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5th and 6th April 2024

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Baruipur, West Bengal, India
In Association With
Institution Of Electronics and Telecommunication
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COMPUTATIONAL INTELLIGENCE IN INDUSTRIE 4.0

- Computational Intelligence
- Multi-Agent Systems
- Chaos Theory
- Evolutionary Computation
- Expert Systems
- Neural Networks
- Pattern Recognition
- Probabilistic Reasoning
- Reinforcement Learning
- Robotics

INDUSTRIE 4.0

- Sensors, Embedded Systems, IoT Components
- Robotics, particularly Human-Robot Interaction
- User Interfaces including Software and Hardware Devices for Interacting with Systems
- Cybersecurity and Functional Safety of IoT Components
- Positioning and Identification Systems
- Wireless Network Technology
- New Methods of Work
- Cloud and Fog Computing
- Artificial Intelligence
- Industrie 4.0 Business Models
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CONTENT

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Smart Plant Guard: IoT-Based Plant Water Monitoring System

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ABSTRACT
The Internet of Things (IoT) is essential for enhancing greenhouse growing techniques and giving farmers and landowners the pertinent data they need to make decisions that will maximise output. In order to monitor plant conditions, this study introduces an intelligent system based on the Internet of Things concept that remotely gives users information on humidity, temperature, and soil moisture intensity. The Android app allows users to monitor plant health statistics and control the frequency and time frame of water sprinkling. With the help of the ESP8266 Wi-Fi module, the sensors gather the data and send it to the Blynk app. Based on the plant's critical condition, the user can operate the solenoid valve using an application for Android to keep it healthy.
Keywords: Internet of Things; Android application; plant health monitoring

1.Introduction:
Large infrastructures are needed for conventional greenhouses, which are hindered by issues including the absence of smart conditions, plant diseases, smaller farms, decomposing soil, and a lack of resources, which lowers agricultural productivity [1].In order to enhance production in agriculture, resource utilisation must be done efficiently. In order to increase crop yield or preserve plant health, numerous technologies are being incorporated into the agricultural sector, particularly with regard to the usage of energy and water. These technologies, which include big data, machine learning, cloud-based computing, wireless sensors, the Internet of Things (IoT), and fog computing, are crucial. A plant has to have its health indicators monitored and remedial action taken when necessary in order to grow successfully. The plant's health declines as a result of environmental circumstances, such as high temperatures, unusual humidity levels, and poor soil quality [2]. By monitoring a plant's environmental parameters, IoT technology can be used to analyse the plant's beginning conditions.

As seen in Figure 1, a variety of sensors, including DHT-11 and sensors for soil moisture, are incorporated in this work to measure the environmental climate. The solution of nutrients is also supplied to guarantee plant growth by spraying water via a relay and electromagnetically valve, in accordance with the fundamental needs of the plant. A DHT-11 sensor is used in the greenhouse to measure the temperature and humidity, and a soil moisture sensor is used to measure the moisture content of the soil. The suggested solution then uses the ESP-8266 Wi-Fi module to send the data collected by the sensors to the IoT platform, enabling users to remotely monitor the various plant metrics.

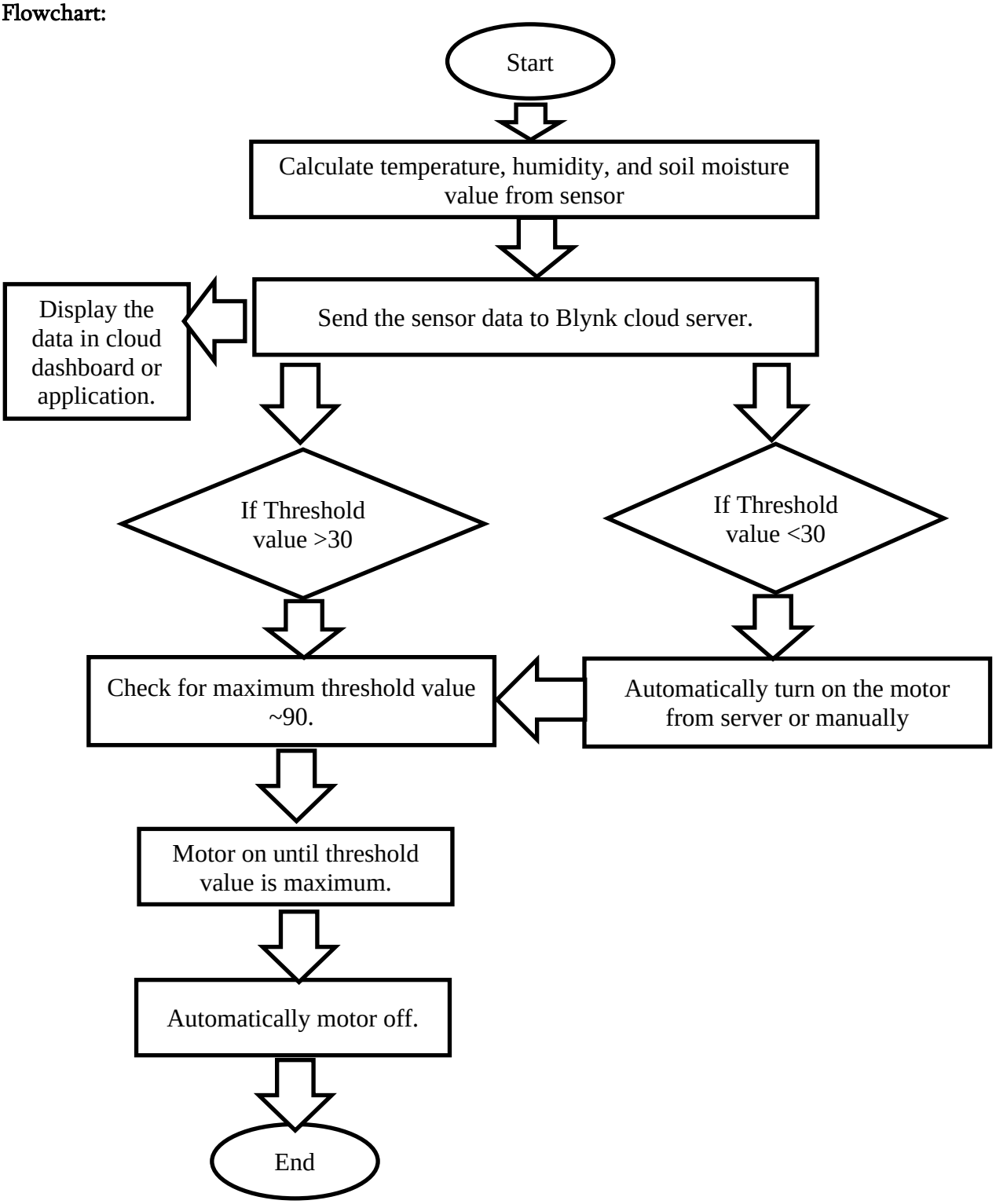
In addition to being helpful for remote viewing, the Android application also controls sprinklers by turning them on and off in accordance with the needs of the plant or plants. This approach is beneficial since it can result in lower labour expenses and eliminates the need for farmers or landowners to physically visit the field in order to check on their plants or crops. The device has a water-saving feature that allows farmers or landowners to remotely irrigate their plants using an application if they believe bad weather will have an impact on the health of their plants. In order to take corrective action prior to the weather getting worse, the system allows remote administration. The soil moisture readings and light intensity levels are gathered by the Internet of Things-based greenhouse automation system, which is created in [3]. It lowers the temperature by turning on the fan automatically. The system is devoid of the capability to remotely sprinkle water, and it does not offer Android application monitoring. Citrus moisture and nutrient levels are monitored by IoT-based agricultural applications, as presented by the authors in [4], however the technology is expensive and complicated. The authors of [5] created an Internet of Things (IoT) system that enables users to use mobile apps and the internet to monitor their farm. On the farm, this investigation encountered difficulties with water control. The water control systems presented in [6,7] are helpful for IoT-based agriculture, but they are expensive to operate for farmers. In the farm, the implemented system makes use of Bluetooth and LPWAN communication [8]. As a result, the user can only utilize the device while they are close to their farm or field.

This work presents a proposed system that addresses the limitations identified in previous research and offers an affordable alternative for plant monitoring in a healthy setting. The format of this document is as follows: Section 2 explains the working methodology of the system. Section 3 describes the results, and Section 4 discusses the conclusions and future work.

2.Methodology:

The Plant Water Monitoring System utilizes an ESP32 micro-controller, soil moisture sensor, and environmental sensors to optimize plant care. Soil moisture is continuously monitored, and when levels fall below a predefined threshold, indicating dry soil, the system triggers automated watering through a water pump and tubing. This ensures plants receive water precisely when needed for optimal growth. Additionally, temperature and humidity sensors provide valuable environmental data, enhancing understanding of the plant's surroundings. The ESP32 processes sensor data and makes watering decisions accordingly. Users can interact with the system via an IoT application, accessing real-time information on soil moisture, temperature, and humidity, and manually initiate watering if necessary. The system emphasizes energy efficiency through power-saving mechanisms, ensuring prolonged operation. Historical data on soil moisture and environmental conditions are logged for analysis, enabling informed decision-making in plant care. By automating watering based on real-time data and providing insights into environmental factors, the system promotes healthier plant growth and simplifies plant care for users.

Flowchart:


Start
Calculate temperature, humidity, and soil moisture value from sensor
Send the sensor data to Blynk cloud server.
Display the data in cloud dashboard or application.
If Threshold value >30
If Threshold value <30
Check for maximum threshold value ~90.
Automatically turn on the motor from server or manually
Motor on until threshold value is maximum.
Automatically motor off.
End

3. Results and Analysis

With the help of sensors and the ESP32 micro-controller, the system successfully tracks temperature, humidity, and soil moisture levels in real time in Figure 1 . Watering functions that are automated are put into place to make sure plants get water when soil moisture levels drop below specified levels. An intuitive Internet of Things application is created, allowing users to monitor soil moisture, temperature, and humidity levels remotely and adjust the system as necessary Figure 2 .Users can manually start watering or change system settings thanks to the integrated manual control features in the user interface.

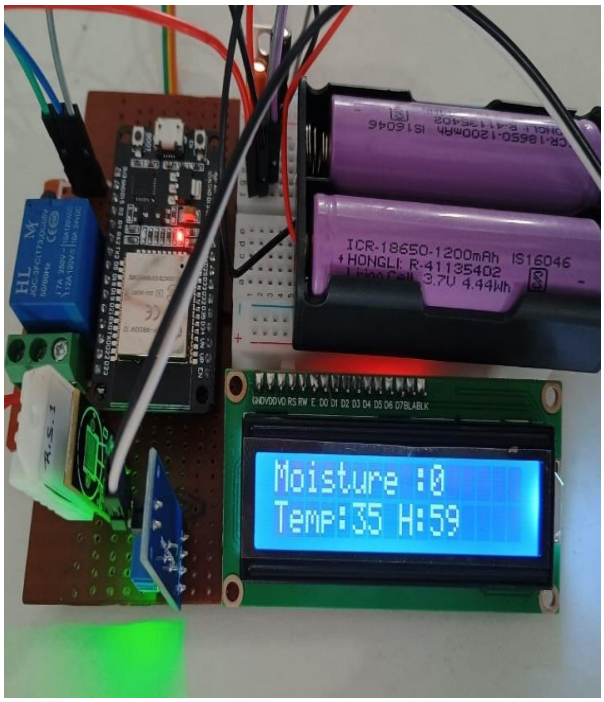


Figure 1. Testing of a proposed system in real-time

Figure 2. Normal conditions of Plant monitoring on Blynk app.

Overall, the data and analysis show that the Plant Water Monitoring System enhances plant health, efficiently automates duties related to plant care, and offers insightful information for the best possible growth and upkeep of plants.

4.Conclusion and Future Work

With the help of the robust and adaptable Internet of Things-based Smart Plant Monitoring System, users may remotely monitor and manage a variety of plant-related functions. It is an extremely adaptable and affordable remote plant monitoring and control system. The system has several uses, including crop monitoring, irrigation control, and greenhouse monitoring, and it is simple to combine with other platforms and devices. The user can take the necessary steps to ensure the best possible growth and health of their plants by monitoring the humidity, temperature, soil moisture, and other critical plant parameters with the aid of this system.Additional sensors or actuators can be added to the system to monitor and manage additional plant features.

Conflicts of Interest

The authors declare no conflict of interest.

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IoT based Weather Monitoring System using NODEMCU

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[5]HOD & Assistant Professor of Dept. of Electrical Engineering, Greater Kolkata College of Engineering & Management

ABSTRACT
An internet-based smart weather monitoring system is proposed in this study. The technology that is being suggested makes it possible to send meteorological parameters over the internet. Without the need for a weather forecasting organisation, it allows consumers to check the weather state instantly online. Using temperature and humidity, the system tracks the weather and delivers real-time meteorological data. The system uses temperature and humidity sensors to continuously check the two variables. This data is continuously sent by the system to the microcontroller, which decodes it and uses a Wi-Fi connection to transfer it to the internet web server. The online server system provides access to this real-time updated data.
Keywords: NodeMCU, Sensor, Humidity, Arduino, Temperature.

I. INTRODUCTION

The Internet of Things (IoT) is a paradigm that connects physical items to the Internet by fusing low-power wireless communication with embedded technologies. The foundation of smart surroundings, including smart cities, smart households, and smart industries, is provided by IoT services. The interoperability of the devices used to build the network of physical items is one of the Internet of Things' biggest concerns. More than 20 years ago, physical objects were connected via Web technologies to create global smart environments [1]. A pioneering effort to connect the virtual and real worlds was HP Labs' Cool Town project, which investigated a system to enable people, places, and objects to have an online presence. On top of the architecture, Internet connectivity was utilised to access web servers that were incorporated into physical items via URLs. In more recent times, the Internet of Things has been regarded as a component of the Internet, circumventing restrictions on host-to-host connection and concentrating on information publication and retrieval—the Internet's most popular usage. It was also shown by other avant-garde solutions that physical things might be integrated into the Web either directly or via a gateway. By building proxies, contemporary technologies connect diverse Web services from the Internet to the Internet of Things. Clients can thus access Web services and IoT devices in the network transparently.

Adopted Methodology

The creation of the Internet of Things platform, Thing Speak, which displays sensor data, will be the main topic of this paper. The process is split into two sections: the software [2] and hardware development sections. Prototype development and circuit building are part of hardware development. In the meantime, data collection, circuit modelling, IoT coding, and circuit schematic drawings are all part of the software component. through the use of three different types of sensors to track four weather parameters: atmospheric pressure, temperature, humidity, and rain. Through an analysis of the present weather [3] using sensor value data, the system will be able to display the weather state. According to the project requirements, the following components are required. The system contains two parts, one is hardware and the second one is software.

Table I : Required Materials

Hardware	Software
ESP8266 Microcontroller (Node MCU)[4]	**Arduino IDE Version 1.8.13:** The IDE is software component used to upload and modify the code developed in integrated development Environment
DHT11 Temperature and Humidity Sensor	
Voltage Regulator 7805	
16X2 LCD Display	
Connecting wires.	
Soldering Iron 25Watt	
Prototype board or Vero board	
12Volt 1A, SMPS Adaptor	

Circuit Diagram

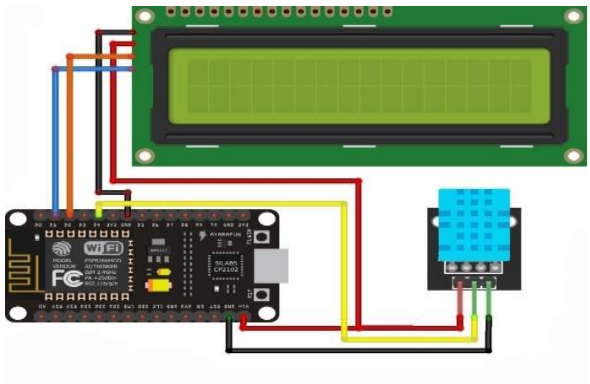

Fig 1: Circuit Diagram of throughout project

Installation procedure through Arduino[5,6]

First Stage: Now let's install the ESP8266 Arduino core. Installing the most recent version of the Arduino IDE (Arduino 1.6.4 or higher) on our PC is the first step.

It must first update the board manager with a unique URL. Get the Arduino IDE open, then select File >

Preferences. Next, paste the following URL into the text field labelled "Additional Board Manager URLs" at the bottom of the window:

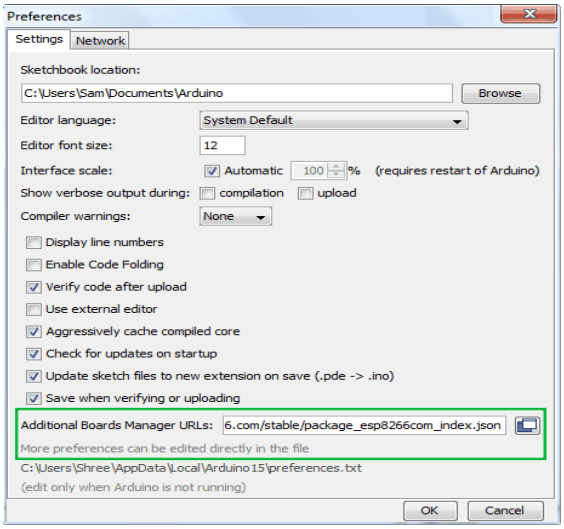

Fig 2: Installation Procedure Stage_1

Second Stage: Click "OK." Next, select Tools > Boards > Boards Manager to access the Board Manager. The usual Arduino boards should be joined by one or two new entrants. To narrow down our search, enter esp8266. Select Install after clicking on that entry.

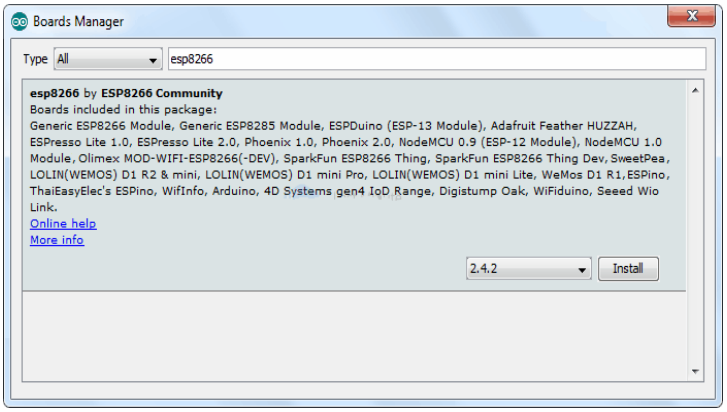

Fig 3: Installation Procedure Stage_2

Third Stage: It could take several minutes to download and install the board definitions and tools for the ESP8266, since they include a brand-new set of compiled binaries for gcc, g++, and other programmes (the archived file is about 110MB). A tiny text message labelled "INSTALLED" will show up next to the entry once it has finished installing. Close the Board Manager now.

Be sure the board is correctly chosen in the Arduino IDE before uploading the sketch and experimenting with the LED. Select the NodeMCU 0.9 (ESP-12 Module) option from the Arduino IDE > Tools > Board menu after opening the programme.

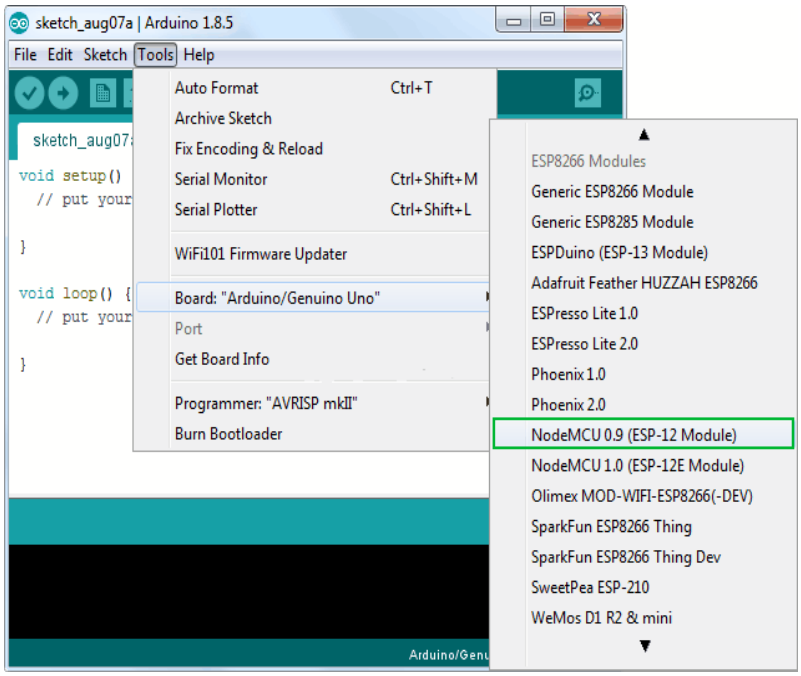

Fig 4: Installation Procedure Stage_3

Final stage: Now, use a micro-B USB cable to connect the ESP8266 NodeMCU to the computer. The board must to be given a distinct COM port as soon as it is plugged in. This will be something like COM# on Windows PCs and /dev/tty.usbserial-XXXXXX on Mac and Linux computers. The Arduino IDE > Tools > Port menu allows you to select this serial port. Additionally, choose Upload Speed: 115200.

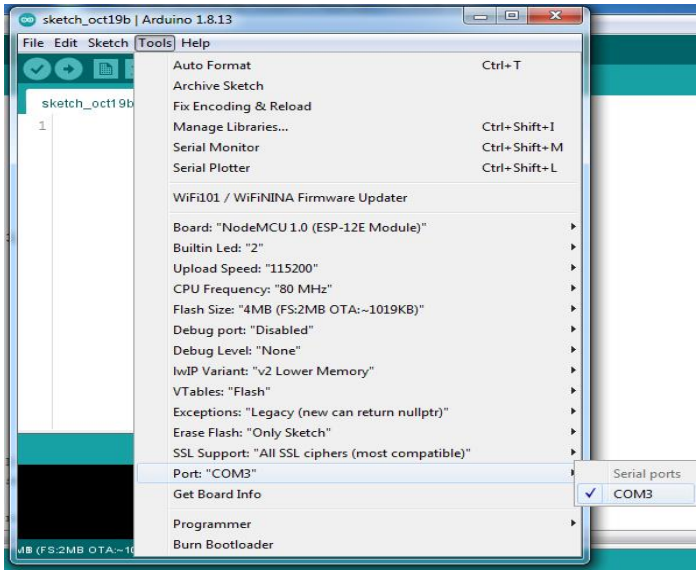

Fig 5: Installation Procedure Stage_4

More attention needs to be given to selecting board, choosing COM port and selecting Upload speed.

Result Analysis

Initially, the control unit system circuit was designed to allow the ESP8266 microcontroller to regulate the DHT11 (temperature and humidity) weather parameter sensor. After that, a USB cable is used to power it and upload the ESP8266 microcontroller's code sketch. The Arduino IDE software allows the sensor data to be displayed on a serial monitor. The ESP8266 will establish a connection with the Wi-Fi hotspot that has been assigned to this system in order to create a web server that will display all of the sensor data. The weather station's received data will be displayed on thing talk to show how the sensor station and weather station[7] can communicate with each other via a Wi-Fi hotspot. The establishment of communication is successful. The web server contains html that can display the sensor data by simple coding and connection where the IP address of the ESP8266 is needed to complete this action.

Table 2 : Result analysis throughout a Day

Date	Time	Temperature	Humidity
19.03.2024	10.00 AM	28.50°C	77.00%
19.03.2024	1.00 PM	32.40°C	78.00%
19.03.2024	10.00 PM	25.70°C	75.00%

Conclusion

This essay has provided a unique analysis of the concepts used in this particular topic. It aims to promote technical innovation[8] so that different instruments can generate dependable and efficient outcomes. Experiments have been carried out with great care. The result shows that using the embedded system does, in fact, lead to increased productivity. Customers will eventually gain from these newest tools through improved services, more dependability, and convenience. Additionally, they will enable embedded intelligence, which will essentially strengthen the instruments' durability, as well as greater adaptability in terms of control, operation, and growth via a shared digital platform. This paper offers a thorough explanation of the key traits and uses of the many concepts that could be used in this field through a variety of categories. The proposed framework and goal cannot be fully implemented by this initial study; additional research and development efforts are needed to accomplish this through the joint efforts of several groups.

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A Review of the Heat Treatment and Corrosion Research on HSLA Steel Using Electroless NiP-Ti Nanocomposite Coatings

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ABSTRACT

Coatings made of nickel phosphorus (Ni-P) have specific structure properties and anticorrosion qualities and are used in the motor vehicles energy, gadgets, and aerospace industries. Adding nanoparticles to their (Ni-P) matrix can improve their characteristics even more. In the present investigation, a review made on electro less depositing process is used to create Ni-P-Ti nanocomposite coatings to be applied on High Strength Low Alloy Steel (HSLA). A comprehensive analysis is conducted on the effect of Ti particles on the mechanical characteristics and structure of Ni-P-Ti coatings.

Keywords : Nickel phosphorus, Nanocomposite, High Strength Low Alloy Steel, Mechanical properties

I. INTRODUCTION

The corrosive prevention effectiveness of the NiP films increased dramatically with the addition of TNPs, as evidenced by the results of electrochemical impedance spectroscopy tests, which reached around 96.4% at a the makeup of NiP-0.5TNPs. Furthermore, the NiP-TNPs coatings have shown superior execution compared to NiP coatings following heat treatment. This was attributed to the inclusion of TNPs into the NiP matriand the subsequent creation stronger, many resilient phases, including Ni3P, Ni3Ti, and NiO (1) Because of their advantageous mechanical (higher toughness and increased resilience to wear and attrition) and anticorrosive qualities, the nickel phosphorus (NiP) coatings find use in the motor vehicles petroleum, energy, electronics, and aerospace industries (2). Alternatively, a metal powder with higher hardness, durability against wear, and a improved communication with the NiP layer can serve as appropriate stimulating particles. It also has a reasonable hardness. Titanium (Ti) is a transition metal with superior durability against corrosion, low density, great strength, and thermal stability at high temperatures (3). When compared to the NiP coating, the NiP-0.5TNPs combination coatings exhibit a minimal high, suggesting improved heat resistance. The substantial TNP contents in the NiP a framework, a more solid option in terms of heat in and of itself, are responsible for this increase in thermal stability(4) Additionally, the dispersion of TNPs into the NiP matrix limits oxygen atom migration, reducing the process that leads to inward atomic diffusion(5). It is possible to perform continuous plating without electrodes by adding specific ingredients to the bath. Science first concentrated on selecting the appropriate process factors, such as various types of linking or reduction agents, pH values, plating settings, and

post-heat processing degrees, in order to create surfaces with better attributes. Utilizing a polarization technique in addition to weight loss (6).

II. Creation and Evaluation Of a NI-P/TIC Composite Coating

In many industries, coatings are seen to offer a potential way to combat wear and corrosion. Although their anticorrosive properties are well recognized, NiP coatings are not mechanically strong. The current study's goal was to ascertain how submicroscale Tic particles affected the physical, shape, electrochemical, and physical aspects and Analysis of the Ni-P/Tic coating. Vickers micro level hardness, nanoindentation, electron microscopes (SEM), atomic force microscopy (AFM), and potential dynamic polarization testing on Gamy were the methods used in this investigation. Ni-P/Tic co-electro deposition at different Tic compositions Temperature, pH, and current density were all tuned for the deposition conditions. The coat's surface morphology is a nodular structure with flawlessly inserted Tic particles. (7)

III. Composite Coating Processing and Mechanical Characteristics

On mild steel, composite coatings were created using homegrown graphene oxide, also known as GO, in an electroless nickel bath. AFM, X-ray photoelectron spectroscopy, energy-dispersive spectroscopy, Raman spectroscopy, SEM, and Raman spectroscopy was employed to examine the shape and surface characteristics.
and elemental content of the as-deposited coatings. According to AFM data, the thickness of each GO film was roughly 5 nm. Microhardness than conventional friction, and Additionally, durability tests were used to assess the mechanical properties of coatings. The durability resistance and microhardness of the composite surface layer were both enhanced by GO (8)

IV. Elements and Composition Of Coatings

The transportation, aviation, oil and gas, and technology industries employ Ni-B coatings because of their high hardness, excellent durability against wear, and durability against corrosion. In this study, mild steel samples are coated with nano-composite Ni-B-TiO_2 layers using the electroless plating technique. An extensive investigation on Ni-B-xTiO2 coatings at varying concentrations of TiO_2 has been carried out. Microhardness, which XRD, wear testers, and SEM are used to characterize the coatings. It has been discovered that adding TiO_2 nanopowder can greatly enhance the mechanical characteristics of Ni-B coatings(9).

V. Qualities That Prevent Rusting

One technology that is especially intriguing is pulse electrodeposition, which offers multiple promising benefits, including easy processing, control over composition, structural homogeneity, and grain refining. Using the pulse electro deposition approach, NiP-ZrO_2 coatings for Nano composite materials s with various quantities of nanoparticles made of ZrO2 (ZONPs) were applied to minimal alloy steel (30CrMnSi). ZONPs have been successfully incorporated into the NiP matrix, as shown by the FESEM and EDX data. The creation of an unadulterated NiP structure devoid of any discernible flaws is confirmed by XRD and XPS investigation. The mechanical response significantly improved as ZONP concentration increased, peaking at NiP-1.0 ZrO_2 coat composition (toughness 6.7 GPa and modulus of flexibility 21.72 GPa(10).

VI. Assessing The Specifications of Electrodeposited Nanocomposite Layers

Enhanced durability and superior corrosion resistance are increasingly needed to lower operating expenses in the Companies. Phosphorus coatings according to nickel have been shown to exhibit superior corrosion resistance, although they lack mechanical strength. Among the several reported reinforcements, zirconium carbide nanoparticles (ZCNPs) are renowned for their assertiveness and indifferent demeanor. The combination and description of new Ni-P-ZrC Nano composite coatings created using the electrodeposition approach are the main objectives of the current investigation. With the use of a customized Watts bath and ideal circumstances, ZCNPs were successfully co-deposited without any visible flaws. The fundamental, the outside, physical, and electrical behaviors of coatings made of Ni-P and Ni-P-ZrC Nano composite materials containing 0.75 g/L ZCNPs were extensively studied in order to provide a clear contrast (11).

VII. Technique for Evaluating Electrochemical Corrosion

The influence of the amount of phosphorus, the incorporation of elements, the inclusion of alloying components, and heat treatment have all been highlighted and thoroughly examined. A succinct analysis is conducted on the impact of corrosive medium and coating method variables on corrosion resistance. Additionally, a methodical investigation is conducted into the impact of adding different elements and particle contents on the electro less Ni-P coating's corrosion resistance. A summary of the most recent methods for assessing electrochemical corrosion is also provided in this study. Searching droplets cells, soaring electrochemical microscopy, examining Kelvin probe, scanning vibrating electrode technology, scanning ion-selective electrode technique, specialized electrochemical impedance spectroscopy, and innovative contactless technique are among the techniques that warrant special consideration in the analysis (12).On the aircraft aluminium alloy, a gradient coating of Ni-P alloy was created using several electro less Ni-P layers with different phosphorus concentrations. The forms, aspect frameworks, element pieces, and corrosion protection of the various Ni-P coatings were characterized using a variety of characterisation and electrochemical techniques. The usage of aluminium alloy in challenging conditions was made possible by the gradient coating's strong adhesion, high corrosionresistance, and high wear resistance. The outcomes demonstrated that optimal adhesion required twofold zinc immersion.

VIII. Harsh Wear Resistance

The frictional coefficients of physiologically graded Ni-P coating on 45 steel were more consistent than those of homogeneous Ni-P coats. The wearer's resistance nearly doubled or quadrupled after being heated to 500°C for an hour. Kang employed electrolysis to produce small crystalline Cu films with an average grain size of about 69 nano meterson 45 aluminium. Both the run-in times and the frictional coefficients decreased as the sliding velocities increased. Additionally, the tribological characteristics seemed better under the same lubricating conditions than those of typically crystal copper covers, which could be related to the surface's enhanced hydrophobicity and hardness(13). In the automotive and aerospace industries, electro less nickel coatings are renowned for their toughness and tolerance wearable. This work examined the impact of post

treatment on wear resistance after electro less Ni–P films were applied to the aluminium alloy substrate LM24. The use of heat and finishing with two distinct surface textures were the post treatments. X-ray diffraction, energy dispersive spectrometry, scanning electron microscopy, and micro-abrasion testers were employed to examine the coatings' morphology, structure, and resistance to abrasive wear. The density and structure of the coating were greatly improved by post-heat treatment, resulting in improved durability and wear resistance. Because of the creation of Ni3P during heat treatment, the level of micro toughness of electro less Ni–P coatings with a thickness of approximately 15 μm increased (14). Even following bending tests at angles greater than 90° and 500 hours of neutralizing salt spray testing at 35°C, the ideal coating did not peel or shred. The heterogeneous form of the high P concentration in the outer layer and the misalignment of these micro flaws in the three distinct nickel alloy layers were identified as the causes of the high corrosion resistance. The investigation of practical gradient coatings that satisfy the demanding application requirements of aluminium alloy components in challenging and demanding aircraft settings is guided by these discoveries.

Conclusion

In conclusion, we reviewed the development and Assessment of a ni-p/tic composite coating, composite coating therapy and mechanical characteristics, elements and formation of coatings, assessing the information of electrodeposited nanocomposite layers, and methods for assessing electrochemical corrosion qualities that prevent rusting, harsh wear resistance. Subsequently, Ni–P and Ni-P-Ti nanocomposite coatings (with variable concentrations of nanoparticles) are successfully deposited on an HSLA steel substrate. Composite coatings that exhibit a uniform, dense structure and sufficient substrate adherence. The microstructure and mechanical characteristics of composite coating materials are effectively influenced by nanoparticles.

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Enhancing Decision-Making in Manufacturing: The Application of ELECTRE II in Selecting Industrial Robots

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ABSTRACT

In the dynamic landscape of the manufacturing industry, decision-makers encounter multifaceted challenges when selecting the optimal alternative, whether it pertains to material selection, robot procurement, or identifying oxy-rich materials. To address these complexities, the concept of multi-criteria decision-making (MCDM) emerged, offering a systematic approach to navigate through conflicting criteria. This paper explores the application of the ELECTRE II method in selecting the most suitable industrial robot, leveraging its effective ranking technique and widespread applicability in diverse manufacturing domains. In 1979, Zionts introduced the concept of multi-criteria decision-making (MCDM), which was further developed by Korhonen et al. in 1992. MCDM entails a decision-maker evaluating multiple criteria to select from a set of alternatives, which may be finite or infinite in nature..One prominent MCDM method is ELECTRE (ELimination Et Choix Traduisant la REalite), which stands for "Elimination and Choice Expressing the Reality." Known for its effective ranking technique, ELECTRE II is a practical MCDM method that has found successful applications in numerous real-world scenarios. It is widely employed, particularly in diverse manufacturing fields, such as selecting the best industrial robot, where it aids in identifying the most suitable alternatives.

Keywords: Decision making, MCDM, ELECTRE, industrial robot, manufacturing, ELECTRE II, manipulator reach

I. INTRODUCTION

The word "Decision" originated from the Latin term 'decisio,' which literally means "to cut off. Chester Barnard, a telephone executive in the mid-20th century, introduced decision-making from public administration to the business world. Decision-making involves selecting the best course of action from multiple options to solve a problem, a common challenge in the manufacturing sector. Decision theory, applicable under certainty, risk, or uncertainty, provides techniques to align decision criteria with the decision-maker's objectives and preferences. Multi-criteria decision-making (MCDM) is a methodological approach used to solve complex decision problems where multiple conflicting criteria need to be considered simultaneously as initially proposed by Zionts in 1979 and further developed by Korhonen et al. in 1992. MCDM involves a decision-maker selecting from a set of alternatives, which can be finite or uncountable, based on multiple criteria [7-8]. MCDM models include descriptive and prescriptive approaches. Descriptive models use decision-maker input to create accurate

representations of the decision-making process, while prescriptive models incorporate decision-makers' constraints. This comprehensive approach addresses real-world problems effectively [8-9].

II. ELECTRE I METHOD

ELECTRE I, a multi-criteria decision-making method, is tailored for choice problem formulations, where the objective is to recommend a subset of alternatives from a larger set. This method is particularly useful when decision-makers need to select the best options from a diverse range of alternatives based on multiple criteria. By systematically evaluating and comparing these alternatives, It consists of following steps.

Suppose that there are m objects (alternatives) $A=(a_1,a_2,...,a_m)$ and n evaluation indices (criteria) $C=(c_1,c_2,...,c_n)$, the evaluation index values of each objects (alternatives) form matrix X, where xij represents value of the ith alternative with respect to the jth criteria. Let r_{ij} represents the normalized rating of ith alternative with respect to jth criteria [2].

$$r_{ij}=x_{ij}/\sqrt{\sum_{i=1}^{m}x_{ij}^2},1\le i\le m,1\le j\le n \tag{1.1}$$

$$x_{ij}=\begin{cases}x_{ij}, \text{ if } x_{ij} \text{ is a benefit index}\\ 1/x_{ij}, \text{if } x_{ij} \text{ is a cost index}\end{cases} \tag{1.2}$$

Mathematical formulation

The outranking methods aim to identify alternatives that dominate other alternatives while remaining undominated by any other alternative. To find the best alternative, outranking also requires knowledge of the weights of the criteria.

Each criterion $C_j \in C$ is assigned a subjective weight w_j, and every pair of alternatives A_i and A_j is assigned a concordance index $c(A_i,A_j)$ given by:

$$c(A_i,A_j)=\frac{1}{\sum_{k=1}^{n}w_k}\sum_{\{k:g_k(A_i)\ge g_k(A_j)\}}w_k \tag{1.3}$$

Where the sum of the criteria weights in the numerator is taken only for those criteria where the values of A_i dominate the values of A_j. A discordance index $d(A_i,A_j)$ is also calculated and is given by:

$$d(A_i,A_j)=\begin{cases}0 \ \ if\ g_k(A_i)\ge g_k(A_j) \ \ for\ all\ k,\\ \frac{1}{\delta}\max\{g_k(A_i)-g_k(A_j)\},\ \ otherwise.\end{cases} \tag{1.4}$$

where, $\delta=\max\{g_k(A_i)-g_k(A_j)\}$. Here, the criterion weights are not used but only normalized values is used. These are the $g_k(A_i)$.

This process outlines the steps for applying the ELECTRE I method to make a decision in a multi-criteria decision-making scenario:

Step 1: Accumulate the criteria values for each alternative. Step 2: Establish the outranking relations by assessing concordance (agreement) and discordance (disagreement) among the alternatives based on the criteria

values. Create a graphical representation to illustrate the dominance relationships among the alternatives. Step 3: Determine the minimum dominating subset using the minimum concordance and maximum discordance indices. If a kernel (essential subset) exists, select it as the minimum dominating subset. Step 4: If the subset contains only one element or is small enough for subjective evaluation, make the final decision. Otherwise, repeat Steps 2 through 4 until a single element or a small subset remains. Finally, apply the ELECTRE I method to obtain a partial ranking or select the best alternative based on the outcomes of the previous steps.

This systematic approach helps decision-makers navigate through the complexities of multi-criteria decision-making, leading to well-informed and rational decisions.

III. ELECTRE II

ELECTRE II methodology is same as ELECTRE I, but the main advantage is in obtaining the full ranking for which we have to go through following exploitation procedure.

$$\text{Pure concordance index (Cj)} = \sum_{k=1}^{n} c(j,k) - \sum_{k=1}^{n} c(k,j)\ (j \neq k) \quad (2.8)$$

$$\text{Pure discordance index (Dj)} = \sum_{k=1}^{n} d(j,k) - \sum_{k=1}^{n} d(k,j)\ (j \neq k) \quad (2.9)$$

After estimating the two indices, create two distinct rankings of the alternatives using these indices. ii. Calculate the average ranking by combining the two rankings obtained in Step (i). iii. Choose the alternative with the best average rank as the final decision [6].

IV. Case Study

Manufacturing companies widely employ robots for tasks that are hazardous or repetitive. Choosing the right robot involves significant investment and input from various experts. With a growing number of robot manufacturers, selecting the most suitable one is challenging. This research aims to develop a comprehensive database of robot options based on key attributes, facilitating efficient selection. The paper proposes using the ELECTRE method, a multi-criteria decision-making approach, to solve the robot selection problem and compares its performance with other methods in an industrial context.

This example concerns the selection of an industrial robot suited for pick-and-place operations while navigating obstacles. Five criteria are considered: load capacity (LC), maximum tip speed (MTS), repeatability (RE), memory capacity (MC), and manipulator reach (MR). Among these, LC, MTS, MC, and MR are favorable attributes (higher values preferred), while RE is undesirable (lower value preferred). The decision involves assessing seven alternative robots based on these criteria. Weights for the criteria, determined by Rao using the analytic hierarchy process (AHP), are applied: w_{LC}=0.036, w_{RE}=0.192, w_{MTS}=0.326, w_{MC}=0.326, and w_{MR}=0.120, informing the ELECTRE method analysis.

ELECTRE I Method

The decision matrix for problem is now normalized using equations (2.1) and (2.2) as given below in Table 1.

Table 1 Quantitative data for example 1[1]

Serial no.	Robot	LC	RE	MTS	MC	MR
1	ASEA-IRB 60/2	60	0.4	2540	500	990
2	Cincinnati Milacrone T3-726	6.35	0.15	1016	3000	1041
3	Cybotech V15 Electric Robot	6.8	0.1	1727.2	1500	1676
4	Hitachi America Process Robot	10	0.2	1000	2000	965
5	Unimation PUMA 500/600	2.5	0.1	560	500	915
6	United States Robots Maker 110	4.5	0.08	1016	350	508
7	Yaskawa Electric Motoman L3C	3	0.1	177	1000	920

Table 2 Priority weights for example 1[1]

Weights	0.1574	0.1825	0.2385	0.2172	0.2043

Now the weighted normalized matrix is calculated by multiplying the respective weights with its criteria, if wj be the weight of the criteria then the $r_{ij} * w_j$ will be its weighted normalized matrix as given below in Table 3

Table 3 Weighted normalized matrix for example 1

Robot	LC	RE	MTS	MC	MR
1	0.1528	0.0390	0.1690	0.0264	0.0727
2	0.0162	0.1287	0.0676	0.1586	0.0764
3	0.0173	0.1466	0.1149	0.0793	0.1230
4	0.0255	0.1108	0.0665	0.1058	0.0708
5	0.0064	0.1466	0.0373	0.0264	0.0672
6	0.0115	0.1538	0.0676	0.0185	0.0373
7	0.0076	0.1466	0.0118	0.0529	0.0675

ELECTRE II method

Now the pure concordance and pure discordance indices for example 1 are computed using equations (2.8) and (2.9).

Table 4 Pure concordance and pure discordance indices for example 1

Pure concordance	Initial rank	Pure discordance	Initial rank	Average rank	Final rank
1.1331	3	-1.3832	3	3	3
1.5724	2	-3.7109	1	1.5	2
3.2940	1	-2.8846	2	1.5	1
0.0742	4	0.2950	4	4	4
-3.0022	7	2.7285	6	6.5	7
-1.1845	5	2.1154	5	5	5
-1.8870	6	2.8397	7	6.5	6

IV. Comparative Study

The mentioned example highlights the effectiveness, practicality, and simplicity of the ELECTRE II method in addressing industrial robot selection decision-making problems that encompass both objective and subjective attributes. To compare the performance of these ELECTRE methods and evaluate the correlation between them,

Spearman's rank correlation values are computed and presented in Table 1.8. The rankings obtained from the different ELECTRE methods demonstrate similarity, leading to the formation of four groups. The resulting combinations within these groups are then assessed and evaluated.

Table 5: Spearman's rank correlation

Method	ELECTRE II
Original [30]	0.8571

Bhangale et al. [12] derived a comparative ranking of the alternative robots as 2-3-1-5-7-6-4 while solving this problem using TOPSIS method. The Spearman's value between ELECTRE II and original (modified digital logic) methods is 0.8571. Spearman's rank correlation coefficient values between most of the methods are reasonable and support the contention that the decision maker is consistent in his/her responses. The proposed procedure utilizing ELECTRE I is versatile and suitable for various multi-criteria decision-making (MCDM) problems. This method is straightforward and effective when all criteria are quantitatively coded on consistent scales. However, ELECTRE I do not offer a complete ranking, so the ELECTRE II method is often employed to provide a comprehensive ranking. ELECTRE methods are particularly beneficial in the manufacturing sector, where selecting the most suitable alternative from a large pool of candidates is critical. These methods consider all attributes and their relative importance, enabling a more precise evaluation of alternatives. They are computationally efficient, easy to understand, and robust, capable of handling both quantitative and qualitative attributes simultaneously, offering an objective decision-making approach. However, while the suggested approach using ELECTRE I is adaptable to various MCDM problems, it may lack practical relevance due to real-world complexities. Real-world applications often involve diverse criteria with numerical and ordinal scales, leading to conflicting outcomes. Additionally, real-world problems inherently contain imprecision, uncertainty, or indeterminacy, which ELECTRE methods may not fully address.

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Smart Electrical Equipment Controlling and Monitoring System

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ABSTRACT

This project outlines a smart home automation and monitoring system. the inability to use a remote or mobile device to access and control the appliances. Numerous sensor kinds, including those for temperature, humidity, light, and presence, are managed by the system. A multitude of wireless communication technologies, including GSM and Wi-Fi, are supported by this system. The central module establishes a Wi-Fi and application-based Internet connection. It can operate different gadgets inside the enclosure or remotely check in on the condition of the dwelling. The suggested solution is easy to install in a home, has a user-friendly interface, and is designed to be low cost. By using adequate monitoring and managing, the user of IoT technology can minimise the wastage (also unit) of electrical power. The platform that was chosen is incredibly adaptable and user-friendly. One way to achieve automation is through the Internet of Things (IoT).

Keywords: IOT, Smart Light, Automation, Sensors, Software.

I. INTRODUCTION

Internet of Things (IoT) and Sensors[i]: IoT technology has revolutionized how we monitor and manage assets. By using various sensors, such as temperature sensors, vibration sensors, and pressure sensors, IoT can provide real-time data on the condition of equipment. This information can be used to predict maintenance needs and prevent costly breakdowns.

