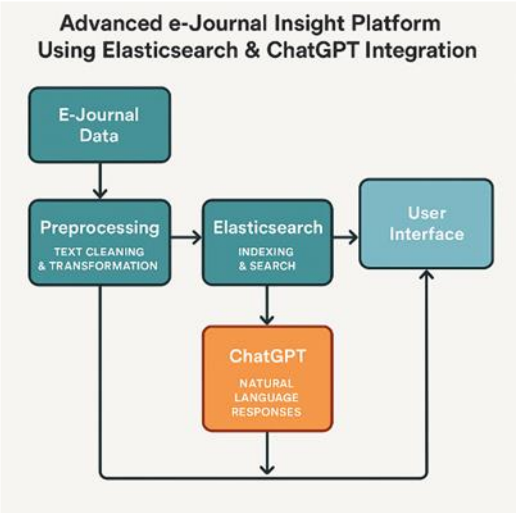

Fig.2: System Architecture

The system architecture of the advanced e-Journal Insight Platform using Elastic search is designed to optimize journal search, retrieval, and analytics while ensuring scalability and modularity. The User Interface Layer provides seamless interaction through a web portal and mobile application, allowing users to perform keyword-based and natural language searches. These queries are processed through the API Gateway, which manages authentication, access control, and communication with backend services via RESTful APIs. In the Backend Processing Layer, journal content is analyzed, structured, and enriched through metadata extraction and AI-driven classification, enabling efficient indexing. Elastic search, forming the Search & Indexing Layer, handles full-text indexing, faceted filtering, and synonym matching to provide fast and relevant results. Complementing this, the Data Storage Layer incorporates NoSQL databases for structured metadata and blob storage for full journal content in formats like PDFs and images. The Analytics & Insights Layer generates research intelligence, featuring AI-driven trend analysis and interactive dashboards for visualization. Finally, the Scalability & Performance Layer ensures high availability through Elastic search's distributed architecture and GPU acceleration for AI-based query processing. This modular and adaptable design facilitates efficient journal discovery, making advanced research accessible

D) Home page

The home page of the E-Journal Library Management System serves as the entry point for users to explore, search, and manage academic journals efficiently. At the top, a navigation bar provides easy access to essential functions, including "Home," "SignUp," "SignIn," and "Contact," ensuring users can quickly register, log in, or reach support. A search bar on the right side allows users to find specific journal entries, facilitating quick retrieval of scholarly content. The main content area features a welcome message, introducing the system's purpose—to enable seamless journal discovery, management, and exploration in a digital format. The background image showcases a stack of books, reinforcing the academic theme and inspiring users to engage in research and knowledge building. These elements collectively create an intuitive and user-friendly experience, making journal access efficient and accessible.

Fig .5: Home page

VI. CONCLUSION

The Advanced e-Journal Insight Platform leverages Elastic search to provide efficient, scalable, and intelligent journal search capabilities. Through its modular architecture, including a user-friendly interface, API gateway, backend processing, and advanced search and indexing mechanisms, the system ensures seamless information retrieval. The incorporation of AI-driven analytics, metadata extraction, and domain-specific adaptability further enhances research accessibility and relevance. With a strong foundation in Elasticsearch, the platform supports rapid, full-text searches, structured filtering, and intelligent insights, making journal discovery effortless. Its scalability, flexibility, and performance optimization ensure continued efficiency as research demands grow. This comprehensive integration of technology enables users to explore, analyze, and manage scholarly content with precision, revolutionizing digital journal access and research workflows.

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Automatic Corrosion Detection of Metal Surfaces by using Image Processing Technique

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ABSTRACT

In order to detect six common types of steel surface defects—namely scratches, crazing, rolled-in scale , patches, inclusion, and pitted surface—in real time and with high accuracy, the project "Automatic corrosion detection of metal surfaces using image processing techniques" uses YOLOv8. Flask provides the driving framework for the Python operations performed by the system, and HTML, CSS, and JavaScript power a responsive user interface. The system recognizes and classifies flaws on the surface of steel using the object detection capabilities of YOLOv8, which is useful for quality assurance and defect management during industrial operations. The interrelation of Flask enables users to operate on the system so as to upload photos and see the outcome of identifying flaws, thus making user experience smooth. This method is used to guarantee that products with no flaws reach the market in an effort to increase manufacturing quality and reduce waste.

Keywords: Steel defect detection, YOLOv8, Flask Framework, real-time classification, surface quality control.

INTRODUCTION

Product quality assurance is paramount in the steel manufacturing industry, as defects in the 'skin' of the steel can have tremendous effects on the usability, safety, and presentation of the end product. Traditional inspection methods often rely on manual checks that are time-consuming and prone to human error, resulting in inconsistent quality and elevated production costs. With advancements in deep learning and computer vision technologies, development gives a unique opportunity to gain speed and accuracy while automating the process of flaw identification.

A reliable, efficient, and automated solution provided by real-time surface defect detection using models such as YOLOv8 addresses these industrial problems. This research aims to bridge the gap between conventional practices and modern technology, enabling industries to achieve improved quality control standards. Because they impact the final product's quality, longevity, and aesthetic appeal, steel surface flaws are a big concern in the manufacturing sector. The structural integrity of steel, which is frequently utilized in essential applications, is compromised by common flaws such as crazing, inclusion, patches, pitted surfaces, rolled-in scale, and scratches.

Traditional inspection methods are based on manual checks that are time-consuming and error-prone. Yet with the latest trends in deep learning, new avenues for improvement and automation of the defect detection process have emerged. To specifically identify and classify various steel surface flaws, a modern object identification model, YOLOv8, is investigated in this study. The system offers real-time analysis and feedback, supported by a Flask-based backend integrated with a user-friendly frontend. This approach is designed to minimize environmental impact caused by waste and rework while also enhancing production quality and lowering operational costs by modernizing steel quality control processes.

CONTRIBUTIONS

The system uses the YOLOv8 model to identify and categorize surface flaws on steel using deep learning and sophisticated image processing techniques. Six forms of fault crazing are quickly detectable by it: inclusion, patches, pitting surfaces, rolled-in scales, and scratches. It prevents human mistakes and significantly improves the operational efficacy of industrial settings by avoiding manual inspections. CSS, in combination with JS and HTML, is used to create interactive content and give space for the loading of photographs and verifying the outcome of the detection of defects, while Flask is configured to establish an effective relationship between the model and user interface. Owing to the model's effectiveness and its adaptability across various surface conditions, data preprocessing steps such as image scaling, normalization, and augmentation have been applied. The proposed solution to this problem in the paper is scalable and cost-effective; hence, implementation of the automated defect detection and quality control to the existing industrial process becomes relatively easy. Furthermore, it lays the groundwork for future improvements, including the variety of the new problem types, the IoT-based monitoring that would be able to send real-time writes, and humans as the tool of predictive maintenance. The addition of all these benefits will be aimed at reducing the cost of operation, improving the process of manufacturing procedures, and maintaining the constant quality of a product in an industrial environment.

METHODOLOGY

The proposed system adopts the latest deep learning model, YOLOv8, used to detect 6 major types of defects on a steel surface at a high rate and in real time. This system provides a seamless experience for a user since it adopts a responsive frontend that is based on HTML, CSS, and JS, and the backend is developed in accordance with the Python language and using the Flask framework. This method ensures a better fault identification process, assists the process itself, and nullifies the human verification requirement completely. An effective and cheap solution that supports the requirements of a large industrial environment but has a positive effect on the quality of the product and the operating efficacy of an architectural composition of the system does not make it complex to integrate with the existing production lines. (Figure 1).

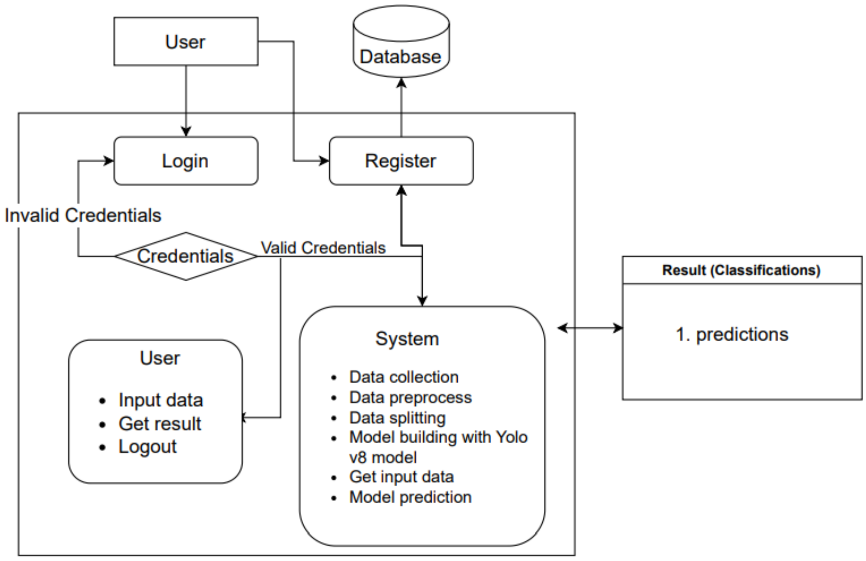

FIGURE 1: System Architecture

Five essential components make up the system design, which also offers completeness and scalability. The first module, known as the Input Module, is in charge of preprocessing and combining images. Steel surface photos are shot for more accurate and consistents, and then the photos are computed in an order of data cleaning, resizing, normalization, and augmentation. The second module, the Defect Detection Module, is configured to use the YOLOv8 model to determine pre-processed photos and six individual types of defects, including crazing, inclusion, patches, pitted surfaces, rolled-in scales, and scratches. This module obtains real-time detection and classification by minimizing human inspection.