Predictive Maintenance (PdM): Predictive maintenance relies on data analytics and machine learning to forecast when equipment is likely to fail. This technology allows maintenance teams to intervene before a breakdown occurs, saving both time and resources. It is often combined with IoT for real-time data collection.

Augmented Reality (AR) and Virtual Reality (VR): AR and VR technologies are used to assist maintenance personnel by providing them with virtual, interactive, and immersive environments. Technicians can receive real-time instructions, visualize complex machinery, and access vital information hands-free, improving work efficiency and reducing errors.

Machine Learning and Artificial Intelligence (AI): Machine learning and AI algorithms can analyze vast amounts of data to identify patterns and anomalies in equipment behavior. These systems can provide early warnings of potential issues and suggest optimal maintenance schedules.

Blockchain Technology: Blockchain can be used to create secure, transparent, and tamper-proof records of equipment maintenance and service history. This technology ensures that maintenance activities are carried out efficiently and according to schedule, enhancing accountability and traceability.

Cloud-Based Maintenance Management Systems: Cloud-based solutions allow for easy access to maintenance data from anywhere, enabling remote monitoring and reporting. These systems often include features like work order management, asset tracking, and predictive analytics.

Robotics and Drones: Robotics and drones can be employed for inspecting and maintaining hard-to-reach or hazardous areas. They can significantly reduce the risk to maintenance personnel while improving efficiency.

Energy-Efficient Technologies: In the context of facilities and infrastructure maintenance, energy-efficient technologies can optimize operations by reducing energy consumption and environmental impact. Smart lighting, heating, and cooling systems can be remotely controlled and adjusted based on real-time data.

Condition-Based Monitoring: Condition-based monitoring systems continuously assess the health of machinery and infrastructure. They use various sensors and data analysis tools to trigger maintenance actions only when necessary, reducing downtime and costs.

Mobile Applications: Mobile apps equipped with features for scheduling, tracking, and reporting maintenance tasks can enhance the productivity of field technicians. These apps often integrate with other technologies for seamless data exchange.

Geographic Information Systems (GIS): GIS technology can be utilized for location-based asset management and maintenance. It helps in optimizing the routing of maintenance teams and ensures that resources are allocated efficiently.

Big Data Analytics: Big data analytics tools can process large volumes of data from various sources to gain insights into equipment and infrastructure performance. These insights are invaluable for making data-driven decisions regarding maintenance and operations.

In conclusion, the development of a Smart Tracking System for the optimization of work efficiency in operation and maintenance activities benefits from a wide array of existing technologies. These innovations can not only improve efficiency but also reduce costs, enhance safety, and extend the lifespan of critical assets. The integration and customization of these technologies in specific industry contexts are essential for achieving the desired operational improvements.

II. Modelling of the Liquid Flow System

Fig.1 Diagram for system creation

III. Circuit Diagram

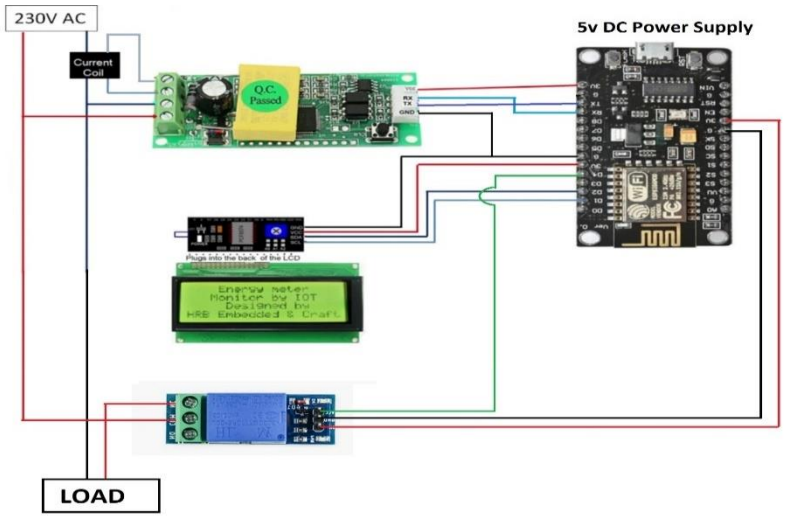

Fig 2: Analysis of Circuit Diagram

IV. Tools and technologies to be used to solve the problem

Table 1 : Required Components

Hardware	Software
ESP8266 Microcontroller (Node MCU)	**Arduino IDE Version 1.8.13:** The IDE is software component used to upload and modify the code developed in integrated development Environment
PZEM -004T (Sensor For Sence The Voltage And Current)	
4 Channel Relays Module	
16 X 4 LCD Display	
Connecting wires.	

Soldering Iron 25Watt	**Blynk IOT**
Prototype board or Vero board	**Mit App Converter**
12Volt 1A, SMPS Adaptor	

V. Challenges/Risk in implementing your Final prototype

Device Compatibility[ii]: Ensuring that the smart home control system can work with a wide range of IoT devices from different manufacturers can be challenging.

Network Reliability: Dependence on the internet and Wi-Fi connectivity can result in disruptions when the network is unstable or down.

Device Reliability: IoT devices can fail or become unresponsive, affecting the system's reliability.

User Experience:

Complexity: Ensuring that the system is user-friendly and easy to set up and use is essential for user adoption.

Integration Challenges: Integrating various devices and creating a cohesive user experience can be complex.

Scalability:

Ensuring that the system can scale to accommodate more devices and users without performance degradation is a challenge.

Data Handling and Analysis:

Managing and analyzing the vast amount of data generated by IoT devices can be resource-intensive and challenging, especially when implementing real-time analytics.

VI. Possible outcome of your work

Users can control various aspects of their home environment, such as lighting, heating, cooling, and security systems, from a centralized interface, a mobile app, or voice commands, making daily life more convenient and comfortable.

Energy Efficiency:

Smart home systems can optimize energy usage by automatically adjusting heating, cooling, and lighting based on user preferences and occupancy, potentially leading to energy savings and reduced utility bills[iii].

Safety:

IoT sensors can detect issues such as smoke, carbon monoxide, or water leaks and immediately alert homeowners or emergency services, potentially preventing disasters and damage.

Cost Savings:

While there may be an initial investment in IoT devices and infrastructure, the long-term cost savings from energy efficiency, reduced maintenance, and enhanced security can outweigh these expenses.

Remote Monitoring and Control:

Homeowners can monitor and control their properties remotely, giving them peace of mind and the ability to respond to emergencies or make adjustments when away from home.

Customization and Personalization:

Smart home systems allow users to tailor their environment to their preferences, such as creating custom lighting scenes, setting thermostat schedules, and automating daily routines[iv].

Environmental Benefits:

Reduced energy consumption and optimized resource use contribute to a smaller carbon footprint, supporting environmental sustainability.

Data Insights:

The system can provide valuable insights into home and energy usage patterns, helping users make informed decisions about resource management.

Health and Well-Being:

IoT devices can support health and well-being by monitoring air quality, sleep patterns, and providing reminders for medications or exercise routines.

Integration with Smart Cities:

Smart homes can become part of broader smart city initiatives, contributing to urban sustainability and resource optimization. [v]

VII. Lamp & Luminaire System

Utilizing[vi] UV-protected lighting in my project ensures prolonged durability and safety, shielding sensitive materials or areas from harmful ultraviolet radiation. This feature not only extends the lifespan of the project but also maintains its integrity by preventing discoloration, degradation, or other UV-induced damage[vii].

Table 2: Date of Fluorescent Tube in terms of UV

Distance in ft.	UV-A micro watt / sq mt.	UV-B micro watt / sq mt.	UV-C micro watt / sq mt.
1	26.7	6.5	4.7
2	17.9	2.8	2.2
3	9.1	0.8	1.3
4	3.5	0.3	0.8
5	2.8	0.2	0.6
6	1.6	0.1	0.4
7	1.5	0.1	0.2
8	1.3	0.1	0.2
9	1.1	0.1	0.2
10	1	0	0.1

Table 3: Date of Special LED in Terms of UV

Distance in ft.	UV-A micro watt / sq mt.	UV-B micro watt / sq mt.	UV-C micro watt / sq mt.
1	4.2	0	1.0
2	3.4	0	0.6
3	1.3	0	0.3
4	0.9	0	0.2
5	0.7	0	0.1

6	0.5	0	0
7	0.3	0	0
8	0.2	0	0
9	0.2	0	0
10	0.2	0	0

VIII. Conclusion

In conclusion, the IoT-based Home Light/Equipment Control and Power Monitoring Device present a forward-thinking solution to the challenges of modern home management. By combining the convenience of IoT-based device control with a commitment to energy efficiency and human health, the system offers a holistic approach to home automation.

The project successfully demonstrates the potential of IoT in addressing not only practical concerns, such as power consumption and device control, but also health-related issues, such as eye protection. As technology continues to advance, the integration of smart and health-conscious features into everyday devices becomes increasingly essential.

Future developments and improvements will undoubtedly enhance the capabilities of the system, ensuring that it remains a relevant and valuable tool for users seeking a sustainable, user-friendly, and health-conscious approach to home automation. The IoT-based Home Light/Equipment Control and Power Monitoring Device represent a significant step toward the future of smart homes.

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Voltage Sag and Swell Mitigation by utilizing Dynamic Voltage Restorer for Power Quality enhancement

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ABSTRACT

Power quality is a crucial concern in the current energy system, since it can have significant effects on both utilities and consumers. The integration of renewable energy sources, smart grid technologies, and a significant reliance on power electronics technology has caused multiple problems in the overall electric power system. Electrical devices can be damaged by fluctuations in voltage and current. These components can be affected by fluctuations in input voltage caused by interference from other sections in the power delivery scheme.

Consequently, the reliability and safety of the power system are highly dependent on power quality, particularly in the current era where there is an increase in the use of costly and delicate electronic devices. The Dynamic Voltage Restorer (DVR) is a commonly used Distribution Flexible AC Transmission System (D-FACTS) device that effectively resolves problems related to abnormal voltage, current, or frequency in the power delivery grid. It maintains a stable load voltage by introducing additional voltages into the distribution line in order to maintain the desired voltage profile. The effectiveness of the DVR-based proposed method in mitigating the distorted voltage induced by harmonics was proved using MATLAB/SIMULINK simulations. The power system model incorporates the third and fifth harmonics and allows for customization of the power source. Assessments are performed with and without DVR to observe the response of the systems to variations in load voltage. The proposed DVR-based technique has effectively managed voltage distortion, leading to a stable corrected load voltage. The third harmonic of the supply voltage contributed around 19% to the load voltage total harmonic distortion (THD) percentage, whereas the fifth harmonic contributed about 25%. In both cases, the recommended DVR resulted in a THD reduction of less than 4%.

Keywords: Power quality, Smart grid, Dynamic voltage restorer, Total harmonic distortion, Voltage distortion.

I. INTRODUCTION

For a variety of electrical and electronic gadgets to operate flawlessly, the quality of the electrical power source is crucial. Nevertheless, power networks are frequently vulnerable to anomalies, including voltage sags, which can cause brief decreases in voltage. On delicate equipment, these voltage dips can have negative consequences that lead to failures and interruptions. The most significant interruption to the electrical grid is caused by voltage swells and sags in the industrial distribution system. This is due to the sufficient time it takes to resolve

faults that cause voltage sags, as well as the spread of these sags from the transmission and distribution system to low voltage loads [1]. Voltage sags are brief drops in voltage, lasting 0.5 cycles to 1 minute, from 10% to 90% of the reference mean voltage. Voltage swells are defined as voltage increases lasting more than three cycles and occurring above the typical voltage level [2].

The development of power electronic devices to efficiently prevent voltage sags and address power quality issues has advanced significantly in recent years. The Dynamic Voltage Restorer (DVR) is an innovative solution for this issue. The DVR is a rapid voltage compensation device that injects voltage into the power supply during voltage sags to restore it to its nominal level and safeguard linked equipment from any adverse consequences. In this paper, a MATLAB/SIMULINK model for the Power Quality (PQ) mitigation of voltage sag utilising a DVR is designed and implemented. Through this simulation, the DVR's capabilities and efficacy in improving power system stability and compensating for voltage sags is investigated. The suggested technique is implemented to evaluate the DVR's performance in various operating environments and its capacity to mitigate power sags in a real time simulation model.

To resolve power quality issues, the most prevalent approach is to install a Dynamic Voltage Restorer (DVR) on the sensitive load side. This device offers voltage compensation capabilities in addition to its fault current limiting functionalities [3]. The proposed DVR is a solid-state device that regulates voltage at the sensitive load side using an injecting transformer to inject voltage into the system. It is typically placed at the point of common coupling (PCC) in a distribution system, between the power supply and the sensitive load line, in order to reduce steady error and improve transient responsiveness caused by the controller's integration [4]. Consequently, in this paper, the DVR system acts as a virtual impedance. This device can be used to safeguard a group of customers in the event that a DVR has a significant fault current that originates in the DVR's feeder. When the breaker trips and disconnects the malfunctioning feeder, this DVR can effectively reduce the faulty current and protect the delicate loads in parallel feeders. Since the DVR in this system operates as a purely effective inductance and does not consume any power from an external source, it ensures the protection of the battery and the dc link capacitor [5]. However, it continues to deplete the energy in the DC connection capacitor [2].
This MATLAB/SIMULINK model was developed and analysed in order to provide a brief discussion of power quality improvement approaches and their advancement. These techniques are critical for maintaining a consistent and dependable power supply in a variety of industries and applications. Furthermore, by laying the groundwork for future advancements in grid resilience and power electronics, this study will ultimately help customers in the residential and commercial sectors.

Background

Certain countries used the FACTS and DFACTS devices to address issues with their distribution and transmission systems. "AC transmission systems containing static and power electronics-based controllers to increase power transfer capability and more immeasurable controllability" is how FACTS are defined in accordance with IEEE standards [6]. Because of resource constraints, economic concerns, and environmental constraints, the construction of generating and transmission infrastructure has not kept up with the substantial increase in energy consumption in recent years. Resources are scarce, therefore expanding the current gearbox system is difficult. Increased gearbox capacity is therefore a workable solution. Some limiting variables that

impact the transmission line's loading capability prevent it from being completely utilised. The dielectric, stability, and thermal limit are understood to be these factors. Present-day lines can have their usable capacity increased and electricity controlled using FACTS controllers. During regular operations and in the event of faults, the FACTS controllers enable power to be transmitted along the line, allowing for nearly equal power transmission as its thermal grades [7], [8]. Employing DVR on the distribution feeder helps protect the load from voltage swells and sags. A battery energy storage system (BESS) is linked to the DVR through a transformer and inverter, which adjust for the active and reactive power required to mitigate voltage fluctuations and variations. The DVR is connected in series with the load [9].

The transformer links the DVR to the distribution system, which provides voltage to ensure voltage stability. The Dynamic Voltage Restorer (DVR), also known as the FACTS device, mitigates voltage fluctuations resulting from variations in load, voltage swells, and voltage sags. Normally, the DVR introduces a minimal amount of voltage in conjunction with the transmission cables. By employing sinusoidal pulse width modulation (SPWM), the DVR calculates the voltages required to protect the load in case of a disruption. Subsequently, the system receives voltage injections in order to maintain stability. During a disturbance, a DVR (Dynamic Voltage Restorer) is responsible for either delivering or absorbing the active or reactive power from the dc-link. However, in the steady-state, the DVR also has the capability to either provide or absorb power [10]. According to Martiningsih et al., it is recommended to install DVR (Dynamic Voltage Restorer) in PT DSS power plants. The DVR functions as a compensator and is linked in series with the distribution line. The proposed PI-based DVR has the ability to restore the power quality constraint [11]. In order to enhance the reliability of power systems, Eltamaly et al. proposed a DVR-based strategy for reducing voltage sag, which leads to the breakdown of electrical equipment. The results show that DVR handles voltage adjustment and sag/swell compensation correctly [12]. An innovative DVR including a power electronic transformer (PET) was created by Ali et al. to mitigate symmetrical and asymmetrical sags and swells. According to the results, the new design effectively decreases voltage swell and sag in distribution lines, both symmetrically and asymmetrically [13]. The primary findings of this study are outlined below, taking into account the recommended methods that are now in use:

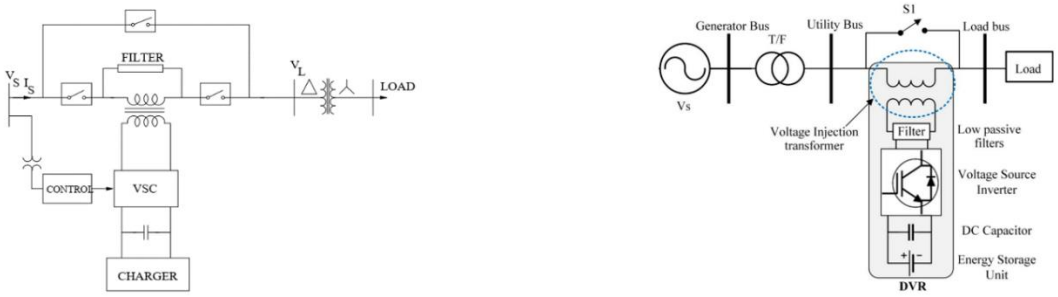
• In order to minimize voltage distortion resulting from harmonics, swell, or sags, it is crucial to keep the total harmonic distortion (THD) below 5%.
• To assess and analyze the effectiveness of the proposed model, both with and without the utilization of DVR, by employing MATLAB / SIMULINK.
•The examination of the power system will be conducted by introducing the third and fifth harmonics into the input voltage profile.
• The objective is to evaluate the performance of the power system with and without a DVR-based system by comparing their findings under the identical conditions of third and fifth harmonics insertion.

Following those introductions, the rest of the study is organized as follows: section II describes the DVR's mechanism, procedure, and operating principle; section III displays and analyzes the simulation results; and lastly, a conclusion is given that highlights the key findings of this study.

The suggested operating concept of the dynamic voltage restorer (DVR)

A Dynamic Voltage Restorer (DVR) consists of a GTO or IGBT-based voltage source inverter (VSI), a capacitor bank, an energy storage device, and an injection transformer. A DVR is a type of solid-state electrical switching

device. Figure 1a depicts a distribution bus connected to a DVR. The operational rules of the DVR are derived from the application of transformer techniques, where a forced commutated converter generates a control voltage proportional to the bus voltage. The control topologies of droop-controlled converters are illustrated in references [14] and [15]. Figure 1b demonstrates that the DC voltage source operates in a manner comparable to an energy-storage device supplied by the DC capacitor.



(a) (b)

Fig.1 (a) DVR's primary design linked at the distribution end [15], (b) Fundamental DVR Outline.

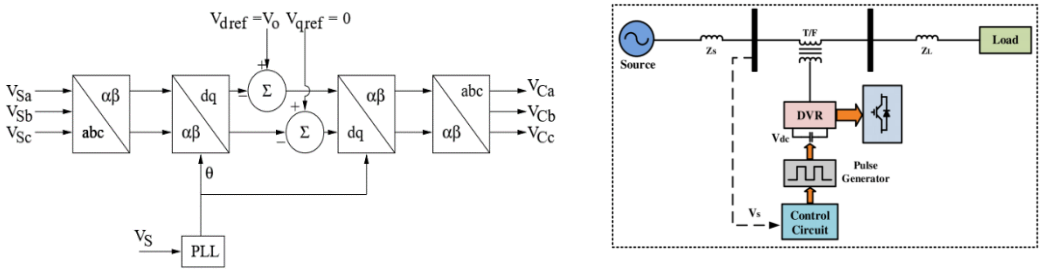
Under ideal conditions, the DVR will not minimize voltage drop because there will be no voltage sag. When a distribution system is in place, the DVR will ensure that the load is sustained and perfect by generating the controlled high frequency voltage and phase angle. To keep the voltage supply to the load constant, the capacitor will be discharged in this instance. The DVR has the ability to generate and consume reactive power, however injecting reactive power requires an external energy source. The voltage sag detection time and power electronics components reduce the reaction time of the DVR. As an example, the tap-changing transformers in DVR have a response time of less than 25 milliseconds, which is faster than the previous methods of voltage correlation.

DVR-based internal management and system security

The different DVR parameters and internal control are simulated using MATLAB/SIMULINK and shown in Figure 2. (a) for the purpose of control. To minimize losses in the filtering circuits, transformer, and converter circuits, it is necessary to control the DVR at the standard supply voltage level. The required injected voltages are supplied to the test system through the installed DVR when an imbalance or distortion in the voltage is detected in the system. Feedback control is utilized to accomplish the task, relying on the voltage (V_{ref}) and the current value of the supply voltage (V_{supply}). The open loop strategy for controlling the DVR circuit is illustrated in Figure 2. (b).

The control algorithm retrieves the reference voltages (V_{ref}) from the supply and the load voltages when the gate pulses supply the VSI to regulate the load voltage at the control algorithm's reference voltage. In order to identify voltage distortion issues, such as voltage sag and voltage swell, this step involves calculating the dq-frame voltages of the load voltage (V_{Load}) and the reference voltage (V_{ref}). A transformation block is used to convert the ABC frame into the αβ-frames by linking the load voltage to it. The reference voltage will equalize the reference voltage (V_{ref}) with the load voltage (V_{Load}) and then create gate pulses in the case that voltage swelling or sag is detected. In order to keep the load voltage at 330V, which is the same as the reference voltage, the VSI will take these pulses and apply pulse width modulation (PWM) to create the desired voltage.

A sensitive load may typically be protected by a DVR from 45% of three phase voltage sag or 60% of single-phase sag. The sag may last for 300 milliseconds. For lower voltage sags, the DVR can tolerate longer durations (up to 600 ms) or compensate for bigger voltage sags that last for shorter periods of time. One millisecond is a possible response time.



(a) (b)

Fig. 2 (a) Diagram of the DVR control circuit, (b) DVR controller with an open loop design.

Numerical model for suggested DVR's working principle

The load absorbed the following power (active):

$P_L = V_L I_L \cos\theta$ (1)

However, if the DVR's active power is provided,

Upon receiving active power from DVR,

$P_{DVR} > 0$ (2)

When DVR consumes active power

$P_{DVR} < 0$ (3)

Without exchanging the active power

$P_{DVR} = 0$ (4)

$\theta_r = \theta_l\ \theta_s - \cos^{-1}\left(\frac{V_L \cos\theta_L}{V_S}\right)$ (5)

This condition should be met in cases where $V_S > V_L \cos\theta_L$. When the voltage's restrictions are ignored, the exchange of active power for the voltage swell becomes zero. However, if there is a voltage sag, the equipment will still supply the active power. If the voltage drop is significant enough to not meet the required condition, the injected voltage will be as follows.

$$V_{INJ} > \sqrt{V_S^2 + V_L^2 - 2V_S V_L \cos(\theta_S - \theta_L)} \quad (6)$$

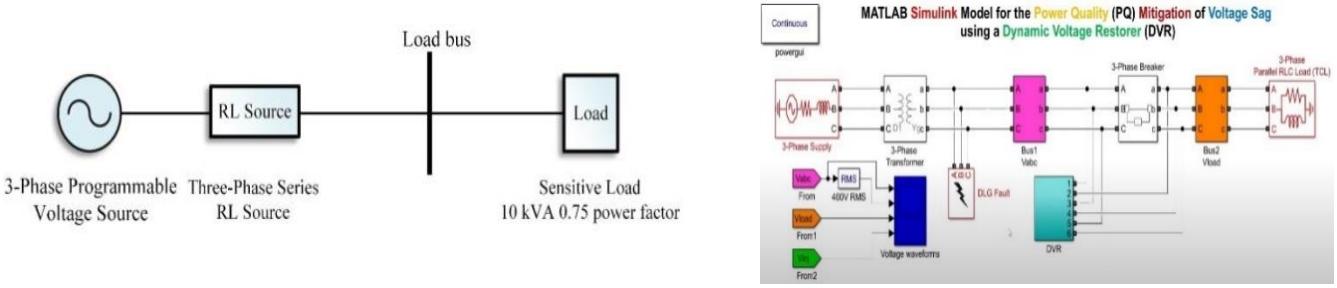
The connection between the DVR system and the transmission line of the test system is established by use of a three-phase injection transformer. The control circuit of the DVR is utilized to enhance the pulses produced by PWM. Subsequently, the voltage is transferred to the transmission line through the transformer.

Results and discussion

Simulations are performed using the Intel (R) Core(TM) i5-7200U processor running at a speed of 2.5 GHz and the Windows 10 operating system. The MATLAB/SIMULINK software environment is adapted to analyze the proposed configuration. A load with a power factor of 0.75 and a capacity of 10 kVA is considered to be delicate or easily affected. The sensitive load is supplied by a 3-phase supply system with a load of 415V and a frequency

of 50Hz. Figure 3. (a) illustrates the single line diagram of the test system, excluding the DVR. The test system consists of a three-phase configuration, an RL source, a programmable voltage source, and a sensitive active and reactive load connected to it. The settings and values of the testing system are displayed in Table I. In this part, a consistent line pattern is employed for all three phases, represented by the colors black, red, and blue.

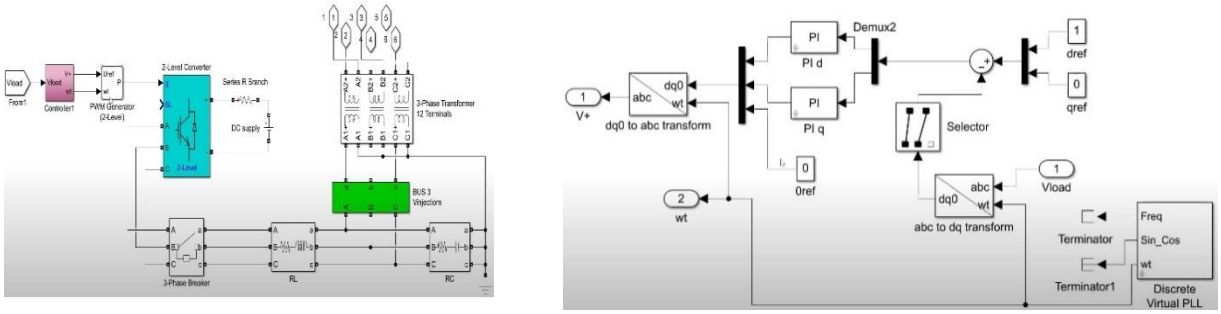
Figure 3 displays a recommended DVR model featuring the power system in SIMULINK. (b). The simulations were run in MATLAB/SIMULINK by involving a three-phase test system connected to sensitive loads, both including and excluding a DVR.



(a) (b)

Fig. 3 (a) Test system's single-line graphic without a DVR, (b) SIMULINK design of the DVR-based test system.

Figure 4(a) shows the test subsystem and DVR as a single line diagram, and Figure 4(b) shows the subsystem SIMULINK representation of the DVR controlling function. Figure 5, which corresponds to Figure 4 (b), shows the flow diagram of the DVR control circuit used to reduce voltage sag. Figures 6(a), 6(b), 7(a), and 7(b) show the voltage sag and swell response in relation to DVR, respectively, when the simulations are executed on various time sets.



(a) (b)

Fig. 4 (a) DVR subsystem, b) Subsystem of DVR open loop control.

Table I : Specifications and values of the test system

Parameter	Values
Input Voltage	430 kV
Frequency	50 Hz
Load Power Factor	0.76
Converter	IGBT (3arm-6 pulses)
Load active power	8.5 kW
Load reactive power	7.6 kW

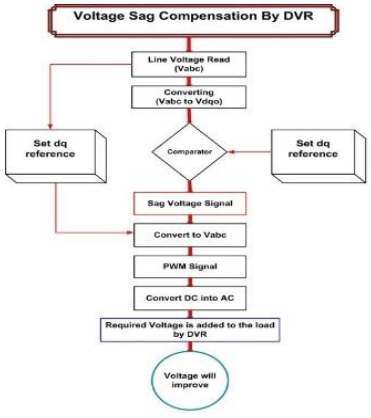
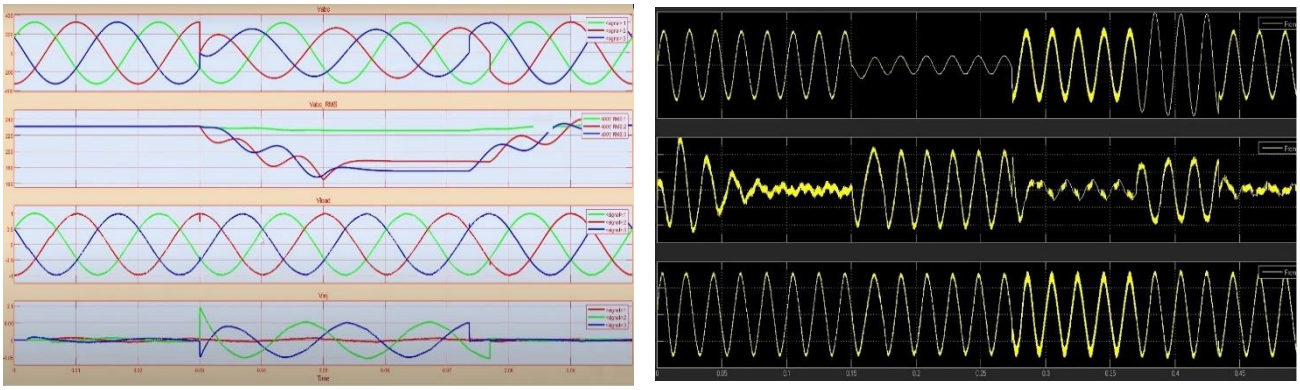
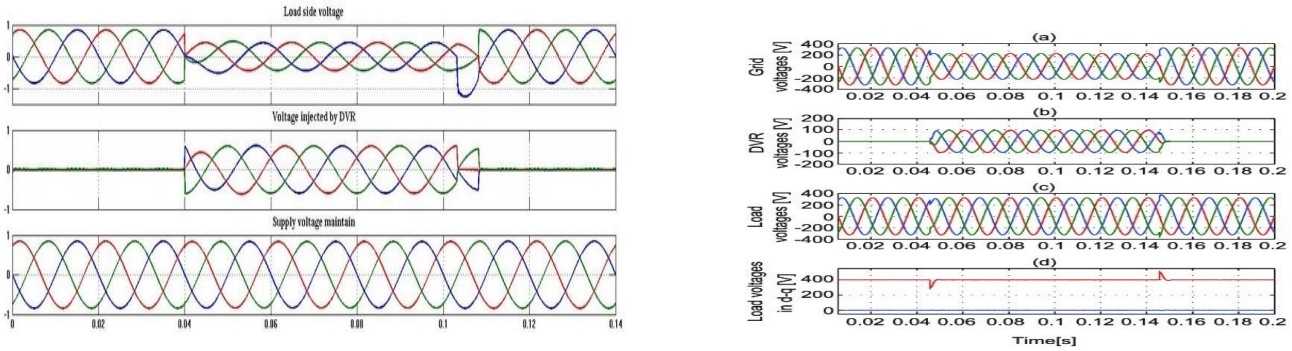


Fig. 5 Flow diagram of the DVR control circuit.



(a) (b)

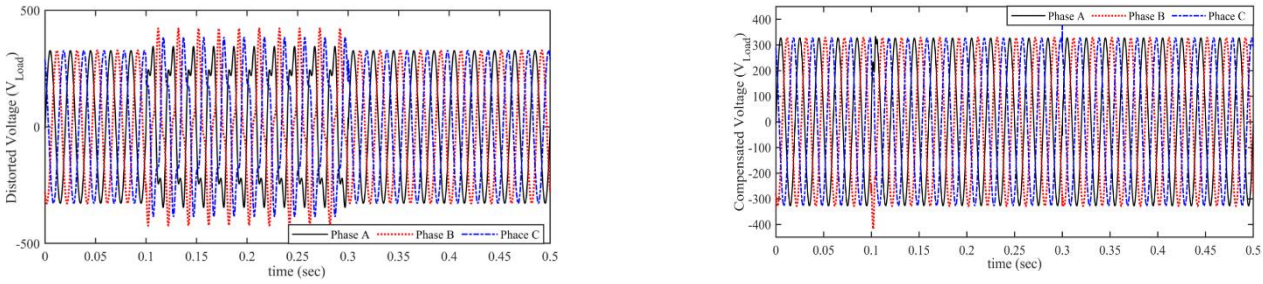
Fig. 6 (a) Phase voltage, RMS voltage, load voltage and injected voltage during voltage sag b) Voltage sag response from SIMULINK scope



(a) (b)

Fig. 7 (a) Load voltage, injected voltage and supply voltage response by using DVR control circuit b) Load voltage, DVR voltage and grid voltage response by another SIMULINK test set.

Insertion of third harmonic component (Test case I) - In the first case, the supply voltage programmable source is fed with the third harmonic voltage. This distorted supply is connected to the three-phase sensitive loads, which are then analysed in all three phases using this distortion. Figure 8 (a) illustrates how the insertion causes a deformation of the voltage profile. The load voltage (V_{Load}) exhibits distortion, characterized by an irregular waveform and some degree of swell. The magnitude of the VRMS phase-to-phase peaks in the voltage profile is around 480 V. Sensitive equipment may malfunction or fail as a result of the voltage profile disruption.

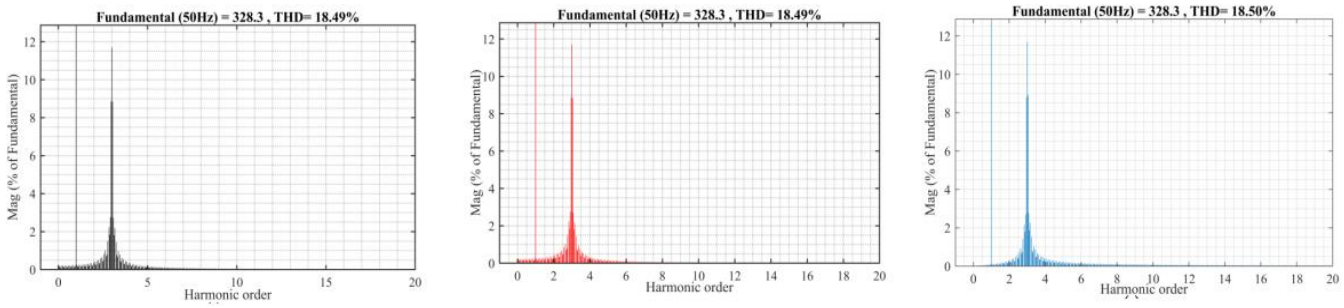


(a) (b)

Fig. 8 (a) Distorted Signal (V_{Load}) in test system without DVR (Case 1), b) Compensated signal (V_{Load}) in test system with DVR (Case 1).

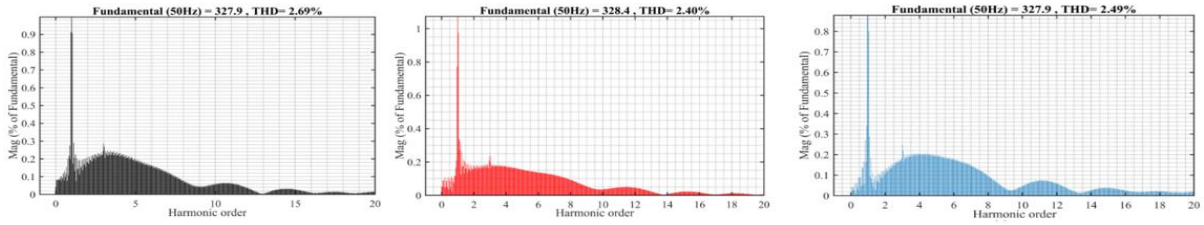
For each of the three phases, Figures 9 (a), (b), and (c) depict the computed THD distortion. Phases A, B, and C all exhibit high total harmonic distortion (THD) of 18.49% as a result of load voltage (VLoad) distortion, which degrades the power quality. The THD plots show that the signal has approximately 11.5% third harmonic content. Since the system is introduced with third harmonics of the same magnitude, all phases have shown almost identical total harmonic distortion (THD) with nearly equal harmonics. The lack of adherence to IEEE standards by these systems results in their non-approval. The THD rate must be five percent below the fundamental frequency, as specified in 1992 IEEE standard 519. The THD is considerably greater than that of IEEE standards. As a result, the introduction of DVR mitigates the voltage source disturbance.

By integrating DVR with a control system, power quality is improved and THD distortion is maintained below the IEEE limit. The load voltage with DVR and the control mechanism are illustrated in Figure 8 (b). The load voltage (V_{Load}) correction is reflected in each of the three phase voltages. This is accomplished via automatic connection; voltage injection occurs during the presence of the DVR when the circuit breakers are opened. The voltage profile returns to normal with a minimal flicker in all three scenarios within 0.1 to 0.3 seconds. A significant reduction in voltage swell is detected between t=0.1 and 0.3 seconds, accompanied by the elimination of harmonics with high magnitudes. At 0.1 and 0.3 seconds, a decrease in magnitude is observed.



(a) (b) (c)

Fig. 9 Without DVR (Case 1): (a) THD in Phase A (b) THD in Phase B (c) THD in Phase C.



(a) (b) (c)

Fig. 10 (a) With DVR (Case 1): (a) THD in Phase A (b) THD in Phase B (c) THD in Phase C.

Insertion of fifth harmonic component (Test case 2) - In case 2, the injection of fifth harmonics modifies the programmable voltage source's properties. The supply voltage change duration in this case was set between 0.1 to 0.4 seconds. Furthermore, as depicted in Figure 8, the DVR has generated a voltage waveform that is distorted for all three phases, with a shape similar to that shown in Figure 8 (b). This indicates that when the DVR is connected to the power supply, there is only a slight distortion occurring at 0.1 seconds. Figure 8(b) illustrates the adjusted voltage for case 2 as a result of the influence of the fifth harmonic component. When the DVR is connected to the system, the THD percentage for phases a, b, and c is reduced by 2.69%, 2.40%, and

2.49%, respectively, as shown in Figure 10(a), (b), and (c). Table II presents an overview of comparative statistics that is considered for the various components, such as total harmonic distortion (THD) analysis, control technique etc. and hence proves the DVR efficiency, when connected in a system during voltage sag and swell condition.

Table III: Comparative statement for THD% of the test system Including and excluding DVR

References	Phases	THD (%) for Case 1		THD (%) for Case 2		DVR open/closed loop control	Software/ hardware setup
Key factors		Excluding DVR	Including DVR	Excluding DVR	Including DVR		
Proposed technique	Phase A	18.49	2.69	22.56	4.06	DVR open loop control	SIMULINK
	Phase B	18.49	2.40	22.56	3.55		
	Phase C	18.50	2.69	22.57	3.74		
(Nielsen *et al.*, 2005) [1]	3-Phase system	N. A	N. A	N. A	N. A	DVR closed loop control	Experimental setup
(Ajaei *et al.*, 2013) [3]	3-Phase system	N. A	N. A	N. A	N. A	DVR control system in FCI mode	PSCAD/EMTDC
(Nielsen *et al.*, 2005) [10]	3-Phase system	N. A	N. A	N. A	N. A	N. A	PSCAD/EMTDC
(K. Ali *et al.*, 2017) [13]	3-Phase system	N. A	N. A	N. A	N. A	N. A	SIMULINK

Conclusion and future scope

The effectiveness and practicality of DVR as a tool for enhancing power quality have been demonstrated, making it the most prominent device in its category. The MATLAB/SIMULINK platform is used to model and structure the power system and control circuit of a DVR, including a sensitive load, in order to execute a simulation. Test systems are used to execute the DVR, and its utilization and nonexistence are analyzed. After the third harmonic is injected to the supply voltage, a programmable voltage source is used to insert a 5th

harmonic, resulting in a distorted output. By adjusting for the distorted load voltage, the proposed DVR-based control method achieved a better, more consistent, and smooth voltage profile with little harmonic content. The DVR can fix any problems and maintain a normal, steady load voltage by injecting the right voltage component into the voltage supply. Keeping the voltage profile adjustment in place, the total harmonic distortion (THD) was reduced to approximately 4%. In both scenarios, the voltage profile displayed total harmonic distortion (THD) values of 2.69%, 2.40%, and 2.69%, whereas in circumstance 2, the corresponding THD values were 3.74%, 4.04%, and 3.60%. The improvement and decrease in THD in load voltage provide an explanation for the effectiveness of the DVR-based control strategy used in this work. One possible avenue for future research in this area is the deployment of soft computing-based control strategies, such as adaptive Neuro Fuzzy controllers, to improve power quality.

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Carbon Nanodots in Photovoltaic Cells and their Role as Solar Energy Harvesters

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ABSTRACT
Carbon nano dots, or carbon dots (CDs) have already prove their presence in scientific field by their wide spread applications in diversified fields of research and development. Presently, in the domain of green energy generation, specifically for solar energy, FRET based photo-voltaic device having varied doped CDs have received excellent appreciation for their environment-friendly and high efficiency characteristics. These hybrid devices have drawn attention of entire scientific world for their low-cost-energy ratio with their outstanding sustainability. Hence, there is a significant opportunity for further research and development. Here in this narrow scope of review, we present a concise overview of the latest advancements in devices having embedded with CDs, along with some reported work those are exhibited excellent efficiency in solar energy harvesting systems.
Keywords: Carbon dots, photovoltaic cell, solar cell, FRET, environment friendly

I.INTRODUCTION
A continuous supply of energy is one of the essential parameter for our modern and developed civilization. Presently, men are working for better, eco-friendly, sustainable, low-cost renewable energy source and its cent percent utilization. Solar energy is the most affordable among others as an alternative source of energy. It makes itself unique by its own characteristics, like the most abundant in nature; sunlight is available throughout the year on most of our earth's surface, no need to pay any penny for this long term natural resources and is completely eco-friendly [1]. Presently, Photo-Voltaic (PV) cell technology is one of the mostly used methodologies to convert solar energy to electrical energy *i*.e. direct current in an optimum way.

Solar energy acts as most cost-effective alternative source of energy for their outstanding diversified properties. Its distinct characteristics make it unique from other alternative source of energy. Sunlight, is the primary source solar energy, is readily available throughout the year across vast expanses of the Earth's surface. Unlike other energy sources, harnessing solar power doesn't require any monetary investment in the long term uses. Solar energy is one of the natural resource that comes free of charge. Additionally, solar energy is entirely eco-friendly, making it a sustainable choice for powering our world.

Statistical reports revealed that almost 88% of solar energy is radiated back into the universe without affecting the Earth's surface. Out of the remaining 12% of solar energy, the majority percentage approximately 11% is utilized by green plants for their photosynthesis. A very small fraction of around 0.3% contributes to heating

the Earth's surface, while an extremely small portion, roughly 0.015%, is effectively harnessed for the conversion of solar energy into electricity. Though every nation has broad opportunity to use solar energy but in reality approximately 85% of global energy is still generated using fossil fuels. In contrast, solar photovoltaic (PV) cells contribute to a mere ~3.5% of the global energy production [2]. Hence, wide opportunities remain open for the research and development in the domain of solar energy harvesting in our near future.

All the new technologies applied in SCs are extraordinary in terms of reducing carbon footprint but cannot avoid the serious health issues for humans. Metal/metallic complexes, dyes, and compounds utilized in these technologies have been found to exhibit serious toxicity and are well-documented for their carcinogenic properties. Several materials such as Pb, Cd, Pd, Si, and Ga compounds used in solar cells (SCs) have exposed toxicity and health concerns. From this perspective, it is essential requirement for advanced research and development efforts towards materials that not only enhance solar cell efficiency but also maintain environmental sustainability. Recent studies have depicted the promising potential of quantum dots, including graphene quantum dots (GQDs) and carbon dots (CDs), which exhibit remarkable characteristics in terms of reduced toxicity and health risks [3].

In 2021, the total energy generated from solar PV cells is 1000.9 TWh. Projections suggest a substantial increase, reaching 7413.9 TWh by 2030, assuming an annual growth rate of 25%. Our nation has made significant strides on the global stage, achieving the largest solar power plant, the Bhadla Solar Park, with a capacity of 2245 MW, as well as the third-largest, the Pavagada Solar Park, with a capacity of 2050 MW. Presently, India has achieved a commendable milestone, generating approximately 7% of its total electricity from solar PV cells. This achievement establishes our commitment to both the global economy and reducing our carbon footprint [4, 5].

The aim of this review is to present a sketch of present development and research on different types of solar to different PV technologies applied for better and efficient devices and special emphasis on sustainable, eco-friendly solar cell.

II. Solar Cells

Solar cells are considered giant leader among alternative sources of energy. A solar cell simply converts solar energy into electrical energy; they operate on the principle of the photoelectric effect combined with a p-n junction mechanism. Typically, electron-hole separation occurs within the cell, resulting in the generation of a voltage across the cell (Figure **1**). Solar cells are categorized based on the various mechanisms and materials used and they are categorized on the basis of their working principles, efficiencies, eco-friendliness, and sustainability [6].

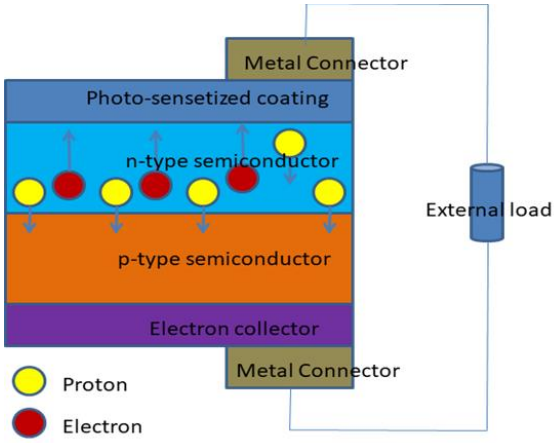


Figure **1**: A typical presentation of solar cell

II.1. Different types of SCs

Solar cells are categorized into three main categories and subdivided as below (Figure **2**);

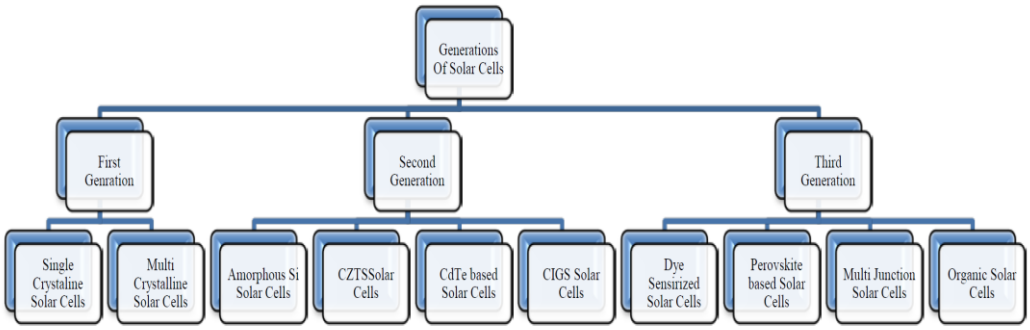


Figure **2**: Flow chart for different categorized SCs

First-generation solar cells, also known as silicon wafer-based solar cells which are of two types of photovoltaic (PV) cells. The first type is single-crystalline solar cells, while the second type is polycrystalline solar cells.

II.1.a First Generation SCs

First-generation solar cells, also known as silicon wafer-based solar cells are of two types of photovoltaic (PV) cells. The first type is single-crystalline solar cells, while the second type is polycrystalline solar cells.

II.1.a.1 Monocrystalline Silicon SCs

First-generation solar cells are generated from pure crystalline silicon materials and the market being largely populated by monocrystalline SCs. Monocrystalline SCs are accounting for over 80% of solar cell production. A high efficiency was reported in 2001 by Green et al., they reported a remarkable efficiency of 25% for crystalline SCs [7]. Due to the utilization of ultra-pure silicon crystals, the market price of monocrystalline solar cells was notably high, presenting it a costly option for generating energy from sunlight. Despite advancements, the maximum thermodynamic efficiency for converting photo energy into electrical energy has been achieved by 31%.

II.1.a.2 Polycrystalline Silicon SCs

To cut down the cost of crystalline SCs, scientists are implemented polycrystalline silicon material in SCs. Zhao *et. al.*, [8] first was introduced with poly crystalline cells with honey comb like structure and reporting a poor efficiency of 19.8% which was notably lower compare to crystalline solar cells. Due to this poor efficiency, there hasn't been extensive research in this area. Polycrystalline solar PV cells available in the market are expected to have a maximum lifetime of 27 years. However, they face challenges in low light conditions, require a wider installation area, and exhibit less thermal stability compared to their monocrystalline counterparts.

II.2.a Second Generation SCs

Second-generation solar cells predominantly made by thin-film technology. The high manufacturing cost associated with crystalline silicon in first-generation solar cells made them very much expensive. In response, the focus shifted towards reducing the amount of silicon used in solar cell production. This led to the emergence and wider acceptance of solar cells based on thin films as a cost-effective alternative.

II.2.a.1 Amorphous Silicon SCs

The markets for amorphous silicon (a-Si) based solar cells have been flourishing for over a decade. These solar cells are highly user-friendly and have found recent application in recharging batteries for calculators and various electronic gadgets. In a-Si solar cells, the amorphous structure contributes to a band gap of 1.7 eV, resulting in higher efficiency, reaching approximately 13.8%.

II.2.a.2 Copper zinc tin sulphide solar cells (CZTS solar cells)

The ready availability and abundance of metals such as copper (Cu), zinc (Zn), and tin (Sn) have received interest among modern researchers in synthesizing CZTS and CZTSS (Copper Zinc Tin Sulfide/Selenide) solar cells. These chalcogenide-based solar cells have shown impressive power conversion efficiency (PCE), reaching up to 11.3% [9]. Consequently, the development of advanced fabrication methods for CZTS-based solar cells is crucial to ensure their sustainability.

II.2.a.3 Cadmium Sulphide and Cadmium Telluride Thin Film Technology

Solar cells made by CdS and CdTe are very well known for their exceptional stability. Following silicon, CdTe-based solar cells are regarded as one of the most prevalent solar technologies. The theoretical maximum efficiency of these solar cells can reach up to 21%, with laboratory-reported efficiencies reaching 16.5% according to NREL [10]. Despite the abundance of constituent materials and their efficiency, along with their wide-ranging applications, the toxicity of heavy materials poses a significant environmental concern.

II.2.a.4 Copper Indium Gallium Di-selenide (CIGS) SCs

These cells find extensive applications in advanced research development. However, their commercial utilization is restricted due to the scarcity of metals such as gallium (Ga) and indium (In). To enhance the efficiency of these cells, they are often coated with heavy alkali metals like cesium (Cs). With such enhancements, the efficiency of these cells can surpass 19.9% [11].

II.3.a Third Generation SCs

First and second generation solar cells are not useful due to the presence of only one junction, short range of absorption, non-eco-friendly and expensive nature. Recently discovered photo voltaic cells are more than 30% efficient. Most of them are multi junctions and absorb over a wider range of frequencies.

II.3.a.1 Dye sensitized SCs (DSSC)

To avoid the high price of the first generation solar cell and manufacturing difficulties of the second generation solar cells, a relatively low cost, highly efficient and economically affordable PV cell is required in our energy sector. DSSC's may be the best fit for all the above for their low cost and easy fabrication techniques. The molecules in DSSC's can absorb the wavelength of the photon even at a very low intensity.

II.3.a.2 Perovskite based SCs

The crystal structure known as type ABX_3 is commonly referred to as the perovskite structure, named after P.V. Perovski, a Russian mineralogist. In recent years, there has been significant progress in the power conversion efficiency of metal halides with the use of these structures. Efficient photon absorption is facilitated by the

appropriate band gap in these types of cells. However, a major concern with perovskite cells lies in their hygroscopic nature and thermal instability.

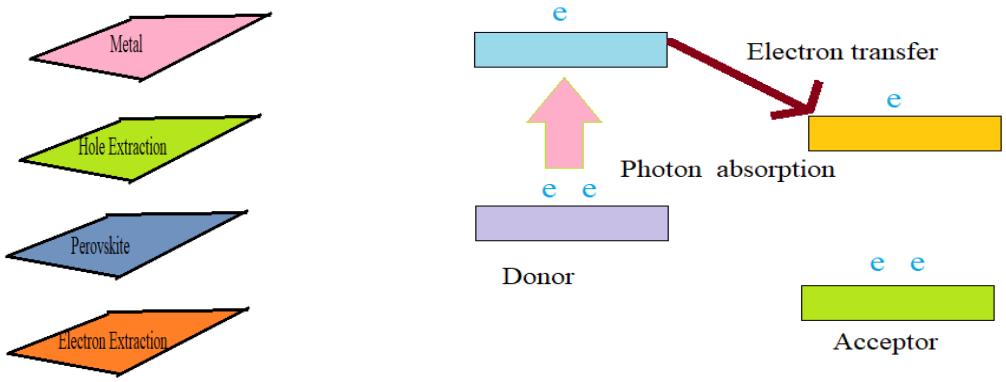


Figure 3: a) different layers in perovskite cell b) a typical example of OSCs

II.3.a.3. Organic SCs

Small organic molecules have the capability to exhibit photovoltaic effects through light absorption of wide wavelength region. These cells are typically manufactured by fabricating organic molecules using techniques such as inkjet printing or thermal vapor evaporation which are comparatively less expensive processes than existing methodology. Since organic solar PV cells do not utilize toxic materials, they are considered environmentally friendly. However, despite their affordability, these cells often suffer from lower efficiency and a gradual decrease in efficiency over prolonged exposure to sunlight.

II.3.a.4. Multi Junction SCs (Tandem cells)

In multi junction solar cell by using multiple p-n junctions, the range of absorption wavelengths can be increased. Due to stacking (tandem configuration) of the several cells the band gap decreases which is responsible for the increase of cell efficiency. By increasing the number of junctions, the efficiency can be increased up to 86.8% which is much higher than theoretical efficiency of 31% in single junction cells [12].

II.4.a. Advanced Generation SCs

CQDs exhibit absorption over a broader range of wavelengths in the visible region as well as UV region. Their bound structure and environmentally friendly characteristics make them as promising alternatives for dye-sensitized solar cells (DSSCs). By tuning the size of the semiconductor dots, the band gap can be controlled, directly impacting cell efficiency. However, the presence of surface defects on conventional quantum dots often leads to reduced cell efficiency. To attain the necessary photo voltage, CQDs are utilized as dopants in various types of third-generation solar cells.

III. Recent and Advanced Development in SCs

It has been well established that SCs showed its astonishing potential in the field of carbon-free green energy. First-generation SCs, well known for their exceptional efficiency and stability, have been used extensively.

However, their widespread use is hindered due to their high costs and inability to function effectively in diffused light. Moreover, damaged cells containing silicon pose health risks. Conversely, second and third-generation SCs, predominantly composed of rare earth metals and oxides, remain costly to produce and additionally, the use of potentially hazardous metals like lead (Pb), palladium (Pd), cadmium (Cd), and arsenic (As) further complicates the environmental impact. Despite efforts to enhance affordability through technological advancements, achieving a completely green energy sector with SCs has proven intangible [13].

IV.a. Use of CQDs in SCs

Presently, there is a concerted effort to develop solar cells while minimizing or eliminating the use of harmful materials. In the past few years, numerous reports have reported to achieve this objective through the exploration of emerging and hybrid technologies. Carbon nanoparticles such as CQDs and CDs have gained significant interest for their potential in creating green and high-performance photovoltaic (PV) devices for solar energy harvesting. Among these, CQDs stand out for their remarkable ability to absorb light across a broad wavelength range, facilitate down conversion of UV light to visible light, and crucially, reduce the band gap of the active photo anode, TiO_2, thereby contributing to higher power conversion efficiency [14].

Applications of CQDs are not only limited in the field of energy but also explosive detection, chemical sensing, food safety, bio-imaging, drug delivery, photocatalysis *etc.* They are successful as because of their a) fabricated surfaces b) different functional groups c) tuning of their size d) doping by hetero-atoms e) bio-compatibilities f) easy synthetic methodology g) can be synthesized in large scale from natural resources h) cost-effective i) stable on exploring a broad range of radiation and j) environment-friendly nature. CQDs are exhibited varied photophysical as well as chemical properties by simply varying their structure, size and compositions.

Generally, CQDs are very well-known by its identity as carbon dots (CDs) having its size within 0-10 nm. Another member of CQDs is graphene quantum dots (GQDs) which are completely different from CDs. GQDs are made of graphene layer having its size less than 100 nm having less than 10 thick layer graphene. Carbons in GQDs are mainly sp^2 hybridized whereas in CDs they are both sp^2 and sp^3 hybridized. In 2004, Xu et al. first reported the CDs from single wall carbon nanotubes (SWCNTs) [15]. Two year later from an accidental discovery of CDs, Sun et al. in 2006 reported the successful synthesis of stable CQDs [16]. In 2008, Ponomarenko et al. first reported the GQDs followed by an extended work of Xu et al. in 2004 [17].

Carbon Quantum Dots (CQDs) are commonly recognized by carbon dots (CDs), typically ranging in size from 0 to 10 nm. Another subset of CQDs is Graphene Quantum Dots (GQDs), which differ significantly from CDs. GQDs are composed of graphene layers with sizes less than 100 nm and typically fewer than 10 layers thick. Carbon atoms in GQDs are primarily sp^2 hybridized, whereas in CDs, they exhibit both sp^2 and sp^3 hybridization.

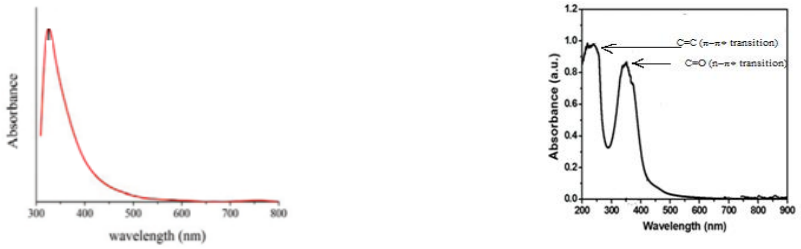
IV.a. 1. Photophysical Properties of CQDs

CQDs bring a revolution in the field of research and development due their marvelous photophysical properties. CDs obtain from different natural sources by different synthetic methodologies provide ample of photo-physical properties. CDs are proved them for their outstanding absorption and emission spectroscopies. CDs exhibit varied type of optical properties like UV-Vis, photoluminescence, phosphorescence and chemiluminescence.

CQDs have made a revolution in research and development thanks to their remarkable photophysical properties. CDs, derived from various natural sources using diverse synthetic methodologies, offer a wide variation of photophysical characteristics. They have demonstrated outstanding absorption and emission

spectroscopies, showcasing diverse optical properties including UV-Vis, photoluminescence, phosphorescence, and chemiluminescence.

Generally, CDs show broad absorption peak in ultra-violet (UV) region (250-350 nm) in addition to that an absorption tailing is due to electronic transition of C=C bonds present in the visible region. CDs responsible for peaks at around ~240 nm. Peaks at around ~340 nm are due to electronic transition of carbonyl moieties. Surface modification, doping of heteroatoms have crucial role for alteration of absorption spectra of CDs as well as their emission spectra. Surface defects present in the CDs are recommended for broad spectral peak. Different functionalities make remarkable changes in HOMO-LUMO energy levels of CDs, resulting a variation of absorption as well as their emission spectra.



(a) (b)

Figure **4**: A typical absorption spectra of CD; (a) broad absorption spectrum, (b) absorption spectrum for □□□* and n□□□ transitions

CDs are very well-known for their fabulous photoluminescent behaviors. In normally, photoluminescent spectra of CDs appear in blue to green region. Similarly as above, photoluminescent properties of selected CDs can be changed by applying surface engineering on CDs. These photoluminescent properties have been successfully applied in different application field like sensing.

IV.b. Use of CQDs as Photoactive Layer in SCs

CQDs are served as a photoactive layer in photovoltaics (PVs) due to their ability to diversified optical phenomena. By tuning their size, one can regulate optical properties such as absorption and emission. Moreover, band gaps can be controlled by employing different heteroatoms by doping techniques. The hybrid combination of TiO_2 and doped CQDs yields outstanding results, following the frontier resonance electron transfer (FRET) mechanism. Studies have shown that doped graphene quantum dots (GCDs) combined with TiO_2 exhibit enhanced light absorption in longer wavelengths as a photoanode. In the case of dye-sensitized solar cells (DSSCs), the power conversion efficiency (PCE) decreases upon exposure to UV radiation. However, DSSCs coupled with N-CQDs showed only a 23% decrease in PCE, compared to a 67% decrease observed without N-CQDs after three weeks of exposure of light. Hence, to avoid toxicity, CQDs present a favorable alternative to dyes in Quantum Dot Solar Cells (QDSCs) [18].

Both simple CQDs and doped CQDs have proven highly successful as counter electrodes in dye-sensitized solar cells (DSSCs). Sulphur and other heteroatom-doped CQDs have demonstrated excellent photo-excitation properties when used in Pt, RuSe, and CoSe as counter electrodes. In DSSCs, incorporating GQDs embedded in polypyrrole (PPy) counter electrodes has shown improved power conversion efficiency (PCE) compared to those without GQD doping. The use of Pt or metal-based counter electrodes significantly increases the cost of solar cells, whereas employing PPy/conductive polymers with GQDs makes solar cells more affordable.

Embedded Perovskite Solar Cells (PSCs) with GQDs and CQDs has yielded enhanced efficiency. Combining CQDs with Au has also demonstrated improved efficiency and cost-effectiveness. In these applications, CQDs have played a pivotal role in reducing the reliance on noble metals for counter electrodes, thereby contributing to the overall cost reduction of solar cells.

IV.c. Use of CQDs as Hole Transfer Layer in SCs

In any kind of PV cell, photosensitized materials eject an electrons and their separation generate a cell potential by an electron transfer mechanism, whereas hole transfer mechanism also plays an important role in building a better potential of the cell.

To enhance the efficiency of Organic Solar Cells (OSCs), Perovskite Solar Cells (PSCs), and other third-generation photovoltaic (PV) cells, an additional hole transfer layer (HTL) is incorporated alongside the active anode. Among the most commonly utilized HTLs is poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS). When PEDOT:PSS is combined with doped GQDs, it has demonstrated excellent performance in solar cells [19].

Despite of their lower efficiency, organic solar cells (OSCs) are favored for their affordability and versatility. Typically, conductive polymers or small organic molecules are employed for photo-excitation. The modification of Carbon Quantum Dots (CQDs) has enabled the creation of hole transfer layers (HTLs) with both electron-rich (n-type) and electron-deficient (p-type) characteristics, which have found successful application in OSCs. Barman et al. demonstrated that doping CQDs with nitrogen and phosphorus renders HTLs n-type, while boron doping results in p-type HTLs, leading to improved efficiency in solar cells.

IV.d. Use of CQDs as Electron Transfer Layer in SCs

Electron transfer layers (ETLs) play a crucial role in enhancing the power conversion efficiency (PCE) and stability of third-generation solar cells, particularly in Perovskite Solar Cells (PSCs) and Organic Solar Cells (OSCs), where they have demonstrated exceptional performance. ETLs are placed between the active layer and the cathode facilitated the extraction of electrons from the active layer to the cathode, resulting in higher cell potential and improved PCE as the ultimate outcome. Commonly used materials for ETLs include phenyl-C_{61}-butyric acid methyl ester ($PC_{61}BM$), TiO_2, SnO_2, and 2,2′,7,7′-tetrakis(N,N-di-p-methoxyphenyl amine)-9,9′-spiro bifluorene (spiro-OMeTAD). However, these materials often face serious drawbacks such as interfacial charge recombination and current leakage [20]. The utilization of doped CQDs as ETLs has proven to successfully overcome these challenges. Remarkably, CQDs embedded in ETLs have been shown to significantly improve the PCE, achieving PCE levels of around 13-14% in PSCs.

Therefore, CQDs has brought a revolution in all kinds of SCs by doping in photoactive layer (anode) and electron receiver (cathode). As an overall, CQDs offer better electrode potentials and ultimately cell potential and make PV-SCs, as low cost, better stability and affordable for all nations. These successes are not only remarkable for science and technological development, but also they lead us to almost very close to long-days-awaited target to generate green energy having zero carbon footprints. It is our firm believes that in near future CQDs will be explored as a completely green counter electrode with modifications.

Hence, the combination of CQDs has made a revolution across various types of solar cells, serving as dopants in both the photoactive layer (anode) and electron receiver (cathode). Overall, CQDs contribute to enhanced electrode potentials, thereby elevating cell potential and rendering photovoltaic solar cells (PV-SCs) more cost-effective, stable, and accessible to nations worldwide. These achievements not only signify significant progress

in science and technology but also bring us closer to the long-awaited goal of generating green energy with zero carbon footprints. We firmly believe that in the near future, CQDs will be further explored as entirely green counter electrodes with additional modifications.

V. Conclusion and Future Prospects

In this short discussion we expressed the most recently developed technologies for existing SCs and new generation SCs toward their affordability, eco-friendliness and cost-effective. Here, we discussed and summarized the successful use of CQDs, GQDs and others in registered 3rd generation SCs viz. OSCs, PSCs and DSSCs through their extraordinary properties like absorption of light with broad range, stability of cell from UV light, reduce the charge recombination and anchoring as better electron transporter to cathode. CQDs proved that these can serve an alternative to different toxic dyes and metal/metal oxide QDs and make SCs green and less expensive. In spite of outstanding technological development in different kinds of SCs, further research and development are necessary in some specific issues to achieve better efficiency and low cost devices. It is needless to mention the future importance of surface modifications of CQDs such as photo-anode, HTLs and ETLs for next generation technologies in PV based SCs. Therefore, we can hope the above mentioned development of CQDs will completely replace the expensive, heavy-metal-based QDs and rare-earth metal toward production of low-cost green energy without any scratching in our mother nature. In this short discussion, we have highlighted the latest advancements in existing and next-generation solar cells (SCs), focusing on their affordability, eco-friendliness, and cost-effectiveness. Specifically, we have outlined the successful utilization of Carbon Quantum Dots (CQDs), Graphene Quantum Dots (GQDs), and other materials in registered third-generation SCs, including Organic Solar Cells (OSCs), Perovskite Solar Cells (PSCs), and Dye-Sensitized Solar Cells (DSSCs). These materials exhibit extraordinary properties such as broad-spectrum light absorption, UV light stability, reduced charge recombination, and enhanced electron transportation to the cathode.

CQDs have emerged as most feasible alternatives to toxic dyes and heavy-metal-based Quantum Dots (QDs), contributing to make SCs green and cost effective. Despite of significant technological advancements in various types of SCs, further research and development are essential to address specific challenges and enhance efficiency while reducing costs. Surface modifications of CQDs, including their use in photo-anodes, hole transfer layers (HTLs), and electron transfer layers (ETLs), hold promise for next-generation PV-based SC technologies. Therefore, we anticipate that the continued development of CQDs will lead to the complete replacement of expensive, heavy-metal-based QDs and rare-earth metals, paving the way for the production of low-cost, green energy solutions that leave minimal impact on our environment.

VI. Acknowledgement

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Effective Strategies to Overcome Construction Accidents: A Comprehensive Review

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ABSTRACT
Construction accidents continue to plague the industry, causing injuries, fatalities, and financial losses. This comprehensive review paper examines the root causes of construction accidents and presents evidence-based strategies to mitigate risks and improve safety outcomes. Drawing upon research findings, industry best practices, and regulatory guidelines, this paper provides valuable insights for construction companies, policymakers, and stakeholders seeking to create safer work environments.
Keywords: Strategy, Construction, Safety, Unsafe Working Conditions, Risk Management

I. INTRODUCTION

Construction is inherently hazardous, with numerous risks present on job sites ranging from falls and struck-by incidents to electrocutions and collapses. Despite advancements in safety regulations and technology, construction accidents remain a significant concern worldwide. Understanding the root causes and implementing effective strategies are essential steps toward overcoming this persistent challenge.

Root Causes of Construction Accidents

Construction accidents are often multifaceted, stemming from various root causes:

A. **Human Error:** Human error is a leading cause of construction accidents, encompassing factors such as miscommunication, lack of training, fatigue, and negligence. Addressing human factors requires comprehensive training, clear communication channels, and proactive fatigue management strategies.

B. **Unsafe Working Conditions:** Poorly maintained equipment, inadequate safety protocols, and insufficient supervision contribute to unsafe working conditions on construction sites. Employers must prioritize regular equipment maintenance, implement robust safety procedures, and ensure adequate supervision to mitigate risks.

C. **External Factors:** External factors, including environmental conditions like weather and site location, can exacerbate construction hazards. Employers should assess environmental risks and implement appropriate measures to protect workers from adverse weather conditions and other external factors.

Effective Strategies to Mitigate Construction Accidents

This section outlines evidence-based strategies to address construction accidents comprehensively:

A. Robust Safety Training Programs: Comprehensive safety training programs are essential for equipping construction workers with the knowledge and skills to identify and mitigate hazards effectively. Training should cover topics such as safety protocols, equipment operation, hazard recognition, and emergency procedures. Employers should invest in ongoing training and utilize innovative approaches such as virtual reality (VR) and augmented reality (AR) for enhanced learning experiences.

B. Strict Enforcement of Safety Regulations: Effective enforcement of safety regulations is critical for promoting a culture of safety and accountability on construction sites. Regulatory agencies play a crucial role in setting and enforcing standards related to construction safety. Employers must ensure compliance with regulations, conduct regular inspections, and impose penalties for non-compliance to maintain safety standards.

C. Cultivating a Culture of Safety: Creating a culture of safety requires commitment from all levels of an organization, from top management to frontline workers. Employers should prioritize safety, encourage open communication, and empower workers to report hazards and near misses without fear of reprisal. Recognizing and rewarding safety initiatives can reinforce a positive safety culture.

D. Leveraging Technology for Risk Management: Advancements in technology offer innovative solutions for managing construction risks. Construction management software equipped with safety features enables real-time monitoring of hazards, incidents, and corrective actions. Wearable technology such as smart helmets and vests provides workers with vital sign monitoring and alerts for potential hazards. Drones offer aerial surveillance capabilities for identifying safety concerns and conducting site inspections.

E. Emphasizing Pre-Construction Planning: Effective pre-construction planning is essential for identifying and mitigating potential hazards before work begins on-site. Employers should conduct thorough risk assessments, develop comprehensive safety plans, and involve all stakeholders in the planning process. Allocating sufficient time and resources for safety measures during project scheduling can prevent accidents and delays during construction.

I. Investing in Ergonomic Design and Equipment: Ergonomic design principles should be applied to tools, equipment, and workspaces to reduce the risk of musculoskeletal injuries and repetitive stress disorders among

construction workers. Employers should select ergonomic tools, provide proper training on their use, and design ergonomic workstations to enhance worker comfort and safety.

G. Providing Personal Protective Equipment (PPE): Personal protective equipment (PPE) is essential for protecting construction workers from various hazards present on job sites. Employers should supply workers with appropriate PPE, ensure proper fit and maintenance, and enforce consistent usage through education and training initiatives.

Conclusion

Construction accidents pose significant risks to workers, project stakeholders, and the industry as a whole. However, by implementing evidence-based strategies informed by research, best practices, and regulatory guidelines, construction companies can mitigate these risks and create safer work environments. From robust safety training programs to leveraging technology for risk management, each strategy plays a vital role in enhancing construction site safety. By prioritizing safety as a core value and investing in proactive measures, the construction industry can move towards a future where accidents are minimized, and workers can perform their duties with confidence and security.

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The heading of the References section must not be numbered. All reference items must be in 10 pt font and APA style. Number the reference items consecutively in square brackets (e.g. [1]).

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Fire Fighting Robot For Household And Industrial Applications

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ABSTRACT

With the advent of technology, humans are replaced with robots in life-threatening situations. We aim to design a prototype robot capable of detecting and suppressing fires. By designing and implementing an autonomous robot capable of detecting and extinguishing flames, disasters can be avoided with minimal risk to human life.

Keywords: Arduino, Fire sensor, Robot.

I. INTRODUCTION

In the modern world, where technology and innovation stride together towards creating safer, smarter, and more efficient environments, the realms of fire safety and emergency response are no exceptions. Each year, fires cause devastating losses, affecting thousands of households and industrial settings worldwide. These incidents not only lead to significant economic damages but, more importantly, pose severe risks to human life and environmental health. Traditional fire safety measures, while essential, have their limitations, especially when it comes to accessibility, response time, and adaptability to diverse and dangerous scenarios.

Enter the era of robotics — a paradigm shifts in approaching complex problems with precision, reliability, and advanced technological prowess. In this present work at hand introduces a sophisticated solution to fire safety challenges: a Fire Extinguishing Robot designed for both household and industrial environments. This robot represents a fusion of engineering excellence and innovative design, built upon the versatile and widely-used Arduino Uno platform, and equipped with a suite of sensors and actuators meticulously chosen to navigate to and combat fires autonomously.

METHODOLOGY:

Fire Detection:

The vehicle uses advanced sensors to detect fires and determine their precise locations.

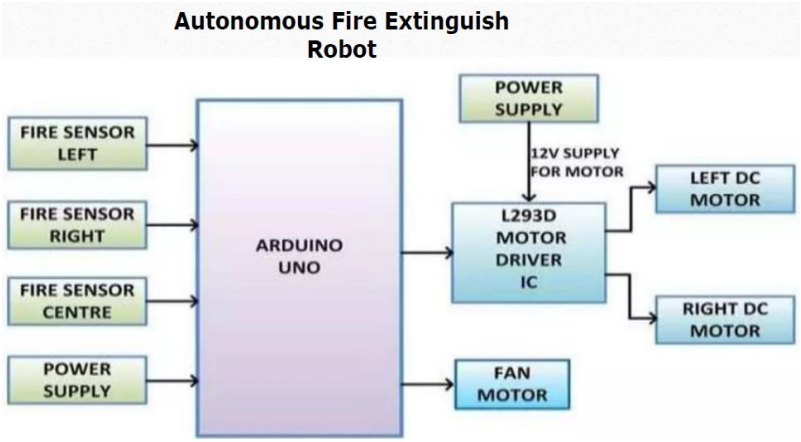
Navigation:

It then navigates through obstacles and reaches the fire location autonomously.

Water Discharge:

Upon reaching the location, it efficiently discharges water to eliminate the fire.

BLOCK DIAGRAM:



COMPONENTS USED:

- Arduino(R3)
- Motor Driver
- DC motor (300 rpm)
- Pump
- Servo moto micro
- Chassis
- Fire sensor
- Connecting wire
- DC supply

Fig1: Arduino Board.

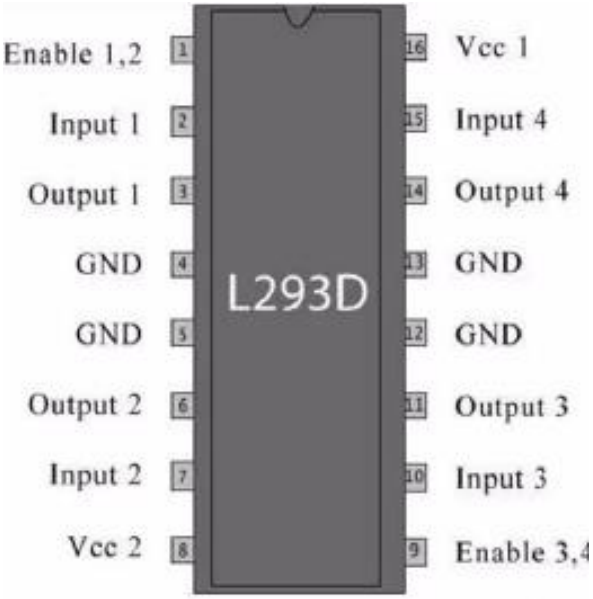
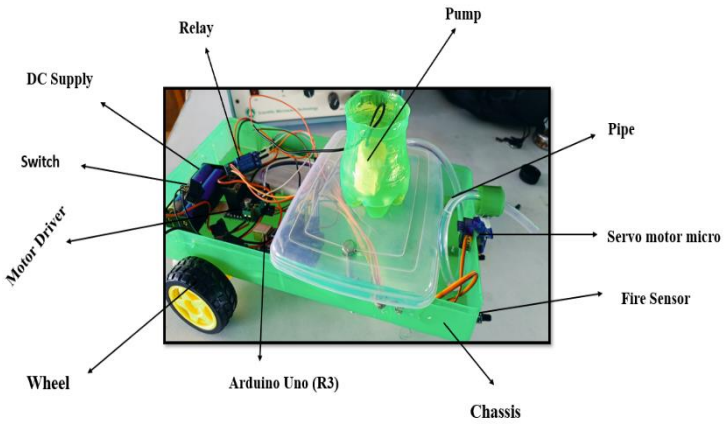


Fig1: Pin configuration Arduino Board.

RESULTS AND DISCUSSION



Conclusion

As we reach the culmination of our journey through the design, development, and deployment of the fire extinguishing robot, it is evident that this present work is not merely an academic endeavor but a beacon of innovation in the realm of fire safety. By successfully integrating the versatile Arduino Uno platform with an array of sensors and actuators, we have laid the foundation for a new generation of fire response technology. Our robot represents a significant leap forward, not only in terms of immediate fire suppression capabilities but also in the broader context of preventive safety and emergency response.

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Modelling of a Hybrid Charging Station for Electric Vehicles Using Wireless Power Transfer

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ABSTRACT
This paper focuses on developing a hybrid electric vehicle charging station that uses wireless power transfer. This charging station is powered by both grid electricity and solar energy. When solar power is not available, Grid Bi-directional Inverter (BI) feeds the wireless power transfer (WPT) system through the grid. WPT system will use grid power as well as solar power to charge EVs in the event that solar irradiation is inadequate.When there is available solar energy, the solar P-V feeds the power to WPT system through a boost converter. Maximum power point tracking is used to regulate the Boost converter (MPPT). In case there is no electric vehicle (EV) present, solar energy directly fed into the utility grid. This model uses a switching control technique to provide smooth power flow in various conditions. The control strategies for tracing the grid frequency and phase are done be the phase lock loop (PLL).
Keywords: Wireless Power Transfer (WPT), Bi-directional Inverter (BI), Electric Vehicle (EV), Maximum Power Point Tracking (MPPT), Phase Lock Loop (PLL).

I. INTRODUCTION

Greenhouse gases produced by conventional fuels contribute to climate change and other environmental problems. Also the conventional fuel is running out day by day [1]. To protect the environment, we need to find some other ways. So the use of EVs is much needed now.The future belongs to EVs. So that people may drive EVs freely, we need to make the system reliable. A large battery is necessary for electric vehicle (EVs) to eliminate range anxiety and require seldom charging [2]. Large capacity batteries make EVs too costly for most consumers. Furthermore, it is unacceptable that electric cars require a lengthy charging period. Depending on the battery's storage capacity, the EVs' range is reduced on a single charge. They will plug in and charge the battery when the chance to charge the EV batteries arises.In addition to causing issues when placed on the floor, these plug-in cables also have issues with old cables leaking. To solve these issues it has been possible to transfer electricity wirelessly [2]. Plug-in problems are eliminated by static WPT, and range anxiety and battery capacity are decreased by dynamic WPT.Our proposed method allows the EV battery to be charged while the vehicle is in operation, which eliminates the challenge for manufacturers to load a large-capacity battery beside the vehicle [3].In this paper Grid and solar electricity are both used in hybrid charging stations [4]. The WPT Charger may obtain its power from the following condition-based sources:

- In the event that solar energy is unavailable (in night and evening), WPT will use grid electricity to charge the EVs.
- WPT will use grid power in addition to solar power if solar irradiance is not strong enough to provide enough power for the EVs.
- The EVs will be charged with solar energy using WPT if there is enough solar radiation.
- Solar energy supplied into the grid if there are no vehicles at the charging station to charge.

II. Simulink Model

The mains parts of this Simulink model are solar PV Array with Boost converter, Wireless Power Transfer, Grid connected Bidirectional Inverter, Switching Mechanism. By using maximum power point tracking (MPPT) we can extract maximum power from solar PV [5].Solar PV produces DC power which is converted into AC power using inverter. This AC power will be transmitted to the full bridge Rectifier by using a transmitter and receiver coil (WPT system). Furthermore, the Rectifier will convert AC power into DC, which will be stored in the battery with the help of a Buck Converter. Bidirectional inverters will convert DC into AC or AC into DC according to the situation. The complete Simulink model is shown in Fig 3.

A. Solar PV with Boost Converter

Here 8 parallel and 6 series-connected PV array modules used. Because temperature and sun radiation affect a photovoltaic array's performance, we won't constantly get the same amount of power. The Maximum Power Point Tracking (MPPT) algorithm is used to obtain the maximum amount of power through the perturb and observe (P&O) method. The steady state is established by measuring the voltage and current and comparing it to the next perturbation [6]. A boost converter with MPPT is shown in Fig 1.

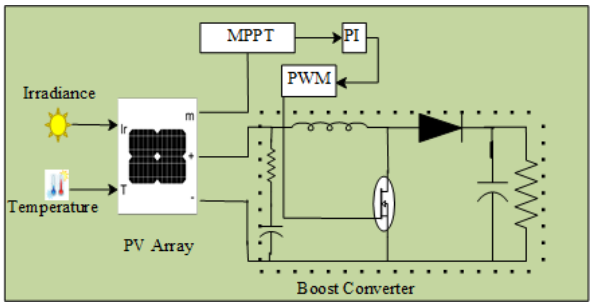

Figure 1. Solar PV with Boost converter

B. Wireless Power Transfer

DC power is converted into AC power by using Half Bridge inverter. The working principle of transmitter coil and receiver coil is based on electromagnetic induction, same as in case of transformer. This is done at high resonance frequency (10KHz). Now this AC power is converted into DC power with the help of Buck converter whose duty cycle is controlled by constant current control method [7]. The gate pulses are generated by comparing the load current with reference current. The complete WPT system is show n in fig 2.

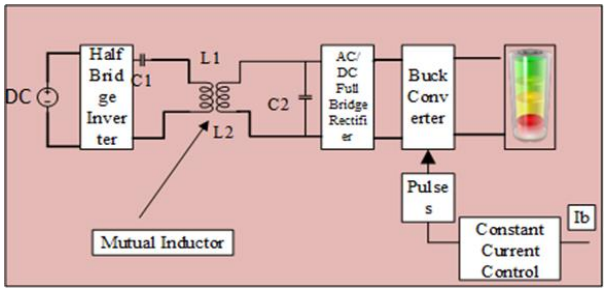

Figure 2. Buck converter and wireless power transfer system

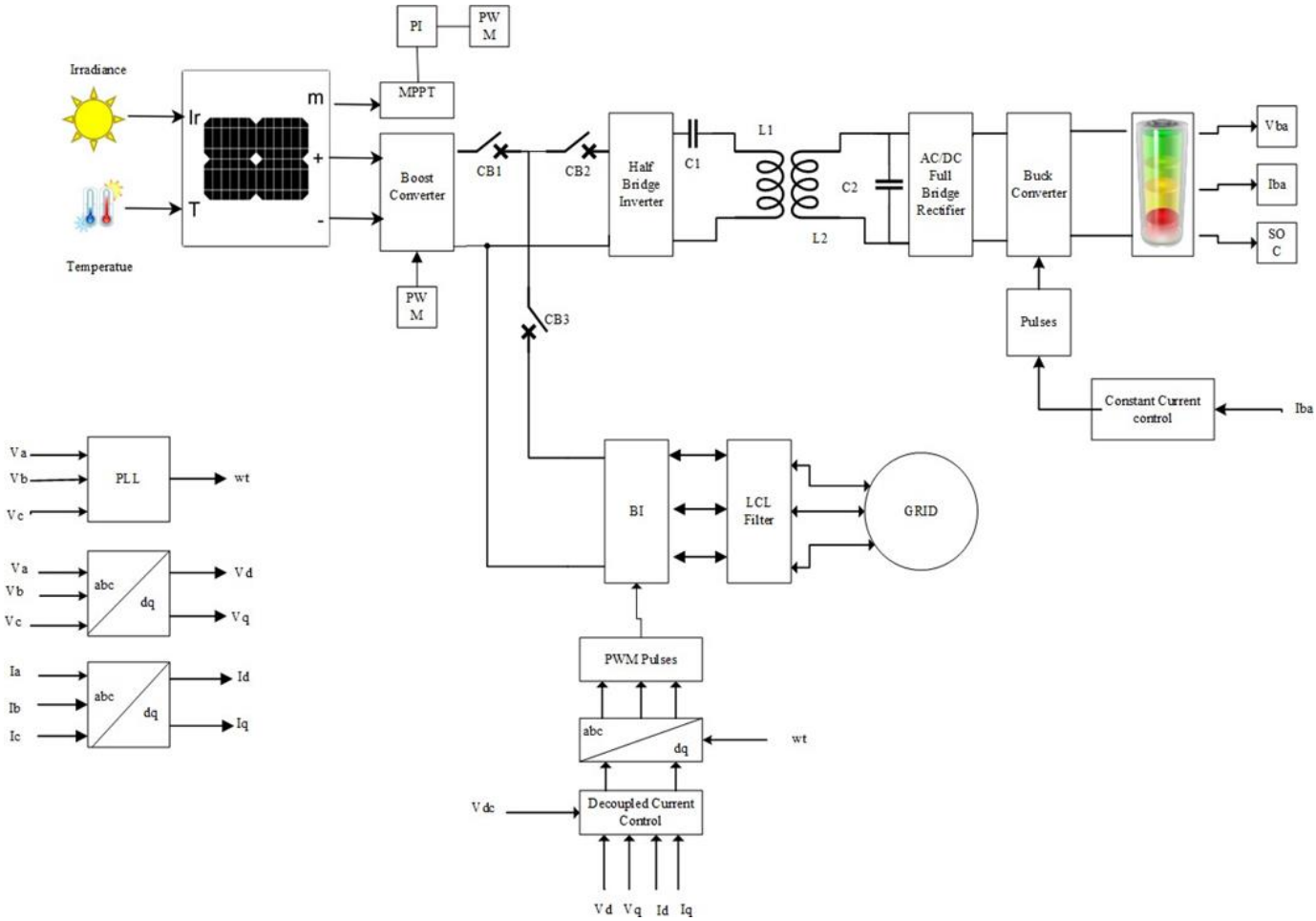

Figure 3. Complete Simulink model

C. Grid connected Bidirectional Inverter

BI is connected between the Boost converter and utility Grid. When electricity is transmitted from solar PV array to the grid, the bi-directional inverter (BI) transforms DC voltage into AC voltage and in case solar irradiance is unavailable, BI will transform AC voltage into DC voltage to charge the electric vehicle battery. Grid connected bi-directional Inverter is shown in fig 4.

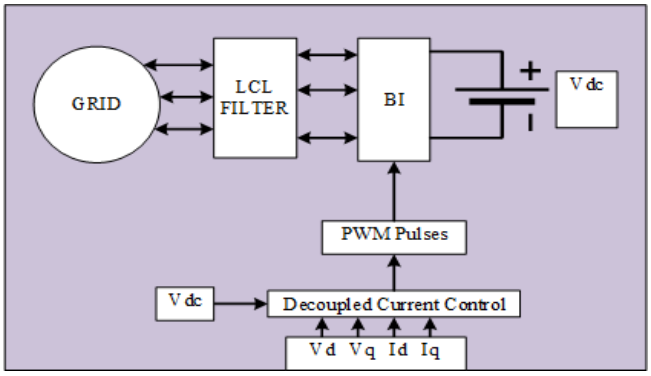

Figure 4. Grid connect BI

To generate the modulating signals the grid voltage and current is transform to a synchronous d-q rotating frame with the help of Park transformation. Pulse width modulation (PWM) [8]-[9] signals are generated by comparing the reference voltage with carrier signal. Phase lock loop (PLL) helps to lock the input and output frequency. But there will be some error. In ideal case phase error is zero. By using PI controller we can minimize the error. To control the active and reactive power separately decouple current control method is used. By using the decoupling current control technique, transient current in reactive power may be eliminated in the event of active power ups and downs. The complete procedure to generate gate pulses for BI is shown in fig 5.

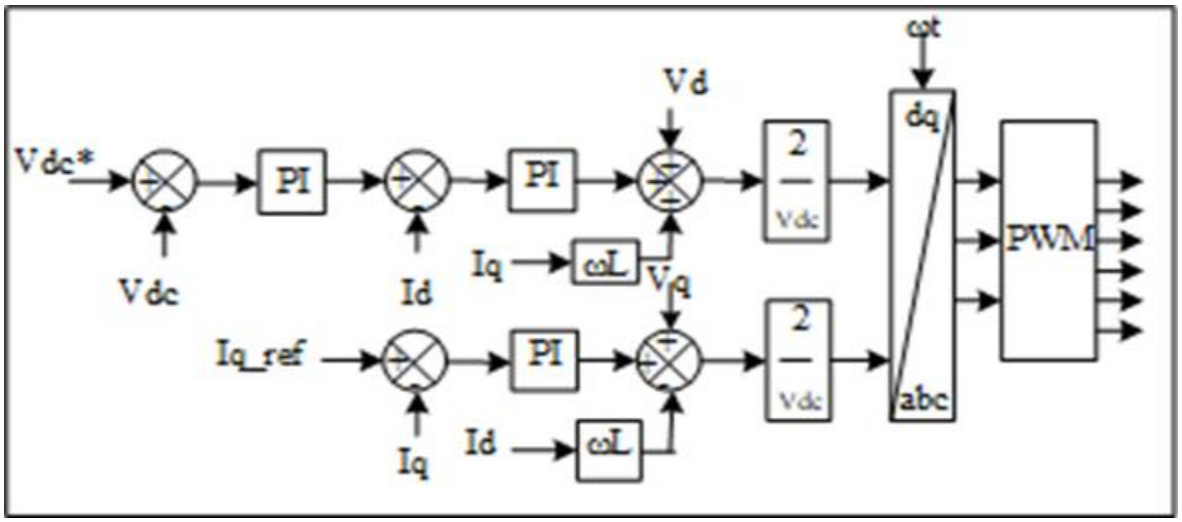

Figure 5. PWM pulses generation and Decouple Current Control method

D. Switching Mechanism

The switching mechanism is created to connect or disconnects the solar PV, wireless power transfer system and utility grid, according to various situations. We have three circuit Breakers (CB1, CB2, and CB3). Switches are controlled by MATLAB function. When irradiance level is less than 200, Circuit Breaker 1 (CB1) and Circuit Breaker 2 (CB2) are closed. When irradiance level is more than 200 all the CB are closed. When there is no vehicle to charge then circuit breaker 2 (CB2) will be open and remaining two switches will be closed.

III.Simulation Results

Here we will discuss the results of this Simulink model. Results are taken in these three situations which are described below. The results in various situations are shown in fig 6.

(i) At irradiance level 1000 W/m2, the power produced by the solar PV is enough to charge the EVs battery. In this scenario, all the switches are closed. Also the current and voltages are completely synchronized with grid which is shown in fig 6. Also the graph indicate that the power is delivering by the solar PV

(ii) At irradiance level=0 W/m², Solar PV power is zero. The graph indicates that all the power is delivered by the grid only. In this case CB1 is open, CB2 and CB3 are closed.

(iii)At irradiance level=200 W/m², solar PV alone cannot generate all the power, so rest of the power is delivered to the battery from the grid. In this case both the solar PV and grid is delivering power to charge the battery.