For the third module, the Backend Processing Module, Flask is used during implementation to ensure smooth flow of communication between the user interface and the YOLOv8 model. It takes care of data processing, receives input images, feeds them through the model, and supports efficient detection output. The User Interface Module, the fourth module, has been made using JavaScript, HTML, and CSS. The module allows users the possibility to upload photos and visualize the defect detection results in an interactive platform with class and fault positioning given in an easy-to-understand manner.

The Future Enhancement Module outlines potential advancements for the system. These include integrating IoT technologies for real-time monitoring and alerts, incorporating AI-driven predictive maintenance to forecast surface degradation, and expanding the detection capabilities to cover additional types of surface defects. The system is designed to be modular in nature so that it should have been made resilient, scalable, and flexible for future industrializations.

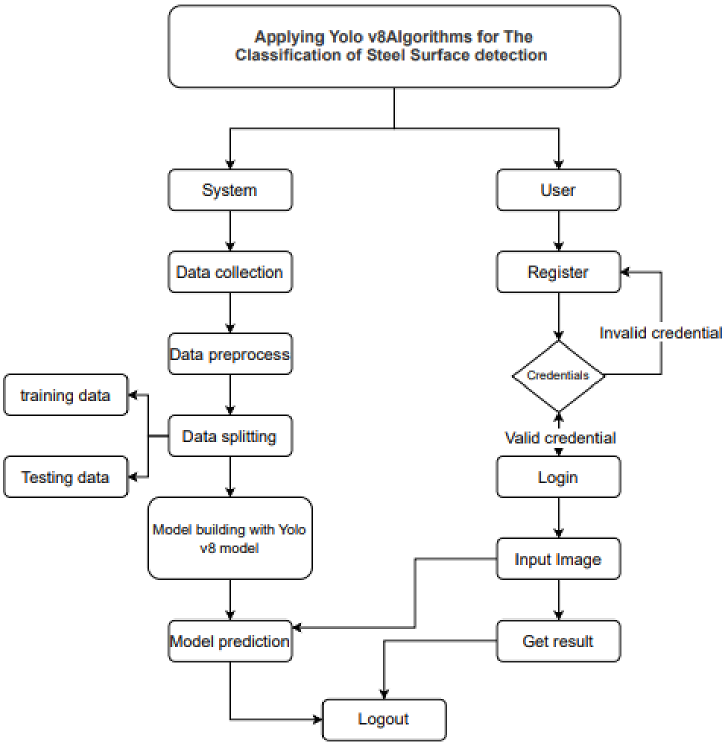

FIGURE 2: Block Diagram

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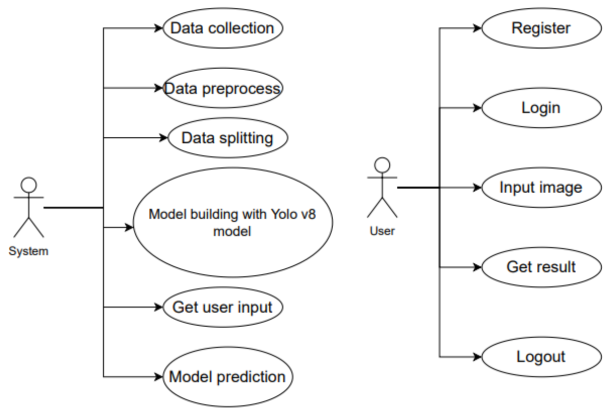
Use Case

There is a kind of diagram of behavior emerging from use-case analysis known as a use-case diagram by Unified Modeling Language (UML). By drawing the relation of actors and the system's use cases, it serves as a graphical demonstration of how the system operates. The primary purpose of a use case diagram is to visually summarize the system's functionality by illustrating the actions performed by various actors and highlighting the relationships or dependencies among the different use cases. This picture is an efficient method of learning and analyzing systems behavior and interaction because the roles and responsibilities of characters in the system are easily understandable.



DFD Diagram

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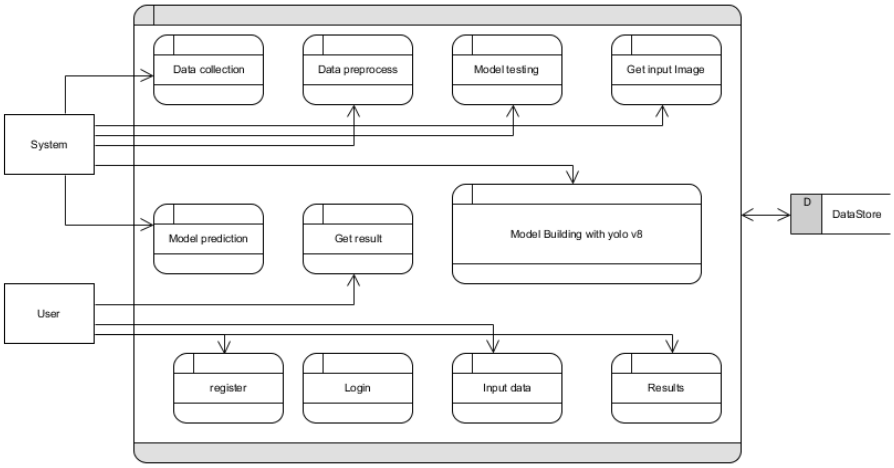


RESULTS

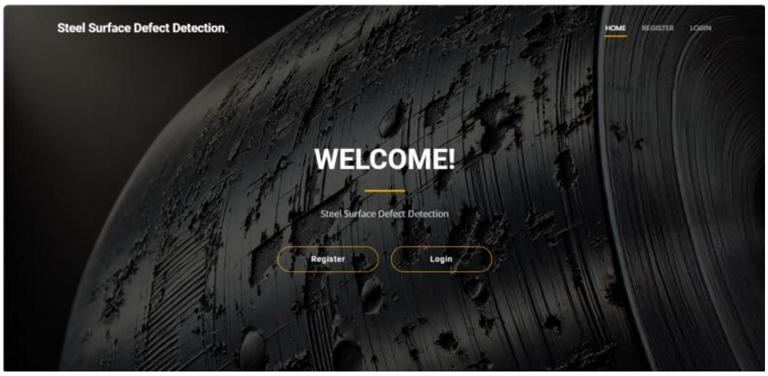
Another important feature is the ability to upload data sets to the system, which is essential for processing relevant information. Typically, these data sets consist of sample data or historical records that the algorithm uses to make predictions. When users upload, they can verify the data set to ensure that the data they provided is presented correctly, which guarantees that sharing the data is open to people. While making predictions or results, the users should input specific values or parameters that would correlate with the variables or features at hand within the dataset.

The system's functionality is structured around a series of essential procedures. First, it receives and processes the dataset provided by the user, which is then utilized to develop the prediction model. Before training the model, the system will preprocess the data to ensure the dataset is properly prepared and structured for effective modeling. This includes data cleaning, missing data, and feature extraction, among others. Then the system trains a prediction model using Python modules and machine learning tendencies to find out the patterns and relations between different parameters of a given dataset according to the preprocessed data. The model is known to generate outputs based on the value that the user has entered after the model has been properly trained. Such outcomes, however, typically apply to specific situations, events, or expectations—for example, ensuring that health insurance premiums are calculated accurately based on the provided inputs.

YOLOv8 (You Only Look Once version 8) is the most recent iteration of the popular YOLO family of real-time object detection models. It combines speed and accuracy, making it perfect for applications needing high-performance detection. By treating object detection as a single regression issue, YOLOv8 performs better than models that depend on region suggestions or multi-step procedures. The first step in the process is picture preparation, which comprises resizing, usually to 640×640 pixels, and normalization, which involves scaling pixel values between 0 and 1. The image is then split into a grid, and a convolutional neural network (CNN) examines it to extract pertinent characteristics.

Utilizing CSP-Darknet, the backbone network assists feature extraction by detecting spatiotemporal information, reducing the dimensions of the feature maps, and deepening them. In order to successfully detect objects that are of various sizes, items in varied scales are captured by YOLOv8 by incorporating a feature pyramid network and a path aggregation network for better feature extraction to be obtained to capture both higher- and lower-level features. The model's head is responsible for predicting bounding boxes and class probabilities, utilizing multiple scales to improve accuracy across small, medium, and large objects. Anchor boxes and regression are used to make bounding box predictions, with different bounding boxes projected for each grid cell. In relation to the anchor box, the model forecasts each bounding box's height, width, and center coordinates.

The objectness scores are computed to forecast if an object will be present in the previously given bounding box, whereas class predictions result in the likelihood of a class. After determining the Intersection Over Union (IoU), YOLOv8 eliminates multiple bounding regions for the same item using Non-Maximum Suppression (NMS). Suppressed boxes are those with more than a specific IoU score. YOLOv8 optimizes a loss function that includes the classification loss, the confidence loss, and the localization loss (IoU loss) following the proper weighting of each component. The model's confidence loss is based on binary cross-entropy, whilst cross-entropy is used for the categorization loss and IoU-based metrics are used for the localization loss.