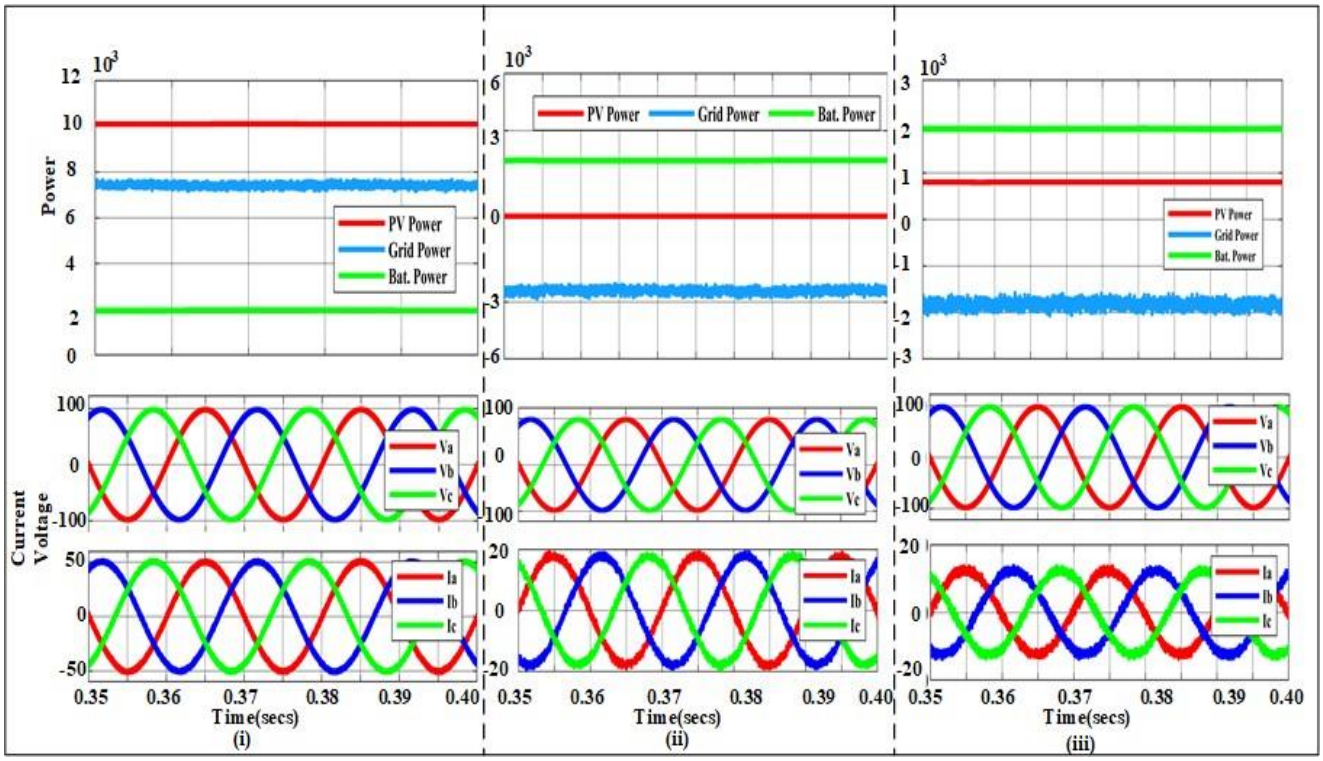

Figure 6. Power, Voltage and Current at different irradiance level

Response of the Battery and DC bus voltage

The graph of the state of charge (SOC), battery current and DC bus voltage is shown in fig 7. The DC bus voltage is fixed at 325 V. When the battery is being charged, the voltage gradually rises. Battery current is constant which is almost 30 A. Initial SOC of the battery is 50 % which is gradually increased to 50.003% in 0.35 seconds. The battery almost takes 3.4 hours to completely charge

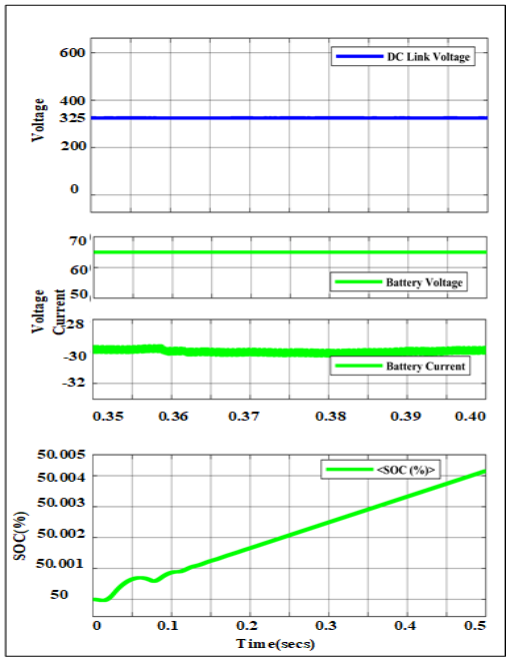

Figure 7. SOC, battery voltage, current and DC bus voltage

Conclusion

The purpose of this work is to enable hybrid power system electric vehicle (EVs) to be charged wirelessly. This implies that the grid will provide the required power in the case that solar power is not available, and the solar panel will offer the input for the charging station. By doing this, we reduce the load on the system and utilize more sustainable and reasonably priced renewable energy sources. This paper presents a MATLAB model and uses graphs and results to validate it. The results demonstrate how well the system functions across a variety of operating circumstances. Apart from creating a pathway for the projected future studies in the domain of wireless technology, these proposed charging stations might be implemented in practice to provide an efficient way to charge electric vehicles, allowing EVs to drive safely.

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Navigating Barriers to Industry 4.0 Integration: Insights from the Manufacturing Sector in India

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ABSTRACT

Industry 4.0, a transformative paradigm, holds significant implications from theory to practice. Despite its potential, adoption in developing countries lags. While prior research reveals benefits, limitations, and the forces behind Industry 4.0, limited empirical research exists on barriers to Industry 4.0 integration within manufacturing enterprises. This study focuses on identifying key barriers in an Indian manufacturing context. Drawing from existing literature, notable barriers are identified. An expert committee comprising professionals from various organizational levels is formed, and the analytical hierarchy process is employed to identify criteria weights. The study reveals that the foremost barriers include "Lack of coordination and information flow across departments" and "Lack of commitment from top management." Addressing these barriers is crucial for the effective execution of Industry 4.0, necessitating policymakers' attention and strategic planning to overcome them effectively.

Keywords : Industry 4.0, Analytic Hierarchy Process, Barriers, Manufacturing industry

I. INTRODUCTION

Industry 4.0, the fourth industrial revolution, has recently become an increasingly popular study topic. It is the meeting point of numerous cutting – edge ideas and innovations, including big data, radio-frequency identification (RFID), machine learning (ML), sensors, cloud computing, robotics, artificial intelligence (AI), additive manufacturing (AM), internet of things (IoT), and augmented reality (AR) [1], [2]. The phrase "industry 4.0" was initially used in a November 2011 German government document that was a component of the high-tech strategy for 2020 initiative [18]. The emergence of digital manufacturing, popularly referred to as the "smart factory," is the central component of industry 4.0. It entails the adoption of creative business models, process mobility, intelligent networking between industry units, flexibility and interoperability of industrial operations, and integration with suppliers and clients. Industry 4.0 relies heavily on intelligent networks constructed on top of cyber-physical systems (CPS). Utilizing the CPS, Industry 4.0 unifies the digital and

physical domains to boost organizational production and efficiency. The CPS is made up of intelligent devices, storage systems, and production plants with the ability to interact, initiate actions, and exert autonomous control over one another. Industry 4.0's cutting-edge technology has the capacity to dramatically increase a production system's productivity and overall efficiency [4]. For example, according to a McKinsey report [5], transitioning to an automated system from traditional production can increase organizational productivity by 45% to 50%.Scholars, executives, and decision-makers assert that integrating CPS and Industry 4.0 methodologies into smart factories facilitates flexible production, enhances supply chains, and produces more efficient company management, all of which have important ramifications for society, the economy, and technology [18].

Industry 4.0integrates personnel, computers, robots, and data into a cohesive platform to improve supply chain agility and responsiveness [7].Even though supply chains can benefit from the introduction of Industry 4.0, there are various barriers that might impede Industry 4.0 advancement [3], [6]. Each obstacle has a varied impact on Industry 4.0 acceptability and performance. For example, according to a recent McKinsey [5] Industry 4.0 worldwide expert survey conducted in several countries, only 14% of CEOs are certain that their companies are sufficiently prepared to adopt the changes required for Industry 4.0 deployment. Because Industry 4.0 adoption presents so many obstacles, the majority of businesses have made little or no progress. Studies [7], [8] indicate that Implementing Industry 4.0 isa challenging process, and numerous businesses worldwide are having trouble with it [9]. Organizations in underdeveloped nations are still in the early phases of implementing Industry 4.0, whereas organizations in affluent nations have already benefited somewhat from implementing Industry 4.0 [10]. This is because organizations in developing nations face a number of obstacles, including inadequate infrastructure, an inadequate regulatory environment, a dearth of governmental laws, and a lack of financial support [8]. Because of this, determining the obstacles and their respective effects is essential to creating a mitigation plan that will facilitate Industry 4.0 adoption more smoothly [9].For Industry 4.0 adoption, developed countries have often created national action plans, whereas developing nations are more likely to rely on private sector efforts than on coordinated government strategies [11].Scientific research on the barriers to the implementation of Industry 4.0 has not been done extensively byresearchers.A portion of the previous research has focused on developing a structural model of the barriers to Industry 4.0 [13], [14], [15], and [16]. However, because barriers have only been identified without the support of a uniform framework, little is known about how they interact. The following research questions have been established in light of the debate above:

(i) What significant obstacles exist for the adoption of Industry 4.0 in developing nations?
(ii) What is the main obstacle that managers need to take into account in order to successfully deploy Industry 4.0 across manufacturing companies?

This research attempts to identify the most important hurdles to Industry 4.0 adoption in light of industrial organizations to ensure that the aforementioned knowledge gaps. For this research, a real-life scenario in the Indian manufacturing sector is being investigated. The barriers investigated in this research were found after a thorough literature review and interaction with industry professionals. Data is gathered through the construction of questionnaires and organized interviews with industry experts. To prioritize different hurdles, AHP isutilized. Finally, the most significant impediment is determined. The remaining portion of this research study is organized as follows: The method employed in this study is described in Section 2. Section 3 describes

the suggested research framework. Section 4 demonstrates the use of the suggested research framework. Finally, section 5 summarizes the results and identifying limitations and future research opportunities.

Methods

This study uses AHP [17] to determine the most important obstacles to the implementation of Industry 4.0. AHP is a "multi-criteria decision-making (MCDM)"approach that integrates the subjective judgments of decision makers (DMs), which would otherwise be hard to quantify. Several researchers use the AHP method in a variety of domains, including quality factor analysis of manufacturing processes, sustainable supplier selection, prioritization of renewable energy resources, and barrier analysis of solar PV energy deployment, green building planning, and sustainability risk assessment. The following are the primary advantages of AHP over other decision-making techniques: (i) it may take into account the relative importance of factors, (ii) it has a lower computing complexity, and (iii) it ensures consistency in the final conclusion, and (iv) it does not necessitate the use of real data sets. The AHP method's step-by-step technique is outlined below.

Step 1: **Development of pairwise comparison matrix (D)**

If the data set has$n$ factors to access, then the square matrix that results from the pair wise comparison of i^{th}andj^{th}factor is as follows:$D = (d_{ij})_{n\times n}$. In this matrix, d_{ij} denotes the weight of the i^{th}factor in relation to thej^{th} factor. In this matrix, $d_{ij} = 1$, when $i = j$, and $d_{ji} = {}^{1}/_{d_{ij}}$. Also, in this matrix all diagonal elements are equal to unity (1).

Step 2: **Computation of the normalized matrix (B)**

The pair wise comparison matrix is normalized by dividing each column entry by the total of the corresponding 'D' column entries for each column. Let b_{ij}represent the i^{th} factor's normalized value relative to thej^{th} factor and is calculated using equation (1).

$$b_{ij} = \frac{d_{ij}}{\sum_{i=1}^{n} d_{ij}}, \text{ for } 1 \le j \le n \quad (1)$$

By averaging each row element, the normalized matrix can be used to determine the normalized relative weight of the matrix elements. The AHP weight (w_i) of each element is calculated using equation (2)

$$w_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \quad (2)$$

Now, two matrices, P and Q are developed in such a way that $P = D \times D' = [p_i]_{n\times 1}$ and$Q = [q_i]_{n\times 1}$ where$q_i = {}^{p_i}/_{w_i}, i = 1,2,3,\dots,n$, and$D' = [w_i]^{\tau}$, where τ is the transpose of the matrix. Next, calculate 'λ_{max}' that is the average of the element's matrix Q i.e $\lambda_{max} = \frac{\sum_{i=1}^{n} q_i}{n}$

Step 3: **Determine the consistency ratio (CR)**

Consistency ratio is evaluated as $CR = {}^{CI}/_{RI}$. Where, CI denotes the consistency index and it is expressed as follows: $CI = {}^{(\lambda_{max} - n)}/_{n-1}$. A lower CI value indicates only a little consistency deviation. RI is the random index for the elements in the system. The different values of RI corresponding to different values of n can be found in the literature of Saaty [17]. Basically, a CR value of 0.1 of less is acceptable as a measure of consistency. If the value is greater than 0.1, then further investigation is required in the pairwise comparison matrix.

Proposed research framework

The research is demonstrated in the subsequent steps as shown in Fig.1.

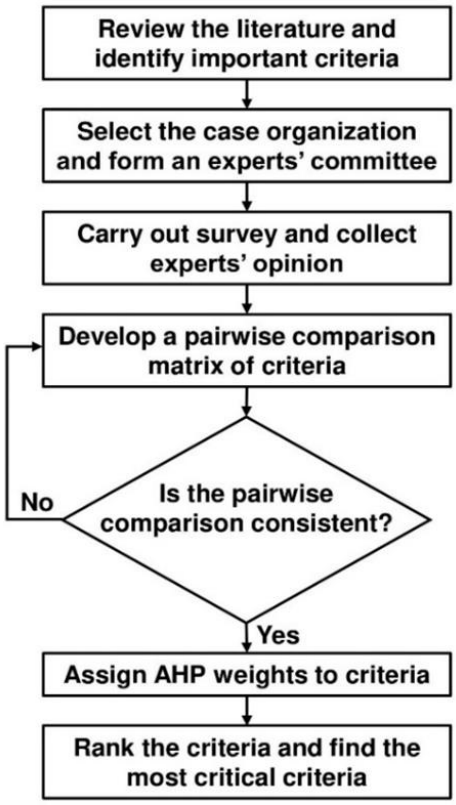

Fig.1 Flow diagram for the suggested framework

First, a research organization is chosen, and significant criteria (barriers) are determined from the body of existing literature. After then, a group of industry experts from different case organization departments create an expert committee. To gather pertinent data, a survey has been conducted. Experts' subjective preference over the relative importance of criteria is taken and measured against a Saaty's9-point linguistic scale [17], which is shown in Table 1.

Table 1 Saaty's 9-point scale of subjective preference

Numerical value	Measure of preference
9	Extremely preferred
7	Very strongly preferred
5	Strongly preferred
3	Moderately preferred
1	Equally preferred
2, 4, 6, 8	Intermediate values

The elements (d_{ij}) in the pairwise comparison matrix is derived from the experts' opinion using this 9-point scale. For example, if the element d_{12} is 7 then, it can be said that according to the decision maker or expert's perception, first criteria is extremely preferred with respect to second criteria.Thus, the pairwise comparison

matrix among criteria is developed with the help of 9-point scale (Table 1). Now, the criteria weights are determined using equation (2). Afterwards, consistency is verified by calculating the consistency ratio (CR). If the CR value lies within the acceptable range, then final weights are assigned to criteria. Otherwise, pairwise comparison matrix needs further assessment by experts. Finally, criteria are ranked according to their AHP weights. The criterion that has the highest weight is identified as the critical criteria.

Application

To show the applicability of the suggested research approach, a real-world challenge of Industry 4.0 deployment in an India-based manufacturing organization is explored. The name, location, company profile, and other identifiable characteristics of the organization are not provided in this study according to the privacy policy. The chosen organization is a well-known name in the Indian manufacturing business. It has implemented various efforts and careful moves towards Industry 4.0 deployment. The organization is working to achieve company sustainability by implementing Industry 4.0 technology. Nonetheless, the company is having a lot of trouble modernizing and bringing the current organizational structure into compliance with Industry 4.0 norms. In practice, it is simply impossible to determine which barriers are more important than others in terms of the degree of their opposition to Industry 4.0 adoption. Furthermore, policymakers in organizations cannot devise methods to remove all hurdles at once. As a result, it is critical to determine which of the barriers is the most obstructive in nature. This study seeks to identify a collection of significant impediments identified in the literature by diverse writers. The most significant obstacle is determined using the suggested research approach, which will assist managers and policymakers in developing effective strategies to remove crucial barriers. The selected criteria are shown in Table 2.

Table 2 List of selected criteria (barriers)

Name	Notation	Source
Lack of IT competence and infrastructure	B1	Müller et al. [13]; Kamble et al. [9]
Lack of data accessibility, data protection and IT security	B2	Orzes et al. [6]; Horváth et al. [10]
Lack of financial support and investment	B3	Tay et al. [14]; Majumdar et al. [16]
Lack of government legislation and regulatory framework	B4	Sony et al. [7]; Raj et al. [12]
Lack of coordination and flow of information across departments	B5	Chauhan et al. [8]; Machado et al. [1]
Lack of willingness of top management	B6	Kumar et al. [15]; Stentoft et al. [3]

A range of experts are chosen from the case organization. Twenty experts have been appointed to a committee, five of whom will be chosen from the tactical, five from the strategic, and ten from the operational levels. Each member has over twenty years of business experience and is extremely talented in their respective fields. The general manager, an engineer for research and development, a manager for quality control, a project manager, facility managers, a process engineer, supervisors, and technicians are among the chosen personnel. Relative

importance of criteria in the pair wise comparison matrix is obtained from the subjective ratings (9-point scale) provided by the experts. As there are twenty experts, the average of their ratings is considered for each element in the matrix. For example, if the rating of d_{ij} provided by the experts is denoted by ${d_{ij}}^k$, where k represents the number of experts (here, $k = 20$), then the average rating of d_{ij} will be $\frac{1}{k}\sum_{k=1}^{k} {d_{ij}}^k$ (for, $1 \leq i \leq n, 1 \leq j \leq n$), where, n is the number of criteria. Thus, the pairwise comparison matrix (D) is constructed (Table 3).

Table 3 Pair wise comparison matrix (D)

	B1	B2	B3	B4	B5	B6
B1	1	0.50	0.33	0.20	0.25	0.13
B2	2	1	0.25	0.33	0.25	0.14
B3	3	4	1	0.25	0.33	0.14
B4	5	3	4	1	0.50	0.50
B5	4	4	3	2	1	0.50
B6	8	7	7	2	2	1

Now, the above matrix is normalized using equation (1) and the normalized matrix (B) is shown in Table 4.

Table 4 The normalized matrix (B)

	B1	B2	B3	B4	B5	B6
B1	0.04	0.03	0.02	0.03	0.06	0.05
B2	0.09	0.05	0.02	0.06	0.06	0.06
B3	0.13	0.21	0.06	0.04	0.08	0.06
B4	0.22	0.15	0.26	0.17	0.12	0.21
B5	0.17	0.21	0.19	0.35	0.23	0.21
B6	0.35	0.36	0.45	0.35	0.46	0.41

The weight (w_i) of each element is calculated using equation (2) and is shown in Table 5.

Table 5 Weights of criteria (w_i)

Criteria	B1	B2	B3	B4	B5	B6
Weights	0.04	0.05	0.10	0.19	0.23	0.40

Now the consistency is examined by finding the CR value. This is shown in Table 6.

Table 6 Consistency ratio table

Particulars	Expressions	Values
Maximum eigen value	λ_{max}	6.38

Consistency index	$CI = {(\lambda_{max} - n)}/{n-1}$	0.076
Random index	$RI_{n=6}$	1.24
Consistency ratio	$CR = {CI}/{RI}$	0.0613

The consistency ratio is 0.0613, which is less than 0.1 and satisfies the condition for consistency. As a result, the pairwise comparison may be considered to be consistent. As a result, the AHP weights are allocated to the appropriate criterion. The criteria are now sorted according to their AHP weights. B6 comes first, followed by B5 > B4 > B3 > B2 > B1. As a result, B6 is given the most weight and is the most important criterion.

Discussions and Conclusion

The findings show the barriers' priority ordering based on their AHP weights. According to Table 5, In the hierarchy of criteria determined by their weights, B6 comes in first. As a result, the 'lack of willingness of top management' is a remarkable barrier to Industry 4.0. This finding agrees with Horváth et al. [10], Jayashree et al. [11], Majumdar et al. [16], and Müller et al. [13]. According to Horváth et al. [10], organizational aversion at various employee and management levels might severely impede Industry 4.0 adoption. According to Jayashree et al. [11], Adoption of Industry 4.0 and overall sustainability are significantly impacted by top management and IT infrastructure.According to Majumdar et al. [16], a key barrier to Industry 4.0 implementation is a lack of commitment from senior management. According to Müller et al. [13], Industry 4.0 can only be successfully implemented if senior management is totally committed and dedicated in its adoption. As a result, this study shows that employee acceptability and management willingness to transition to Industry 4.0 are critical. B5, or 'lack of coordination and information flow among departments,' is ranked second. It is also a powerful barrier. This supports the conclusions of Machado et al. [1] and Saatçiolu et al. [2], who stated that coordination, and communication across departments is critical for the efficient adoption of Industry 4.0. To effectively deploy Industry 4.0, the organisation must tear down the fictional wall separating departments and bring ideas from all divisions together on the same platform. Concurrent engineering principles, in other words, should be implemented. Other than B6 and B5, the remaining barriers have lower weights. As a result, in comparison to B6 and B5, the remaining barriers have no substantial impact on Industry 4.0 deployment. This study makes several theoretical advances, such as revealing that the 'lack of commitment of top management' and the 'lack of coordination and flow of information across departments' are two important barriers. The findings also imply that managers and governments should prioritise these barriers and devise appropriate methods to overcome them. In practice, the AHP weight-based framework may be an effective option for analysing many aspects and determining the most important component in a variety of decision-making sectors. It is simple to utilise and put into action. To the best of the authors' knowledge, no study has been carried out that looks into the major barriers to Industry 4.0 adoption while conducting a field-based investigation in a developing country.

Although this study finds six significant barriers based on the literature, more significant barriers may have been ignored. Because Industry 4.0 is a new field of study that has yet to be completely adopted in most businesses in both developed and developing nations, quantitative data and exact estimations may be unavailable in real-world circumstances. In such instances, decision-makers must rely on professional

qualitative assessment. AHP is a great decision-making method for dealing with qualitative data. To assess the relative relevance of criteria, this study combines experts' subjective preferences. As a result, ambiguity may exist in the end result. Future research may seek to eliminate ambiguity by including fuzzy set theory into the suggested technique. Future research can look at a larger number of barriers to determine the most significant ones. Other decision-making methodologies, such as "Interpretative Structural Modelling" (ISM) and "decision-making trial and evaluation laboratory" (DEMATEL), can be used to identify important obstacles and their interactions. Furthermore, future research might use the presented paradigm to determine obstacles facing Industry 4.0 deployment in additional industrial sectors.

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Review on Application of Cold Mix Asphalt

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ABSTRACT
By utilizing more environmentally friendly products, the construction sector is attempting to lessen its impact on global warming. As an illustration, consider cold mix asphalt (CMA) technology, which eliminates the need to heat components in the same way as conventional hot mix asphalt (HMA). This results in reduced energy consumption and greenhouse gas emissions while building new roads. Although CMA has many advantages over HMA, it isn't always as reliable, particularly in high-traffic regions. Scientists are working to improve CMA, but their progress is slow. This essay examines several facets of CMA, including its composition, design, functionality, and potential for improvement. It discusses CMA's advantages and disadvantages and makes recommendations for Cold Mix Asphalt.
Keywords: Global warming , hot mix asphalt, Sustainable products, Cold mix asphalt.

I. INTRODUCTION

Road construction is happening at a fast pace worldwide. For example, India built about 26.93 kilometres of roads per day in 2018–19 and aimed to increase that to 27.40 kilometres per day in 2019–20. However, this increased road construction also poses a threat to global warming, which is a major challenge we're dealing with today. Just like other industries, the environmental impact of road construction is being talked about a lot. More roads mean more greenhouse gases being released into the atmosphere, contributing to global warming. To tackle this, various industries are adopting different measures to reduce their carbon footprint. The road construction industry is also taking steps in this direction. One such measure is using Cold Mix Asphalt (CMA) in road construction to lower the production of greenhouse gases. CMA is made by mixing emulsified bitumen, cutback, or foamed bitumen with unheated aggregates. Unlike traditional methods, this process doesn't require heating the aggregates, making CMA both cost-effective and less polluting.

Around the world, the majority of roads are made using asphalt mixes, which are used in flexible pavements. These mixes can be grouped into three main categories based on how they're produced and at what temperature they're made:

- Hot mix asphalt (HMA) - made at temperatures between 150–190°C.
- Warm mix asphalt (WMA) - made at lower temperatures, typically between 100–140°C.
- Cold mix asphalt (CMA) - made at even lower temperatures, ranging from 0–40°C

So, depending on the method and temperature used, asphalt mixes fall into one of these three categories.

Figure – 1: Asphalt

II. COLD MIX ASPHALT

This paper provides an overview of recent developments in Cold Mix Asphalt (CMA). It aims to explain how cold bituminous emulsion asphalt is created and to address certain challenges faced in further research. The key points covered in this paper include the components of CMA, its mix design, performance, durability, moisture sensitivity, as well as its advantages, disadvantages, and conclusion. Cold Mix Asphalt (CMA) offers several benefits such as cost-effectiveness, lower energy consumption, and being environmentally friendly. Currently, CMA is primarily used for minor construction and repair projects. It is manufactured at temperatures ranging from 0–40°C. Because it doesn't require heating during production, CMA saves a significant amount of energy. Additionally, the production of cold mix doesn't require expensive equipment, making it easier to adopt. CMA can be used in remote areas and for both initial construction (using 100% new materials) and recycling old asphalt pavement (using Recycled Asphalt Pavement or RAP). The main advantages of CMA include cost-effectiveness, environmental friendliness, lower emissions, and easy availability. However, there are some drawbacks to using cold mix, such as lower strength in the early stages, higher voids, and increased susceptibility to moisture [References: Lu et al. (2013), Read and Whiteoak (2003), Needham (1996), Thanaya et al. (2007b)] .

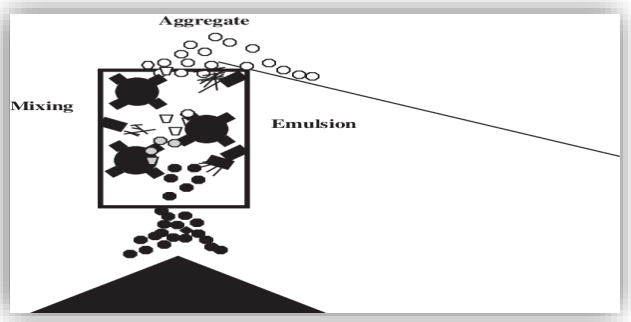

Figure – 2: Cold Mix Asphalt

III. Component of cold mix asphalt

Like any other asphalt mix, Cold Mix Asphalt (CMA) consists of two main components: aggregates and binding materials. The aggregates include coarse aggregate, fine aggregate, and fillers. What sets CMA apart from other asphalt mixtures is the addition of water (when emulsion is used as the binder) or solvent (when cutback is used as the binder). These extra components help the binding material to work effectively in cold temperatures, allowing for the mixture to be applied without the need for heating.

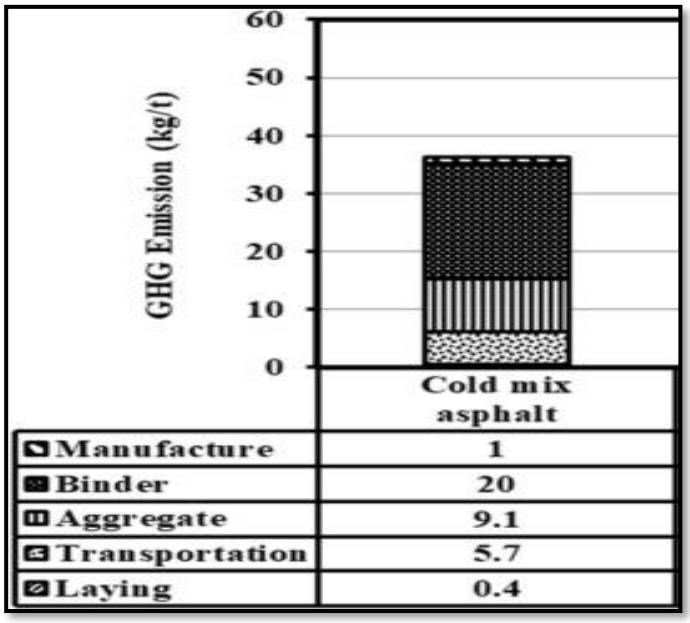

Figure – 3: Cross Section of Different layers of Cold Mix

IV. Tests for Cold Mix Asphalt

Bitumen content testing

To determine the asphalt content of the stockpile mixes, the ASTM D2172 standard method for solvent extraction was followed. Here's a breakdown of the process:

1. Test samples were heated in an oven at a specific temperature range (110±5 °C) until they softened enough to be separated with a trowel.
2. A representative sample was then quartered and oven-dried at the same temperature until it reached a constant weight, meaning no more moisture was being released.
3. Once dried, the sample was removed from the oven and allowed to cool down.
4. A weighed quantity of 850 g of the cooled sample was placed in a centrifuge extractor.
5. Trichloroethylene, a solvent, was added to the extractor to extract the binder from the sample. More trichloroethylene was added until the aggregates were completely clean, indicating that all the binder had been extracted.
6. The aggregates obtained from the extraction test were then oven-dried again to ensure they reached a constant mass at 110 °C.
7. The test was repeated two more times following the same procedure to ensure accuracy and consistency.
8. Finally, the asphalt content was calculated as the average of the three tests, providing a reliable measure of the binder content in the stockpile mixes

Aggregate gradation testing

After figuring out how much asphalt was in the mix, the rocks from the asphalt were checked to see how big they were. Here's how they did it:

They took some of the dried rocks from the asphalt tests and put them on the top of a bunch of screens with different-sized holes. Then, they put all those screens with the rocks in a machine that shook them. The shaking made the smaller rocks fall through the holes in the screens. They collected the rocks that didn't fall through each screen and weighed them. They figured out what percentage of the rocks stayed on each screen by comparing the weight of the rocks on each screen to the total weight of all the rocks. Then, they subtracted that percentage from 100 to find out what percentage of the rocks passed through each screen. This helped them understand how big the rocks were in the asphalt mix, which is important for making roads.

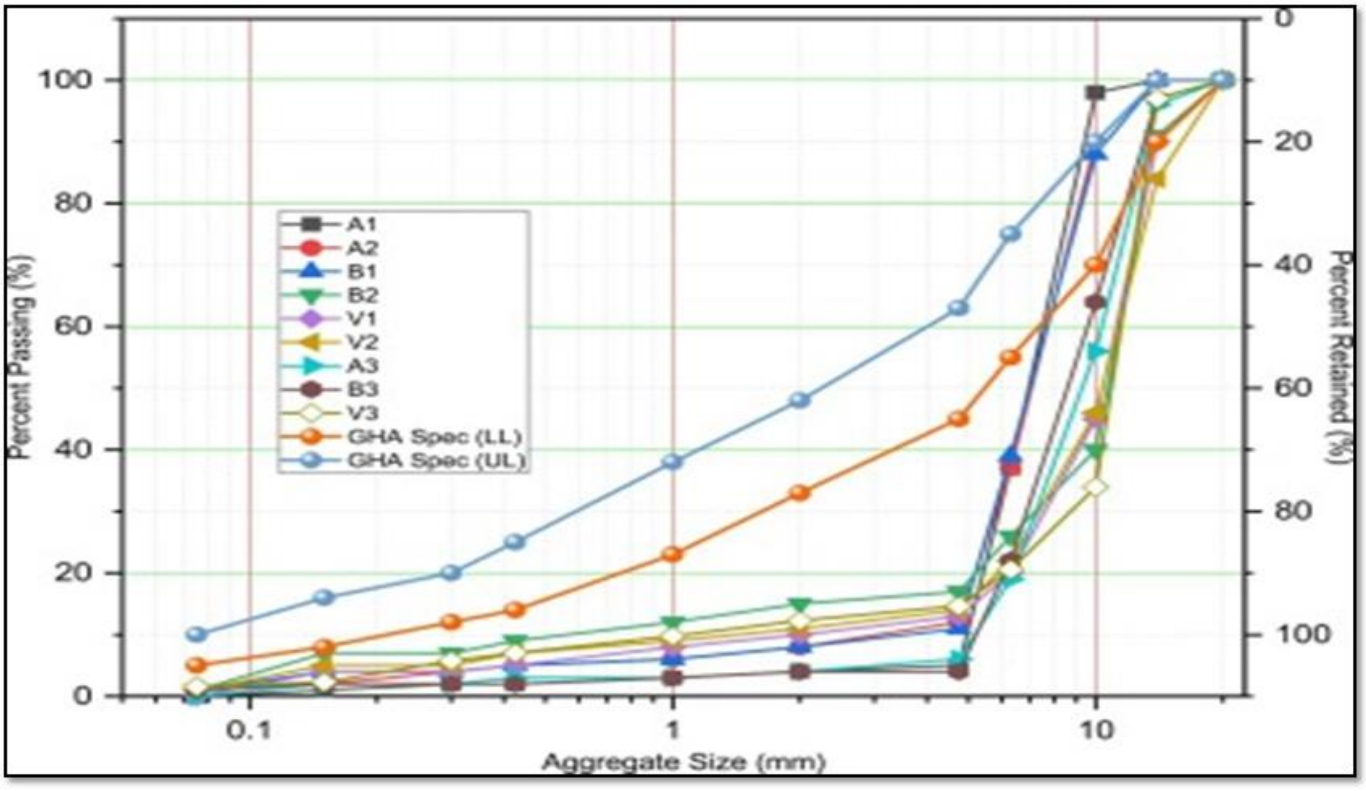

Figure – 4: Aggregate size versus Passing

Stability and flow

The cold mix asphalt samples were compacted using a machine that dropped a heavy hammer onto them from a specific height. These samples were put into a special mould that had a base plate, forming mould, and extension. The height of the samples varied slightly. To prepare the samples for compaction, they were heated in an oven and then vigorously stirred with a spatula. After that, the mould was placed on the compaction machine, and each sample was hit 50 times on each side. This was all done at room temperature, with the mixtures being around 35 °C. After compacting, the samples were left in the mould for some time before being removed. Later, they were placed in a hot water bath for 30 minutes to condition them. After this, the samples were taken out, dried, and tested by applying pressure until they broke. This test helped determine how much pressure the asphalt could handle before breaking and how much it compressed under that pressure.

V. Results and discussion

Asphalt content of stockpiled and failed patch materials

The discussions primarily revolved around the results obtained after extracting the binder content from the sampled materials and analysing their gradations. However, the stability and flow test results were not considered in the discussions because not all samples could be tested. This was because the specimens disintegrated during conditioning for the stability and flow tests, as illustrated in Plate 1, which showed samples nearly falling apart after being removed from the moulds. This disintegration could be attributed to the lack of cohesion in the compacted specimens. The absence of cohesion and stickiness indicates poor gradation and insufficient binder within the compacted material. These issues suggest that the asphalt mixture may not have been properly formulated or compacted, which could affect its performance and durability in real-world applications.

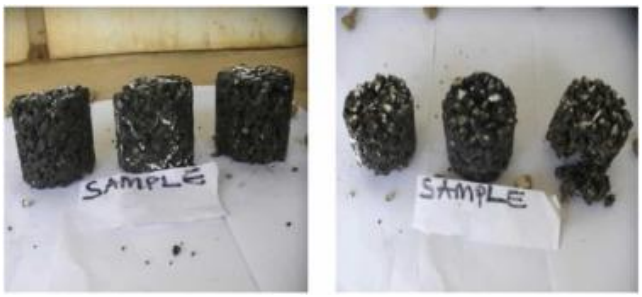

Figure – 5: Cold Mix Asphalt test

Cold mix design

When it comes to designing asphalt mixes, there are different methods used depending on whether it's a cold mix or a hot mix. Cold mix design happens at regular room temperature, while hot mix design usually involves much higher temperatures, around 140°C to 160°C. For cold mix design, the temperature considered is typically between 0°C to 40°C. Different countries have their own preferred methods for asphalt mix design. In the USA, they often use the SUPERPAVE method, while in Europe and Asian countries, the MARSHALL method is more common. These methods help engineers figure out the best recipe for making durable and safe roads.

Preparation of Cold Mix Asphalt

Here's a simplified explanation of the method for producing a cold mix asphalt paving composition:

1. First, the non-asphalt impurities are removed from reclaimed asphalt pavement to get purified asphalt rubble.
2. Next, this purified asphalt rubble is crushed into smaller pieces to create a mixture of asphalt and aggregate.
3. The mixture is then tested to find out how much asphalt it contains.
4. Finally, an asphalt emulsion is added to the asphalt-aggregate mixture in the right amount to make a cold mix asphalt composition. This composition typically contains between 4.0% to 6.5% of asphalt by weight.

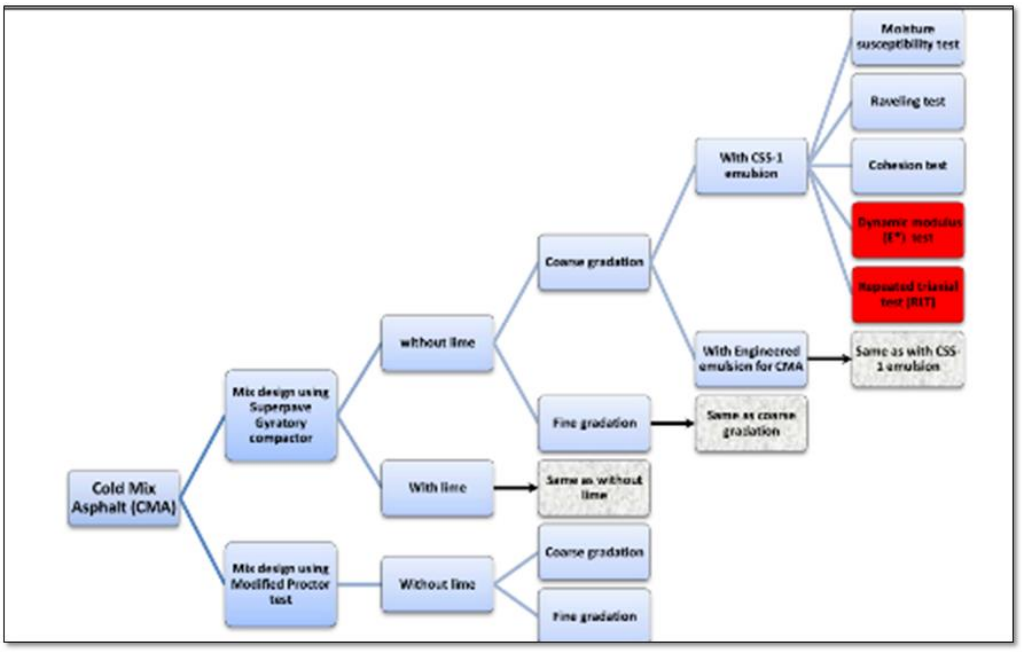

Figure – 6: Process of Preparing Cold Mix

The cold mix asphalt paving mixture is used to cover surfaces like roads, parking lots, and driveways. After applying this mixture to a surface, another layer called a top coat can be added on top of the cold mix asphalt pavement.

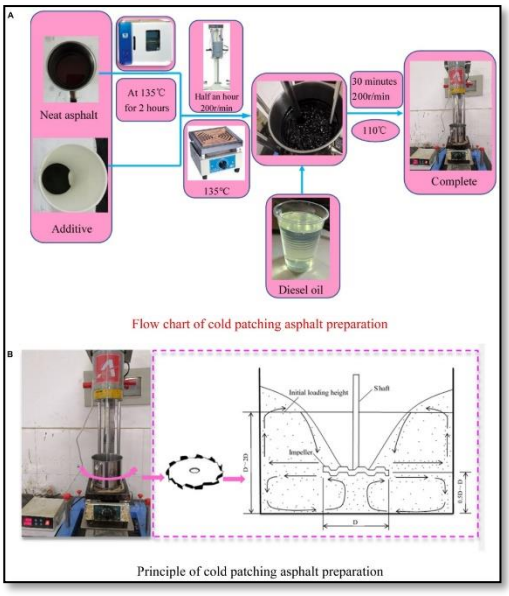

Figure – 7: Different tests conducted for Cold Mix

VI. Benefits and drawbacks

Using cold mix asphalt (CMA) with its low manufacturing and compaction temperatures has several benefits. The most important ones are that it reduces emissions, saves fuel, and creates better working conditions for workers. This also saves money by using less fuel. However, there are some costs involved in using CMA that need to be considered. This section looks at the pros and cons of using CMA, especially focusing on financial costs and benefits. Despite these environmental and economic advantages, CMA has mainly been used for building rural roads and roads with less traffic because of concerns about its stability and durability. However, researchers are now working on ways to improve how well CMA performs.

VII. Performance of cold mix asphalt

Cold mix asphalt (CMA) has a lot of environmental and economic advantages compared to hot mix asphalt (HMA). It's often used for small construction jobs and maintenance work because it's made at lower temperatures. However, it can have some issues like not being as stable and having more air pockets. The things that affect how well CMA works include the type of binder used, how the materials are mixed together, how long it takes for the mixture to set, and the characteristics of the aggregates and other materials used in it.

VIII. Curing of cold mix asphalt

Hot mix asphalt (HMA) usually becomes strong within 24 hours after it's put down, but cold mix asphalt (CMA), especially when made with bitumen emulsion, takes longer to get strong. The time it takes for CMA to become fully strong is called its curing time. During this curing process, the water in the cold mix evaporates. As the water evaporates, the binder in the emulsion goes back to its original state and becomes resistant to water again.

IX. CONCLUSION

Cold mix asphalt (CMA) is an excellent option for building new pavements in a sustainable way. It comes with several advantages, such as significantly lower greenhouse gas emissions, cost-effectiveness, improved working conditions for construction workers, and the ability to be used in cold weather. However, there are some downsides to using CMA, mainly its lower performance compared to traditional methods. To address this, various studies have looked into using different fillers, additives, and modifiers to enhance CMA's performance. Here are some key points about CMA:

- CMA offers many benefits, including reduced energy consumption, lower emissions, and improved working conditions for workers.
- Despite its advantages, CMA technology still faces challenges and limitations, particularly regarding its performance and durability.
- However, the future of CMA technology looks promising, with on-going research focused on improving production and placement techniques, developing new binders and additives, and integrating CMA with intelligent transportation systems.

- Further research and development will be crucial to overcome these challenges and ensure that CMA continues to meet the evolving needs of the transportation industry and society.
- Overall, the potential benefits of CMA for sustainable and cost-effective pavement solutions are clear, and its future appears promising.

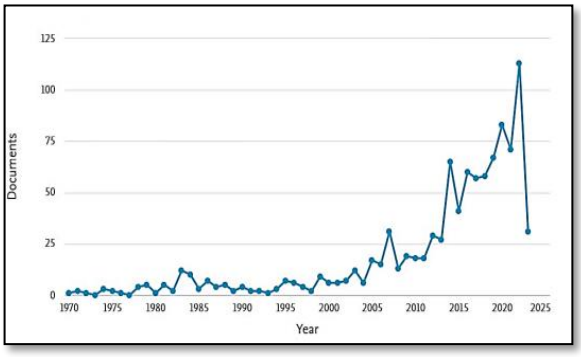

Figure 8 a: Number of research document on Cold mix asphalt represented through graph

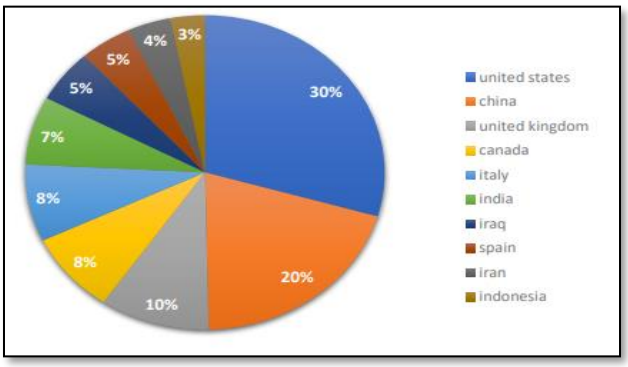

Figure 8 b: Number of research document on Cold mix asphalt represented Pie Chart.

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IoT-based Multi-Functional Smart Home Automation system

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ABSTRACT
The project signifies the Internet of Things (IoT) based multi-layer Smart Home Automation System by employing Raspberry PI. In recent days, smart home automation is a great evolution of emerging technology, to enhance comfort, efficiency and ease of access for human beings. The authors illustrate the system with sensors, actuators, controllers, and communication protocols. This device can interact with the application programming interface (API). For designing this system, the Node MCU ESP8266 Raspberry PI module was used for the execution of automation. The author demonstrated the performance of the devices to control the Home appliance via GSM and Voice automation. The device can control the rotor of the electric appliance such as light and fan. It alerts the gas leakage or fire detection period and for safety purposes, it can auto-cut the power supply at home. If it is connected to the door surface, within a 1-meter distance the device can detect the object and alert the home person. These devices enhance security properties, remote monitoring, real-time home applications as well as energy and cost-effective.

Keywords: Home Automation System, Internet of Things (IoT), Raspberry PI, Application Programming Interface (API), Node MCU ESP8266

I. INTRODUCTION

Multifunctional home automation through the IoT consists of several integrating devices within a home to regulate diverse operations such as lighting, managing temperature, security, and entertainment. Nowadays, IoT is a great evolution concept of the internet. It applies in various domains, like smart homes, manufacturing units, the agricultural sector, industrial automation, healthcare units etc. IoT is a network of interrelated devices, where every device is assigned to an IP address to make the unique and identifiable on the internet. It transfers the data from device to device or device to human through the internet. This technology uses wireless environments such as Bluetooth, and Wi-Fi-enabled devices related to the other devices. Bluetooth-based IoT automation is a low-cost, fast, easily to deployable technology but it is enabled for a short distance. For long distances, IoT can use the ZigBee network to communicate to the other end. In this report, the author integrates IoT at home automation systems. Users can monitor and operate from any place and control them. This device can control the light or fan via smartphone app and voice control automation technique. This system is implemented, when no one physically available for assistance of device, then user can operate it through mobile control. It is also speech enabled system. This device can enabled by voice assistance. It is a low-cost embedded system for complete home automation. The author also designs the Gas Leakage alarm and fire safety detector to incorporate with this device. For home safety purposes, it is very crucial innovation and

alert humans to take precautions. When it detect any type of uneven situation by the sensor, the system auto-cuts the power supply and protects the people. The authors also integrate an obstacle avoidance model with these sensor devices. This obstacle avoidance autonomous system avoids collision with others. Without collision, it can reach its destination and if any unknown object comes to the nearby area, then it can detect and give an alert to the users. As a result, it gives more efficiency with less work. The author's main objective of this paper is to manage this smart automation system in industry-level orientation using a microcontroller. So, applying it at home can be more effective in anyone's daily life. It can track every footstep of inside or outside of our home. This functional diagram of IoT IoT-based Multi-Functional Smart Home Automation System is depicted in Figure 1.

Fig.1 Functional Diagram of IoT-based Multi-Functional Smart Home Automation System

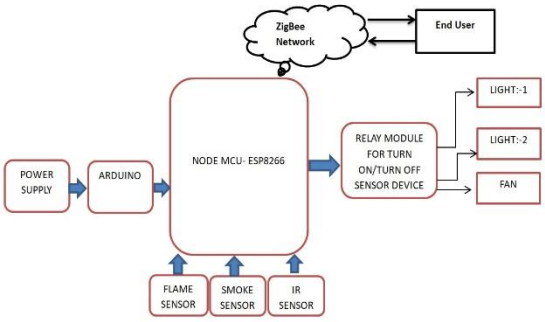


Fig.2 Block Diagram of IoT-based Multi-Functional Smart Home Automation system.

Literature Survey

In 2023, Dawande reported his work to more accurate implementation of the home automation system according to the user's demands and daily functionalities. It was implemented by the author's smartphone or voice command. In 2022, M. Khan et.al. designed a smart IoT-based Home Automation system using Raspberry PI module and ESP8285 chips. It is also implemented by the actuators or sensors. Authors can control this device for long-range home appliance automation via smartphones. In 2022, Nandewar et.al. reported an intelligent home automation system using IoT. In this thesis, the device enables users to access and operate physical objects or regulate device over a wireless network from any location. In 2021, Doshi et.al. described the IoT-based home automation system, where control of any household appliance, security camera, or door camera be wirelessly through a cloud network. In 2017, Yekhande et.al. designed a home automation system using Raspberry PI with a peripheral. It provides security for household appliances and controls the authenticity of the device. In 2013, K.Baraka et.al. reported the low-cost Arduino/Android-based home automation system. It is implemented as an energy and cost-efficient Android-based highly scalable smart automation device. It works as a smart task development through wireless ZigBee and wired x10 technology.

Methodology

Recently, IoT technology brought a significant transformation in residential home automation systems. This paper represents a complete approach to designing and implementing IoT-based smart application-based home automation systems. This system methodology incorporates hardware integration, user interface design, security implementation, testing and verification, maintenance, and continuous improvement.

A. Hardware implementation: The system consists of different sensors, like gas, flame sensor, and LDR. Initially, the device connects to the internet through Wi-Fi. The authors developed this system to operate in combination with smartphone and PC which includes Arduino UNO, NodeMCU-ESP8266 microcontroller

board, Wi-Fi module and relay module. Arduino UNO is composed of C and C++-based language platforms. After the processing, data is sent to Node-MCU from the user's device via Wi-Fi. The Arduino module reads the data and controls through the relay module. LDR sensors and PIR sensors are used to power down devices when users fail to deactivate manually w.r.t of specific periods. This home automation system allows multi-user access with security features. In automatic mode, the relay module is operated by DHT11 sensor, PIR sensor and LDR. This automation system is to manage lighting and electrical devices within the residential and official zone using voice commands. This setup enables the system to monitor temperature, humidity and gas levels within the room. In case of a gas level rise, an audible warning is triggered by the buzzer while the panel board visually indicates to turn on the LED. In this device the author uses the flame sensor and smoke sensor, after detecting the fire, the alarm is activated and power will be automatically cut off for home safety purposes. The Block Diagram of the IoT-based multi-functional smart Home Automation system is depicted in Fig. 2.

B. Working Principle:

In Fig 3 represents the circuit diagram of IoT-based Multi-Functional Smart Home Automation System. At first, the Arduino module is to be activated with a 5volt DC power supply. Arduino fully controls the entire procedure of the device. It is connected to the Node MCU-ESP8266 module. Node MCU is an open-source microcontroller unit based on an IoT platform. It is implemented for global connection through a web server. The Author uses the ZigBee Network to establish the connection.

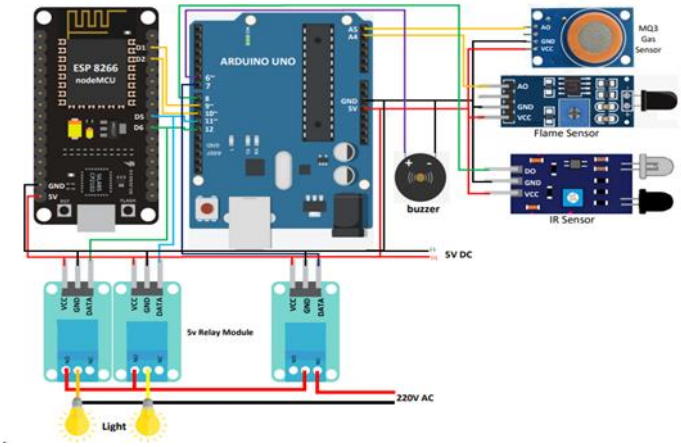


Fig.3 Circuit Diagram of IoT-based Multi-Functional Smart Home Automation System

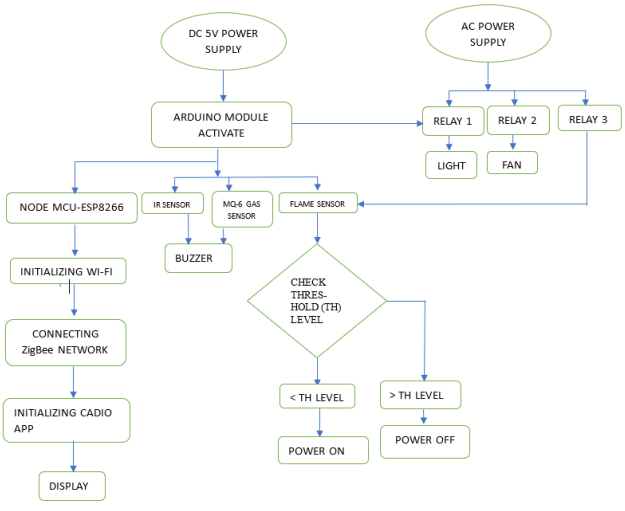


Fig.4 Flowchart of IoT-Based Multi-Functional Smart Home Automation System

Here the authors use three sensors, i.e. IR Sensor, Gas Sensor and Flame Sensor which is also connected to the Arduino board. The first operation of the project is Obstacle Avoidance which is operated by IR sensor. If any object moves in front of the sensor, it is operated and alerted to the user by the buzzer. So, it can be implemented for home safety purposes also. The second operation of the project is the Gas sensor or smoke sensor. It is operated when the sensor detects LPG gas or any smoke inside the house or nearest zone of the module. It can detect Alcohol, Propane, Hydrogen gas, and carbon monoxide (CO) gas. It is very much applicable for household purposes. The author uses another sensor, i.e. Flame sensor, made by an electromagnetic radiation receiver. It is utilized when fire or flame is detected, sensor alerts the user. It connects to the Arduino module and relay module. The relay module works as a switch to provide a signal to Arduino as well as a sensor for alarming the user. The flame sensor always checks the threshold value. When the flame is detected, the threshold value will increase, the buzzer will turn on and the household main power will be cut off. It should remain on until the threshold level reaches the normal value and then power on. Here the Author uses three relays for connecting electrical appliances such as light, fan, and switch. All sensors' activation or deactivation signal comes to the IoT module via the Arduino module and Relay. This data is sent to the user through the ZigBee network. The user can control the operation by the CADIO app through the server network. The Author illustrates the entire operation of the home automation system given in the flowchart shown in Fig. 4.

Result and Discussion

The IoT-based multi-functional Home Automation System was constructed with circuit schematics. It was controlled by the CADIO app and monitored by the ZigBee server network. The Authors demonstrate every sensor's outcome under typical conditions. In the typical environment, the Author observed the flame threshold value is 97 and the Gas threshold value is 146 at the app dashboard, shown in Fig 5. After flame detection, a threshold value reaches 293 to 498 and after Gas/Smoke detection, the threshold value is enhanced by 177 to 245, as shown in Fig 6 and Fig 7 respectively. Whenever any obstacle is detected by the IR sensor, it is activated to "1" as illustrated in Fig 8.

Fig 9 displays the experimental setup of the Multi-functional Home Automation System in working condition. Here, we can notice, that the user can control the entire setup through the mobile. By using relay, we can turn on or off the light by using a mobile. With this setup, the author demonstrated the sensor and through the IoT, the user can monitor from anywhere. Figure 10 shows the CADIO app interface. The user wants to turn on or turn off the light or other electrical components by pressing your mobile switch or voice enable, then the user sends the signal to the IoT module via an app. ESP8266 sends this signal to the relay circuit and the device turns on or off the light fan or others. The author shows the voice enable turn off or turn on operation in Fig 11 and Fig 12.

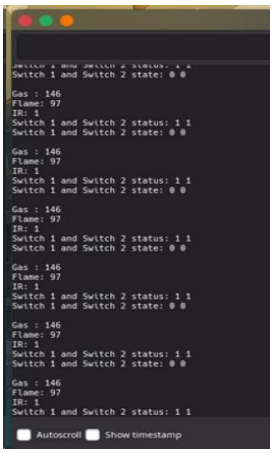


Fig.5 Threshold Value Before Detection

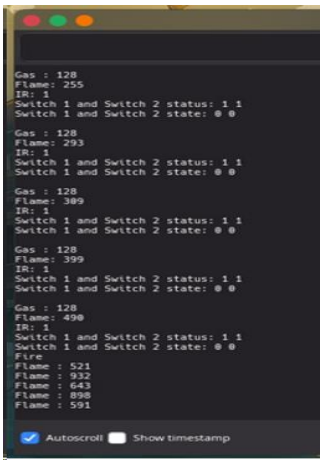


Fig.6 Threshold Value After Flame Detection

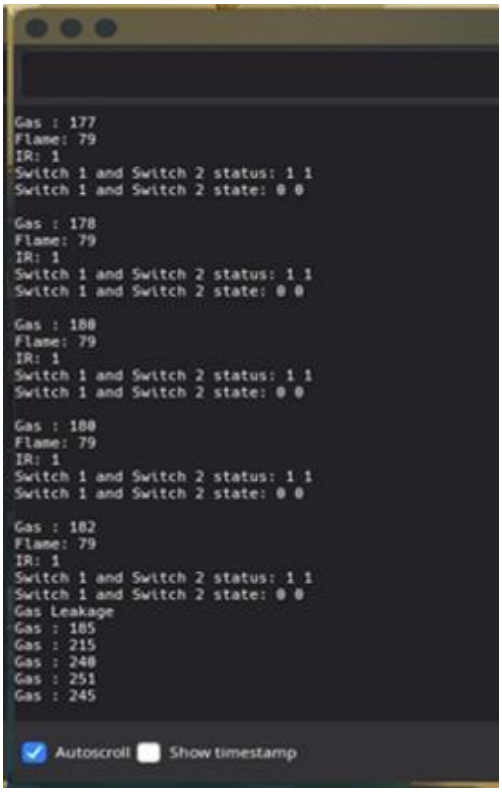


Fig.7 Threshold Value After Gas/Smoke Detection

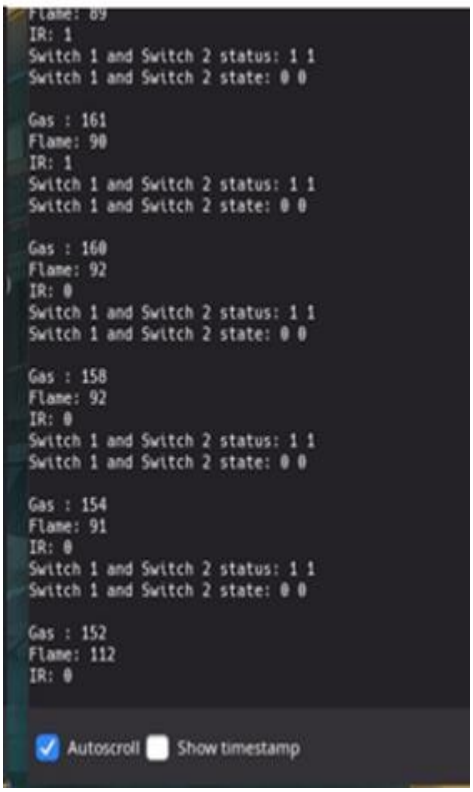


Fig.8 Threshold Value After IR Detection

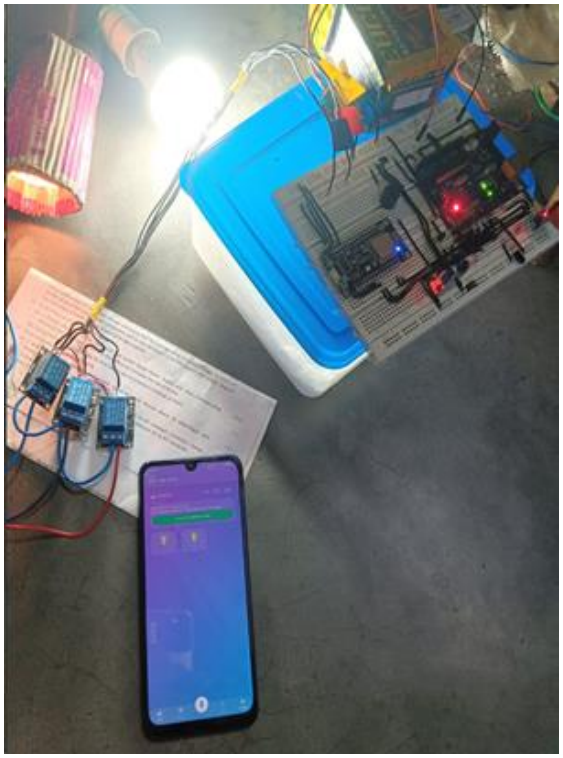
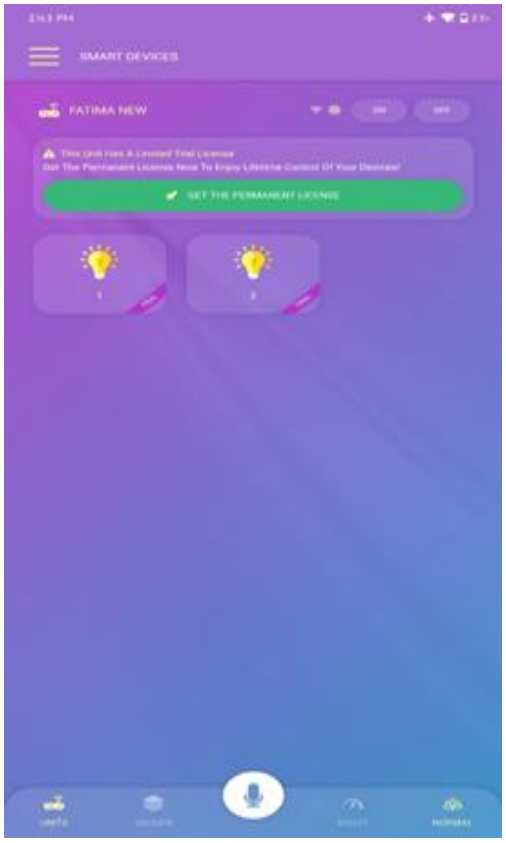


Fig.9 IoT-based Multi-Functional Home Automation System

Fig.10 CADIO Application Interface



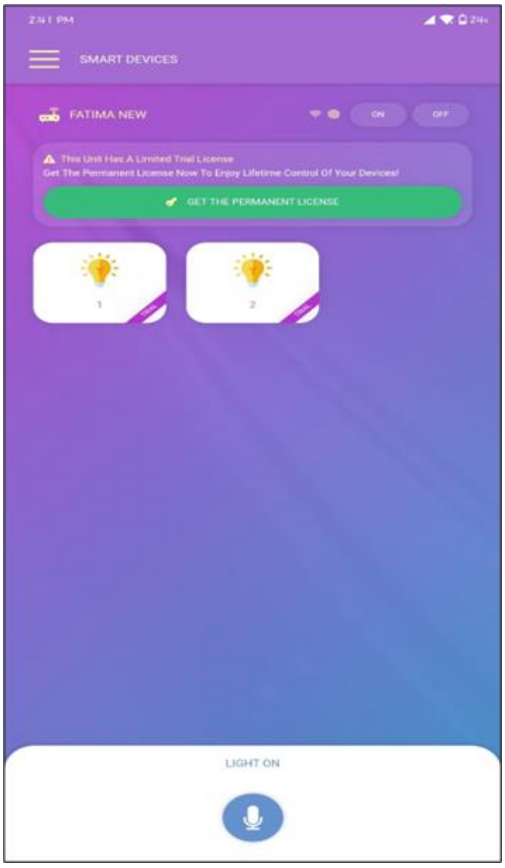


Fig.11 Light Off Condition **Fig.12 Voice Enables Light on Condition**

Conclusion

The IoT-based multi-functional home automation system was developed and tested where household appliances can be controlled. The IoT device used for user identification and administration purposes. It can be operated centrally. By using the same network, all sensors transmit and receive the signal to the user. Its main objective is the safety and comfortable life of human beings. IoT devices, sensors, and actuators, relay makes the systems to be intelligent, smart and automated. Users can manage their homes effortlessly from any location with capabilities like voice control and remote access through mobile apps. A more connected and sustainable lifestyle is made possible by device interoperability and integration with smart grids and smart cities. To ensure user data protection and maintain trust in these systems, privacy and security issues must be considered. IoT-based smart home automation solutions have the potential to create awareness through security cameras, creating awareness and overall efficiency in our living spaces.

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Low-Cost Pavement Work In A Rural Area

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ABSTRACT

Correct pavement thickness design for varying traffic situations and subgrades is crucial for the economical and effective building of highways. Pavement design science is a relatively recent field. In the past, the road crust in India was created primarily based on the highway engineer's experience rather than some reasonable statistics. Some arbitrary pavement thicknesses were adopted, which resulted in expensive failures and waste; in other circumstances, the thickness of the pavements was pricey. Since there are no appropriate design standards, building roads was nearly always unprofitable. Therefore, a road will be constructed more affordably if the crust thickness is carefully designed and calculated based on factors such as subgrade bearing capacity and traffic load calculation.

Keywords: highways, economical construction, pavements

I. INTRODUCTION

Low-cost flexible pavement refers to roads that may be built and maintained with relatively little money by utilizing resources that are readily available in the area. The District Development Committee, or DDC, must balance the construction of roads with relatively higher specifications, in which case it must shorten the length of such roads, or with relatively lower specifications, which can be referred to as low-cost flexible pavement, to cover a larger area of the district.

•Low-cost flexible pavement is defined as follows:
- Design year traffic of less than 20 cars per day;
- Generally built at the natural ground's ruling grade;
- Primarily made of in-situ soils;
- Built using simple designs.

II. OBJECTIVES AND REQUIREMENTS OF PAVEMENTS

A pavement's surface should be solid and non-yielding so that big wheel loads in traffic can travel with the least amount of rolling resistance. The road should be even along its longitudinal profile so that fast vehicles can travel securely and comfortably at the design speed. A pavement layer is deemed more effective or superior if it can distribute wheel load stress over a greater area per unit depth of the layer. The pavement's elastic deformation should be within the allowable limits, so that it can endure numerous repeated load applications during its design life.

It is always preferable to build the pavement much above the maximum level of ground water to keep the subgrade relatively dry even during rainy season. At excessive moisture content, the soil weakens and softens, yielding under heavy wheel loads, increasing tractive resistance.

III. TYPES OF PAVEMENTS

Pavements are often divided into three types based on their structural behaviour:

1. Flexible pavement
2. Rigid pavement
3. Semi-rigid pavement.

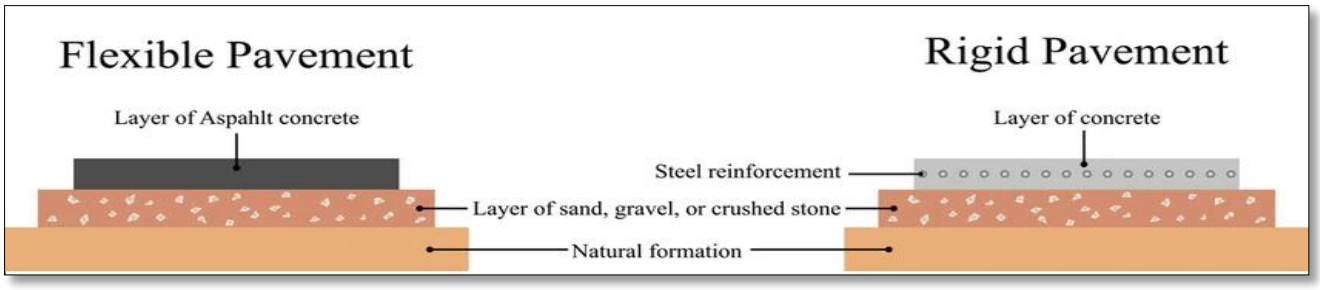

Figure – 1: Rigid & Flexible Pavement

Components Of Pavement Works

- Soil Subgrade
- Sub Base
- Base Courses
- Wearing Course

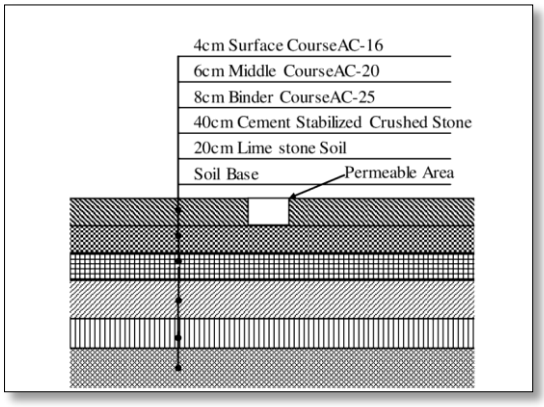

Figure – 2: Semi – Rigid pavement Cross Section

IV. FACTORS AFFECTING THE DESIGN OF LOW-COST PAVEMENT WORKS

Pavement design consists of two parts:

I. Mix design of material to be used in each pavement component layer.
II. Thickness design of the pavement and the component layer

The various factors to be considered for the design of pavement are:

- Design of Wheel load
- Subgrade Soil.
- Climatic Factors
- Pavement Components & Materials
- Environmental Factors

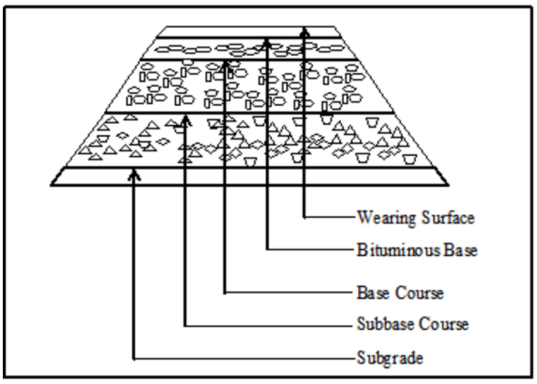

Figure – 3: Different layers of a pavement

V. PROJECT IN CONSIDERATION

Site location: Bir Para Village, Pin Code-731251,
Post Office – Jamtala, District- Birbhum, West Bengal.

Survey Report

Stn	Distance	Back Side	Inter Sight	Fore Sight	Rise (+)	Fall (-)	Reduced Level	Remarks
A	0.0	0.98					100.00	B.M=100.00
	15		1.120			0.14	99.86	
	30		1.090		0.03		99.89	
	45		1.020		0.07		99.96	
	60		0.950		0.07		100.03	
	75		0.920		0.03		100.06	
	90		0.910			0.03	100.07	
	105		0.850		0.06		100.13	
	120		0.860			0.01	100.12	
B	135	1.250		0.770	0.09		100.21	CP
			1.220			0.45	99.76	
	150		1.090		1.130		100.89	
	165		1.125			0.035	100.815	
	180		0.980		0.145		100.96	
	195		0.960		0.02		100.98	
	210		0.860		0.10		101.08	
	225		0.770		0.09		101.07	
	240		0.680		0.09		101.34	
	255		0.600		0.08		101.99	
C	270	1.440			0.10		100.56	
	285		1.380			0.88	100.59	
	300		1.350		0.03		100.65	
	315		1.290		0.06		100.74	
	330		1.200		0.09		100.79	
	345		1.150		0.05		100.89	
	360		1.050		0.10		100.99	
	375		0.990		0.06		100.66	
	390		1.100			0.11	100.75	
	405		0.950		0.15		100.99	

D	420	1.350				0.08	100.91	CP
	435		1.180		0.09	0.25	100.66	
	450		1.190		0.075		100.75	
	465		1.115		0.11		100.825	
	480		1.005		0.025		100.935	
	495		0.980		0.08		100.96	
	510		0.900		0.10		101.04	
	525		0.800		0.15		101.14	
	540		0.960			0.16	100.98	
E	555	1.250				0.03	100.95	CP
	570		1.180			0.19	100.76	
	585		1.165		0.015		100.775	
	600		1.145		0.02		100.795	
	615		1.138		0.007		100.802	
	630		1.149			0.011	100.791	
	645		1.160			0.011	100.78	
	660		1.178			0.018	100.762	
	675		1.190			0.012	100.75	
	690		1.175		0.015		100.765	
F	705	1.125			0.01		100.775	CP
	720		1.095		0.07		100.845	
	735		1.070		0.025		100.87	
G	750				0.015		100.885	CP

Table – 1: Survey Report

Materials Chosen for Use In The Project In Consideration

The materials which are considered in this project are: -

- Soil
- Fly Ash
- Moorum
- Stone Chips
- Bitumen

Planning

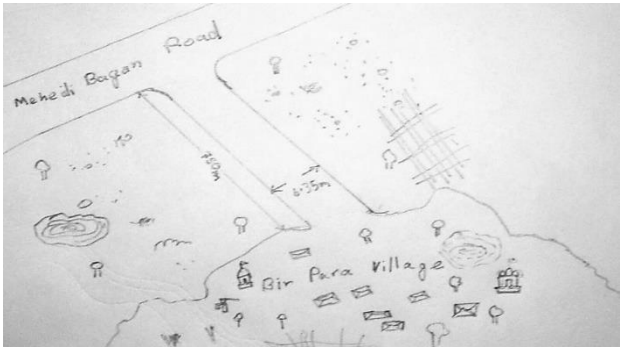

Figure – 4: Plan for the Proposed Road [Map not to scale]

Bir Para Village, Pin Code-731251, Post Office – Jamtala,District- Birbhum, West Bengal.

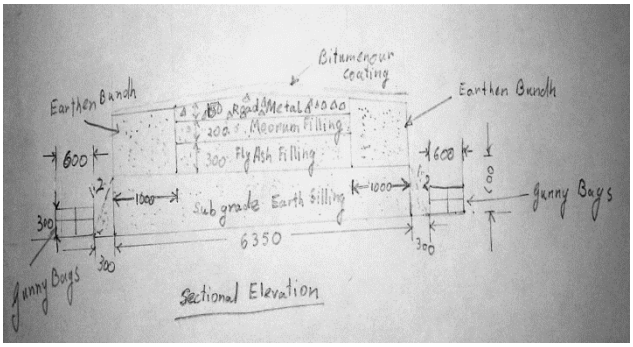

Figure – 4: Sectional Elevation [Scale1:100]

VI. WORKING PROCEDURE OF THE PROJECT IN CONSIDERATION

There is a high need of a Road starting from "Bir Para" village, Pin Code-731251, Post Office – Jamtala, District-Birbhum, West Bengal, connecting with "Mehedi Bagan Road" District- Birbhum, West Bengal. This Project should begin in the pre-monsoon season. The Proposed Road will have a carriage of 750m length and 3.75m width. After getting the survey report, the identified site will be cleared of all hindrance. The gunny bags will be provided in both the sides, width 600mm both sides and height of 300mm in two layers. The subgrade earth filling work will be done with a width of 6.35m in the base and gradually rising it to 5.75m (the earth filling to be done up to a height of 600mm and it should gain a trapezoidal shape of side slope 2: 1). The earth filling to be done in four layers of 150mm. After completing each layer, sprinkling of water should be done and the same should be compacted with the help of a road roller.

- **Note: -** Water should be sprinkled in a perfect quantity where the erosion is prevented.

After the subgrade earth filling work, the width changes to 5.75m. In this 5.73m, from two ends, the earthen bundh of 1m width will be provided as per required height in both sides. The 3.75m will be filled up and compacted with fly ash in two layers 150mm i.e., 300mm total. After each layer, water sprinkling and rolling should be done. After compaction of fly ash, Moorum is placed over it in two layers of 100mm, i.e., 200mm total. After moorum compaction, stone consolidation of 150mm i.e., 75mm each layer is to be done. Lastly a bituminous emulsion will be provided over the stone consolidation and the whole thing will be left for natural stabilization in monsoon. After the monsoon, another layer of bituminous emulsion with road metals will be done. Thus, the whole process ends.

ESTIMATION OF THE PROJECT WITH RATE ANALYSIS

Sl. No.	Particulars	Unit	Length (m)	Breadth (m)	Height (m)	Quantity	Rate	Amount (Rs)
1.	Gunny Bags filled withearth. [750/0.75x8]	Nos.	750	0.3	0.15	8000 nos.	Rs15/bag	120000/-

2.	Earthwork in road embankment in ordinary soil to correct profile as perdesigned formation level with earth obtained from land owned and deposited in layers of 150mm thickness including breaking clods, draining and compacting by power roller etc. Complete as per specification, drawing anddirection of EIC.	Cum	750	(6.35+ 5.75) = 12.1	0.6	2722.5 cum	Rs151/cum	411097.5 /-
3.	Construction of road embankment with fly Ashand deposited in layers of150mm thickness, including breaking clods, draining and compacting by power roller etc. Complete as per specification, drawing anddirection of EIC.	Cum	750	3.75	0.3	843.75 cum	Rs450/cum	379687.5 /-
4.	Supplying, spreading, and consolidating moorum to adepth of 75mm each layerincluding breaking clods, draining and compacting by power roller etc. Complete as per specification, drawing anddirection of EIC.	Cum	750	3.75	0.2	562.5 cum Large compacte d 562.5 x 0.67 = 376.88 cum	Rs700/cum	263816/-
5.	Supplying, spreading, and consolidating stone metal, range of course aggregate 63-45mm, compacting by power roller etc. Complete as per specification, drawing and direction of EIC	Cum	750	3.75	0.15	421.88 cum	Rs1600/cu m	675008/-
6.	Providing and applying bituminous coating with emulsion	Sq. m	750	3.75	_	2812.5	Rs12/sq.m	33750/-

7.	Providing and applying bituminous coating with emulsion	Sq. m	750	3.75	_	2812.5	Rs12/sq.m	33750/-
	Total =							**Rs 1917109/-**

Table – 2: Estimation of The Project with Rate Analysis

So, the estimated round figure is Rs 1917109/-

V. CONCLUSION

The main observations and conclusions drawn are summarized below:

- It can be concluded that there is a need of connecting Bir Para Village to Mehedi Bagan road.
- Our project naming "Low-Cost Flexible Pavement Work in a Rural Area". Total length 750m and roadwidth 3.7m
- It will take about 3 months to complete the Project including surveying, Soil testing, Estimating and costing etc.

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Study of Parametric Instability by Developing Mechanical Parametric Pendulum

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ABSTRACT

In this project importance is given to the study of parametric instability in different physical system specifically in mechanical system. In mechanical one our object is to create an experimental setup of length varying pendulum (with periodic time) and to study parametric instability in practical situations. This is a review of harmonic oscillator and hence deduction of equation of motion of mechanical parametric pendulum and the condition of parametric resonance. Hence we give the experimental analysis of the parametric pendulum. We also give the overall conclusion and future scope of our project work.

Keywords: Unstable System, Parametric Instability, Parametric Pendulum, Oscillator, Frequency of oscillation.

Introduction

A system is unstable when it exhibits limit cycle behavior. After being excited if the system does not come back in its stable state, the system becomes unstable.

Instability in system is generally characterized by some of the output or internal states growing without bound not all system that is not stable is unstable. System can also be marginally stable or exhibits limit cycle behavior. The system is unstable if any of the root of its characteristic equation has real part greater than zero. This is equivalent to any of the Eigen value of state matrix having real part greater than zero. Here in the figure: 1.1 the position of the ball at the top of a hill shape object is an example of instability. The position of the ball is not stable; it may fell down either side of the object at any moment at any time.

Fig 1.1: Unstable System

The solution of the differential equation of a network function is given as-

$$i(t) = k e^{S_n t} = k e^{\sigma_n t + j\omega_n t} \quad 1.1$$

Where S_n is the complex root of the characteristic equation given as-

$$S_n = \sigma_n + j\omega_n \quad 1.2$$

Where first part of equation 2 is the real part and the second one is imaginary part. Now when the real part of equation 2 is greater than zero the system become unstable.

If any property of a system varying nonlinearly for changing the parameter of system by a negligible value then the property of that system is called parametric instability.

Name of the different physical system where parametric instability is found:

Electronic system (parametric amplifier), Mechanical system (three coupled oscillator, parametric pendulum), Optical system (OPA), Biological system (Parkinsons's disease) etc.

II. Experimental

II.A. Experimental study of the parametric Pendulum

In our practical arrangement parametric instability is shown in terms of mechanical system. Swing found in Children's Park is the simplest example of parametric instability in terms of mechanical system. Most of the child makes the swing instable by changing their centre of mass by moving their leg up at the extreme end of their oscillation and moves the leg downward at the middle of the oscillation. We have made a system, length varying pendulum by using a 12v dc motor which shows the same parametric instability.

In simple harmonic oscillator the term simple refers to system which can be characterized by single variable, for example the angular displacement of pendulum, the height of a bouncing ball, and the charged on a capacitor connected in series with an inductor etc. The figure of the corresponding is given bellow-

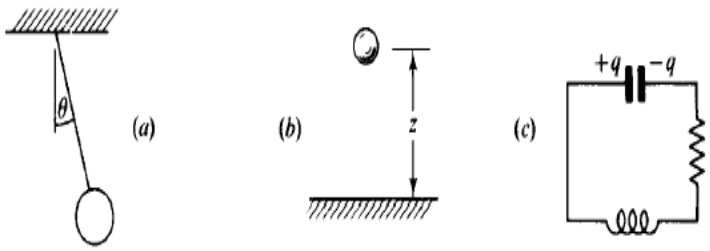

Fig 1.2: Different type of harmonic oscillator

The behavior of such system displaces harmonic nature in its motion, so those systems are called simple harmonic oscillator.

The equation of motion of simple harmonic oscillator can be referred as

$$m\ddot{x} + \mu x = 0 \quad 1.3$$

Where m is mass of the pendulum, x is the amount of displacement and μ is the spring constant. And the most important characteristic of simple harmonic oscillator is, it shows

Linear characteristic shows energy conservation during its motion which can be showed by equation

$$E = T + V \qquad 1.4$$

Where kinetic energy and the potential energy is denoted by T & V respectively, E is the total energy.

II.B. Equation of motion of Parametric Pendulum

Now we derived the differential equation of motion of parametric pendulum, which we arranged for the experimental setu

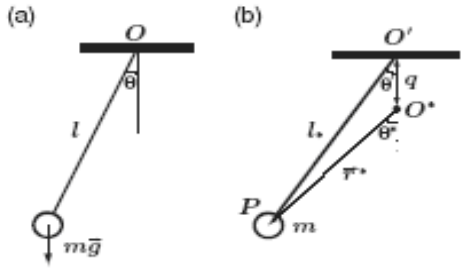

Fig 1.3: Pendulum of varying length

Final equation of motion of Parametric Pendulum is

$$\frac{d^2\theta}{dt^2} + \left(\frac{2}{l_0} + \alpha\omega_p \sin\omega_p t\right)\frac{d\theta}{dt} + \frac{g}{l_0}\left(1 + \frac{\alpha}{l_0}\cos\omega_p t\right)\theta = 0 \qquad 1.5$$

II.C. Analysis of parametric behaviour of length varying pendulum

To derive with the equation,

$$\frac{d^2\theta}{dt^2} + \left(\frac{2}{l}\frac{dl}{dt} + \frac{\gamma\ drag}{m}\right)\frac{d\theta}{dt} + \frac{g}{l}\sin\theta = 0 \qquad 1.6$$

Now this equation for parametric region

$\frac{\alpha}{l0}$<<1. $\theta(t) \ll 1\ \&\ \gamma = 0$ 1.7

For small parameter,

$\lambda = \frac{\alpha}{l_0}$ Now $\theta(t) = n(t)\lambda_n$ 1.8

Equation of co eff θ_n (t) at the order of $O(\lambda_n)$:

$$O(\lambda_0): \frac{d^2\theta_0}{dt^2} + \omega_0^2\theta_0 = 0 \qquad 1.9$$

$$\theta(t) = A\exp(^{\omega_p t}/_2)\sin(wt + \beta) + o(\lambda^n) \qquad 2.0$$

This is the expression for the amplitude term of parametric amplifier.

II.D. Design of mechanical parametric pendulum

In the process of making the pendulum the most vital part is the design of the correct kind of stand by which we will be able to change the length of the silk thread and measure the amplitude of the oscillation to at least considerable value. The schematic diagram of the mechanical parametric pendulum is given below,

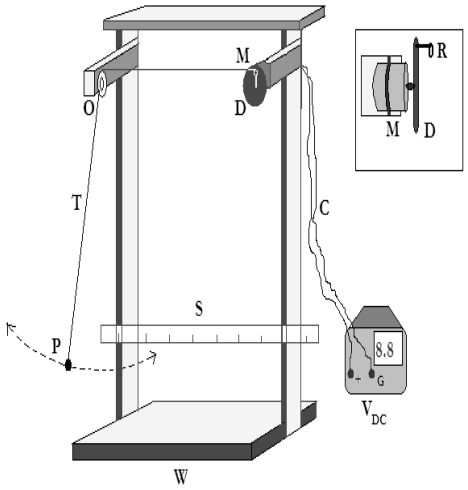

Fig 1.4: Mechanical parametric pendulum

Figure 1.4 shows the schematic diagram of mechanical parametric pendulum. In above figure *W* shows the wooden stand on which the other things are attached. We here use a 12v, 100 rpm geared dc motor which is denoted by *M*, the motor is attached with a part of wooden stand by a clamp as shown in the figure. *A* circular disk which is made of wood is attached with the rotor of the dc motor by Yamaproxy gum. A
small metal ring *R* is join with a nail which is attached with the wooden disk such a way that it can circulate freely with the movement of the nail. Now a pulley is attached left half side of the wooden stand. The pulley and the ring are made on the same straight line. A metal bob of pendulum *P* is hanging by a silk thread *T* from the pulley and last end of the thread is binding from the metal ring *R*. A meter scale *S* is there for measuring of amplitude of the pendulum. The motor *M* is connected with a variable dc power supply V_{DC} by connecting wire. The time is measured with a digital stop watch.

III. Result and Discussion

Now first we take the data of RPM of motor with different voltages and the corresponding graph is shown in figure 1.5. Next we measured the amplitude of oscillation of the parametric pendulum with corresponding time for different voltages and the figure is shown in figure 1.6. We again plot the data obtained from the theoretical expression by changing the time and keeping the pumping frequency fixed, and both the results approximately matched, the corresponding graph is shown in figure 1.7.

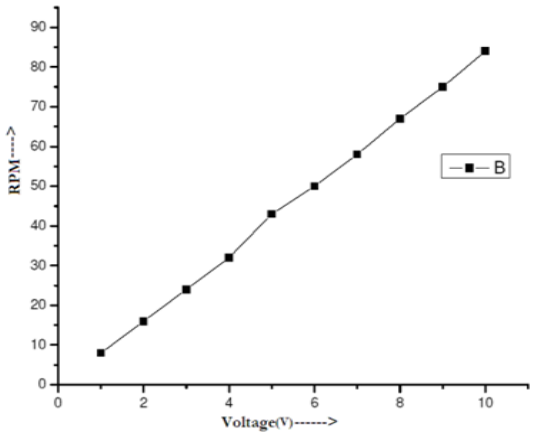

Fig 1.5: Variation of RPM with applied voltage to the motor

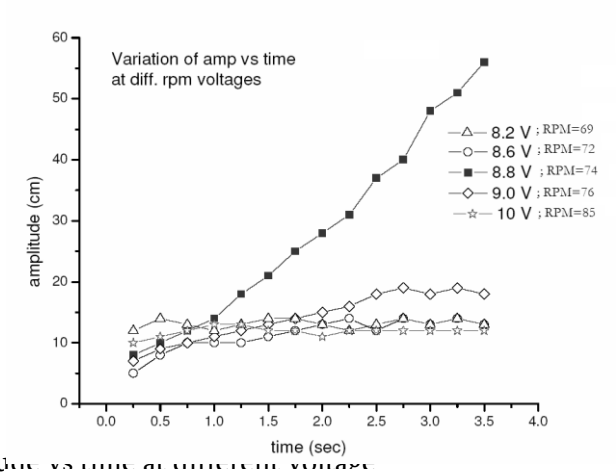

Fig 1.6: Graph for amplitude vs time at diff rpm voltages

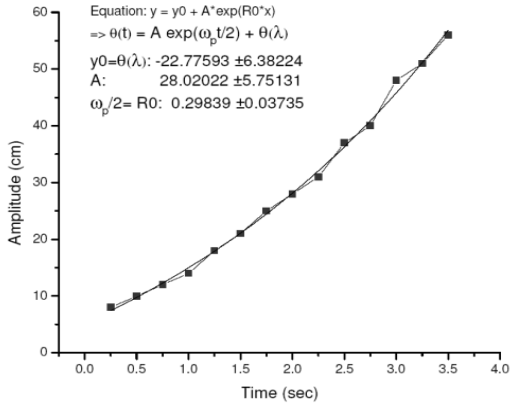

Fig 1.7: *Graph for curve fitting of amplitude vs time when voltage fixed at 8.8V*

IV. Conclusion

We here study the parametric instability in different physical system mainly in mechanical system. In mechanical system we are working with parametric pendulum with a self prepared model.

Here we have done the necessary analysis of an amplifier with a Parametric Pendulum.

In mechanical part we have done the theoretical as well as practical analysis of parametric pendulum as,

- The Differential equation of motion for this mechanical pendulum is deduced along with the condition of instability and hence the amplitude is also deduced.
- Next we collect the data from the practical analyss and plot the graph for amplitude vs different voltage. Plotted Graph shows that the voltage is fixed at 8.8V only then the amplitude of oscillation is increases exponentially with time. But the pendulum not shows nonlinearity at other voltage below or high from 8.8V.
- The curve fitting for both theoretical and practical value for voltage 8.8V is almost same.

Hence we conclude that the pendulum shows parametric instability only when the condition of instability is satisfied that means when $\omega_P = 2\omega_0$.

V. Future Scope

Here we are studying the parametric instability in electronic system and mechanical system. In electronic system we are working with the parametric amplifier and in mechanical system we are observed the characteristics of mechanical parametric pendulum. Now there are lots of future scope of work to do both in parametric amplifier and parametric pendulum, these are described below.

1. In parametric amplifier, the matlab model can be use for simulation of different type of amplifier circuit by changing the corresponding simulink model.
2. If we can change the pumping circuit into a feedback circuit the amplifier may be act as oscillator circuit.
3. As we get frequency conversion here in parametric amplifier circuit, so one can use the circuit as different type of frequency converter.
4. Here the parametric amplifier circuit is use only in the GHz range, so the future work is to study the parametric instability in the lower frequency range.
5. In the parametric pendulum the amplitude in increase nonlinearly. So there should be a method to restrict the nonlinear amplification in a certain time.
6. If possible one can made such a device that can be measure the amplitude and corresponding time mechanically, so the error becomes less.

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VII. Figure captions

Fig 1.1: Unstable System
Fig 1.2: Different type of harmonic oscillator
Fig 1.3: Pendulum of varying length
Fig 1.4: Mechanical parametric pendulum
Fig 1.5: Variation of RPM with applied voltage to the motor
Fig 1.6: Graph for amplitude vs time at different voltage
Fig 1.7: Graph for curve fitting of amplitude vs time when voltage fixed at 8.8V

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Bluetooth-Based Voice-Controlled Obstacle Avoiding Robot Car

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ABSTRACT

This paper introduces a versatile Bluetooth-based voice-controlled obstacle avoidance robotic vehicle. It is a future advancement technology, which provides real-time data for the system. This robotic vehicle senses the object by the ultrasonic sensor for obstacle avoidance and sends an acknowledgment to the Arduino module and activates the autonomous vehicle braking system. Users of this system can control by own speech and the system can task user commands significantly. Obstacle avoidance robots are being used in hazardous locations inaccessible to humans. The Author presents this system employed by Bluetooth-based automation, navigation, robotics technology, and smart environments when avoiding obstacles is necessary for the user. Bluetooth technology can create communication between robots and human control power. This project offers a practical and easy-to-use way to improve control and safety in a variety of real-world circumstances by Voice control incorporated with Bluetooth technology. In the future, this technology can be enriched by AI or IOT for global control.

Keywords: Ultrasonic Sensor, Arduino UNO, Bluetooth Technology, Navigation, Robotic Technology, AI, IoT.