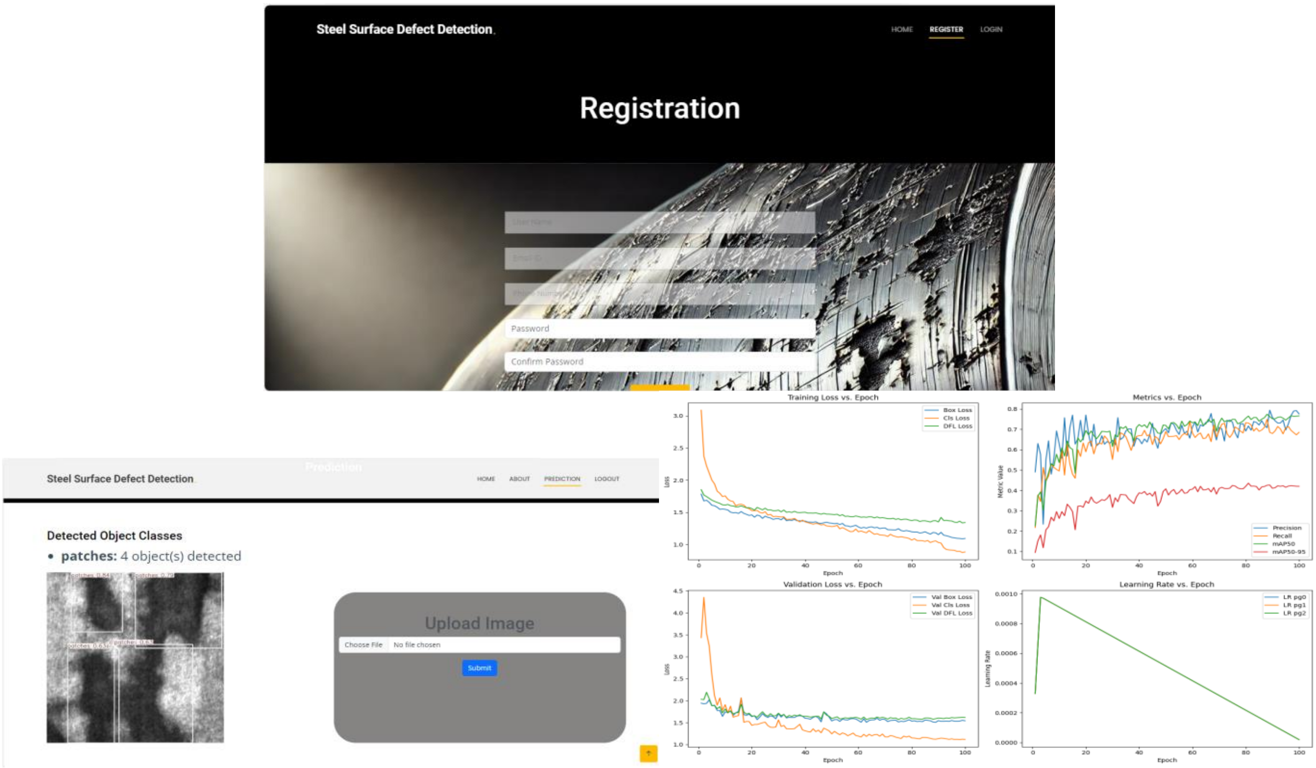


FIGURE 5: Results

DISCUSSION

Indeed, YOLOv8 is a tremendous breakthrough in the models of real-time object detection based on the synergy between the architectural innovations towards better accuracy and speed, which were inherited from its predecessors. CSP-Darknet being the backbone network can provide for the trade-off between detection precision and computing cost to be solved so that proper feature extraction can take place. To help the model quickly and accurately detect an object using an efficient dimensionality reduction for relevant spatial properties of the input data, this backbone is useful in this situation.

The helix connecting the FPN and PAN networks, which enables the multi-scale feature fusion, was the major advance that TYCO concentrated on. Due to its dual-path structure, which retrieves both high-level semantic variables and low-level spatial features, the model is robust in terms of object identification capabilities. The way that YOLOv8 detects tiny objects by utilizing different sizes reflects previous problems.

Anchor boxes and regression operations are employed in the object coordinate and dimension capture for every grid cell in the YOLOv8 bounding box prediction. The sigmoid function is used to provide prediction stability, which guarantees that the bounding box offsets fall within a specific limit. Rather, the predefined anchor boxes may be restrictive if the objects to be detected change greatly from the anchor boxes in terms of aspect ratio.

Non-Maximum Suppression (NMS), an integral element of the post-processing stage of YOLOv8, decreases the probability of several parallels for an item. The model ensures that only the most certain detections are retained by computing the IoU for overlapping boxes and suppressing those that had an IoU score above a threshold. The accuracy of detection and reduction of false positives also require this stage.

There are three primary parts to the YOLOv8 loss function. loss of localization, categorization, and confidence. The localization loss, which is usually IoU-based and represents an inaccuracy between predicted and ground truth bounding boxes, emphasizes the significance of precise object localization. The confidence loss uses binary cross-entropy to quantify the objectness predictions of the model and make sure it is immune to false detections. Finally, depending on the precision of the class predictions in cross-entropy, the classification loss motivates the model to effectively distinguish between the object categories.

While YOLOv8 excels in speed and accuracy for object detection, several challenges remain, including managing computational costs on resource-limited devices and improving the detection of overlapping objects and small objects in complex backgrounds. Performance can be further enhanced in specialized scenarios by fine-tuning the model on specific datasets and adjusting hyperparameters, such as anchor box dimensions and IoU thresholds.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

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Anchor boxes and regression operations are employed in the object coordinate and dimension capture for every grid cell in the YOLOv8 bounding box prediction. The sigmoid function is used to provide prediction stability, which guarantees that the bounding box offsets fall within a specific limit. Rather, the predefined anchor boxes may be restrictive if the objects to be detected change greatly from the anchor boxes in terms of aspect ratio.

Non-Maximum Suppression (NMS), an integral element of the post-processing stage of YOLOv8, decreases the probability of several parallels for an item. The model ensures that only the most certain detections are retained by computing the IoU for overlapping boxes and suppressing those that had an IoU score above a threshold. The accuracy of detection and reduction of false positives also require this stage.

There are three primary parts to the YOLOv8 loss function. loss of localization, categorization, and confidence. The localization loss, which is usually IoU-based and represents an inaccuracy between predicted and ground truth bounding boxes, emphasizes the significance of precise object localization. The confidence loss uses binary cross-entropy to quantify the objectness predictions of the model and make sure it is immune to false detections. Finally, depending on the precision of the class predictions in cross-entropy, the classification loss motivates the model to effectively distinguish between the object categories.

While YOLOv8 excels in speed and accuracy for object detection, several challenges remain, including managing computational costs on resource-limited devices and improving the detection of overlapping objects and small objects in complex backgrounds. Performance can be further enhanced in specialized scenarios by fine-tuning the model on specific datasets and adjusting hyperparameters, such as anchor box dimensions and IoU thresholds.

Recommendations

To improve the efficiency of automatic corrosion detection systems using image processing, several key recommendations can be followed. First, accurately identifying genuine corrosion patterns and incorporating advanced machine learning techniques, such as deep learning models like CNNs, can significantly boost detection accuracy. The model's robustness and versatility can also be enhanced by expanding the dataset to include a diverse range of surfaces and corrosion types across varying climatic conditions. Real-time processing can be achieved by integrating frameworks like OpenCV or TensorFlow Lite, enabling on-site corrosion detection using mobile or embedded devices. Additionally, optimizing image pre-processing—through methods like contrast enhancement, adaptive thresholding, and histogram equalization—can improve detection performance in challenging lighting conditions. Applying edge detection algorithms and texture analysis allows the system to identify even the most subtle or minute corrosion features.

Rotation, flipping, and scaling are data augmentation techniques that decrease overfitting through varying the training sample to accommodate more cases. By integrating with predictive analytics through which corrosion process can be understood, these analytics will help the firm plan maintenance and take action when may be necessary thus save the firm money. The facility would be able to develop easy to use interface, or mobile app, which would allow convenient input of data and representation of corrosion detection results, e.g., severity evaluations and corrective actions. Moreover, a broad picture of the risk of corrosion may be provided by Internet of Things sensors controlling such factors as the temperature and the humidity as well.

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Detection of Cyberbullying Using Machine Learning and Deep Learning Algorithms

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ABSTRACT

Use of digital technologies lead to the development of cyberbullying and social media has become a major source for it compared to mobile phones, platforms such as gaming and messaging. Cyberbullying can take several forms that includes sexual remarks, threats, hate mails and posting false things about someone which can be seen and read by millions of people. Compared to traditional bullying, cyberbullying has a longer lasting effect on the victim which can affect them physically or emotionally or mentally or in all the forms. Number of suicides due to cyberbullying has increased in recent years and India is one among the four countries that has more number of cases in cyberbullying. Prevention of cyberbullying has become manda- tory in universities and schools due to rising cases since 2015. This paper aims to detect cyberbullying comments automatically using Machine learning and Deep learning techniques. Metrics such as accuracy, precision, recall and F1-score used to evaluate the model performance. It is found that Gated Recurrent Unit, a deep learning technique outperformed all the other techniques which are considered in this paper with an accuracy of 95.47%.

Index Terms—Machine Learning, Deep Learning, Cyberbully- ing, Social media.