I. INTRODUCTION

Vivid research is related to an instructive mode control system that combines robotics, programming and electronics components with the help of Arduino for the designing of a robot car with the virtue of obstacle avoidance. Over the past decade, technological advancements have led to the widespread integration of sensors into electronic devices, revolutionizing various aspects of our daily lives. These ingenious devices play a pivotal role by transforming different energy forms into electrical energy, contributing to enhanced convenience and efficiency across diverse applications. Through the process of assembling a robot car generally, we are incorporating sensors and linking them to an Arduino board using proper code anybody can produce a multipurpose vehicle that is capable of navigating around obstacles on its own and being controlled from a distance using voice commands and Bluetooth. With a mobile device that is connected via Bluetooth, users can travel through complex landscapes and manage the movements of the system remotely. Voice commands also improve ease and usability. This research article has many benefits, such as improving problem-solving skills, developing a grasp of robotics, and polishing programming abilities. Additionally, it offers experience in hardware assembly, wiring, and troubleshooting, promoting an understanding of electronics. Many applications are possible with an Arduino-based robot car due to its versatility. Sensors play a crucial role in establishing a

seamless connection between the environment and various electronic devices. These environments span a broad spectrum, ranging from military zones, airports, factories, hospitals, shopping malls, home automation, and surveillance. Modern technology has witnessed the proliferation of digital gadgets like smartphones, robots, tablets, and smartwatches, every with a big selection of applications spanning manipulate, protection, imaging, and presentation. The rapid evolution of the sensor era, including temperature sensors, pressure sensors, proximity sensors and human detectors, has transformed their function from mere light fixtures to important tools that significantly facilitate a regular lifestyle. These sensors allow devices to sense and respond to adjustments in their environment with clarity and precision. In the modern landscape, artificial intelligence (AI) has ushered in the development of state-of-the-art robot systems. Emotion recognition emerges as an essential detail in robotics, permitting robots to interpret and respond to human feelings efficiently. Meanwhile, electronic devices encompass a variety of technologies, including smartphones, robots, tablets, and smart clocks. In the contemporary landscape, the integration of artificial intelligence algorithms has led to the development of sophisticated robot systems. The ability of a robot to interpret its environment is paramount, especially in applications such as military operations, where identifying explosives or detecting potential threats requires precise sensor-based perception. The applications of these devices are extensive, involving control, protection, imaging, and identification within industrial processes. It gives prospective engineers real-world experience in areas like environmental monitoring, smart cities, and driverless cars.

Literature Survey

In 2004, L. Zhizeng et.al. reported a Speech recognition robot control system incorporated with a linear predicted coefficient (LPC), pattern comparison, and dynamic time warping technique. In 2017 S.S. Pujari et.al. designed a remotely controlled autonomous robot using Android, which can be controlled from any remote place. In 2021, A. Ananth et.al. developed a Bluetooth-based obstacle-avoiding Autonomous Robot. The Author tested this model from different distances. In 2016, D. Chakraborty et.al. designed an Android-based auto-obstacle detection and prevention robotic controlled car. Various sensors can control and monitor the movement of this vehicle via Bluetooth. In 2019, D. V. Sai et.al. reported an IoT-based modern technology-oriented obstacle detection car for long-range communication. It is a more accurate, efficient, cheap, fast automated transport system.

Methodology

The methodology of the Bluetooth-based voice-controlled Obstacle Avoiding Robot Car is designed by many sensors depicted in Fig. 1. The proposed system consists of a Motor Driver circuit (L293D), four BLDC motors, an Arduino UNO module, a Li-Ion Battery, a switch, Ultrasonic Sensors, servo motor, Bluetooth Module. This entire system is controlled by automatic mode. It is Bluetooth-based technology and it can communicate with an Arduino module. Arduino UNO is the main brain of this model. It is an embedded C-programming based module. From this module, every component is connected. To the best output, it will be acknowledged. Here HC-06 Bluetooth module is connected to the motor driver as well as the Arduino board. It creates communication between the device and the user interface by USART serial communication. The L293D motor driver circuit is connected to the DC motor, which converts electrical energy to mechanical energy using DC. It is used for turning the wheels which helps move the devices. Here the Author uses the ultrasonic sensor Hc-Sr04 which is connected with an Arduino module for sonar navigation and object detection. Sensors emit an

ultrasonic sound and can measure the distance from object to sensor. After determining the distance, it sends the signal to the Arduino board. Then it stops the movement of the robot or moves to the other side. Ultrasonic sensors have two transducers, one is speaker and other is microphone. The flowchart of the Bluetooth-based Voice-Controlled Obstacle Avoiding Robot car is designed in fig 3.

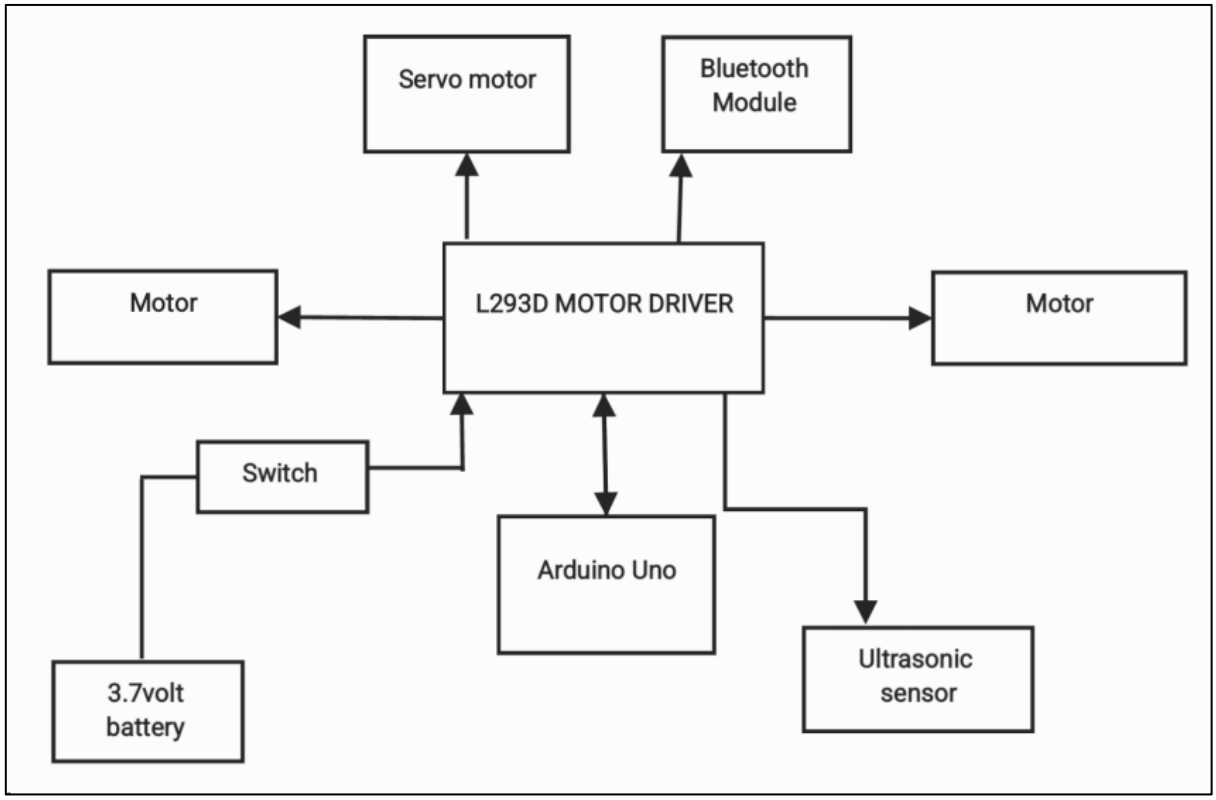


Fig.1 Block Diagram of Bluetooth-Based Voice-Controlled Obstacle Avoiding Robot Car

Software Requirement: The Author uses the Arduino IDE software platform. It is an easy-to-use environment for a microcontroller programming software platform. It is an essential tool that makes creating, developing, and uploading code to Arduino boards easier for both beginner and skilled developers. The Arduino programming language is straightforward to learn and understand, based on C and C++, and the IDE supports it. The Arduino IDE is a valuable tool due to its extensive collection of prewritten code, or "sketches." These illustrations save time and scale when coding by offering ready-to-use code snippets for a variety of hardware parts and functionalities. Moreover, the Arduino IDE features an integrated serial console that enables developers to track and troubleshoot their projects in real-time. It ensures wide platform compatibility by being interoperable with several operating systems, such as Windows, Mac OS X, and Linux. To summarize, the Arduino IDE is an intuitive interface and interoperability with a wide range of hardware elements. It gives people the freedom to express their creativity and realize their technological projects.

B. Operating Principle: In the working principle, at first, the robotic car assembles all the components, such as, an Arduino board, Motor driver circuit, BLDC motor, wheels, sensor, battery, and switch. The Circuit Diagram of the proposed model is designed in Fig 2.

After generating input from the battery, activate the Arduino board and send the all information to the peripherals.

After activating Arduino board, all peripherals which is connected must be activated.

User sends information via Bluetooth connection by mobile interface or user's voice commands; ultrasonic sensor is activated and the robotic car moves according to the user's information.

When it will be moving, first it checks its mentioned direction through the sensor and check every period for objects available in their way.

If an object is detected, it will be moved in a clockwise direction. Object checking in every direction. If objects are detected in their lines, then move in an anti-clockwise direction and then in a backward direction respectively.

If every direction is blocked. The car moving has been stopped.

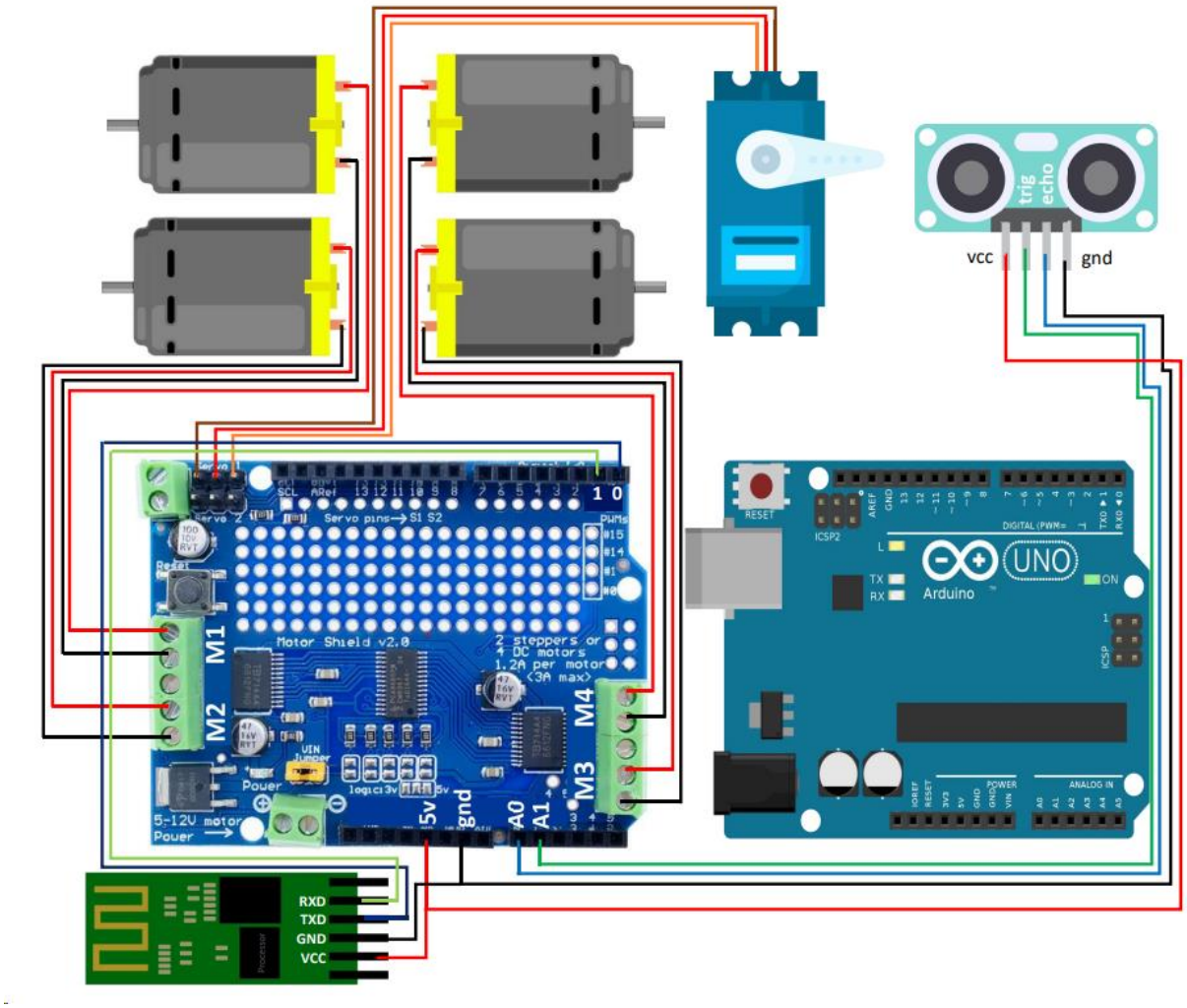
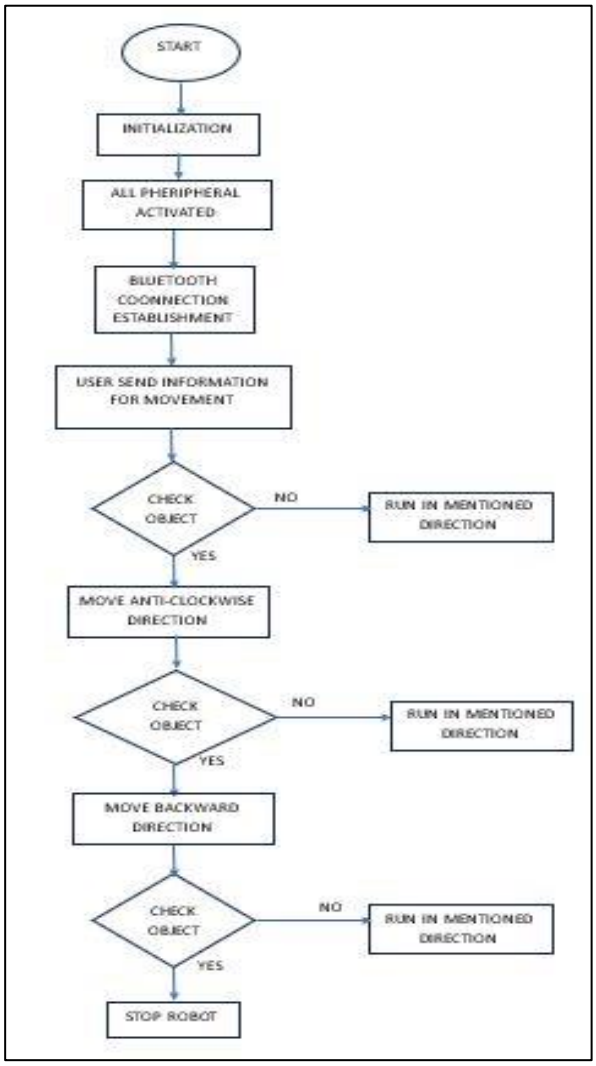


Fig 2: Circuit Diagram of Bluetooth-Based Voice-Controlled Obstacle Avoiding Robot Car



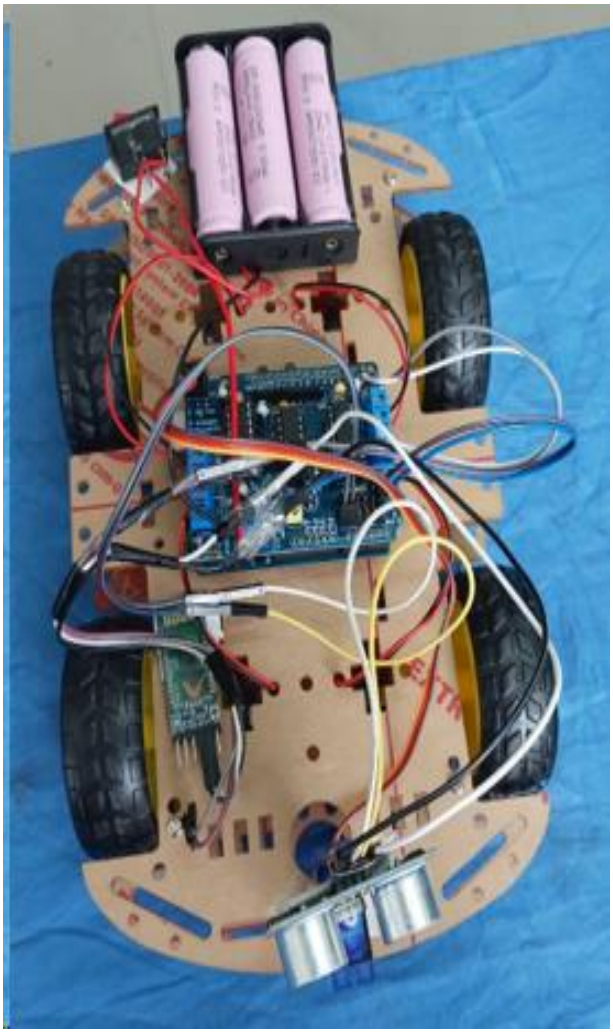


Fig 3: Flowchart of the Designed Model

Fig 4: Proposed of the Designed Model

Conclusion

Bluetooth-based voice-controlled Obstacle Avoiding Robot Car using Arduino is designed and developed for diverse applications. This model incorporates many components, operated autonomously and software-controlled. It is a fully Bluetooth-based complete obstruction removal emerging technology in remote-controlled robotic vehicles that is a remarkable blend of time and innovation. This proposal is a modern breakthrough in advanced, scalable electronics and robotic-like intelligent devices. It works Bluetooth timing enables, Wi-Fi to switch zones in robotic vehicles, greater flexibility and convenience. Through robotic vehicle development and unbiased monitoring of systems, it prevents troublesome valuable energy, decisional thinking and authority. Overall, particularly, generally obstacle-based remotely controlled robotic devices based on Bluetooth are the age's transformative ability to advance the boundaries of what can improve our lives time exemplified by the rapid and controlled advances in robotics and automation.

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Replacement of River Sand by Waste Foundry Sand In Paver Blocks

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ABSTRACT

This study investigates the use of leftover foundry sand in place of river sand while making paver blocks. For foundries, disposing of the plentiful and occasionally underutilized waste foundry sand—a consequence of metal casting operations—presents a challenge. The study assesses the durability, mechanical properties, and physical properties of paver blocks manufactured with various amounts of leftover foundry sand. The findings indicate that river sand can be effectively substituted with waste foundry sand without sacrificing quality. Paver blocks constructed using waste foundry sand have mechanical and physical properties that are comparable to those of blocks made with ordinary river sand. Tests for durability show satisfactory results, guaranteeing the structural integrity over time. Although this study is in favor of the circular economy and environmentally friendly construction practices, more investigation and implementation are required to maximize.

Keywords: waste foundry sand, materials, concrete, natural sand

I. INTRODUCTION

Alternative materials for construction are being investigated by industry and researchers in response to the depletion of natural resources and growing environmental concerns. Waste foundry sand, which is produced as a byproduct of metal casting operations, is one such substance that is being examined. There is a chance to use waste foundry sand in building because of its availability and the environmental problems associated with disposing of it. This project aims to investigate the possibility of using leftover foundry sand to make paver blocks instead of river sand. Given their widespread usage in pavement and landscaping, paver blocks are a good choice for investigating sustainable material substitutes. This study's main goals are to evaluate the environmental, mechanical, and physical characteristics of paver blocks made with leftover foundry sand. The study seeks to assess the environmental impact, durability, and structural integrity of the paver blocks using different amounts of waste foundry sand through extensive laboratory testing and analysis. Moreover, the study aims to tackle issues about the elimination of leftover foundry sand by offering a workable and sustainable remedy by incorporating it into building supplies. The results of this project should add to our understanding of

sustainable building techniques and provide information on the viability and efficiency of producing paver blocks using scrap foundry sand.

II. Literature Review

This study emphasizes the utilization of residual foundry sand in concrete as well as the various applications for concrete. Numerous studies have examined the use of leftover foundry sand as a partial or complete replacement for fine aggregate in concrete.

[1] According to Siddique et al. (2016), there is an improvement in these qualities with age as well as an increase in compressive strength, modulus of elasticity, flexural strength, and splitting tensile strength with a 30% content increase in WFS. According to Siddique, adding WFS to concrete can boost its strength properties by up to 15% for both 28 and 91-day ages. It also raises the UPV value of the concrete while reducing the penetration of chloride ions. The author noted that WFS can be utilized appropriately to produce concrete. Similar findings were obtained for the strength properties, and it was found that 20% of WFS inclusion yields the maximum value. The results for the concrete's abrasion resistance were also comparable to those of the control mix. Siddique investigated the effects of WFS on two classes (M20 & M30) of concrete mixtures when used in part instead of natural sand. According to the author, M20 grade outperforms M30 grade in terms of all strength attributes, UPV, and chloride ion penetration in concrete. Siddique conducted research on the microstructural characteristics, strength, and durability of concrete by substituting fine particles for a portion of the WFS. According to the author, using a 30% replacement level in concrete is ideal and shouldn't go above 50%.

[2] Guney et al. (2016) investigated the possible reuse of WFS in the creation of high-strength concrete through a series of experiments in which fine aggregates were substituted for WFS at various percentages (0%, 5%, 10%, and 15%) in the concrete. The author observed that in terms of strength qualities (compressive strength, modulus of elasticity, and splitting tensile), the 10% of WFS shows about the same value as the control mix. By substituting ordinary sand for WFS at five different percentages (0%, 10%, 20%, 30%, and 40%) by weight, Basar studied the impact of WFS as a partial replacement of fine aggregates (natural sand) on the microstructural, mechanical, and leaching aspects of RMC (ready mix concrete). According to the author, WFS can substitute ordinary sand by 20% without compromising the mechanical and physical characteristics of concrete. Naik studied the behaviour of both fresh and hardened concrete using clean, new foundry sand and waste foundry sand, and by substituting fine particles at 25% and 35% replacement level by weight in the concrete. The author noted that clean/new foundry sand displayed values that were nearly identical to the control mix, while waste foundry sand displayed values that were 20%–30% lower than the control mix.

[3] In 2017, Monosi et al. conducted research on the manufacturing of structural concrete and mortar through the reuse of two different types of waste foundry sand (WFS) collected at two separate phases of the foundry's processing. The author stated that fine aggregates can partially replace these two forms of WFS in mortar and concrete, with replacement levels ranging from 0% to 30%. This method is advantageous for disposal in construction projects. Etxeberria conducted multiple experiments in which fine aggregates were substituted at varying percentages for both chemical and green foundry sand. According to the author, when concrete containing 25%, 50%, or 100% chemical foundry sand was exposed to high temperatures, it demonstrated

superior workability and compressive strength in comparison to traditional concrete. In concrete, Khatib substituted fine aggregates for waste foundry sand in various percentages (0%, 30%, 60%, and 100%). According to the author, as the amount of waste foundry sand in the concrete increased, there was a systematic increase in water absorption, a fall in UPV, and a decrease in compressive strength due to capillary action.

[4] According to Siddique and Singh, WFS is mostly used in concrete and controlled low strength materials (CLSM) with particles sized between 150 and 600 μm. In a similar vein, Prabhu has claimed that WFS with particle sizes ranging from 150 μm to 600 μm can be utilized to make concrete with suitable results. By partially substituting WFS with fine aggregates in concrete from 0% to 50%, the author examined the impact of WFS as fine aggregates in the production process. The results indicated that 20% of waste foundry sand inclusion with fine aggregates could be used effectively in the production of high-quality concrete without compromising concrete standards.

[5] Guney et al. (2018) investigated various influences on the characteristics of concrete and conducted multiple tests on the manufacturing of high strength concrete by substituting waste foundry sand in concrete up to a specific point. According to the author, droop and fluidity decrease as the percentage of WFS increases. In comparison to other combinations, standard concrete (without WFS inclusion) exhibits the largest slumps, measuring 160 mm. Subsequently, there is a systematic decline in strength, with the largest resultant loss recorded at 15% of WFS inclusion in concrete, or 60 mm. The author noted that waste foundry sand contains small particles of a clay type, which reduces the fluidity of concrete and causes a systematic deterioration in strength as the percentage of WFS increases.

[6] In order to examine the characteristics of concrete, Khatib et al. (2018) completely substituted fine aggregates for WFS, or 0%100%). According to the author, slump systematically decreases as the percentage of WFS in concrete increases. The control mix with 0% WFS inclusion, or 200 mm, had the largest slump, which was followed by a systematic decrease in slum to 0% for 100% WFS inclusion in concrete. The author noted that the presence of fine clay particles was responsible for the reduction in slump. Concrete becomes less fluid as a result.

[7] By replacing waste foundry sand with fine aggregates in concrete at predetermined replacement levels up to predetermined percentages, Bilal et al. (2019) examined the properties of the mixture. The author reports almost similar results up to 20% of WFS, or 30 mm, as compared to the control mix, or 32%, and a systematic decrease in slump for up to 31.25% for 40% of WFS as contrasted to the controlled mix. The author also supplied the compaction factor values and reported that, in comparison to the control mix, which had a value of 0.85, the results were almost the same up to 20% of inclusion, or 0.84. After that, the compaction factor steadily dropped to 0.81, or 40% of WFS. The decrease in workability was found to be caused by fine particles detected in waste foundry sand, including ashes, impurities, and clay-type fine particles. Concrete becomes less fluid due to the increased requirement for water caused by these particles.

[8] Prabhu et al. (2019) added fine aggregates to concrete at various replacement levels in place of waste foundry sand in order to examine the mechanical and durability characteristics of the material. According to the author, the highest slump value was recorded at 115 mm for the control mix that contained 0% WFS. The

lowest slump value was recorded at 63 mm for the concrete that contained 50% WFS. The introduction of WFS led to a systematic decrease in slump for all replacement levels, as noted by the author. After 30 minutes, the control mix—96 mm, or 0% WFS—was combined right away. Slump decreased systematically with the addition of WFS for all replacement levels; the lowest slump value was 21 mm for concrete containing 50% of WFS. Following a 60-minute duration, the control mix containing 0% of WFS (51 mm) was seen to be mixed immediately. Slump decreased systematically with WFS addition for all replacement levels; nevertheless, for 50% WFS inclusion in concrete, the lowest slump value was 0 mm.There is a dearth of literature on workability, but what is known from these investigations is that workability systematically decreases when the amount of waste foundry sand in concrete is replaced. Additionally, the value of the compaction factor decreases as the proportion of discarded foundry sand in concrete increases. The presence of tiny clay particles in WFS greatly lowered the fluidity of the concrete, which was the main reason of the drop in slump and compaction factor values in concrete as the percentage increased.

[9] Gadhave, Akshay T. et al. (2020) Regulations on sand extraction have been implemented across India due to environmental concerns raised by excessive dredging, which has a direct financial impact on the manufacture of concrete. Finding a suitable and eco-friendly way to sand is necessary to meet the enormous demand from the concrete production sector. At the same time, up to 40% of waste plastic in India ends up in landfills and is rarely recycled. The long-term environmental problem is the disposal of such compounds, which decompose at extremely low rates, meaning they remain in the environment. The low cost of recycling plastic garbage has a significant impact on the amount of toxins in the environment. The improper disposal of waste foundry sand, a byproduct of the steel casting industry, contributes to environmental problems.

[10] Mushtaq Sheikh Mayesser et al. (2021) Due to its widespread usage as a construction material, concrete has led to an over-exploitation of natural resources, such as river sand and gravel. In the meantime, expanding populations and developing businesses have also led to an enhanced era of waste materials. A large number of those waste materials can be used to make concrete. The impact of one such waste material, known as Waste Foundry Sand (WFS), at concrete homes has been examined in this study. Many researchers have examined the impact of WFS at the mechanical residences of concrete.
Nonetheless, a lack of agreement has been achieved, and there have been reported contradicting outcomes. Furthermore, researchers are no longer as interested in the shrinkage of concrete containing WFS, and there is very little literature available on this feature. This study investigates these concretes' workability, compressive power, split tensile power, and drying shrinkage. WFS was utilized to partially replace the extraordinary combination, with replacement tiers varying from zero to fifty percent in the same increments of ten percent. It was discovered that adding WFS to concrete decreased its cut-up tensile and compressive strengths. On the other hand, the real WFS3 (30% WFS) combination verified a power very similar to manageable concrete. When concrete was manipulated at the age of 28 days, a massive boom of 16.7%, 23.44%, 29.05%, 36.35%, and 45.18% was found to be within the drying shrinkage value, while the amount of WFS in the concrete varied from 10 to 50%. It also became apparent that shrinkage prediction models could not be used to concrete that contained waste foundry sand.

III. MATERIAL SELECTION

The impact of partially replacing fine aggregates with leftover foundry sand containing concrete at different percentages was studied. Moreover, how waste foundry sand affects the mechanical qualities and longevity of concrete.

Cement: Portland pozzolana cement (PCC), which complied with IS 1489-Part1[82], was utilized as the cement. The different physical properties of cement are measured using the following methods as outlined in IS 1489-Part-1.

Natural Sand: The material, which had a nominal maximum fine aggregate size of 4.75 mm, was readily available locally. According to BIS: 383–1970[83], the fine aggregates were evaluated. BIS: 383–1970[83] determined the specific gravity, fineness modulus, water absorption, and sieve analysis.

Coarse Aggregates: The material, which had a nominal maximum fine aggregate size of 4.75 mm, was readily available locally. According to BIS: 383–1970[83], the fine aggregates were evaluated.

Waste Foundry Sand: The leftover foundry sand was supplied in sacks by the cast iron foundry located in Batala, Jalandhar, Punjab. Waste foundry sand was tested in compliance with BIS: 383-1970[83]. The specific gravity, fineness modulus, water absorption, and sieve analysis were measured by BIS: 383–1970[83].

Super Plasticizer: Super plasticizers, also known as water reducers, are produced or utilized in the manufacturing of high-grade concrete. Super plasticizers shorten the concrete's curing time by 30% and lower the amount of water in the concrete. They successfully raise the fresh concrete's performance.

Magnesium Sulphate: The powdered magnesium sulfate was obtained from a nearby pharmacy. It's the mixture that has polycarboxylic ether as its foundation.

Water: A crucial component that aids in giving concrete the necessary strength is water. It needs nearly three-tenths of its water weight to provide the vital function of hydration. A concrete structure may suffer if water is not used in concrete according to the design specifications. Less water used can have an impact on workability, which in turn can have an impact on the mechanical and durability aspects of concrete; more water used can result in bleeding and segregation within the concrete's structure.

• Mix Proportion

• After 28 days of curing, the control mixture (M-1) of concrete was produced with a 40 MPa compressive strength in compliance with Standard Specifications BIS: 10262–1982[84] and BIS 456-2000. More concrete mixtures (M-2, M-3, M-4, M-5, M-6, and M-7) were made by using fine aggregates at weight percentages of 2.5%, 5%, 7.5%, 10%, 12.5%, and 15% with residual foundry sand. For all planned concrete combinations, the water cement ratio is maintained at the same level. The table provides the mix proportion for each type of concrete mixture.

Mix no.	**M-1**	**M-2**	**M-3**	**M-4**	**M-5**	**M-6**	**M-7**
Cement(kg/m^3)	398.57	398.57	398.57	398.57	398.57	398.57	398.57
Waste foundry sand (%)	0	2.5	5	7.5	10	12.5	15
Waste foundry sand (kg/m^3)	0	21.16	42.34	63.51	84.68	105.85	127.02
Sand (kg/m^3)	850	828.75	807.5	786.25	765	743.75	722.5
W/C	0.35	0.35	0.35	0.35	0.35	0.35	0.35

Water (kg/m^3)	139.5	139.5	139.5	139.5	139.5	139.5	139.5
Coarse aggregates (kg/m^3)	1081.836	1081.836	1081.836	1081.836	1081.836	1081.836	1081.836

Table: Mix design of concrete mix for M40 grade containing waste foundry sand

Specimens Preparation and Casting

The processes of mixing, batching, and casting were carried out with extreme caution. Weighed materials included cement, super plasticizer, coarse and fine aggregates, scrap foundry sand, and water. A fixed amount of waste foundry sand was dry mixed separately to give a uniform color instead of fine particles. To get a consistent hue, the cement, coarse, fine, and waste foundry sand were dry mixed individually. Superplasticizer was individually and in the appropriate quantity applied to water in separate containers. These were combined by hand or mechanically to create a consistent hue on an impermeable surface. The preparation of each concrete mixture sample followed Indian Standard Specifications. BIS: 516–1959.The samples were first allowed to remain in the steel mold at room temperature for a full day. These samples were carefully demolded after a day to prevent breaking at the edges and for proper testing. The samples were then placed in a curing tank that had an ambient temperature of 27± 2 °C and left there to cure for however long the test took or until it was needed.

*All specific details of various tests are given in table.

Results and discussion

Compressive Strength

Test	Specimen	All testing ages
Compressive strength	150 mm cubes	7, 14 and 28 days
Splitting tensile strength	150 mm cubes	7, 14 and 28 days
Flexural strength	150 mm cubes	7, 14 and 28 days
Sulphate ion resistance	150 mm cubes	14nd 28 days

Concrete's compressive strength gives insight into its properties. This one test can be used to determine whether or not concrete was completed correctly. The primary determinants of concrete's compressive strength are its cement strength, the ratio of water to cement, the quality of the materials used to make it, etc. The strength of concrete mixtures that contained waste foundry sand was nearly equal, and the strength of the concrete rose as the amount of waste foundry sand increased, as indicated in Fig. The improvement in strength was 3.65%, 8.6%, 6.17%, and 3.3% when concrete mixtures M-2 (2.5%), M-3 (5%), M-4 (7.5%), and M-5 (10%) were compared to the control mix without waste foundry sand M-1 (0%) at a curing age of seven days. M-7 (15%) and M-6 (12.5%) concrete mixtures had nearly identical strengths, however there were slight declines of up to 0.13%.

The concrete mixture M-6 (12.5%) demonstrated a slight gain in strength of 0.71% at the 28-day curing age, whereas the concrete mixture M-7 (15%) demonstrated a drop in strength of 3.67%. As opposed to the 42.83 MPa of the control mix M-1 (0%), the concrete mixtures M2 (2.5%), M-3 (5%), M-4 (7.5%), and M-5 (10%) shown improvements in strength of 3.93%, 9.3%, 6.54%, and 5.7%. In comparison to the control mix, which had a strength of 44.37 MPa, concrete mixtures M-2 (2.5%), M-3 (5%), M-4 (7.5), M-5 (10%), and M-6 (12.5%)

shown improvements in strength of 4.87%, 9.45%, 7.8%, 6.27%, and 1.27%, respectively, at 56 days of curing time. A reduction in strength of up to 3.52% was seen in concrete mixture M-7 (15%).Figure makes it simple to see how the values of compressive strength vary. It was revealed that the compressive strength values for M3 (5%) of inclusion exhibited increased strength in comparison to control mix M1 (0%) at all curing ages, and that there was a systematic drop in strength after 5% inclusion of foundry sand for all ages in concrete.

Table Percentage of increment and decrement of compressive strength as compare to control mix

WFS %	7 days	14 days	28 days
0			
2.5	3.65%	3.78%	3.93%
5	8.6%	8.90%	9.3%
7.5	6.17%	6.30%	6.54%
10	3.3%	4.2%	5.7%
12.5	-0.13%	0.29%	0.71%
15	-4.5%	-4.08%	-3.67%

Table Compressive strength versus age

WFS %	7 days (MPa)	14 days (MPa)	28 days (MPa)
0	31.23	31.23	42.83
2.5	32.37	32.37	44.51
5	33.89	33.89	46.81
7.5	33.16	33.16	45.63
10	32.26	32.26	45.25
12.5	31.19	31.19	43.16
15	29.85	29.85	41.26

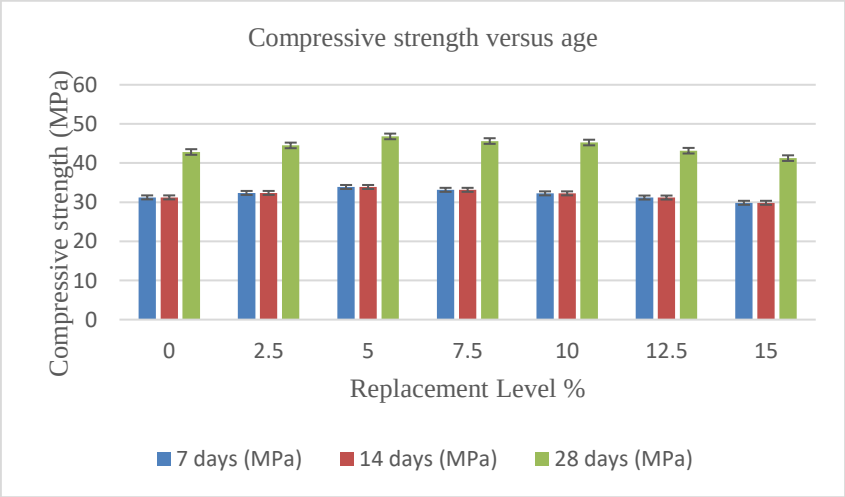

Fig Compressive strength versus age

Splitting Tensile Strength

Tensile strength is one of the basic and crucial properties of concrete that has a big impact on how big cracks get in a construction. Concrete is extremely weak in tension because it is brittle by nature and cannot tolerate direct tension. Consequently, when tensile forces are greater than the tensile strength of concrete, cracks in the concrete elements appear. Splitting tensile strength increases at all of the curing ages shown in the figure when waste foundry sand replacement levels reach a certain threshold. The concrete mixtures M-2 (2.5%), M-3 (5%), M-4 (7.5%), and M-5 (10%) shown improvements in strength of 4.46 percent, 10.8%, 7.97%, and 3.51%, respectively, following seven days of curing. Comparing the concrete mixtures M-7 (15%) and M-7 (12.5%) to the control mix M-1 (0%) revealed roughly the same strength, 1.6%, although the former indicated reductions in strength of 4.78% and 3.24 MPa, respectively.

Table Percentage of increment and decrement of splitting tensile strength as compare to control mix.

WFS %	7 days	14 days	28 days
0			
2.5	4.46%	4.6%	4.8%
5	10.8%	11.08%	11.37%
7.5	7.97%	8.15%	8.34%
10	3.51%	3.76%	4.05%
12.5	1.6%	2.06%	2.53%
15	-4.78%	-4.28%	-3.79%

Following a 28-day curing period, the strength of the concrete mixtures M-2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%) increased by 4.8%, 11.37%, 8.34%, 4.05%, and 2.53%, in that order. On the other hand, at 3.96 MPa, the strength of the concrete mixture M-7 (15%) decreased by 3.79% in comparison to the control mix M-1 (0%). The concrete mixtures M2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%) demonstrated strength improvements of 5.31, 12.84%, 8.63%, 4.21%, and 3.32%, respectively, following 56 days of curing. On the other hand, the strength of the concrete mixture M-7 (15%) decreased by 3.54% in comparison to M-1 (0%) or 4.52 MPa. The split tensile strength fluctuation is shown in the figure. Strength showed a noticeable rise up to 5% of WFS replacement level; after that, strength at all cure ages continuously dropped. The concrete that had 5% WFS included in it had the maximum strength. Similar findings and observations were reported by Siddique et al. [12], Guney at el. [26], Prabhu et al. [28], Siddique et al. [34], Siddique et al. [40], and Bilal et al. [58].

Siddique et al. [12] reported an increase in strength, or 3.7 MPa and 4.38 MPa with 10% WFS inclusion in concrete at both grades, in comparison to the control mix, which measured 3.42 MPa and 4.32 MPa at 28 days of curing age for both grades of concrete. The author's observations indicate that the split tensile strength of concrete rose with the curing age. Guney at el. [26] observed a rise in split tensile strength and carries maximum strength at 10% of WFS inclusion in concrete, or 3.91 MPa, compared to the control mix after 28 days of curing age, or 3.57 MPa. The author observed that split tensile strength rises with increasing curing age.

According to Prabhu et al. [28], 10% of WFS inclusion in concrete has a marginal decrement of 2.612 MPa in comparison to the control mix's 2.765 MPa, and carries nearly the same strength. The splitting tensile strength of concrete systematically decreased after 10% inclusion of WFS, and the author noted that this strength increased as sample curing age increased. According to Singh & Siddique [34], at 28 days of curing age, the 10%

of inclusion in concrete showed an increase, or 4.64 MPa, and as the percentage of WFS increased, it increased from 3.55% to 10.40% compared to the control mix, which showed 4.21 MPa.

Siddique and colleagues (2019) conducted a series of experiments in which they substituted fine aggregates at varying percentages for WFS. In contrast to the control mix, the author observed a strength improvement of up to 9% from 10% to 30% inclusion of WFS at 28 days of curing ages, or 2.75 MPa. According to Bilal et al.'s [58] observations, there was a slight increase in strength (3.38%) at 10% inclusion of WFS in concrete, as compared to the control mix after 28 days of curing age, or 3.28 MPa. The strength also rises with the proportion, reaching a maximum of 30% of inclusion, or 9.87%.

Table Splitting tensile strength versus age

WFS %	7 days (MPa)	14 days (MPa)	28 days (MPa)
0	3.14	3.50	3.96
2.5	3.28	3.71	4.15
5	3.48	3.94	4.41
7.5	3.39	3.84	4.29
10	3.25	3.68	4.12
12.5	3.19	3.60	4.06
15	2.99	3.40	3.81

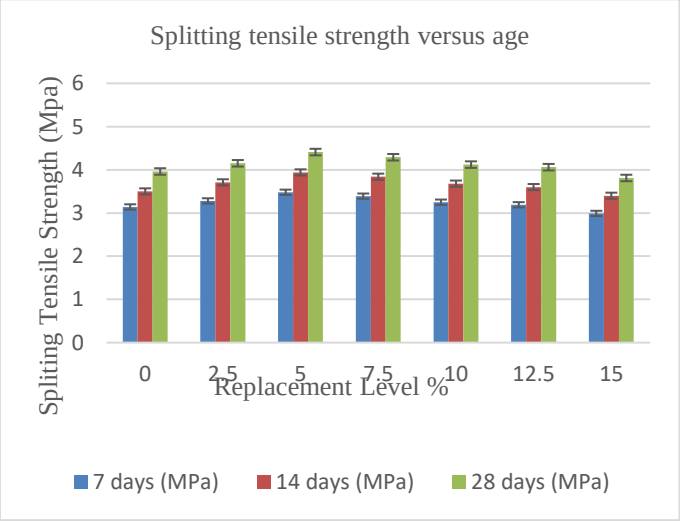

Fig Splitting tensile strength versus age

Flexural strength

Flexural strength, also known as bend strength, transverse of rupture, or modulus of rupture, is a mechanical property of brittle materials. It is the ability of a material to tolerate deformation under different loads. Flexural strength is a basic mechanical property that is connected to compressive and splitting tensile strength. Flexural strength increases as the replacement level of waste foundry sand increases, up to the amount shown in the figure. Following a seven-day curing period, the concrete mixtures with the highest strength increments—

3.46%, 10.09%, 7.21%, 4.33%, and 3.18%—were M-2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%). In comparison to the control mix M-1 (0%), or 3.47 MPa, the concrete mixture M-7 (15%) had the greatest strength decline, measuring 4.61%.

Table Percentage of increment and decrement of flexural strength as compare to control mix

WFS %	7 days	14 days	28 days
0			
2.5	3.46%	3.63%	3.81%
5	10.09%	11.18%	12.27%
7.5	7.21%	7.93%	8.66%
10	4.33%	4.80%	5.29%
12.5	3.18%	3.28%	3.39%
15	-4.61%	-4.84%	-5.08%

The concrete mixtures with the highest strength increases, after 28 days of curing, were M-2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%). Their respective increments were 3.81%, 12.27%, 8.66%, 5.29%, and 3.39%. In contrast, at 4.73 MPa, the concrete mixture M-7 (15%) displayed the largest strength decrease compared to the control mix M-1 (0%) at 5.08%. Following 56 days of curing, the concrete mixtures with the highest strength increments of 4.92%, 13.26, 10.26%, 7.58%, and 4.93%, respectively, were M-2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%). On the other hand, compared to the control mix M-1 (0%), the concrete mixture M-7 (15%) displayed the largest strength decline, measured 5.28 MPa. The flexural strength values vary, as seen in the figure. Strength showed a noticeable rise up to 5% of WFS replacement level; after that, strength at all cure ages continuously dropped. The concrete that had 5% WFS included in it had the maximum strength. Similar findings and observations were reported by Prabhu et al. [28] and Bilal et al. [58].

Prabhu et al. [28] concluded that there was a systematic drop in flexural strength after carrying out a number of studies. At 28 days of curing age, the 10% and 20% WFS inclusions show almost the same strength, 3.986 MPa and 3.988 MPa, respectively, in comparison to the control mix, which is 4.089 MPa. These mix values, however, show less strength than the control mix. 10% addition of WFS in concrete resulted in a minor 3.1% improvement in strength, according to Bilal et al. [58]. At 28 days of curing age (6.15% MPa), the strength grew further as the percentage increased, reaching a maximum of 30% of inclusion (10.15%) in compared to the control mix.

Table Flexural strength versus age

WFS %	7 days (MPa)	14 days (MPa)	28 days (MPa)
0	3.47	4.1	4.73
2.5	3.59	4.25	4.91
5	3.82	4.56	5.31
7.5	3.72	4.43	5.14

10	3.62	4.3	4.98
12.5	3.58	4.23	4.89
15	3.31	3.9	4.49

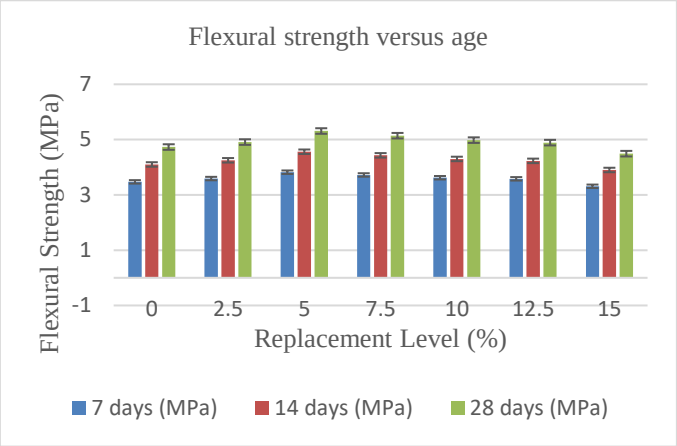

Fig Flexural strength versus age

Durability property

Sulphate Resistance Test

The test for sulphate resistance was conducted using specimens that were 150 x 150 x 150 mm cubes. After casting, the cubes were properly cured in water for a period of 28 days. After 28 days of curing, cubes were immersed in a magnesium sulphate solution, and two more compressive strength tests were carried out at 14 and 28 days of curing.

Conclusion

Ultimately, the experiment successfully demonstrated that waste foundry sand can be substituted for river sand in the creation of paver blocks. It was discovered that the paver blocks created using the leftover foundry sand met or exceeded industry standards with regard to their mechanical, physical, and durability attributes. This addresses the challenges associated with waste management in the foundry industry and offers a sustainable remedy for the depletion of natural resources. In general, the building industry now has a workable and environmentally friendly alternative in the form of paver blocks made from leftover foundry sand, which could lead to the development of more morally and environmentally conscious building techniques in the future.

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Optimizing Ambulance Dispatch in Road Traffic Accidents with AI-driven Location Analysis

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ABSTRACT
Efficient ambulance dispatch during road traffic accidents is crucial for saving lives and minimizing injuries. However, conventional dispatch methods often struggle to accurately determine optimal routes and response times. This paper proposes integrating artificial intelligence (AI) into location analysis using the OpenStreetMap API for ambulance dispatch to enhance response times and outcomes. Inspired by mapping applications like Ola and Uber, our framework displays ambulance locations, distances, and real-time traffic conditions, enabling users to suggest the best route to reach their destination swiftly. By leveraging AI-driven algorithms and real-time data analytics, this research aims to optimize ambulance dispatch by considering accident severity, traffic conditions, and geographic features. The paper reviews existing literature, highlights challenges with traditional dispatch methods, outlines the proposed AI-driven approach, and discusses its potential impact on emergency medical services.
Keywords: ambulance dispatch, OpenStreetMap, OpenHospital, API, AI PathSense, ULMA10

I. INTRODUCTION

Road traffic accidents pose significant public health challenges globally, resulting in injuries and fatalities. The World Health Organization (WHO) identifies road accidents as a leading cause of death and disability, with an estimated 1.35 million fatalities annually [1]. Prompt medical intervention is vital in mitigating the consequences of these accidents, underscoring the pivotal role of timely ambulance dispatch in delivering life-saving care to victims.

Efficient ambulance dispatch is paramount for reducing response times and improving patient outcomes. Traditional dispatch systems often rely on predefined protocols and manual decision-making processes, which may not adequately consider dynamic factors such as traffic conditions, accident severity, and geographic

constraints. Thus, innovative approaches leveraging advanced technologies are necessary to optimize ambulance dispatch in real-time.

Conventional ambulance dispatch methods encounter various challenges, including limited real-time data integration, suboptimal route planning, and inefficient resource allocation. Moreover, discrepancies in dispatch protocols across different regions may lead to disparities in response times and quality of care. Addressing this challenge, this paper advocates for the integration of artificial intelligence (AI) into location analysis using the OpenStreetMap API for ambulance dispatch. Inspired by mapping applications like Ola and Uber, our framework provides real-time insights into ambulance locations, distances, and traffic conditions, enabling users to suggest the most efficient route.

In this research our aims to explore the potential of AI-driven location analysis in optimizing ambulance dispatch during road traffic accidents. The primary objectives include:

- Reviewing existing literature on ambulance dispatch methods and AI applications in emergency medical services.
- Developing a framework for AI-driven location analysis in ambulance dispatch with the assistance of the OpenStreetMap API, incorporating real-time data streams and advanced algorithms.
- Evaluating the effectiveness of the proposed framework through case studies and performance analysis.
- Providing insights into the implications of AI-driven dispatch for emergency medical services and public health policy.

The rest of this paper is organized as follows. Sect. II is a detailed review about related works for the problem statement. In Section III describes our proposed methodologies, Section IV discusses the experiments performed and results obtained from the proposed framework. The paper delivers the discussion and future scope in Section V.

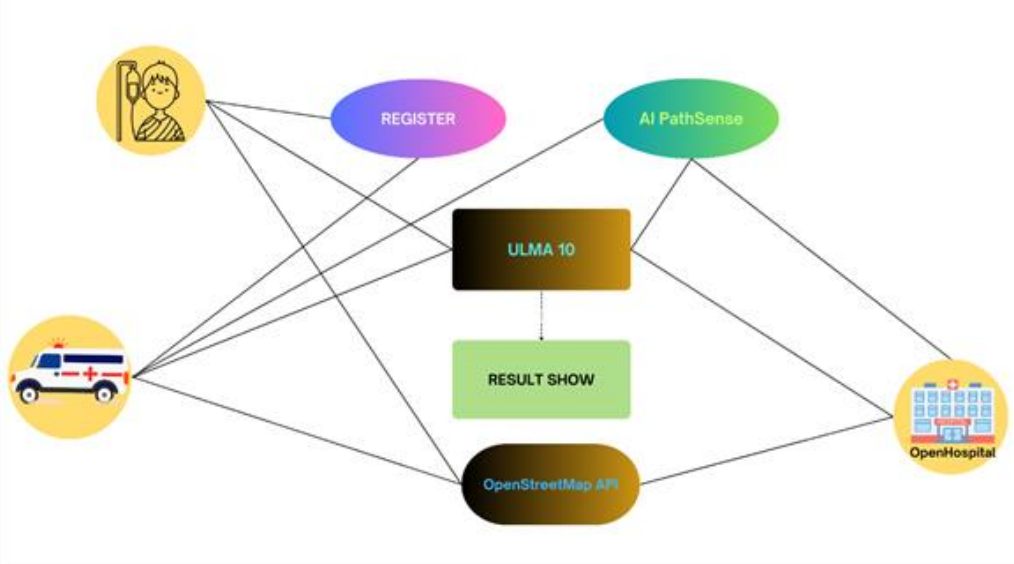
Literature Review

Efforts to optimize ambulance dispatch systems have been ongoing, driven by the imperative to improve emergency medical response and patient outcomes, particularly in the context of road traffic accidents. This section reviews existing literature on ambulance dispatch methods and the integration of artificial intelligence (AI) in emergency medical services. In [2], the author introduces a simulation model designed to delineate the optimal path, considering multiple ambulances, dispatching locations, and hospitals. The data utilized for this model is sourced from the Australian Government, with a focus on Victoria, Melbourne, and includes hospital admissions across Australian states and territories, chosen to ensure manageable scope. Additionally, the author underscores the significance of intelligent routing strategies and their potential impact on patient outcomes. This paper the author's proposes in [3], aims to enhance emergency medical services (EMS) in South Delhi by optimizing ambulance dispatch in South Delhi by analyzing fatal crash data and utilizing advanced techniques like ArcMap clustering and the Google Maps API. Results show the optimized system achieves full coverage within 14 minutes compared to the existing system's 22 minutes. Two scenarios were analyzed: one with 29 ambulances in current locations (S1), and another placing them across 100 sites (S2). The optimized system achieves full coverage with 11 ambulances, compared to 29 in the existing system. This enhances emergency medical services in South Delhi, reducing response times and improving overall coverage. In [4], this author's of this paper provided an article discussing a comprehensive approach to minimize road accidents' fatalities by integrating IoT and AI technologies. It proposes an intelligent accident detection and rescue system using

cognitive agent-based collision detection. The system utilizes IoT sensors to detect accidents and sends relevant data to the cloud, where a deep learning model validates the incident and triggers the rescue operation. The article highlights the importance of minimizing response time in rescue operations to save lives. Experimental results compare the performance of different deep learning models, indicating ResNet-50's superiority for accident detection. In [5], the proposed method introduces online optimization for routing and scheduling ambulances during mass casualty incidents, addressing uncertainty in victim conditions. Techniques include competitive analysis, introducing online heuristics, and comparing results against offline optimal solutions. Results show that the optimization-based algorithm generally performs better with fewer victims and no initial information. However, as the number of victims increases, the utility-based algorithm outperforms, especially in reacting to observed victim conditions. A drawback is the reliance of the optimization-based algorithm on an optimization solver, while the utility-based algorithm shows more reliable performance across varying scenarios. Overall, the study highlights the importance of considering real-time information in ambulance routing decisions during emergencies. In [6], this article discusses an innovative approach to mitigate road accident fatalities through the integration of IoT and AI technologies, proposing an intelligent Accident Detection and Rescue System (ADRS) driven by cognitive agent-based collision detection. Utilizing IoT sensors for accident detection and cloud-based deep learning models for incident validation and rescue operation triggering underscores the urgency of minimizing response time for life-saving measures. Although the experiment effectively compares deep learning models, emphasizing ResNet-50's superior performance for accident detection, it lacks thorough consideration of security implications, warranting future research endeavour's. Overall, the integration of IoT and AI presents promising prospects for enhancing emergency response in smart cities, but further attention to security aspects and real-world validation is imperative. In [7] this article author's proposed examines traffic accident rates in the Czech Republic from 2011 to 2018 and the integrated rescue system's efficiency. Despite road safety efforts, challenges persist in reducing fatalities and injuries, echoing the EU's aim to halve accident-related deaths. The National Strategy for Road Traffic Safety 2011–2020 aims for reductions, but recent data suggests goals may not be met, with 2018 seeing an increase in accidents. Further analysis is needed to understand causes and refine strategies. Globally, traffic accidents annually claim 1.25 million lives and injure 20–50 million, with the EU recording 25,100 deaths and 135,000 severe injuries in 2018. The author's proposed in [8] method optimizes EMS efficiency by integrating historical and real-time data to allocate ambulances dynamically, maximizing coverage and response times. Using hexagonal cells and advanced algorithms like Uber's H3 package, it determines optimal ambulance numbers for each cell over time and adapts to changing demand patterns. The mathematical model minimizes operational costs while ensuring adequate coverage within the golden time window. Experiments with Seoul data show a significant reduction in zero zones, indicating improved ambulance accessibility. Notably, the number of zero zones areas where ambulances cannot reach within the golden time saw a notable decrease of approximately 47.37%. Further refinement and scalability assessments are needed, but overall, the approach holds promise for enhancing EMS performance in urban areas. In [9] this paper the author's discusses the application of deep learning techniques for optimizing ambulance positioning in road traffic accidents, emphasizing the crucial role of pre-positioning ambulances to minimize response times. While the study introduces a novel deep-embedded clustering approach and compares it with traditional clustering algorithms, it acknowledges limitations due to a restricted dataset and variables, which could hinder accuracy. To enhance the study, expanding the dataset by including additional variables such as road type and accident severity, and extending the analysis period could provide more comprehensive insights. Furthermore, conducting comparative studies across diverse geographic

and socio-economic settings, along with integrating real-time data feeds for dynamic ambulance positioning, would strengthen the research's validity and applicability. The findings from the test dataset, particularly after applying cross-validation, demonstrate the superiority of the proposed deep-embedded clustering framework over standard clustering algorithms, as evidenced by improved performance metrics such as silhouette score of 0.1960,distance score of 7.325, Davies Bouldin score of 1.472, and Calin ski Harbasz score of 2195.50. In [10], this paper the author's investigates deep learning for optimizing ambulance positioning in traffic accidents, stressing pre-positioning's importance for faster responses. Their novel clustering method outperforms traditional ones but faces data scarcity and lacks variables like road type and accident severity, limiting analysis. Despite promising 95% accuracy in cross-validation, expanding datasets, and conducting comparative studies across socio-economic contexts are essential for robustness. Integrating real-time data for dynamic positioning could enhance emergency response strategies, aiding decision-makers in allocating resources effectively. In [11] this paper proposes a framework using traffic surveillance cameras and action recognition to promptly detect and respond to traffic accidents in the US, enhancing emergency services' efficiency. While advanced technologies like smart city accident detection systems hold promise for improving traffic management, privacy concerns and algorithm biases need addressing. Further refinement and validation of the framework are necessary to ensure both effectiveness and ethical implementation. Previous studies explored diverse accident detection methods, but the proposed framework advances by integrating spatial and temporal dependencies for real-time accident prediction. However, its effectiveness could be hindered by data quality and scalability issues. Analyzing traffic accidents from 2016 to 2020 emphasizes the persistent challenge of improving road safety, underscoring the need for comprehensive strategies addressing various contributing factors. Although autonomous accident detection systems show potential, further research is crucial to understand accident causes fully and devise effective interventions, considering ethical implications and societal impact.

Proposed Framework



Patient (User): In the proposed framework for optimizing ambulance dispatch in road traffic accidents, the focus lies on enhancing the experience and outcomes for the patient, who is the primary user in this context. Through leveraging AI-driven location analysis, the system aims to efficiently identify and respond to the needs of patients involved in road traffic accidents. By integrating various data sources, including real-time traffic data, historical accident patterns, and geographical information, the framework seeks to ensure timely and

effective ambulance dispatch to the location of the patient. The system will prioritize patient safety and well-being by promptly identifying their location and dispatching the nearest ambulance equipped to handle their specific medical needs. Through advanced algorithms and machine learning techniques, the framework will continuously optimize ambulance routes to minimize response times and maximize the chances of successful patient outcomes. Additionally, the system will provide patients with real-time updates on ambulance arrival times and estimated arrival at the hospital, helping to reduce anxiety and uncertainty during emergency situations.

Ambulance Dispatch: Efficient ambulance dispatch plays a critical role in the proposed framework, ensuring that patients receive timely medical assistance following road traffic accidents. By integrating AI-driven location analysis, the system will identify the nearest available ambulance equipped to respond to the specific needs of the patient. Real-time traffic data, historical accident patterns, and geographical information will inform dispatch decisions, enabling the system to dynamically adjust ambulance routes to avoid congestion and minimize response times.The framework will leverage advanced algorithms to optimize ambulance dispatch based on factors such as the severity of the patient's condition, the availability of medical resources, and the proximity of the nearest hospital. By continuously analyzing incoming data and adapting dispatch strategies in real-time, the system will ensure that patients receive prompt medical attention, improving their chances of a positive outcome.

ULMA10: The short form of the official web architecture, which stands for "User Location and Measurement Ambulance Location Within 10 KM." This architecture likely facilitates the efficient determination of both the user's location (patient) and the nearest available ambulance within a 10-kilometer radius.

AI PathSense; Presumably, this refers to an artificial intelligence-based system designed to analyze and optimize ambulance routes in response to traffic accidents. It likely utilizes advanced algorithms to predict the most efficient path for ambulances to r each the accident site and transport patients to the hospital.

OpenStreetMap API: This is an application programming interface (API) that provides access to OpenStreetMap (OSM) data, which is a collaborative mapping project. It likely serves as a source of geographical data used by the framework to identify road networks, traffic conditions, and other relevant information necessary for optimizing ambulance dispatch.

OpenHospital Integration: Integration with OpenHospital systems is essential for streamlining patient transfers and ensuring timely medical intervention. Hospitals within the vicinity will be registered within the ULMA10 framework, enabling automated routing of ambulances to the nearest facility with available resources. Real-time communication between ambulances and hospitals will facilitate the pre-notification of incoming patients, allowing hospitals to prepare accordingly. Then, the proposed framework, OpenHospital Registration, serves as a crucial component for streamlining the patient intake process and facilitating seamless communication between emergency responders and healthcare facilities. By registering patients upon ambulance dispatch, the system will enable hospitals to anticipate incoming cases and allocate resources more efficiently.

Registration Process: Ambulance service providers and hospitals will undergo a registration process to participate in the ULMA10 network. This process will involve verifying credentials, ensuring compliance with standards, and providing access to the necessary APIs and protocols. Registration will enable seamless coordination and data sharing among all stakeholders involved in the emergency response process.
Through integration with the ULMA10 system and AI PathSense, OpenHospital Registration will provide hospitals with real-time updates on incoming patients, including their location, medical condition, and estimated time of arrival. This information will enable hospitals to prepare the necessary medical staff, equipment, and treatment protocols in advance, ensuring that patients receive timely and appropriate care upon arrival.

Technological Components: The framework will leverage advanced technologies, including the ULMA10 platform, AI PathSense algorithms for location analysis, and the OpenStreetMap API for accurate mapping and routing. These components will work synergistically to enable real-time monitoring, analysis, and optimization of ambulance dispatch operations.

Moreover, by leveraging OpenStreetMap API, the framework will enhance the accuracy of location data and improve ambulance routing to hospitals, further reducing response times and optimizing patient outcomes. Overall, OpenHospital Registration plays a pivotal role in enhancing the efficiency and effectiveness of emergency medical services in the context of road traffic accidents.

Performance analysis

Implemented within the framework, these components collectively contribute to significant improvements in ambulance dispatch efficiency and patient outcomes in RTAs. By leveraging AI-driven location analysis and seamless integration with existing healthcare systems, the proposed framework represents a transformative approach to emergency response optimization. Through ongoing evaluation and refinement, stakeholders can continue to adapt and enhance the framework to address evolving challenges and further improve emergency medical services for communities worldwide.

Future Directions and Research Opportunities

As authors of this research, we recognize several promising avenues for future exploration and development in the realm of optimizing ambulance dispatch in road traffic accidents. Firstly, further integration of diverse data sources, including weather conditions, road infrastructure quality, and population density, could significantly enhance the accuracy and effectiveness of our framework. Additionally, ongoing advancements in machine learning algorithms offer opportunities to refine dispatch optimization and adaptability, with exploration into deep learning techniques holding particular promise. Dynamic resource allocation strategies, considering real-time availability of ambulances and hospital capacities, represent another area ripe for investigation. Addressing privacy and security concerns, improving user interface design for enhanced usability, and fostering stakeholder collaboration are also critical areas for future focus.

Conclusion

In response to the critical real-life problem of optimizing ambulance dispatch during road traffic accidents, our proposed framework offers a comprehensive solution that harnesses the power of artificial intelligence (AI) and real-time data analysis. By addressing the shortcomings of traditional dispatch methods, which often struggle to factor in dynamic variables such as traffic conditions, accident severity, and geographic constraints, our framework represents a significant advancement in emergency medical services. Through the integration of advanced technologies like machine learning algorithms and the OpenStreetMap API, coupled with seamless communication with healthcare facilities via OpenHospital integration, we provide a sophisticated system for efficiently identifying and dispatching ambulances to the scene. This framework prioritizes patient safety and well-being by ensuring timely responses and optimal resource allocation, ultimately leading to improved outcomes for those affected by road traffic accidents. As we move forward, continued research and refinement of the framework, along with stakeholder collaboration and ongoing evaluation, will be essential in realizing its full potential and making meaningful strides in enhancing emergency response capabilities worldwide.

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IoT Based Smart Car Accident Prevention And Detection Management System

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ABSTRACT

The increasing incidence of vehicular accidents necessitates innovative solutions for enhanced road safety. In this paper, we present an AI-based vehicle accident prevention system that integrates advanced sensor technologies to monitor and mitigate risk factors in real time. The system employs a speed meter and GPS sensor to measure vehicle speed and ensure adherence to location-specific speed limits. Additionally, an alcohol sensor detects driver intoxication levels. Upon identifying over-speeding or driver intoxication, the system sends immediate notifications to the vehicle owner, enabling swift intervention. This approach leverages AI algorithms to analyze sensor data and provide proactive accident prevention measures. Our comprehensive evaluation demonstrates the system's effectiveness in diverse driving conditions, highlighting its potential for significant impact on vehicular safety. The results indicate enhanced stability and reliability, making this system a valuable asset for future automotive safety applications.

Keywords: Real-time accident detection, Drunk driving detection, Emergency call forwarding, Vehicle speed monitoring, and Temperature monitoring inside the vehicle.

1. Introduction

Vehicular accidents are a pervasive global concern, contributing to a significant number of fatalities, injuries, and substantial economic costs each year. Despite the continuous advancements in automotive technology and the implementation of various road safety measures, human error remains the predominant cause of many accidents. Two of the most common and critical factors leading to accidents are speeding and driving under the influence of alcohol. These issues underscore the urgent need for advanced systems capable of actively monitoring and mitigating risky driving behaviors in real time.

In response to this pressing need, we have developed an AI-based vehicle accident prevention system that integrates a suite of sophisticated sensor technologies. This system is designed to monitor vehicle speed and detect driver intoxication levels, thereby addressing two major causes of vehicular accidents. The system employs a speed meter and GPS sensor to continuously measure vehicle speed and verify compliance with location-specific speed limits. By dynamically adapting to different driving environments, the system ensures that the vehicle operates within safe speed thresholds, thereby reducing the risk of speed-related accidents.

In addition to speed monitoring, our system incorporates an alcohol sensor that continuously monitors the driver's alcohol levels. Upon detecting that the driver is intoxicated, the system triggers an immediate alert that is sent to the vehicle owner. This notification mechanism allows for prompt intervention, potentially preventing accidents caused by impaired driving. By ensuring that real-time alerts are sent to responsible parties, the system enhances the overall safety of the vehicle's occupants and other road users.

The core functionality of our system is driven by advanced AI algorithms capable of analyzing data from the integrated sensors to make real-time safety decisions. These algorithms process and interpret the sensor data to detect deviations from safe driving behaviors and initiate appropriate actions to mitigate potential risks. By combining speed monitoring with intoxication detection, our system provides a comprehensive and proactive solution to enhance vehicular safety.

In this paper, we detail the design and implementation of our AI-based vehicle accident prevention system. We elaborate on the integration of various sensor technologies, the development and deployment of AI algorithms for data analysis, and the communication mechanisms employed for alert notifications. Furthermore, we present experimental results that validate the effectiveness and reliability of our system under diverse driving conditions. Our findings demonstrate that this approach can significantly enhance vehicular safety, offering a robust and proactive tool for accident prevention in future automotive applications. This system not only promises to reduce the incidence of accidents but also serves as a pioneering step towards smarter and safer transportation systems.

2. Methodology

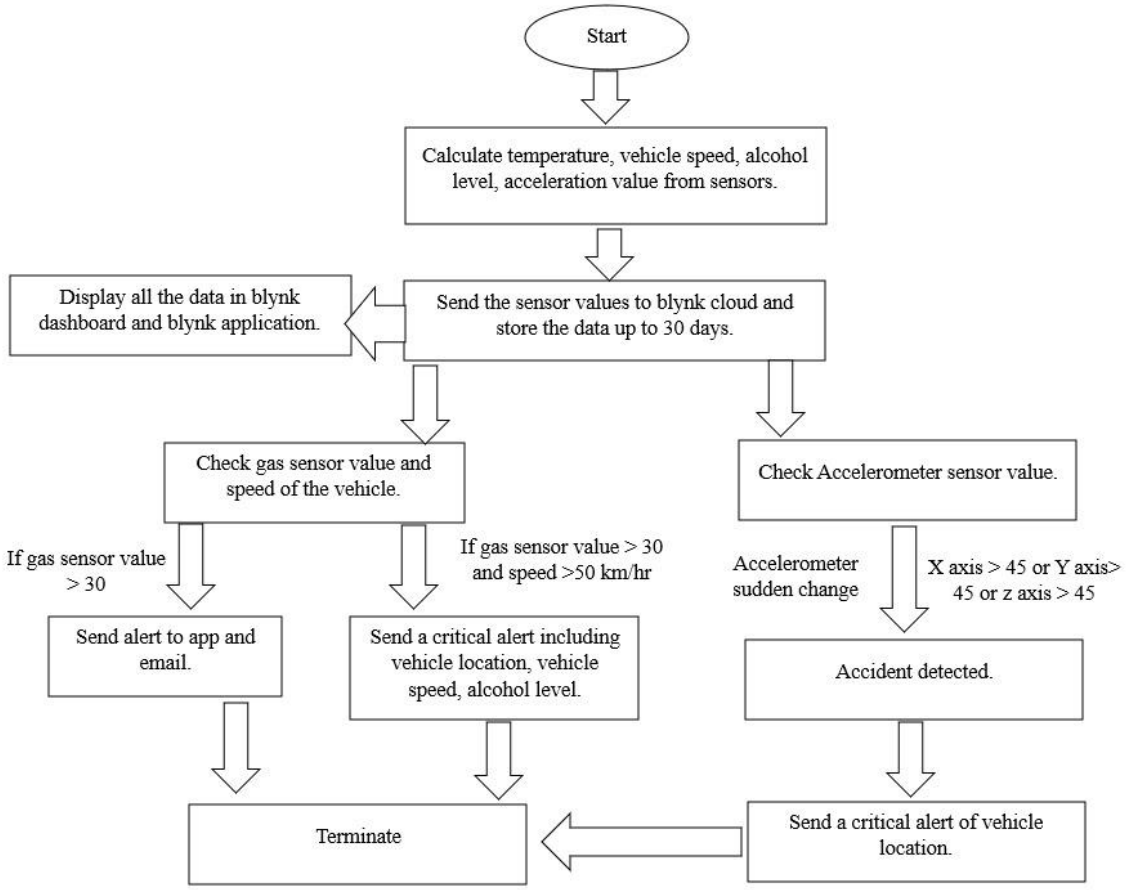
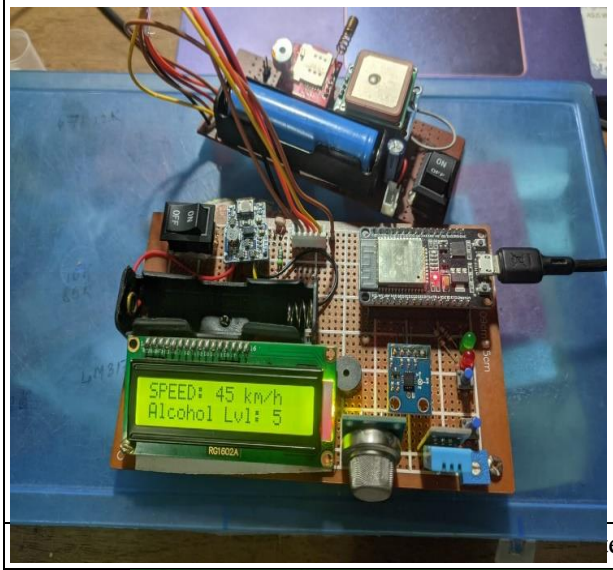
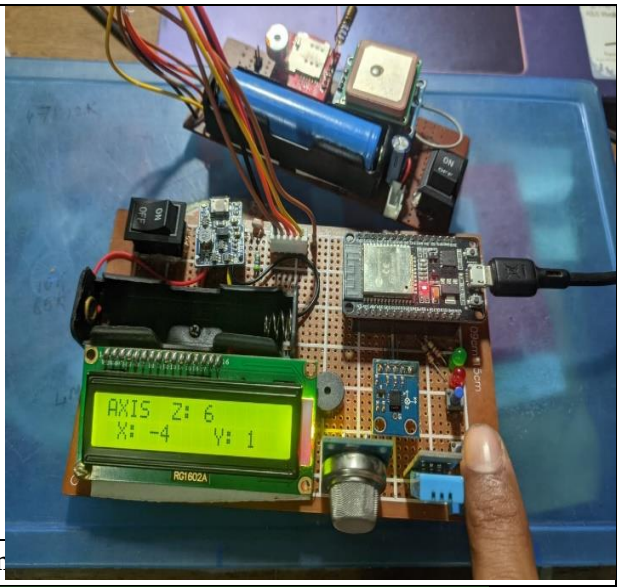


Figure 1. Flowchart of the smart-based car accident prevention & Detection System

The Smart Accident Detection project employs a combination of sensors and technologies to enhance road safety. Sensors such as accelerometer, speedometer and gps detect overspending and send notification to vehicle owner. If drunk driving is detected through alcohol detection systems, alerts are triggered. In the event of an accident an emergency call, containing accident details and location, is then forwarded to authorized users via GSM/GPRS modules. Meanwhile, speed sensors interface monitor driving behavior, providing insights into vehicle speed and other parameters. Through this integrated approach, the Smart Accident Detection project aims to promptly detect accidents, discourage drunk driving, and facilitate timely assistance to those involved in emergencies, thereby enhancing overall road safety.

3. Result Analysis:





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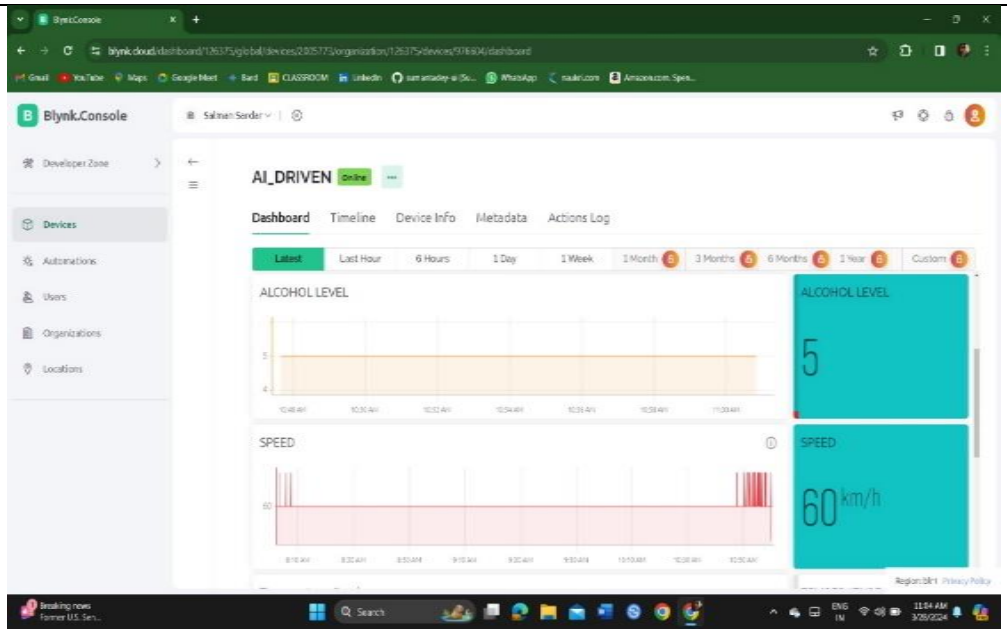

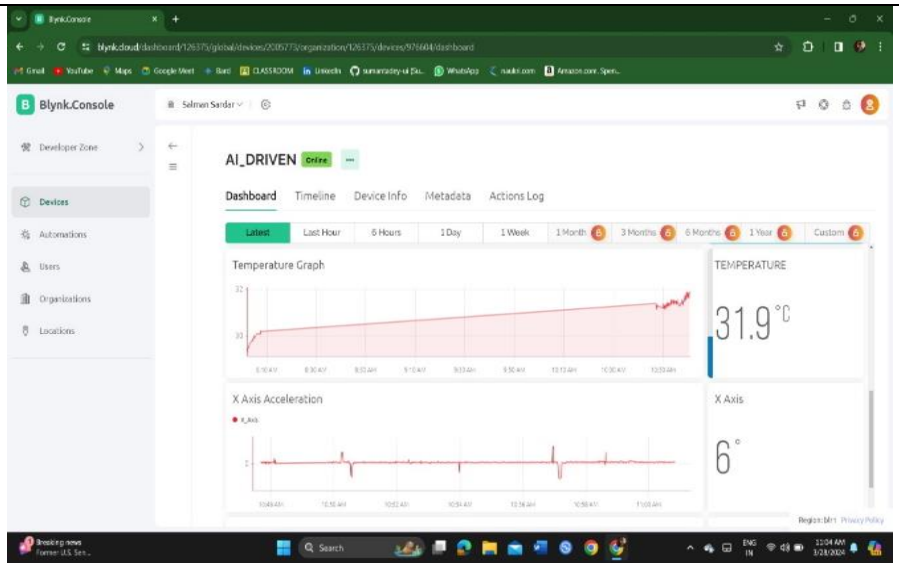

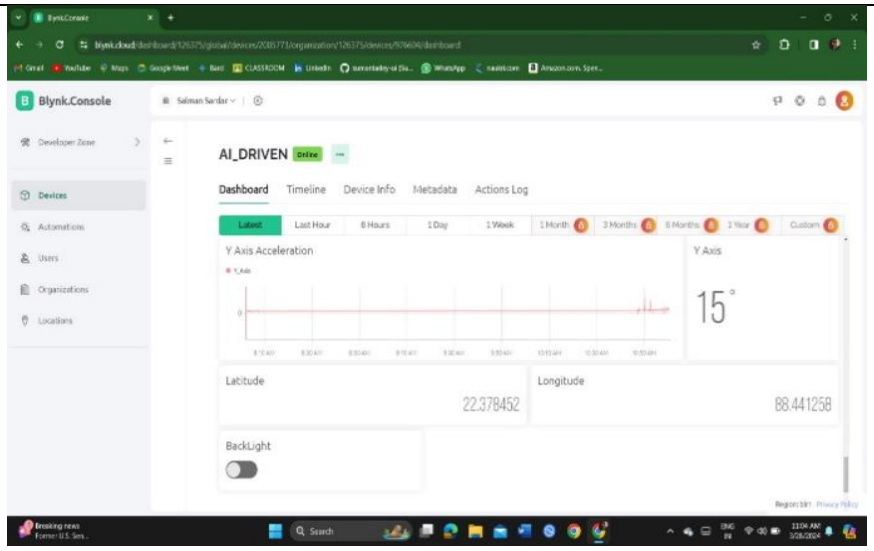

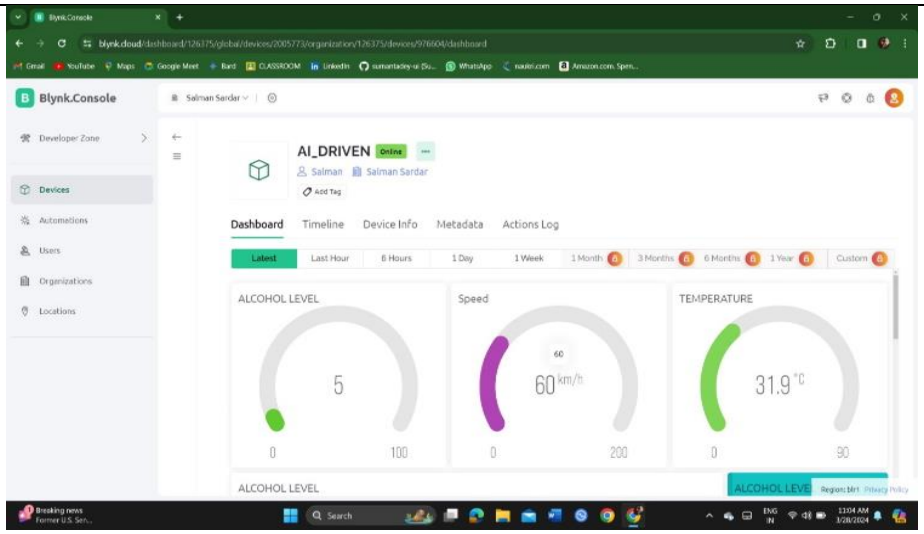

Figure 3. Graphical representation of Alcohol, accelerometer sensor, and temperature sensor for real-time data

Conclusion:

Smart accident prevention and detection are proposed using technologies such as V2V communication, Raspberry Pi, various sensors, MEC architecture, etc. It is an efficient one for solving the problem of accidents. From the above-conducted examination and analysis, we can conclude that this system mainly comprising RFIDs, Sensors, etc. has an upper hand over the traditional systems. The system prevents accidents by monitoring various conditions such as red light detection, validating driving licenses, detection of drunken driving cases, and many more. Using this method we can track and ensure that our loved ones are safe. This also solves the problem of maintaining the traffic properly for the sake of their and others' safety. It is efficient in terms of both the parameters as well as performance.

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Design A Controller to Control Robotic ARM

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ABSTRACT
The goal of this paper is to create a controller for a robotic arm. Robotic arms are essential tools for many different sectors, it is critical to optimize their control systems. Driven by the need to go beyond the constraints of current approaches, this work aims to create a customized controller that will enable robotic arm systems to reach their maximum potential. By means of rigorous design and implementation, the controller seeks to optimize performance, accuracy, and flexibility across a range of operational scenarios. The effectiveness of the suggested controller is demonstrated by experimental validation, which bodes well for important improvements in robotic arm control.
Keywords: Robotic Arm, Kinematic, Actuation, Controller, Intelligence, Efficiency.

Introduction
Robotic arms [1] are crucial elements of modern automation, enabling accurate and flexible manipulation in a variety of industries. Robotic arms are the pinnacle of accuracy and efficiency in difficult operations; they are used in operating theatres to improve medical procedures and manufacturing lines to maximise production. However, the effectiveness of these mechanical wonders depends on their control systems, which have to precisely navigate complex settings and carry out manoeuvres. With this requirement in mind, this study sets out to design a custom controller specifically designed to govern the movements of robotic arms [2]. The need to overcome the shortcomings of current control approaches and unleash the potential of robotic arm systems is what drives this research. Through the creation of a customised controller that is adjusted to the unique characteristics of robotic arm control, we want to break free from the limitations of traditional approaches and usher in a new era of increased reliability and efficiency. The potential consequences of robotic arm control advancements span numerous industries, including manufacturing, healthcare, logistics, and more. Increased productivity, improved quality, and increased flexibility in a variety of operational scenarios are all potential benefits of enhanced control capabilities. By pursuing these goals, we hope to advance robotic arm control and create the foundation for increased effectiveness, accuracy, and versatility in a range of applications. This

paper's later sections will outline the process that guides controller design [3], give empirical results, and discuss implications for the larger field of robotics and automation.

Literature Survey

Robotic arm control is so important to so many different industries, including manufacturing [4], healthcare, and space exploration, it has been the focus of a great deal of research. A wide range of strategies, including machine learning techniques, sophisticated algorithms, and conventional control methods, are covered in the literature on this subject. The purpose of this study is to summarize significant developments in robotic arm control and to highlight important contributions to the field's body of research.

Working Principle of Robotic Arm Control

In order to control the motion and manipulation of the robotic arm, a combination of hardware elements, mathematical models, and control algorithms [5] are used in the robotic arm control system. Fundamentally, the control system takes in data from sensors, interprets it, and outputs commands to move the end-effector and joints of the robotic arm.

Sensing: To sense the environment and condition of the robot, the control system uses a variety of sensors. These sensors include depth sensors or cameras for visual input, force/torque sensors for detecting interaction forces, and encoders for measuring joint angles. With the use of sensory data, accurate control and interaction with the environment are made possible by knowing vital details about the robot's position, orientation, velocity, and external forces.

Kinematic and Dynamic Models: The link between joint motions and end-effector movements is described by mathematical models [6], such as kinematic and dynamic equations. Trajectory planning and inverse kinematics solutions are made possible by kinematic models, which translate joint angles to end-effector positions and orientations. Accurate motion prediction and control are made possible by dynamic models, which take into consideration the dynamics of the robot, including inertia, friction, and outside forces.

Control Algorithms: To accomplish desired motions and tasks, the robotic arm's response to sensory inputs is determined by control algorithms. These algorithms fall under a number of categories, such as

- **PID Control**: A traditional feedback control technique, proportional-integral-derivative (PID) control modifies joint velocities according to the discrepancy between the desired and actual positions.
- **Computed Torque Control:** To provide precise motion control, this model-based control technique computes control torques based on intended trajectories, robot dynamics, and sensor feedback.
- **Force governs:** These algorithms govern the forces that interact with the robot's end-effector and its surroundings, enabling it to carry out activities including manipulation, assembly, and cooperative movement.
- **Learning-Based Control:** The robotic arm can learn the best control strategies[7] through experience, adjust to changing conditions, and gradually increase performance thanks to machine learning techniques like neural networks and reinforcement learning.

Actuation: Actuators convert control commands into actual joint motion of the robotic arm. Typically, they are electric motors. In order to move the joints along the intended trajectories determined by the control algorithms, actuators provide torques or forces.

Integration and Feedback: To continually monitor and modify the robot's movements in real-time, the control system combines sensory feedback with control orders. Feedback loops guarantee that the robotic arm maintains stability and performance during operation by precisely responding to uncertainties, disturbances, and changes in the environment.

Circuit Diagram

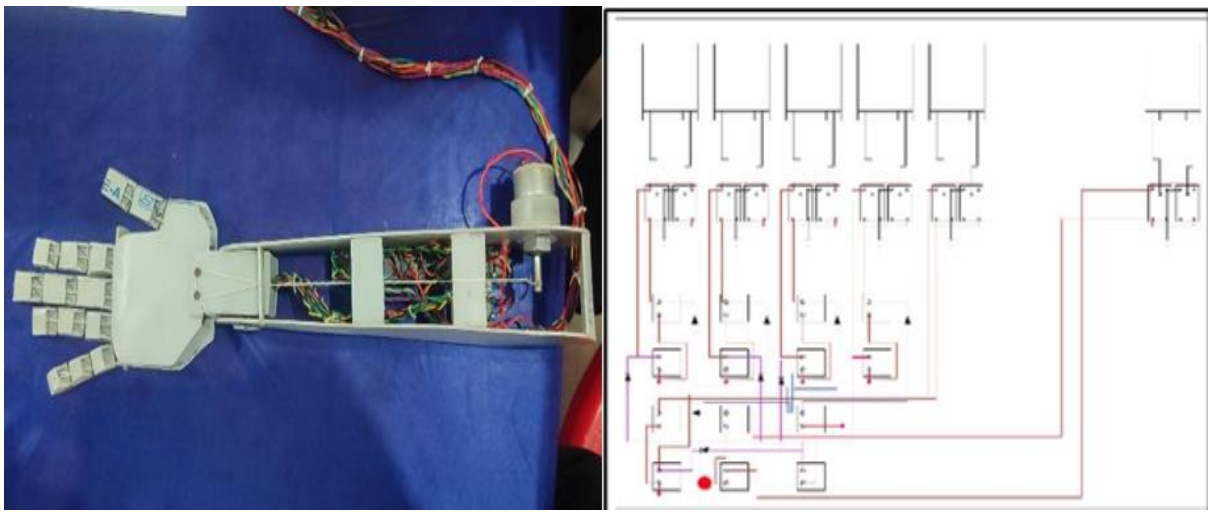

Fig 1: Construction of Robotic Arm and Circuit Diagram

Innovation

The invention put forth here transforms robotic arm control by creating an adaptive control system that easily combines cutting-edge machine learning methods[8] with conventional control approaches. The robotic arm control paradigm has changed with the introduction of the Adaptive Robotic Arm Control System (ARACS), which provides previously unheard-of levels of intelligence, efficiency, and adaptability in a variety of applications.

Applications

The ARACS, or Adaptive Robotic Arm Control System, is a flexible and adaptive technology that may be used in a multitude of industries and applications. Its hierarchical architecture, adaptive control techniques[9], and sophisticated machine learning integration allow for accurate and effective manipulation in a variety of operating scenarios. Here are a few important uses for ARACS:

Production Automation: Agile and adaptable robotic automation is made possible by ARACS, which transforms production procedures. It can be used on assembly lines to do pick-and-place operations, quality inspection, and part manipulation. Because of its adaptive control capabilities, it can easily adjust to changes in production needs, increasing productivity and efficiency.

Healthcare Robots: ARACS is used in patient care, rehabilitation support, and surgical robots in the healthcare industry. Robotic arms with ARACS capabilities can be used by surgeons to perform minimally invasive procedures with greater accuracy and faster recovery. Furthermore, ARACS can enhance the quality of life for individuals who have mobility problems by helping them with everyday tasks like eating and grooming.

Research and Development: By offering a versatile and adaptable platform for experimentation, ARACS supports research and development in robotics and automation. ARACS can be used by researchers to prototype new robotic systems, investigate human-robot interaction, and test novel control algorithms. By continuously improving upon current designs, researchers may push the bounds of robotics innovation thanks to its continuous learning capabilities.

Future Scope

With continuous developments in robotics, AI, and automation technologies [9], the field of adaptive robotic arm control systems has a bright future ahead of it. The range and significance of adaptive control systems like ARACS will grow along with the capabilities of robotic arms. Here are some major developments and trends for this technology going forward:

Enhanced Autonomy and Adaptability: More autonomy and adaptability will be seen in future adaptive robotic arm control systems. The ability of these systems to seamlessly integrate into dynamic and unstructured situations will be made possible by their constant learning and adaptation to shifting activities, contexts, and user preferences. Robots will be able to anticipate and react to novel obstacles in real-time without the need for explicit programming thanks in large part to machine learning algorithms.

Human-Robot Collaboration and Interaction: This will be a key component of robotic arm control in the future. Robots and humans will be able to collaborate closely in shared workspaces thanks to adaptive control systems, which will support and enhance human abilities rather than replace them. To enable safe and natural contact between humans and robots in this collaborative paradigm, advancements in safety, perception, and communication technologies will be necessary.

Conclusion

An enormous turning point in the history of robotics has been reached with the development of adaptive robotic arm control systems, which have brought about previously unheard-of levels of intelligence, efficiency, and adaptability. These systems have completely changed the robotic manipulation [10] environment by combining cutting-edge control algorithms, machine learning approaches, and cutting-edge hardware to provide solutions for challenging problems in a variety of industries. It has been through the fundamental ideas, cutting-edge characteristics, and possible uses of adaptive robotic arm control systems. These systems have proven to be adaptable and have the potential to change a wide range of industries, from space exploration and assistive technologies to healthcare robotics and manufacturing automation. Adaptive robotic arm control systems provide countless prospects for development and innovation in the future. We should anticipate

increasingly higher degrees of autonomy, cooperation, and robustness in robotic manipulation as technology develops. These technologies will continue to push the envelope of what is feasible with continued research and development, opening up new avenues for productivity improvement, human-robot interaction, and societal effect. To sum up, adaptive robotic arm control systems are a revolutionary development in the field of robotics that provide answers to some of the most important problems that humanity is currently experiencing. Let us embrace the promise of these systems to construct a future where humans and robots coexist peacefully to create a better world as we set out on this adventure of research and discovery.

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CodeArena: Coding Challenge and Competition Hub

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ABSTRACT

In today's rapidly evolving technological landscape, nurturing the next generation's proficiency is paramount. Problem-solving skills are vital for intellectual growth and competence. To deepen students' grasp of programming, a competitive coding platform has been established, fostering peer learning and healthy competition, particularly in educational settings. Many students grapple with code analysis, prompting the development of support systems that encourage collaborative learning. Users can submit code across various languages for evaluation against set standards, with the platform tracking their progress and accomplishments. The competitive aspect spurs motivation and innovation, while the room-based setup facilitates diverse perspectives and teamwork. Collaborative problem-solving enhances understanding and creativity, supplemented by constructive peer feedback. This fosters a supportive community where students inspire each other, cultivating excellence and camaraderie within the coding realm. In essence, these coding challenge hubs blend peer learning, competition, and networking, nurturing academic and social growth in students.