I. INTRODUCTION

BULLYING is considered to be an act of abusing a person physically or mentally or verbally while cyberbullying is bullying using digital technologies. Though bullying occurs in specific places such as schools, universities, parks, and workplaces at specific times, cyberbullying occurs at any point of time, anywhere in private online areas. Unlike bullying, cyberbullying doesn't require a large group of people or physical strength for face-to-face interaction. However, it is considered to be a form of harassment that includes pre-teens or adolescents and damages a person.

Social media has become a major source of cyberbullying which is carried out using digital gadgets such as cell phones, laptops, and tablets. Visiting or engaging in whatsoever web forums on social networking sites or applications, or gaming events with the objective of delivering disrespectful, harassing, or nasty text messages or comments on other postings, or sending or posting unsettling images or videos, is considered cyberbullying. If the personal or private information of one person is shared with another person, then that might poten- tially be considered criminal behaviour.

Cyberbullying is a common phenomenon in universities and schools which can affect the mental health of a person and indulge in activities such as violent behaviour, and drug and alcohol addiction. A cyberbullied person can become nervous, insecure, and anxious and can start to feel ashamed about himself or herself. These characteristics make them be away from their family and friends and increase negativity in them, feel guilty about things they did or did not. It has been proven that an age group between 10 and 19 are affected more by cyberbullying when it happens on social media through videos or pictures and via text messages. Cyberbullying is completely unlike traditional harassment, but it's similar and also distressing and has a longer-lasting effect on the victim. According to a survey by the European Commission's Joint Research Centre(JRC), more than 6,000 children of an age group between 10 and 18 were considered and they reported that about 50% of the children had experienced one of the several forms of cyberbullying in their lifetime. The amount of bullying or hate speech among teens and children has increased by 70% during the pandemic. Among 81% of active social media users in studies, it is reported that 22% of users aged between 8 and 16 are experiencing cyberbullying. As the number of social media users is increasing every day, India has ranked 4th position in cyberbullying which is not shocking news anymore. A survey made by CRY(Children Rights and You) which is an NGO showed that around 9.2 percent of children were bullied in the capital state of India.

Common symptoms that are found with the people who experiences cyberbullying includes frequent headaches, feeling lonely, overwhelmed and stomach aches. Cyberbullying can also make a person to lose his or her motivation to do the things that they usually enjoy doing and isolate them from others. This can bring negative thoughts and feelings which can adversely affect a person's mental health and well-being. Growth of internet and social media platforms have made students connected to people of various age groups using online platforms and spend large amount of time. Number of cyberbullied cases are increasing day by day. Compare to bullying cyberbullying is hard to find and prevent it. So the main aim of this research paper is to use the state of art tech- nology to detect and classify cyberbullying comments from the available text. It is known that deep learning techniques are outperforming compared to machine learning techniques to solve many real-world problems. The present study uses

both of these techniques.

II. Background

A. Machine Learning

Machine learning (ML) comes under the most booming topic which is artificial intelligence as a branch and also mentions the capability of delivering unmanned or automatic extensive learning which improves the outcomes coming from experiences by detecting the patterns. This technology uses current algorithms as well as datasets in order to develop any computer programs which provide sufficient solutions for the specific problem mentioned and that program will use those algorithms and dataset to learn without any human intervention. The learning process gets started with observing in data given, then identifying the patterns present in the data next creating progress findings by using those algorithms in next coming years based on the identified preexisted patterns. The main aim of using machine learning is that it can make any electronic device not only computers learn automatically without having any interference from humans or to change results correspondingly. Machine learning algorithms can an- alyze huge amounts of data which results in high accuracy in a small amount of time.

B. Deep Learning

Deep Learning is one of the main techniques which is used in machine learning. In deep learning, data models are designed in such a way that they bind to the particular task. Deep Learning has applications in various fields including classification and recognition of images, recognition of patterns also in the field of making decisions. These algorithms requires large dataset to achieve better accuracy.

The remaining of this paper contains the following sections. The related works of other authors in the field of cyberbullying detection is discussed in Section III followed by detailed methodology explained in Section IV and Section V is all about results obtained from the study discussed in detail. Finally in Section V1 conclusion of the paper is mentioned.

III. **Related Works**

Cyberbullying must be detected not only to avoid adverse physical but also effects. Many researchers are working con- tinuously to develop a model using efficient cyberbullying detection techniques. This section primarily includes research- related works done in the field of cyberbullying.

Md Manowarul Islam et al. [1] developed a model, by employing Naive Bayes, Support vector machine (SVM), Decision Tree, and Random Forest on two distinct datasets to detect cyberbullying. One from Twitter, while the other from Facebook comments and posts.Authors were able to get better results for both Facebook and Twitter datasets. Support Vector Machine provided higher performance when they used TF-IDF as a feature extractor.

Haidar et. al [2] presented an study for English and Arabic languages to detect cyberbullying by collecting texts from Facebook and Twitter platforms. They used Support Vector Machine and Naive Bayes classifiers to examine the collected datasets. Around 90.1% Precision was got from Naive bayes and 93.4 %precision for SVM. Baliram Chavan et al. [3] likewise designed a model for Machine Learning to identify and also to check cyberbullying on Twitter platform that utilizes Naive bayes and Support vector machine classifiers. They accumulated the data using Twitter and got accuracy of 71.25 %.

Many more studies on identifying cyberbullying exist, such as [4], in which G. A. Leon-Paredeset et. al, used machine learning algorithm by collecting spanish texts from Twitter and got an accuracy of 93%. Work done by Ali et al.[5] achieved 80% accuracy by using Machine learning algorithms on the three datasets collected. If deep learning techniques had been utilised in these studies, the accuracy and text classification would have improved.

Varun Jain et al. created a model for detecting cyberbullying using a big dataset in [6]. The researchers designed and evaluated the system using a binary classification problem, in which they recognised two categories of cyberbullying: On Twitter for hate speech and on Wikipedia for personal attacks and classified the content as cyberbully or not. They dis- covered that employing Natural Language Processing (NLP) approaches and procedures resulted in 90% accuracy using simple ML algorithms for the Hate speech dataset. As tweets with Hate speech comments or posts consist of bad language which turned out to be easily detectable.

Rounak Ghosh et al. [7] developed a model for Cyberbully- ing detection in Indian Language. The Authors wanted to build a system that detects Cyberbullying in the Bengali language which is considered to be outspoken. In the data preprocessing step, they used a stop word filter and transformed all the data into lower case and further tokenization was carried out. To extract the feature from the input text comments, they used TF-IDF method. In Final stage, ML algorithms were used for classification such as, Passive Aggressive Classifier, Support Vector Machine (SVM), Random Forest Logistic Regression. After the classification, the Passive-Aggressive algorithm got high accuracy for N-Gram level features. For the Support Vector Machine algorithm for the word level feature extraction method, they were able to get a better result.

Furthermore, Vijay Banerjee et al. [8] used deep learning methods to construct a model for detecting cyberbullying. For tweet classification, the authors proposed using Word vectors by feeding them into Convolutional neural network (CNN). The authors collected dataset from multiple online social media websites to validate their findings. They implemented their project in python and TensorFlow. For the neural network model in this research, it was implemented using Keras which is a library that works on top of TensorFlow. They were able to achieve 93.97 % accuracy upon testing their model.

Work done by A. M. Syed et al. [9] designed a new technique using deep learning to identify cyberbullying. They collected 39000 tweets using the Twitter API and achieved a maximum accuracy of 95%. In their study, they exclusively used tweets. In a similar line, Srivastava et al. [10] investigated the usefulness and deep learning performance to identify cy- berbullying. For the data collected from Kaggle, bidirectional LSTM surpassed the other four deep learning models with an accuracy of 82.18%. Although the accuracy achieved by them is adequate, but we outperform them in terms of accuracy.

Comparative literature review for sentiment analysis con- ducted Jain et al. [11] proved, many researchers were able to achieve 90% accuracy for machine learning algorithms. With Deep Learning and Combination classifiers one could achieve 93.1-94.9%accuracy. This research inspired us to compare and experiment the performances of algorithms in Machine learning and Deep learning.

Work by April Kontostathis et al. [12] used Machine learning algorithms by collecting data from Formspring. me platform to detect cyberbullying. This website is used to ask questions and answer them. To label the truth data sets, they used Amazon’s Mechanical Turk service. Data is divided into two categories that is ”yes” or ”no”. Two separate training sets were recovered, one for counting data and the other for normalising data. For training sets, the J48, JRIP, IBK, AND SMO ALGORITHMS were used. A decision tree is created using J48. Surprisingly, the overall accuracy rate was 81.7 %. But they used around 2600 text input for their study which is very less but in this study more than lakh comments were used as an input to achieve better accuracy.

Andrew M. Dal et al. [13] used CNN and LSTM to create a sequence learning supervised model. They discussed SoftMax combination in multicategory classification using both one- versus-all and one-versus-one classifiers. K. Duan et al. [14] study demonstrates how to apply the binary classification approach to multi-category classification efficiently. Their re- search demonstrates the application of the binary classification approach in classifying multiple categories. Quanzhi Li et al.

[15] designed a classification strategy for sentiments in tweets on schemes like weighting, the negation of texts.

A survey [22] showed, Instagram ranked highest in cyberbullying activities. Around 42% of people who participated in the survey experienced harassment on this social media platform.

The works discussed above are all excellent, yet they are all imprecise. The dataset, which contains 184397 English texts, is one of the study's distinctive features. This study not only meant to apply different algorithms but also comparing them to detect cyberbullying in English texts. We go over our recommended methodology in-depth in Section IV.

IV. Proposed Methodology

A. Dataset

The present study uses a dataset from the Mendeley data website consisting of 159,686 comments, out of which 144,324 were labelled non-bullying and 15,362 as bullying. The pres- ence of imbalanced data made the classifier detect the cyber- bullied comments with low accuracy. For this reason, 24,708 bullied comments were added to the considered dataset. A sample labelled text is shown in Table 1.

TABLE I SAMPLE INPUT TEXT DATA

Texts	Label
I hate to admit that you are a piece of shit	1 (Bullying)
Please shut the fuck up!! you asshole	1 (Bullying)
Guys lets go on a vacation for a week	0 (Not Bullying)
Can you please look over my cats for a day?	0 (Not Bullying)
You go and fuck your dad	1 (Bullying)
Hello Beautiful	0 (Not Bullying)

B. Work flow

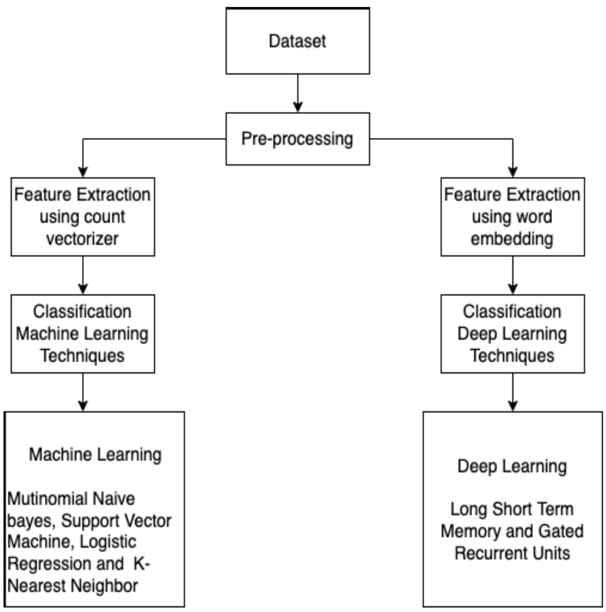

Fig. 1. Flow diagram of present study

The steps followed in the study are shown in Fig. 1. Before building the classification models using both machine learning and deep learning techniques, a pre-processing task has been carried out for the better performance of the model. In this process, count vectorizer is used in the case of machine learning and word embedding is used in the case of deep learning technique. To maintain uniformity in the dataset, all the sentences are converted from title case or capital case into the lower case as part of pre-processing. In addition to that tokenization is carried out to generate tokens from the text which could make the model understand the context. Finally, stopwords and punctuation were removed from the text which is considered to be an important task in pre-processing the reason that these things don't contribute to the process of developing a model.

Since the machine learning techniques require numeric input, each sentence in the data set is converted into a vector form using count vectorizer which converts based on the frequency of each word. For deep learning techniques, word embedding is used which follows a similar representation for the words with similar meanings. After extracting and import- ing features using these approaches the processed data are sent to both machine learning and deep learning techniques.

In both the approaches 80% of the data is used for training and 20% is used for validating the model.

C. Machine Learning Algorithms

Four Machine learning based classifiers are built using preprocessed data namely K-Nearest Neighbor, Multinomial Naive Bayes, Logistic Regression, and Support Vector Ma- chine.

1) Multinomial Naive Bayes: This classifier works on the Bayes theorem which is represented using Equation 1. Since the dataset consists of text sentences, the prob- ability of each class label is computed and returns the class label which has the highest probability.

$$P(h|b) = P(h|a) * P(h)/P(b) \qquad (1)$$

2) Support Vector Machines (SVM): This is one of the powerful classification techniques that come under supervised learning which can work better even if the number of dimensions is greater than the number of samples. This technique is considered to be a memory-efficient technique which determines the best decision boundary between the two classes with the help of a support vector. To categorise data points in N- dimensional space, SVM finds a hyperplane where the number of features is denoted by N. Among the several alternatives, SVM selects the hyperplane with the biggest margin. Increasing the margin distance allows for more exact classification of the following data points.

3) Logistic Regression: For two-class classification, logistic regression is a popular classification method. The lo- gistic sigmoid function is used in logistic regression to transform any actual value into a number between 0 and 1. It is used to translate predicted values to probability. Equation 2 is for sigmoid function.

$$S(Z) = \ 1 + e^{-Z} \qquad (2)$$

S(z) can be represented by the output range of 0 to 1. The function's input is z, and the natural log's base is e. In order to translate the value returned by the function into a discrete class, a threshold value is defined above which the values will be classified as class 1 and below which the values will be classified as class 2. The mapping is shown in Equations 3 and 4.

$$P \geq 0.5; class = 1 \qquad (3)$$

$$P > 0.5; class = 0 \qquad (4)$$

4) K-nearest Neighbor(KNN): This algorithm is an instance-based learning technique for multi-class prob- lems and uses the metric distance between a fresh sample and its neighbour to classify it. From the training set, determine the K-nearest neighbours and assign an item to the class that is most common among its nearest neighbours denoted by k. This classifier is a non-parametric lazy learning algorithm that makes no assumptions about the distribution of the underlying data.

D. Deep Learning Algorithms

Deep learning is the subset of machine learning techniques which are used to imitate the human brain. Unlike machine learning algorithms these algorithms use numerous layers to build the model. Deep learning algorithms require a larger dataset to get good accuracy. Such two popular deep learning techniques for text classification are namely LSTM and GRU, used in the present study.

1) One of the popular deep learning neural networks is Recurrent Neural Networks also known as RNN has certain drawbacks such as vanishing gradient problems and short-term memory due to which the classifier may not perform better in case of longer sentences. LSTM is a type of RNN which performs fairly better due to its long term memory. It can have multiple hidden layers and pass on the relevant information through every layer and discards unwanted

information. It keeps track of dependencies across long gaps [18] and prevents gradi- ents from disappearing. The forget gate is the LSTM's middle layer, and it determines which data should be normalised and which should be forgotten. An input gate modulates the inputs of each memory cell, whereas an output gate modulates the output. The architecture of LSTM is shown in Fig. 2. The present study uses

32 hidden layers with the rectified linear unit as an activation function and a sigmoid activation function in the output layer.

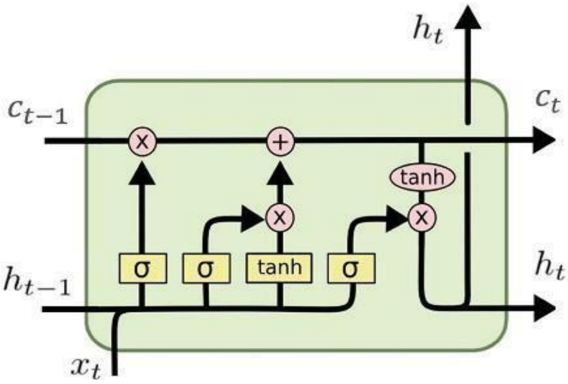

Fig. 2. LSTM architecture

Another type of RNN architecture called Gated Recur- rent unit also known as GRU uses two different gates namely reset and update. To combine the new input along with the previous memory reset gate is used and how much of the previous memory to be retained is handled by the update gate. Though GRU is similar to LSTM, it trains faster and performs better. It also solves the vanishing gradient problem. The architecture of GRU

$$Precision = \frac{TP}{TP + FP} \quad (6)$$

$$Recall = \frac{TP}{TP + FN} \quad (7)$$

$$F1 - Score = 2 * \frac{Precision * Recall}{Precision + Recall} \quad (8)$$

TABLE II. CONFUSION MATRIX RESULTS OF CLASSIFIERS

	Algorithm	TP	FP	FN	TN
Machine learning	Support Vector Machines	27,924	942	982	7,032
	Logistic Regression	28,274	592	1,446	6,568
	Multinomial Naive Bayes	28,354	512	1,580	6,434
	K-Nearest Neighbor	26,978	1,888	2,683	5,331
Deep Learning	Gated Recurrent Units	28,204	820	847	7,009
	Long short-Term memory	28,050	816	921	7,093

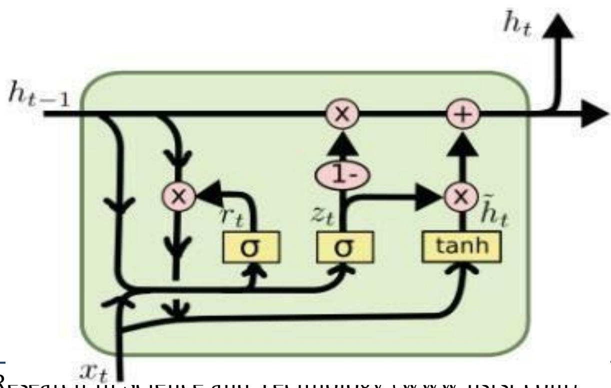

Fig. 3. GRU architecture

V. Results and Discussion

To test the model's performance in terms of conceptual soundness, a model validation has been carried out using test data. The models which are built using training data are evaluated using metrics including precision, recall, accuracy and f1-score and the accuracy details are recorded in Table III while other metrics details are recorded in Table IV and V. The information required to compute such metrics are presented in Table II and the corresponding confusion matrix is shown in Fig. 4 in terms of True Positive(TP), False Positive(FP),False Negative(FN), and True Negative(TN). The values of TP, TN, FP, FN for the test data are recorded in Table II. The corresponding graph is shown in Fig. 5 for the Machine learning approach and shown in Fig. 6 for deep learning approach.

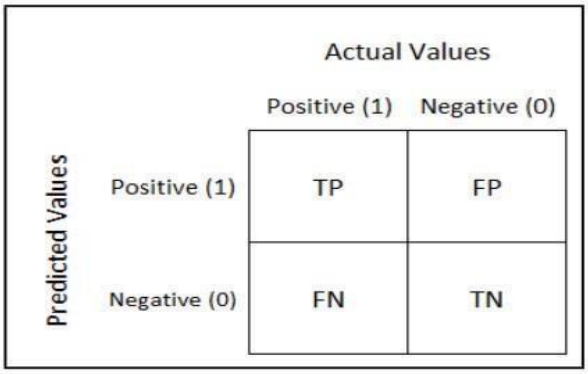

Fig. 4. Confusion Matrix

Equations 5, 6, 7, and 8 are used to calculate the accuracy, precision, recall, and f1-score.

As shown in Table II, Gated Recurrent Units exhibited the best performance by identifying 28,204 positive labelled correctly on testing data and 7,009 test data were labelled as negative. The lowest result was got when K-nearest neighbour is applied. As it correctly classified 26,978 positive and 5,331 negative labelled testing data.

TABLE III Accuracy results of Machine learning and Deep learning classifiers

	Classifier	Accuracy
Machine Learning	Support Vector Machines	94.78%
	Logistic Regression	94.47%
	Multinomial Naive Bayes	94.32%
	K-Nearest Neighbor	87.60%
Deep Learning	Gated Recurrent Units	95.47%
	Long Short-Term memory	95.29%

From the Table III we can observe, one of the Deep learning classifiers Gated Recurrent Unit performed well with an accuracy of 95.47% and Support Vector Machine got high- est accuracy of 94.78% among machine learning classifiers applied.

TABLE IV. PRECISON, RECALL AND F1-SCORE RESULTS FOR MACHINE LEARNING CLASSIFIERS

	Classifier	NB	B
Precision	Support Vector Machines	0.97	0.88
	Logistic Regression	0.95	0.92
	Multinomial Naive Bayes	0.95	0.93
	K-Nearest Neighbor	0.91	0.74
Recall	Support Vector Machines	0.97	0.88
	Logistic Regression	0.98	0.82
	Multinomial Naive Bayes	0.98	0.80
	K-Nearest Neighbor	0.93	0.67
F1-Score	Support Vector Machines	0.97	0.88
	Logistic Regression	0.97	0.87
	Multinomial Naive Bayes	0.96	0.86
	K-Nearest Neighbor	0.92	0.70

TABLE V. PRECISON, RECALL AND F1-SCORE RESULTS FOR DEEP LEARNING CLASSIFIERS

	Classifier	NB	B
Precision	Gated Recurrent Units	0.97	0.90
	Long Short-Term memory	0.97	0.90
Recall	Gated Recurrent Units	0.97	0.89
	Long Short-Term memory	0.97	0.89
F1-Score	Gated Recurrent Units	0.97	0.89
	Long Short-Term memory	0.97	0.89

Table IV and V displays the metrics of six classifiers, Preci- sion, recall, and f1-score percentage for Machine learning and Deep learning algorithms applied in the study respectively. In Table V, 'B' represents Bullied category and 'NB' respresents non bullied category.

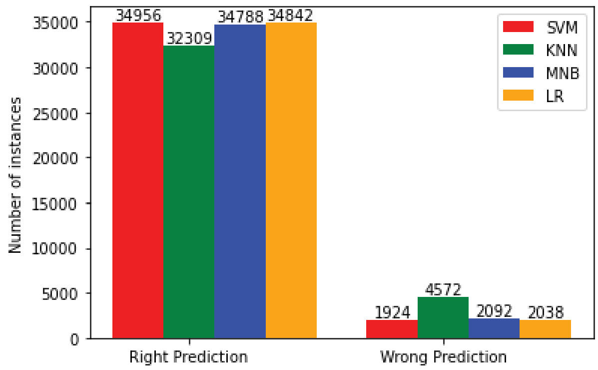

Fig. 5. No. of right and wrong predictions in Machine Learning Algorithms

As shown in Fig. 5 among four Machine Learning algo- rithms applied, Support Vector Machines performed well by correctly classifying 34,956 occurences and incorrectly identi- fying 1,924 cases. And in Fig. 6 Gated Recurrent Units (GRU) performed well by correctly classifying 35,213 occurrences and incorrectly identifying 1,687 cases.

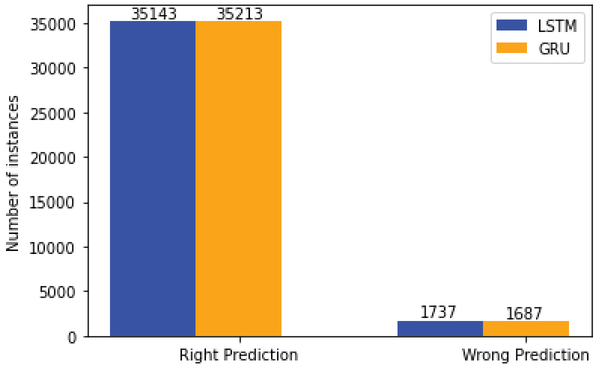

Fig. 6. No. of right and wrong predictions in Deep Learning Algorithms

The sample output given by the Multinomial Naive Bayes model for the new set of test comments shown in Fig. 7 where

'B' represents bullied comments and 'NB' represents non- bullied comments.

```
['B'] ['Please shut the fuck up you asshole']
['B'] ['I dont want to listen all your bullshits you morons']
['B'] ['I hate to admit that you are a piece of shit']
['NB'] ['Can you please look over my cats for a day']
['NB'] ['Consider you guys are lucky to be here']
['NB'] ['Come on you can solve this problem on your own']
['NB'] ['Guys lets go on a vacation for a week']
```

Fig. 7. Sample output for new test comments

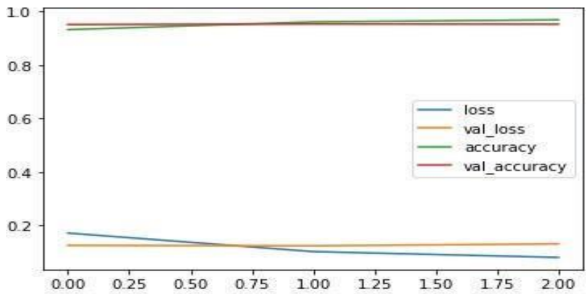

Fig. 8. Accuracy and loss graph of LSTM

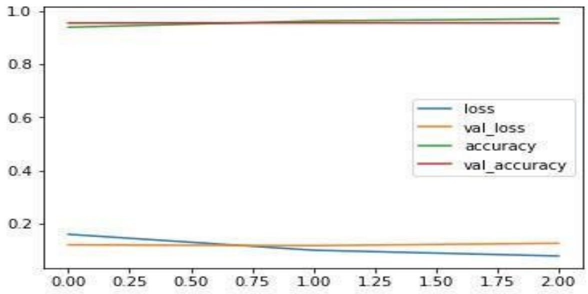

Fig. 9. Accuracy and loss graph GRU

Fig. 8 explains the loss, validation loss, accuracy and validation accuracy for the LSTM model and the same for GRU is shown in Fig. 9.

VI. Conclusion and Future Scope

It is observed that SVM is performing better in the case of the machine learning approach and GRU is slightly performing better compare to LSTM. However, it is also clear that deep learning techniques are outperforming compare to machine learning techniques.

It is found that among all the techniques that are applied in the present study, Gated Recurrent Units is performing better with an accuracy of 95.47%.

The present study considers cyberbullying and non-cyber bullying as two different categories further we can also explore various forms of cyberbullying as future work.

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Hand Gesture-based Virtual Mouse using Open CV

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ABSTRACT

In a world driven by constant innovation, the pursuit of more intuitive and accessible human-computer interaction remains a key focus. This project pioneers a gesture-controlled automation system designed to transcend traditional input methods like mice and keyboards. By leveraging the ubiquity of standard webcams and the power of advanced computer vision, our system allows users to interact with their computers through natural hand movements.

At its core, the system integrates OpenCV for real-time video processing, MediaPipe for precise hand landmark detection, and PyAutoGUI for seamless GUI automation. This synergy enables the translation of recognized hand gestures—including those for mouse control, application navigation, and automated tasks—into concrete computer commands. The aim is to create a touchless interaction paradigm that not only enhances user experience through fluid and direct control but also significantly improves accessibility for individuals with physical limitations. This innovative approach offers a cost-effective and versatile solution, paving the way for a future where human- computer interaction is more natural, intuitive, and universally available.

Keywords—OpenCV, MediaPipe, Gestures, Presentation, Computer Vision, Raspberry Pi, OpenCV, Gesture Recognition, 3D Printing

I. INTRODUCTION

The landscape of computing has undergone a dramatic transformation, evolving from room-sized machines to powerful devices that fit in the palm of our hands. This relentless pace of technological advancement consistently strives to simplify human life, often by reducing direct physical interaction with complex systems. Our project stands at the forefront of this evolution, presenting a novel approach to human-computer interaction that minimizes physical contact and enhances user accessibility through **gesture control**.

This paper introduces an innovative system that empowers users to control their computers through the intuitive power of **hand gestures**. Imagine navigating your laptop or PC, scrolling through documents, or managing volume settings simply by moving your hands. This technology aims to create a seamless and natural bridge between human intention and digital action, offering a touchless interaction paradigm that promises to redefine how we engage with the digital world. Beyond convenience, this system offers a significant advantage for individuals with disabilities, providing a more accessible and comfortable way to interact with technology. The recent global pandemic also underscored the critical need for contactless solutions, further highlighting the relevance and importance of such a system in today's world.

II. RELATED WORK

The burgeoning field of human-computer interaction has seen significant strides in developing natural and intuitive control mechanisms, with gesture recognition emerging as a promising alternative to traditional input methods. Our project is firmly situated within this evolving landscape, building upon and contributing to the body of knowledge established by prior research.

Recent advancements in hand tracking and gesture recognition form the bedrock of our system. Sruthi and Swetha [1] showcased a real-time hand tracking system utilizing the MediaPipe Hands pipeline with a single RGB camera, demonstrating its strong performance and accuracy, particularly in augmented and virtual reality environments. This highlights MediaPipe's efficacy in precise hand landmark detection, a core component of our approach. Similarly, Uboweja [2] focused on optimizing gesture classifiers for real-time performance on mobile GPUs using neural networks, underscoring the practicality of implementing hand gesture recognition even in resource- constrained settings. While our primary focus is desktop environments, the emphasis on real-time efficiency resonates with our goal of a responsive system.

The concept of customizable gesture recognition, as proposed by Patil [3], offers a flexible framework for users to define and deploy hand gesture recognition models tailored to specific application needs. This work on enhancing interactivity and adaptability in gesture- controlled systems provides a valuable precedent for designing a system that can be extended or modified to suit diverse user requirements.

Several studies have demonstrated the practical applications of gesture control in specific domains. Ismail [4] presented a gesture-controlled system for managing presentations, integrating OpenCV and MediaPipe to enable hands-free slide control, thereby improving the efficiency of live presentations. Likewise, Sung [5] developed a media player application responsive to hand gestures for actions such as play, pause, and volume control, highlighting the potential of gesture recognition for intuitive and touchless user interfaces. These examples validate the utility of gesture control in enhancing user experience for common applications, aligning with our project's aim to provide comprehensive computer control.

Despite these advancements, challenges in hand gesture recognition persist. Zhang [6] extensively explored technical difficulties arising from variations in hand pose, orientation, lighting, and scale, advocating for more robust algorithms and diverse datasets to improve real-world application performance. This study serves as a crucial reminder of the complexities involved and informs our meticulous approach to designing a system that is resilient to varying environmental conditions and user behaviours, ensuring accuracy and reliability in practical deployment. Our work seeks to address these challenges by meticulously leveraging the capabilities of OpenCV and MediaPipe to achieve robust recognition.

III. METHODOLOGY

Our gesture-controlled automation system leverages a synergistic combination of readily available hardware and cutting-edge software libraries to provide a natural and intuitive human-computer interface. The core methodology revolves around real-time video capture, advanced hand landmark detection, and seamless translation of recognized gestures into computer actions.

System Setup and Video Capture

The foundation of our system begins with real-time video input. We utilize a standard webcam as the primary sensor. To ensure continuous operation, the video capture runs within a continuous loop, allowing for constant frame processing. Each frame is read and then displayed to the user, providing a live feed of the captured input.

Hand Detection and Landmark Extraction

The crucial step of hand detection and landmark extraction is performed using the MediaPipe library. Incoming video frames are processed by MediaPipe's pre-trained models to accurately detect hands and pinpoint 21 distinct 3D landmarks on each detected hand.

These landmarks represent key points such as fingertips, knuckles, and the palm center. For visualization and debugging, these landmarks are drawn directly onto the video feed, offering a clear visual representation of the detected hand structure. The x and y coordinates of these landmarks are obtained and scaled relative to the frame's width and height, enabling precise tracking of hand movements. The frame is also typically flipped along the Y-axis to provide a mirror-like view, enhancing user intuition.

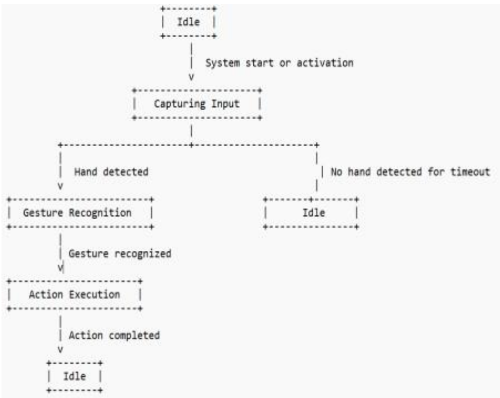


Figure 1. Flowchart of Working

Figure 2. Detection of Hand Landmarks Gesture Recognition and Automation

Once the hand landmarks are accurately detected, the system proceeds to recognize predefined gestures and translate them into computer actions using the PyAutoGUI library. PyAutoGUI allows us to programmatically control the mouse and keyboard, obtaining screen dimensions to map hand movements to cursor positions accurately.We implement several key gesture-to-command mappings:

Mouse Cursor Movement: When a specific finger, typically the index finger, is extended while other fingers are down, its x and y coordinates are mapped to the screen's dimensions. By tracking the index finger's movement in the camera feed, the system precisely controls the mouse cursor on the screen.

Left Click: A designated gesture, such as a thumb-up (thumb extended, other fingers down) or a pinch gesture (e.g., bringing the index finger and thumb close together), is configured to trigger a left mouse click.

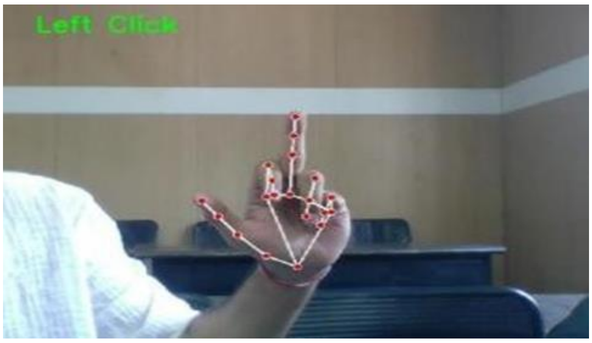


Figure 3. Mouse Left Click

Right Click: Extending the index finger while other fingers are down and the dumb finger is at a angle below 25 degree with the centre. Now bending the index finger will initiate the right click with the cursor.

Figure 4. Mouse Right Click

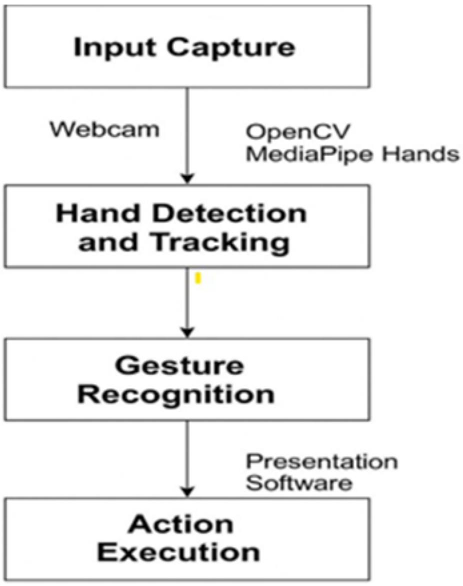
Double Click: For the double click function we just have to raise the index and middle finger and bend it together.

Figure 5. Double Click Gesture Additional Features

Scrolling via Object Detection (e.g., Yellow Object): This feature enables scrolling functionality by detecting a specific colored object in the camera's field of view. OpenCV is used to process the frame, create a mask for the target color, and then identify contours. If a sufficiently large colored area is detected and its vertical position changes, PyAutoGUI can simulate the 'Space' key press or scroll wheel actions, which often trigger scrolling in applications like PDF viewers, websites, and YouTube. A visual indicator (e.g., a colored rectangle) is drawn around the detected object for user feedback.

Volume Control: This functionality can be achieved by measuring the distance between specific finger landmarks, such as the thumb tip and index fingertip. As this distance changes, the system dynamically adjusts the system volume. A very small distance can mute the volume, while increasing the distance gradually increases it.

IV. SYSTEM ARCHITECTURE



The architecture of the gesture-controlled presentation system consists of the following key components:

1. Input Capture

Utilizes OpenCV to capture live video stream from the webcam.

2. Hand Detection and Tracking

Media Pipe Hands is used to detect and track hand landmarks (fingertips, joints).A custom Hand Tracking Module processes these landmarks to extract gestures.

3. Gesture Recognition

Predefined gestures are mapped to specific presentation actions:

Thumb Finger – Previous slide Little Finger – Next slide

Index + Middle Finger – Hold pointer Index Finger – Draw/annotate

Middle Three Fingers – Erase/undo

4. Action Execution

Recognized gestures trigger commands in the presentation software.Compatible with slide navigation, annotation, and pointer control.

V. RESULT

Testing the control system, the robotic arm responded in real time to both directional and hand pose detection commands. The recognizing gestures of the hand proved successful in a testing environment. The limit switches on the robotic arm worked to stop movement when they were pressed preventing damage to items being held or the robotic arm, but there is room for improvement.

Suggested Improvemts :

The first recommendation is to explore a better method of calibrating for hand color or apply a form of background subtraction that is computationally effortless. The second recommendation is to apply a detection method for individual finder movement and articulation. This could be accomplished by splitting the hand contour into smaller vectors and evaluation their position or magnitude relative to other segments.

The third recommendation is to have the Raspberry Pi communicate with a smaller microcontroller such as the Arduino Mega. This would require a voltage level shifter to communicate via I2C protocol or communicate with a wireless module such as an nRF24L01 module.

There are three reasons to choose an Arduino over Raspberry Pi.

1) PWM Control With the Raspberry Pi, PWM control is taxing on the CPU. With each additional PWM wave generated, the timing accuracy of the Raspberry Pi diminishes. The Raspberry Pi only has one natural PWM control output port and the rest must be generated with the support of software writing library for PWM signals. The Arduino Mega has 15 PWM ports and could easily control the servo motors.

2) Analogue Inputs The Raspberry Pi does not contain any analogue input pins. This requires an analogue to digital converter to process signals from pressure sensors. This is important because more precise pressure sensors could be used for delicate handling of material. The Arduino Mega has 16 analogue input pins making it perfect for numerous sensors to be placed on the robotic arm.

3) Library Support The Arduino Integrated Development Environment contains servo motor specific functions that could prove beneficial to this or similar projects. The "servo read" function can provide current position of the servo motor which would benefit an interrupt system based on pressure.

VI. Future Enhancements

The paper suggests several areas for improvement and expansion:

1. More Gestures & Actions Add gestures for:

a. Zoom in/out b.Highlighting

c.Trigger multimedia elements (videos, animations)

2. Multi-User Collaboration

Enable multiple presenters to use gestures simultaneously.

Assign roles or implement handover gestures for control transfer.

3. Platform Compatibility

Extend support to popular presentation platforms like:

a. PowerPoint

b. Google Slides

c. Apple Keynote

These improvements aim to enhance interactivity, expand usability, and allow collaborative and multimedia-rich presentations.

VII. CONCLUSION

This project successfully pioneers an advanced gesture- controlled automation system, moving beyond conventional input devices to offer a more natural and intuitive human- computer interaction. By meticulously integrating OpenCV for real-time video processing, MediaPipe for accurate hand landmark detection, and PyAutoGUI for seamless GUI automation, we've developed a robust and user-friendly prototype.

Our system effectively demonstrates touchless control for fundamental computer operations, including precise mouse cursor movement, left and right clicks, and the potential for double-click functionality through defined hand gestures. Beyond basic mouse control, the methodology supports the integration of features like scrolling via object detection (e.g., yellow color tracking), and lays the groundwork for more advanced modalities such as eye and mouth-based control, as well as volume adjustments through fingertip proximity.

The conceptual inclusion of a virtual keyboard further expands system's utility, enabling virtual typing through hand movements.

This research not only showcases the practical application of virtual reality concepts in a real-world computing environment but also emphasizes the significant advancements possible in accessibility and user experience. The prototype has undergone rigorous testing, consistently demonstrating its functionality and reliability. This innovative solution holds immense potential to enhance productivity, offer invaluable assistance to individuals with limited mobility, and pave the way for a truly immersive and natural digital interaction paradigm.But also emphasizes the significant advancements possible in accessibility and user experience. The prototype has undergone rigorous testing, consistently demonstrating its functionality and reliability. This innovative solution holds immense potential to enhance productivity, offer invaluable assistance to individuals with limited mobility, and pave the way for a truly immersive and natural digital interaction paradigm.The prototype has undergone rigorous testing, consistently demonstrating its functionality and reliability. This innovative solution holds immense potential to enhance productivity, offer invaluable assistance to individuals with limited mobility, and pave the way for a truly immersive and natural digital interaction paradigm.

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Enhancing Clinically Significant Prostate Cancer Detection in Multiparametric MRI via Integrated 3D CNNs, RNNs, and Transfer Learning

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ABSTRACT

Prostate cancer is one of the most common types of cancer that affects men in every corner of the world. Its precise and timely diagnosis is exceptionally important for effective treatment. MpMRI imaging has become one of the most powerful non-invasive diagnostic methods for prostate cancer. In this particular work, we develop a new model for hybrid deep learning that combines 3D Convolutional Neural Networks (3D-CNNs) with Recurrent Neural Networks (RNNs) using transfer learning to improve clinically significant prostate cancer detection from mpMRI scans. Our method utilizes the feature extraction capabilities of 3D-CNNs, the time-series prediction abilities of RNNs, and the advantage of transfer learning from extensive medical databases. Evaluated on the public PROSTATEx data set our method out performs present baselines which results in improved sensitivity and specificity in the identification of significant lesions. This framework is a step forward in reliable automatic mpMRI interpretation and we put forth that it may support radiologists in clinical decision making.

1. Introduction

Prostate cancer is still a great public health issue in which early detection plays a key role in effective management. We see mpMRI which includes T2 weighted imaging, Diffusion Weighted Imaging (DWI) and Dynamic Contrast Enhanced (DCE) imaging as a tool which enables in depth anatomic and functional assessment of the prostate gland. Although it has its benefits mpMRI interpretation is a complex and subjective process which in turn produces inter observer variability. Therefore, computer aided detection systems which use deep learning may play a transformative role. Latest studies show promise for 3D-CNNs (three-dimensional convolutional neural networks) in utilizing contextual information from mrPIs (multiparametric Magnetic Resonance Imaging) mpMRI. With respect to prostate lesions, these exhibit disparate morphologies across sequences and slices, which motivates the addition of sequential modeling. Also, the lack of sufficiently annotated medical data makes building robust models difficult, something transfer learning can help deal with. This study provides a custom system designed to improve detection of prostate cancer by combining 3D-CNNs, RNNs (recurrent neural networks), and transfer learning.

2. Related Work

2.1 Deep Learning for Prostate Cancer Detection A variety of works have applied mpMRI prostate cancer classification using 2D and 3D CNNs. While 2D models do not capture effective volumetric data, 3D models such as VNet and 3D U-Net have had success with lesions' localization and segmentation.

2.2 RNNs in Medical Imaging Sequential clinical imaging data have been processed with RNNs, most commonly with Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) networks, which impose a form of temporal or spatial order dependency. The combination of RNNs and CNNs has demonstrated effectiveness in areas such as cardiac MRI or longitudinal imaging studies.

2.3 Transfer Learning in Medical Imaging The application of transfer learning enables knowledge to be transferred from models built on large datasets like ImageNet and other medical datasets.

3. Methodology

3.1 Dataset

We exploit the PROSTATEx dataset, containing mpMRI scans with annotations for clinically significant lesions. Each case includes T2-weighted, DWI, and DCE sequences.

3.2 Preprocessing

The following tasks are included in the complete workflow.

- correcting N4 bias
- normalization of intensity
- co-registration of sequences
- Resampling to isotropic voxel dimensions

lesion oriented cropping (e.g., 64x64x32 block centered at the ROI)

3.3 Architecture Overview

Our architecture consists of three main components:

- **3D-CNN Backbone**: Extracts spatial features from volumetric patches. A modified 3D ResNet-18 pretrained on a medical imaging dataset is used.
- **Sequence Modeling with RNNs**: Each slice (or segment of the 3D volume) is treated as a timestep which outputs to a GRU based RNN to capture inter-slice dependencies.
- **Transfer Learning:** The weights of the 3D-CNN are initialized using weights from a previous training on a prostate segmentation task or an applicable 3D imaging dataset, for instance MedicalNet.
- **Classification Head:** Clinically significant vs non-significant cancer classification using fully connected layers and softmax output.

3.4 Training Protocol

- Optimizer: Adam
- Learning rate: 1e-4 with cosine annealing
- Batch size: 8

- Loss function: Weighted cross-entropy to address class imbalance
- Evaluation: Stratified 5-fold cross-validation

4. Experimental Results

4.1 Evaluation Metrics

- Overall accuracy
- Micro and Macro metrics of precision, recall, F1-score
- Area under curve of receiver operating characteristic curve (AUC-ROC)
- Sensitivity for PI-RADS 4-5 lesions.

4.2 Performance Comparison

Method	**Accuracy**	**F1-score**	**AUC**
3D-CNN Only	82.3%	0.81	0.86
3D-CNN + GRU	86.7%	0.85	0.90
Ours (3D-CNN + GRU + Transfer)	**89.4%**	**0.88**	**0.93**

Our hybrid method surpasses traditional models with respect to recall and clinically relevant cancer detection.

5. Discussion

The combination of 3D spatial features with sequential modelling leads to more complete representations of the lesion dynamics. With the limited size of prostate MRI datasets, transfer learning has a considerable impact on speeding up convergence and improving generalization. Other limitations include the heterogeneity of the data (vendor differences, scanner strength) and the dependency on correct annotations.

6. Conclusion

With this work, we propose a new framework for the detection of clinically significant prostate cancer in mpMRI scans using 3D-CNNs, RNNs, and transfer learning. The results obtained using the proposed framework were better than the baseline methods which confirms the effectiveness of deep learning approaches to assist in diagnosis. Further development will focus on attention mechanisms and application to multi-center datasets.

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