Keywords: Coding Competition, Peer learning, Virtual rooms, Teamwork, Competitiveness, Innovation, Peer feedback

I. INTRODUCTION

In 1970, ACM-ICPC organized a groundbreaking competition at Texas A&M University, marking the genesis of competitive programming. This intellectually stimulating endeavor, often referred to as a "mind sport" according to Competitive Programming, involves participants programming to meet specified requirements either online or via local networks.[1] These participants, known as sports programmers, engage in solving a series of logical or mathematical problems presented by hosts, ranging from tens to several thousand in number. The challenge lies in crafting computer programs capable of solving each problem within a set timeframe. Real-time scoreboards heighten the excitement as participants strive to conquer tough problems and outperform their rivals. At higher echelons of competition, elite athletes from various regions or schools converge to vie for prestigious accolades like gold medals, trophies, or even cash prizes. Numerous platforms such as CodeChef [2], CodeForces [3], and HackerEarth provide arenas for competitive coding across over 50 programming languages, nurturing a robust community where students and professionals alike can hone their skills through learning,

competition, and improvement. These platforms host a variety of contests, categorized into short-term rounds lasting 1 to 3 hours and long-term competitions spanning from a few days to several months. With most competitions comprising multiple rounds, online participation predominates, except for final rounds necessitating onsite presence. Top performers at esteemed events like IOI and ACM-ICPC receive medals, while cash rewards await winners in other contests. High standings in these competitions often catch the eye of recruiters from software and internet companies. While competitive programming may not perfectly mirror real-world programming, it fosters efficiency and enhances debugging skills. Tackling challenging problems necessitates breaking them down into manageable components, solving each individually, and then synthesizing solutions—a process that hones practical problem-solving abilities invaluable in professional contexts. While competitive programming isn't the sole path to mastering these skills, it stands as one of the most effective avenues for their development. Typically, students engaged in programming competitions have access to a variety of contest platforms like Codeforces, USACO, COCI, TopCoder, CodeChef, and HackerEarth, each hosting contests at different intervals. The permitted programming languages vary significantly across platforms: for instance, IOI and IIOT restrict participants to C, C++, and Pascal only, while ICPC expands the list to include Python (both 2 and 3), Java, and kotlin.

Methodology:

Competitive programming stands as an intellectual challenge where programmers vie to tackle algorithmic problems swiftly and efficiently. Unlike the broader scope of subjects covered in app development, such as networking, GUI, and databases, these competitions focus sharply on algorithmic proficiency, a deep understanding of data structures, and adept implementation skills. It's a domain where the mastery of algorithms reigns supreme, honing problem-solving abilities and fostering a profound appreciation for the intricacies of computational logic.

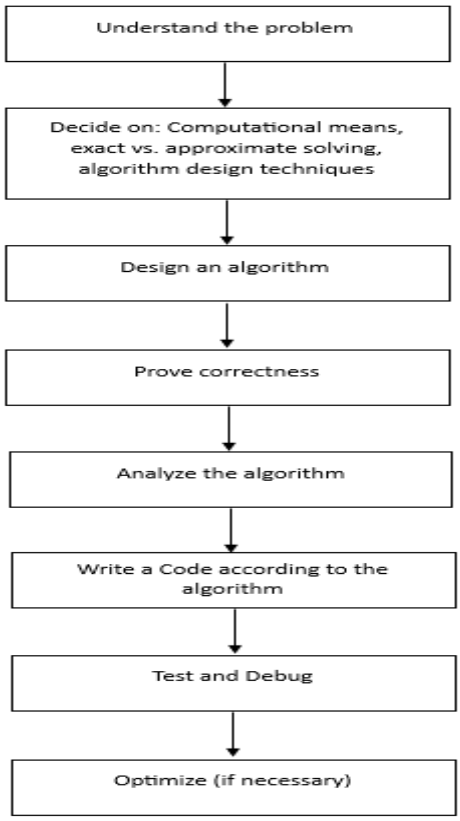


Fig 1: Algorithm design and analysis process

A system is developed for introducing a programming exercise format tailored for beginners, featuring small contests within a peer environment. The system automatically evaluates uploaded answer programs by executing them with provided sample data, promptly informing users of results. Progress updates for all users are displayed in the profile section. The system employs a series of execution tests with a flexible matching approach for iterative refinement. This system recognized the significance of competitive programming and its impact on the IT industry and computer science graduates, particularly students.

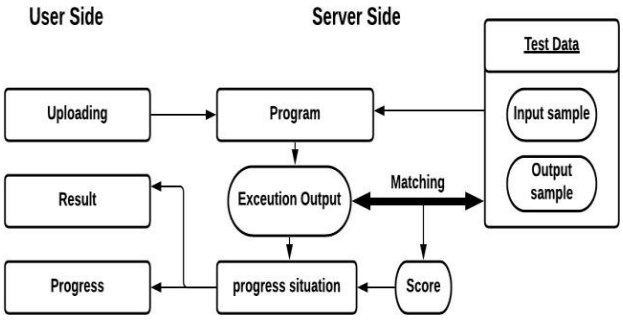


Fig 2: The program judgment by execution tests with given sample data

A programming contest entails a competitive setting where participants are presented with a series of programming tasks, referred to as problems, to solve within a constrained timeframe and under specific time and space limitations. These problems vary in complexity, with some comprising simpler subtasks that can be tackled using basic techniques within the stipulated time and space constraints. However, others pose greater challenges, demanding specialized algorithmic techniques and intricate data structures to overcome.

The system developed using JavaScript, NodeJS, React, and MongoDB. Following contest participation, the problem list page provides an overview of each problem. On each problem page, users can access the title and description of the problem, a code editor, an input editor, and a display section. We utilized an inner frame technique to maintain a seamless user experience without page transitions. The problem statement includes sample data, implementation hints, and an input form for submitting source code solutions.

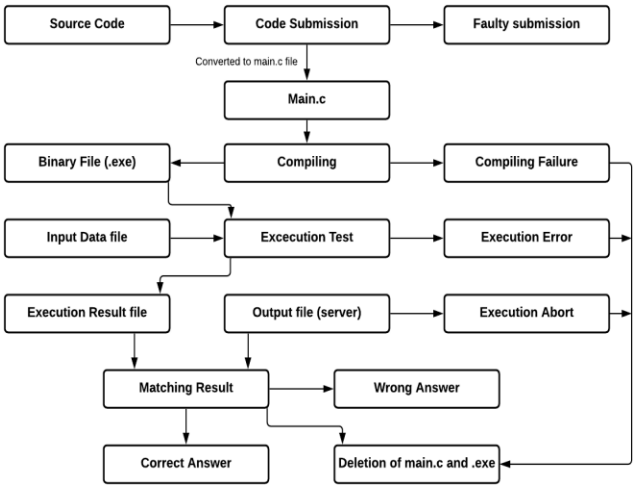


Fig 3: The steps in the judgment process given by a sample data

The system is dependent on JavaScript, react for the front end, and node js in the backend. The system utilizes specific dependencies for both front-end and back-end structures to enhance user experience and functionality. For the front end, dependencies like CodeMirror facilitate real-time code editing, while Sass streamlines stylesheet management also as it cloud-based software solutions that allow users to access and use applications over the internet so, it does not require the need to be installed and configured locally. Frameworks and libraries like React, along with accompanying tools like react-icons and react-router-dom, aid in building interactive and responsive user interfaces. Additional utilities such as confetti-js add visual feedback, while buffer assists in data manipulation. ESLint ensures code quality and consistency, while Vite optimizes the development environment. On the back end, Cors enables secure cross-origin resource sharing, while Express simplifies server-side routing and handling of HTTP requests. Mongoose provides an interface for MongoDB, facilitating database operations and data modeling. Together, these dependencies create a robust and efficient environment for users to practice coding challenges, interact with the platform seamlessly, and receive timely feedback on their solutions.

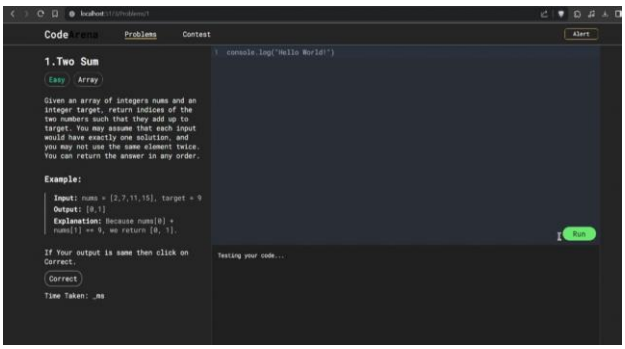
Tech stacks that is used in this system:

- **Client:** React, Code mirror

- **Server:** Node, Express

Result and Discussion

The implementation comprises two main sections: firstly, the "compiler page" allows users to code and execute without specific problem statements provided. Secondly, the "problem statement page" presents users with a selection of problems. Upon choosing a problem to solve, users submit their solution, and the system compares their output with the expected output on the server side, as illustrated in the figure provided. Upon code submission, the server converts it into a respective file format based on the programming language: "main. c" for C, "main.java" for Java, and so forth. This generated file is then processed into machine code with the aid of compilers and executors, resulting in different file formats such as ".exe" for C and a class file for Java. Any errors in the code are promptly communicated to the user. If the code compiles successfully, executing the compiled file produces an output that is then compared with the expected output in the problem statement. A correct match signifies a successful verdict; otherwise, an incorrect verdict is relayed to the user. After this feedback, all server-generated files, including compiled and executable files, are automatically deleted, marking the completion of the process. Successful task completion earns the user scores, which are added to their progress. Only the website administrator holds the authority to add problem statements, typically in the form of a file.txt containing the problem description and output. The problem statement page allows users to view a list of problems, and there's a submission form for problem descriptions and outputs. Additionally, users can access a profile page displaying their activity list, including solved problems and credentials. Users will be able to earn stickers and badges based on their score values. Furthermore, students can enhance their learning through a room-based arrangement with peer-learning approaches. Competitive programming serves as a prominent avenue through which universities establish their academic reputation, showcasing the talent within their student body. Engaging in competitive programming enables students to hone their problem-solving skills, crucial for navigating the challenges encountered in tech-oriented companies such as Facebook, Twitter, and Google. Moreover, it plays a pivotal role in preparing students for rigorous coding interviews conducted by these industry giants. Despite the limited number of graduates entering top tech firms, enhancing the competitive programming skills of Computer Science/IT graduates remains essential.



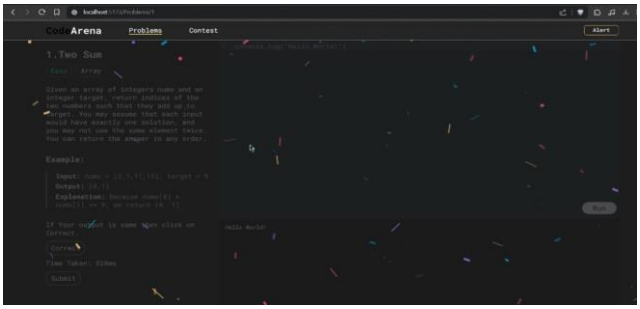


Fig 4: The above figures describe successfully code execution is performed

Conclusion

In this study, the main focus is on competitive programming competitions, which serve as platforms for enhancing problem-solving abilities and refining coding skills. Through a comprehensive review of existing literature, the necessary data are compiled to derive the findings. The information gathered from various sources is stored in a database system for analysis. Results have demonstrated the effectiveness of this approach in producing competitive outcomes. Furthermore, diverse activities have been developed to offer training for online programming contests.

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Comparative Performance of various Fuel blend for Diesel Engine in Emission perspective

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ABSTRACT
Researchers have generated several fuel combinations and used them in CI engines without any modifications to find the best diesel engine replacement fuel, but operational issues linger. Lemon peel oil (LPO), which has near-equivalent fuel properties to diesel fuel, and Jatropha biodiesel, which has the highest oxygen concentration, are used in this study to reduce emissions. Nine fuel blends have been generated by blending diesel, Jatropha biodiesel, and LPO in nine different proportions. Diesel RK commercial software uses these fuel blends to simulate and forecast the emission levels of the virtual Kirloskar TV1 single-cylinder, 4-stroke direct injection diesel engine. The D80J5L15 fuel combination has the lowest CO2 and particulate matter (PM) contamination in comparison to other fuel blends and produces less smoke and slightly more NOx emissions than diesel fuel. The D80J5L15 fuel combination may partly or totally replace diesel fuel in this engine from an emission perspective.
Keywords: Biodiesel, Biofuel, Lemon Peel Oil, Jatropha Biodiesel, Diesel RK Simulation

Introduction

Petroleum fossil fuels have far-reaching economic consequences for every country, especially in the areas of transportation and power production. The petroleum fuel industry, however, is prone to monopolization because of the finite worldwide supply of petroleum resources [1]. Moreover, hydrocarbons used to power vehicles worsen global warming along with various issues related to the environment [2]. This has led to a flurry of activity in the energy sector as researchers seek renewable and recyclable fuel alternatives. When considering alternatives for engines powered by diesel, biodiesel appears to be the best option.

Transesterification of easily accessible plant-based oils or fats from animals allows for efficient production in many developed countries [3–4]. However, biodiesel has encountered difficulties when used in diesel engines, such as elevated viscosity, reduced heat conductivity, gum emergence, and oxidation as well, each of which impacts the efficiency and durability of the engine [5–6]. Grass, leaves, and other plant-based biofuels have their own distinct advantages over conventional diesel, but they're otherwise rather similar. For improved atomization and evaporation, these kinds of biofuels usually have low viscosities and boiling temperatures. Furthermore, their thermodynamic properties nearly approach those of standard diesel fuels [7]. Biofuels made from vegetable and fruit peels have recently attracted attention from researchers all over the world as a possible eco-friendly alternative to conventional diesel fuel.

Purushotam et al. [8] adopted orange peel oil biofuel in their experiment to analyze and compare the performance and combustion characteristics of a single-cylinder diesel engine with regular diesel fuel. As a result, they have established that BTE increased by 8.2% due to the longer delay period and combustion duration. Orange oil-based fuel has identically shown a declining trend in CO and HC emissions but shows increased NO_x emissions as contrasted with diesel fuel at all loads. Dhinesh et al. [9] conducted an experiment by combining the lemongrass oil biofuel in varying percentages of 10%, 20%, 30%, and 40% with diesel fuel to assess the performance of the diesel engine. The experiment indicated that a fuel blend incorporating 20% biofuel generated a similar kind of BTE. In another study, Ashok et al. [10] used LPO in varying quantities with diesel fuel in order to investigate the consequences of various proportions of LPO on diesel engine functioning and pollution features and discovered that BTE improved but rather generated higher amounts of NO_x under every load scenario when operated with 100% LPO by volume.
On the contrary, biodiesel produces fewer quantities of CO, HC, and PM inside the exhaust fumes owing to the fact that it contains 10%–11% oxygen by weight as opposed to diesel fuel [11]. Agarwal et al. [12] observed that a fuel mixture comprising 20% of the volume of biodiesel and the remainder of the volume occupied by diesel with an EGR effectiveness of approximately 15% is a good alternative to employ because it boosts BTE, lowers BSFC, and reduces exhaust pollutants as well. Again, Carraretto et al. [13] observed a contrary pattern where BSFC increased with biodiesel. CO emissions are dropping, but NO_x emissions are rising. Similarly, Aziz et al. [14] claimed that the engine demonstrated the same type of BTE with biodiesel in comparison to diesel fuel and also identified the lowered quantity of exhaust pollutants released from the engine apart from NO_x emissions.

The literature review reveals that the utilization of biodiesel with diesel fuel as an alternative fuel in CI engines has some operational difficulties, yet biofuels generated from plant leaves demonstrate the same attributes as diesel fuel, which increase engine performance. Again, it has also been discovered that blend of biodiesel and diesel fuels minimizes the emission of pollutants emitted into the atmosphere. Therefore, the authors decided to develop a hybrid blend by considering LPO biofuel and Jatropha biodiesel with diesel fuel to operate on the diesel engine to estimate the emission characteristics, by using Diesel RK Software which had not been previously done.

Diesel RK Software Simulation Model

Utilizing the concepts of the first law of thermodynamics, thermal modeling is applied to examine the operational features of engines through the execution of Diesel-RK software. Various thermodynamic parameters are evaluated in connection with crank inclination and throughout time intervals. Engine friction and heat transfer are integrated, and taking into consideration by semi-empirical correlations established from

data obtained from experiments. The combustion process inside the combustion chamber is emulated using a multi-zone framework, which integrates the essential equations for conservation as presented by Fiveland et al. [15].

NO_x Formation Modeling

NO is a substantial component of diesel engine emissions, among other nitrogen oxides [16]. Thus, the current article focuses primarily on the generation of NO employing the Zeldovich approach. Kuleshov [17] described the method used in developing this framework. It is a sequential calculation, including the optimal degradation of combustion products for eighteen organisms inside the burned gas zone. Thermal NO is computed employing the chain Zeldovich technique, and the fundamental stages for NO formation are outlined below:

$$\begin{aligned} &O_2 \longleftrightarrow 2O \\ &N_2 + O \longleftrightarrow NO + N \\ &N + O_2 \longleftrightarrow NO + O \end{aligned} \tag{1}$$

The above-mentioned actions run at certain rates depending on the quantity of atomic oxygen present. The applicable equation [17] is used to compute the fraction of the total volume of NO in the products of combustion generated during the present calculation stage:

$$\frac{d[NO]}{d\theta} = \frac{p.2.333*10^7.e^{-\frac{38020}{T_z}}[N_2]_e.[O]_e.\left\{1-\left([NO]/[NO]_e\right)^2\right\}}{R.T_z.\left(1+\frac{2365}{T_z}.e^{\frac{3365}{T_z}}.\frac{[NO]}{[O_2]e}\right)}.\frac{1}{\omega} \tag{2}$$

Soot and PM Formation Modeling

The following formula [18] is used to calculate the rate of soot generation inside the region of combustion.

$$\left(\frac{d[C]}{dt}\right)_k = 0.004\frac{q_c}{V}\frac{dx}{dt} \tag{3}$$

The degree of soot generation may be described as the Hartridge smoke level, and it is estimated by means of the subsequent equation:

$$\text{Hartridge Smoke Level} = 100[1-0.9545\exp(-2.4226[C])] \tag{4}$$

PM emissions are computed employing an equation that is expressed as a function of the Bosch smoke number, as described by Alkidas [18]. The equation appears as follows:

$$[PM] = 565\left(\ln\frac{10}{10-\text{Bosch}}\right)^{1.206} \tag{5}$$

Simulation Method

The diesel RK program is used to model an engine by entering its basic parameters, creating a new project, and saving it. It is crucial to keep operating systems updated, set the engine's temperature and RPM, and check the spray nozzle's functionality. The component arrangement and combustion chamber geometry are prepared, and the engine's piston bowl arrangement is an input. Precision and investigation into injection qualities are necessary, and the simulation results should be run after examining the setup parameters [19].

Engine Specification

The data from the Kirloaskar TV1 engine was utilized for this numerical investigation at a single load of 100%, the engine operated at a constant 1500 rpm. The following are the specifications of the Kirloskar TV1 engine:

Table 1 : Engine Specification Details

Model	Kirloskar TV1
Description	Single Cylinder, 4 Stroke, direct injection diesel engine
Rated Power	5.2 kW
Bore	87.5 mm
Stroke	110 mm
Compression Ratio	17.5:1
Speed	1500 rpm
Type of Cooling	Liquid Cooled

Properties of Fuels used

Nine distinct hybrid blends with varying proportions of diesel, LPO, and Jatropha biodiesel were developed for this numerical prediction. For the aforementioned study, 60%, 70%, and 80% diesel were combined with LPO and Jatropha in equal and balanced weighted proportions. Based on experimental data, the thermophysical properties of these blends were calculated using the weighted average approach. Table 2 displays the findings.

Table 2 : Properties of different Fuel blends used

Properties	D60J20 L20	D60J30 L10	D60J10 L30	D70J15 L15	D70J20 L10	D70J10 L20	D80J10 L10	D80J15L5	D80J5 L15
Carbon Composition	0.8532	0.8408	0.8656	0.8574	0.8512	0.8636	0.8616	0.8554	0.8678
Hydrogen Composition	0.1183	0.12115	0.11545	0.12022	0.12165	0.1188	0.12215	0.12357	0.12072
Oxygen Composition	0.025	0.0363	0.0137	0.01975	0.0254	0.0141	0.0145	0.02015	0.00885

Sulfur Fraction	0.00848	0.00772	0.00924	0.00886	0.00848	0.00924	0.00924	0.00886	0.00962
Low Heating Value (MJ/Kg)	39.902	38.801	41.003	40.5515	40.001	41.102	41.201	40.6505	41.7515
Cetane Number	42.4	46.2	38.6	43.8	45.7	41.9	45.2	47.1	43.3
Density of Fuel @ 323K (Kg/m3)	840.4	841.6	839.2	837.8	838.4	837.2	835.2	835.8	834.6
Molecular Mass of Fuel	197.648	212.224	183.072	195.736	203.024	188.448	193.824	201.112	186.536
Dynamic Viscosity Co-efficient (Pa-sec)	0.00464	0.00436	0.00492	0.00423	0.00409	0.00437	0.00382	0.00368	0.00396
Specific Vaporization Heat (KJ/Kg)	240	239	241	242.5	242	243	245	244.5	245.5

Result and Discusssion

Table 3 exhibits the notation of the various fuel combinations used in the computational forecasting, which included evaluating all fuel combinations at full load at 1500 rpm, the engine's rated speed.

Table 3: Representation of different Fuel blends used

Fuel Blend	D100J0L0	D60J20L20	D60J30L10	D60J10L30	D70J15L15	D70J20L10	D70J10L20	D80J10L10	D80J15L5	D80J5L15
Notation	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10

CO_2 Emission

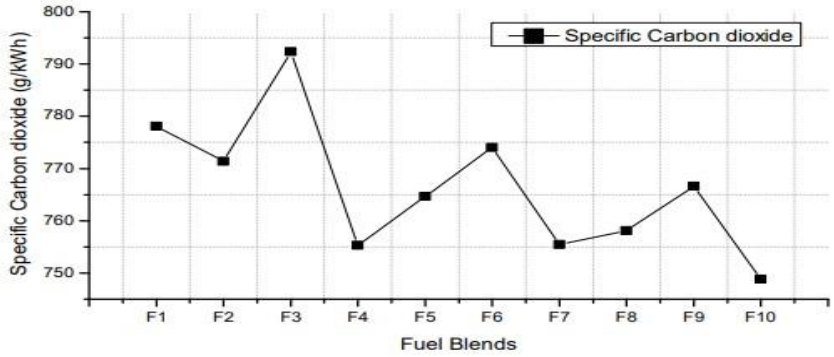

Fig.1 Variation of CO_2 Emission with different fuel blends

Figure 1 depicts the variability of CO_2 emissions across various fuel blends, with the F10 fuel mix designation having the lowest CO_2 emissions. It is the outcome of a thorough and complete combustion process. The lower

amount of lemon peel oil and jatropha blend, with an increase in the quantity of diesel fuel, produces a limited supply of oxygen, thus leading to incomplete combustion and reducing CO_2 emission.

NO_x Emission

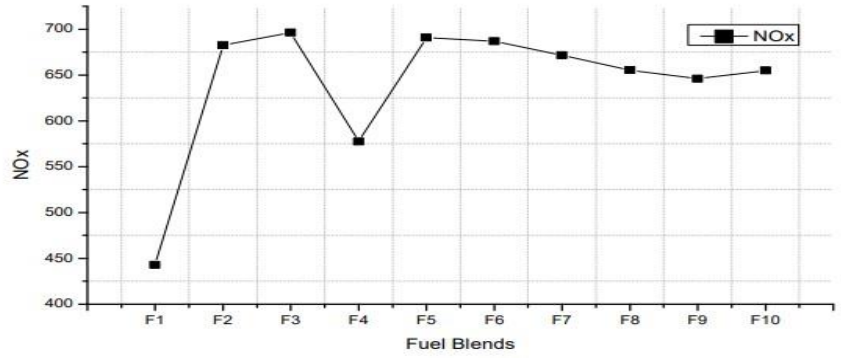

Fig.2 Variation of NO_x Emission with different fuel blends

The combustion chamber's high gas temperature and oxygen levels caused the NO_x to be released. The correlation between nitrogen oxide emissions and various fuel blends is shown in Figure 2. The figure illustrates that diesel fuel releases the least amount of NO_x. This is because biodiesel made from Jatropha, which has a greater oxygen concentration, delivers more oxygen during combustion, resulting in increased NO_x generation. Additionally, all the mixed fuels have lower cetane values compared to diesel fuel, resulting in greater ignition delay and higher NO_x emissions [20].

Smoke Emission

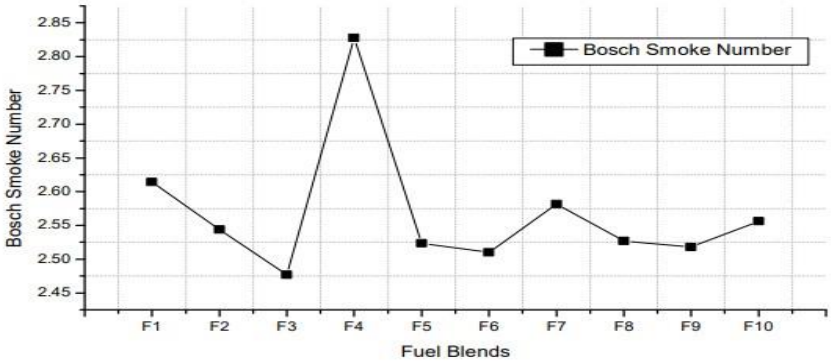

Fig.3 Variation of Smoke Emission with different fuel blends

Smoke emission is generated by the fuel-rich region, and F3 is indicated as D60J30L10, which comprises 60% diesel and 30% Jatropha biodiesel by volume, which is the highest among other fuel blends that offer more oxygen, and resulting the blend of fuel produced a least amount of smoke emission.

PM Emission

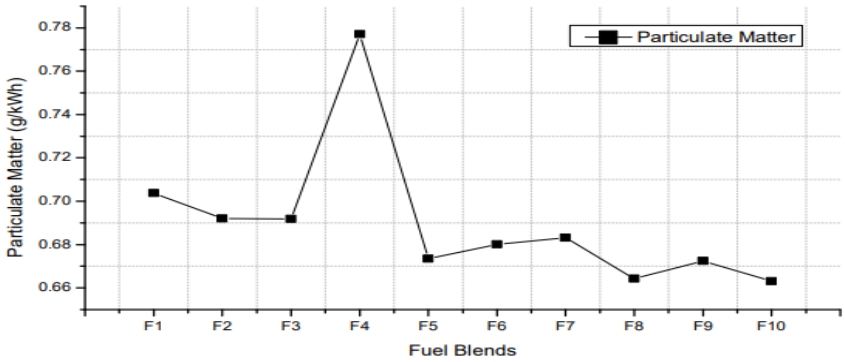

Fig.3 Variation of PM Emission with different fuel blends

PM emissions in CI engines are caused by improper combustion, but the F10 fuel combination, D80J5L15, reduces this emission due to a lesser amount of biodiesel fuel. Though it contains 80% of diesel but contains only 5% of bio diesel lowest among the other blends, which leads to decrease the volume percentage of fatty acid and the decreased viscosity properties of LPO facilitate spray atomization during the process of combustion, and this is related to the lack of fatty acid content, which improves the combustion process [21].

Conclusion

The study analyses the optimum fuel combination for a diesel engine by combining diesel and LPO with Jatropha biodiesel in various proportions. It indicates that the D80J5L15 fuel blend could substitute diesel fuel since it generated the lowest CO_2 and PM emissions among various fuel combinations used for this numerical simulation and releases a reduced amount of smoke in comparison to diesel but generated a bit more NO_x emissions, as anticipated by the numerical simulation.

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Utility of Geo-informatics for Morphometric Analysis in a Watershed : A Review

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ABSTRACT

Land forms, land reliefs, and land surface dimensions are all mathematically analyzed and measured in the field of morphology. The morphometric character of a watershed is represented by its various linear, areal, and relief features. The morphometric analysis of a watershed can be used to look into the erosion status of the watershed, its susceptibility to flooding, and the important areas in the drainage basin that are affected by soil erosion. Geospatial technology may be used to prioritize watersheds based on the level of erosion within river basins, using various morphometric characteristics. Prioritizing different watershed management techniques can stop soil erosion and further deterioration in areas that are severely degraded. From all of the material that was gathered, we discovered that the researchers employed Geographic Information System (GIS) and Remote Sensing (RS) technologies for morphometric analysis and prioritization, taking into account various linear, areal, and relief aspects of watersheds. The approach taken, the conclusions drawn for improved watershed management, and the input data used were the main topics of this paper. The introduction, conceptual framework, methods, findings, conclusion, and references are the six sections that make up this study.

Keywords : morphometric analysis, watershed, remote sensing and GIS, prioritization

I. INTRODUCTION

India should make use of its wealth of natural resources, including its water and soil [27]. It has been highlighted by academics that unchecked resource use degrades these resources and impedes the possibility of sustainable development [22]. Moreover, a large amount of water is no longer fit for use or consumption due to its deteriorating quality [5]. These issues are brought about by the overuse of these resources, poor agricultural practice adoption, and lack of knowledge about watershed management. Due to these misguided farming methods, there has been a decrease in groundwater recharge, an increase in runoff, an increase in soil erodibility, and a reduction in reservoir storage capacity [9]. The sustainable use of already available natural

resources to maximise productivity while guaranteeing environmental preservation is the definition of watershed management, according to a study by another researcher [23]. In a watershed or river basin, the use of morphometric analysis is crucial to the evaluation and development of surface and groundwater resources. Important insights for efficient watershed development and management can be obtained by looking at a variety of characteristics, including the drainage basin's topography, lithology, erosional status, and drainage pattern [20, 34]. Relief, areal, and linear features of the watershed are among the parameters that are used in the study of morphometric analysis [6]. Researchers have suggested [38] that artificial recharge sites can be investigated through the use of GIS and remote sensing tools in morphometric analysis. Research has shown that morphometric feature analysis can help distinguish across watersheds based on distinct topographical and geomorphological parameters [19]. Using satellite data for remote sensing makes it possible to obtain a thorough picture across a wide region [23]. Although conventional techniques can also be utilized to acquire morphometric parameters, a quicker and more practical method is provided by combining remote sensing, GIS, and a digital elevation model (DEM) [2]. For the purpose of analyzing spatial data pertaining to morphometric parameters across various places within a basin, GIS offers a flexible and effective tool. Decision-makers can better plan and manage watersheds by using GIS to prioritize regions that are most susceptible to erosion and deterioration. With the aid of this technology, important areas that need to be addressed right away can be identified, facilitating the methodical and efficient execution of conservation measures. The well-being of the population living in the watershed or river basin will benefit from this strategy as well as sustainable development.

Conceptual Framework

According to Horton [14], the smallest tributary at the end of a finger that has no further tributaries is the first order stream. When two first order streams combine, a second order stream is created; higher order streams follow the same pattern. The resulting stream order is always the same as the lower order when two streams of different orders collide. The stream order rises in direct proportion to the drainage area's size, according to Strahler [31]. The number of streams of a given order drops as stream order rises, whereas the number of streams of the lowest order rises relative to all other higher order streams [31]. The ratio of lower order streams to the number of streams in the higher order stream that follows right after is known as the bifurcation ratio [31]. Plotting the natural logarithm of the stream rank against the total number of streams shows a somewhat varying straight line relationship. Any departure from this relationship suggests that the drainage network is influenced by lithology. Three categories were created out of several morphometric data: linear, relief, and aerial parameters. Watersheds that are circular have a higher probability of flooding than those that are longer. In the watershed with the highest basin relief parameter and the largest amount of forest area, soil erosion would be lessened, and vice versa. Since these watersheds will face the highest erosion, priority should be given to the one with the highest linear and relief parameter value and the lowest relief parameter value [7].

Methodology

With GIS, morphometric parameters of the drainage basin may be obtained, making it a useful tool for spatial information analysis. Following a thorough analysis of the various literatures, we conclude that several linear, relief, and aerial aspects warrant further study in order to improve watershed management.

Data Used

The raw data sources used in all research papers were 1:50,000 scale toposheets from the Survey of India (SOI), 90-meter resolution Shutter Radar Topography Mission (SRTM) data, 30-meter spatial resolution ASTER Digital Elevation Model (DEM) data, 30-meter spatial resolution CARTOSAT DEM data, 5.8-meter spatial resolution LISS IV data, RESOURCESAT-2 LISS-III data, and Landsat Thematic Mapper OLI data [1-38].

Process

Arc GIS, ERDAS IMAGINE, or QGIS must be used to digitalize a drainage basin and define its drainage network and watershed borders in order to analyze the morphometry of the basin. There are numerous software choices and tools available to support the various morphometric analysis techniques. Figure 1 shows the flow chart of the morphometric analysis process.

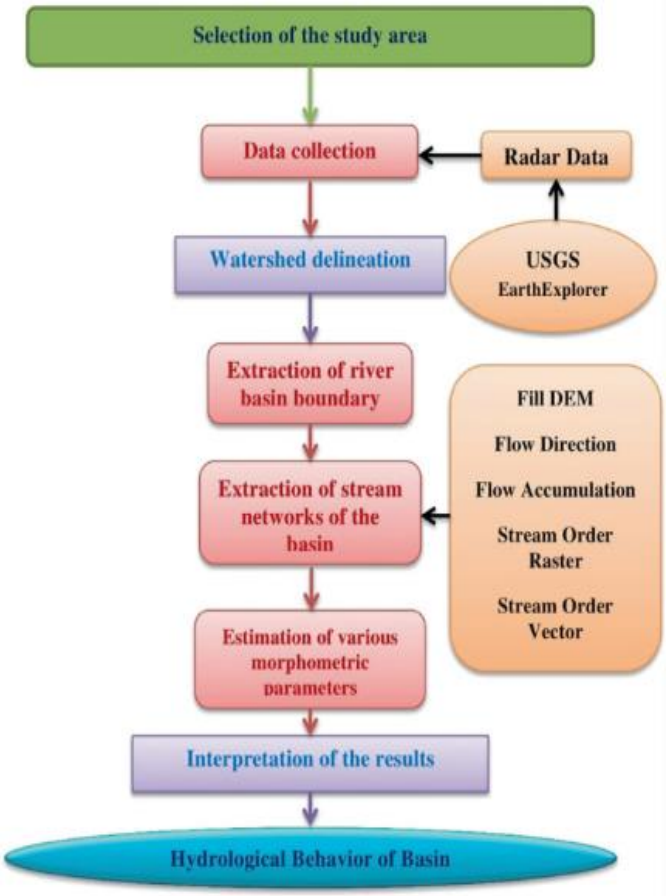

Figure 1: Flowchart of process of morphometric analysis

Results

As shown in Table 1, the experimenters looked at a variety of morphometric parameters in each publication. The drainage characteristics, development stage, and flood susceptibility of a basin are revealed by study on morphometric analysis. Because of the knowledge gathered from this investigation, improved watershed management techniques will help boost agricultural production.

Table 1: Formulas used for computation of results of morphometric parameters

Morphometric Parameters	Formula/Method	References
Linear		
Stream order	Hierarchical Order	Strahler, 1964
Stream Length	Length of the Stream in km	Horton, 1945
Mean Stream Length (L_{sm})	$L_{sm} = \frac{L_m}{N_m}$, Where, L_m = Total stream length of order 'm' and N_m = Total no. of streams of order 'm'	Horton, 1945
Stream Length Ratio (R_L)	$R_L = \frac{L_{sm}}{L_{sm-1}}$, Where, L_{sm}=Mean stream length of a given order 'm', L_{sm-1}= Mean stream length of next lower order 'm-1'	Horton, 1945
Bifurcation Ratio (R_b)	$R_b = \frac{N_m}{N_{m+1}}$, Where, N_m = No. of streams of a given order 'm', N_{m+1}= No. of stream segments of next higher order	Schumn, 1956
Areal		
Drainage density (D_d)	$D_d = \frac{L}{A}$, Where, D_d = Drainage Density (1/Km), L = Total stream length of all orders (Km); A = Area of the basin (Km^2)	Horton, 1945
Stream Frequency (F_s)	$F_s = \frac{N}{A}$, Where, F_s = Stream Frequency (number/ Km^2); N = Total no. of streams of all orders and ; A = Area of the basin (Km^2)	Horton, 1945
Texture Ratio (T)	$T = \frac{N_1}{P}$, Where, N_1 = No. of streams of 1st order ; P = Basin perimeter (Km)	Horton, 1945
Form Factor (R_f)	$R_f = \frac{A}{L_b^2}$, Where, A = Area of the basin (Km^2); L_b = Basin length (Km)	Horton, 1945
Compactness coefficient (C_c)	$C_c = \frac{0.2821\,P}{A^{0.5}}$, Where, P = Basin perimeter (Km); A = Area of the basin (Km^2)	Partha *et al.*, 2018
Drainage texture (D_t)	$D_t = \frac{N}{P}$, Where, N = No. of streams of all order ; P = Basin perimeter (Km)	Horton, 1945
Circulatory Ratio (R_c)	$R_c = \frac{4\pi A}{P^2}$, Where, A = Basin area (km^2) ; P= Basin perimeter (Km)	Miller, 1953
Elongation Ratio (R_e)	$R_e = \frac{2\sqrt{(A/\pi)}}{L_b}$, Where, A= Area of the basin (Km^2); L_b= Basin length (Km)	Schumn, 1956
Channel Main tainance conatant (C)	$C = \frac{1}{D_d}$, Where, D_d = Drainage Density (Km/ Km^2)	Horton, 1945
Infilteration Number (I_n)	$I_n = D_d \times F_s$ Where, D_d = Drainage Density (Km/ Km^2); F_s = Stream frequency (Number/ Km^2)	Faniran, 1968
Length of Overland Flow (L_{of})	$L_{of} = \frac{1}{2D_d}$ Where, D_d = Drainage Density (Km/ Km^2)	Horton, 1945
Relief		
Basin relief (H)	Vertical distance between the lowest and highest points of watershed	Schumn, 1956
Relief Ratio (R_h)	$R_h = \frac{H}{L_b}$, Where, H = Basin Relief (Km) ; L_b = Basin length (Km)	Schumn, 1956
Relative Relief (R_r)	$R_r = \frac{H}{P}$, Where, H = Basin relief (Km); P = Basin Perimeter (Km)	Melton (1957)
Ruggedness Number (R_n)	$R_n = H \times D_d$ Where, H = Basin Relief (Km) ; D_d = Drainage Density (Km/ Km^2)	Schumn, 1956

Conclusions

For an overall examination and management of watersheds, all of the scholars suggested that morphometric analysis is crucial. Distinct watersheds have distinct challenges, such as areas affected by drought, flood proneness, and hazards from soil erosion. These issues can be detected and resolved by analyzing the drainage network, soil lithology, form features, and relief factors of the watershed. The drainage network and the watershed's delineation were carried out using ASTER and SRTM DEM data, together with 1:50000 scale Survey of India (SOI) toposheets, in the majority of the literature. One researcher suggested that studying the finer features of watersheds at the meso and micro watershed levels would benefit more from better resolution satellite data, such as ASTER (30 m). Scholars have suggested that employing GIS for morphometric analysis is a better strategy than more conventional methods. The scientists discovered that there is good agreement between the morphometric analysis utilizing satellite data and the geological inspection that was done on the site. Percolation tanks, check dams, and recharge shafts are examples of artificial recharge sites that can be

located by using GIS-based morphometric analysis. This examination can evaluate the lithological and topographical features and ascertain whether the drainage network is subject to any structural regulation. Ultimately, this study has the ability to improve the quality of life for those living in the watershed or river basin through the implementation of an efficient watershed management strategy.

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Studying the comparative performance of the heterojunctions grown by chemical bath deposited (CBD) p–CuO nanoflower and p-CuO films on n-Si substrate

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ABSTRACT
Using the chemical bath deposition (CBD) process, nanoflowers and films of cupric oxide (CuO) is grown on silicon (n-Si) substrate. The stoichiometric composition and the electronic properties are observed to be greatly dependent on the orientation of the nanoflowers along with uniformity of the grown film. The surface morphology and chemical composition are investigated by using FESEM and EDAX analyses. Through the measurement of current voltage characteristics in both dark and light conditions, the electrical properties of the fabricated heterojunctions are studied.
Keywords : CuO nanoflowers, CuO film, heterojunction diode, photo-detector

I. INTRODUCTION

Nanoscale devices mostly focussing on nanostructures such as nanoflowers[1], nanotubes[2], nanowires[3] have found wide spread application in the domain of optoelectronics[4], chemical sensing[5], spintronic devices[6] and piezoelectrics[7]. Of all the reported nanostructures, nanoflowers are of particular interest as it offers a higher surface to volume ratio, cost-effectiveness and environment friendly growth techniques[8]. In recent years, researchers worldwide are focussing in the preparation, characterization and application of semiconductor nanostructures since they are playing a major role in upcoming technologies. Most semiconducting materials, such as II-VI or III-V compound semiconductors exhibits excellent applications in the field of electronics. Due to its basic benefits of possessing strong electrical and optical characteristics, an availability of source material, an affordable and straightforward growth technique and non-toxic features, copper oxide (CuO) has attracted substantial study attention among diverse semiconducting materials[9]. Copper oxide nanostructures possess a variety of uses, such as energy harvesting[10], photo electro chemical cells[11], field emission devices[12], photodetection and photovoltaic devices[13]. Such nanostructures can be grown by employing several techniques such as chemical vapour deposition (CVD)[14], reactive sputtering[15], chemical conversion[16], thermal oxidation[17], sol-gel techniques[18] and hydrothermal method[19].

Researchers have given a lot of emphasis on chemical bath deposition (CBD) growth technique because of its broad area scaling for commercial production, cost efficiency, repeatability and ease of use.

Experimental Details

On an n-Si substrate, the CuO films and nanoflowers (NFs) are produced by the chemical bath deposition (CBD) method. The cleaning of Si wafers are done using the RCA-I and RCA-II processes before the growing phase. After that, a dip in a 10% HF solution is done to remove the native oxide. A solution of 0.05 M copper nitrate dihydrate [$(Cu(NO_3)_2.2H_2O$] in 100 ml DI water is heated for 10 minutes while being continuously stirred in order to facilitate the formation of CuO film using the CBD approach. In the bath solution the cleaned Si wafers were immersed. 5ml of ammonia is added dropwise to the bath solution after it reaches 60ºC, and the deposition process is let to run for 20 minutes. Following the film deposition, both samples were cleaned with running DI water and allowed to air dry in a N_2 environment.

For the growth of CuO NFs, a bath solution is prepared containing 0.05 M equimolar aqueous solution of [$(Cu(NO_3)_2.2H_2O$] and hexamethylenetetramine ($C_6H_{12}N_4$) in 100 ml DI water. The solution is mixed together for 10 mins by a magnetic stirrer. Using a sample holder, one of the CuO film coated samples is vertically dipped in the bath solution and agitated at 250 rpm. The deposition is carried out for 1 hour under constant stirring and heating. The sample was removed from the precursor solution and washed in DI water to get rid of any remaining CuO particles once the deposition period was over. The CuO film, CuO NFs, and Si substrate were coated with an ITO layer with a thickness of 100 nm to obtain the contacts, followed by 50 μm-diameter of Ag dots. Tungsten probe having diameter of 9.5 μm, were used to take the electrical contacts.

The following is a description of the reaction mechanism.

$$NH_3 + H_2O \rightarrow NH_4^+ + OH^- \quad \text{(i)}$$

$$Cu(NO_3)_2.2H_2O + 2NH_4^+ + 2OH^- \rightarrow 2NH_4(NO_3) + Cu(OH)_2 \quad \text{(ii)}$$

$$Cu^{2+} + 2OH^- + 2H_2O \rightarrow Cu(OH)_4^{2-} + 2H^+ \quad \text{(iii)}$$

$$Cu(OH)_4^{2-} + 2H^+ \rightarrow CuO(Solid) + 3H_2O \quad \text{(iv)}$$

In the chemical process described above, NH_4^+ and copper nitrate combine to generate ammonium nitrate $NH_4(NO_3)$, and OH^- and copper hydroxide $Cu(OH)_2$, respectively. A dehydration process converts the intermediate development of $Cu(OH)_2$ into CuO (solid phase) with a progressive rise in bath temperature and duration. A better control over the film growth rate may be achieved by adding ammonia solution drop-by-drop, which also helps in calculating the deposition rate[18]. Using Zeiss Auriga 39–63 field emission scanning electron microscopy (FESEM), the surface morphology and elemental composition of the generated CuO film and NFs. With n-Si serving as the cathode and CuO film or NFs serving as the anode, the electrical characterizations are carried out by using a Keithley 2611B parameter analyzer. Using an AM 1.5 light source, the impact of illumination on the heterojunctions has also been studied.

Results and Discussion

Figure 1 displays the CuO films and CuO NFs FESEM micrographs that were produced on Si substrates in succession. Figure 1(a) shows that a consistent CuO coating was created using the n-Si substrate. The film's average thickness is determined to be 110 nm. Fig 1(b) shows the formation of CuO NFs on the CuO film. It is evident that the NFs has a high density, which may be attributed to the presence of CuO film beneath the NFs.

The film has acted as a seed layer, which formed the nucleation sites for the NFs thereby compensating the lattice mismatch.

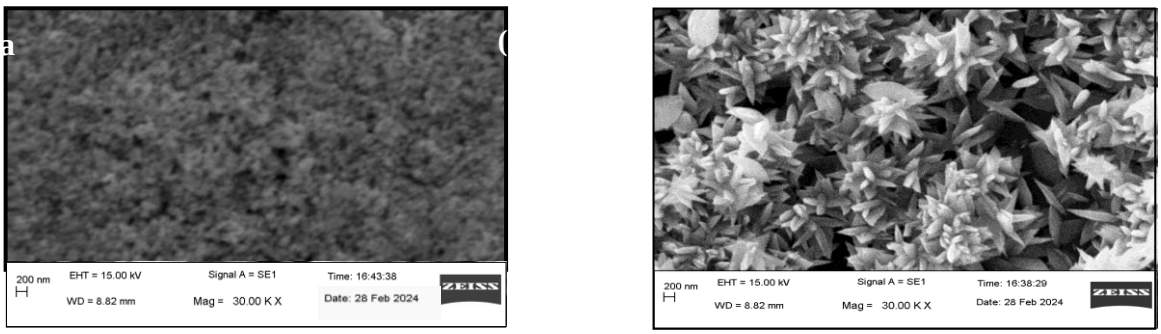

Figure 1: SEM images of (a) CuO film and (b) CuO NFs / CuO film grown on Si substrates.

The elemental composition performed by X-ray spectroscopy (EDAX) verifies the existence of Cu, O and Si in both the samples. The elemental plot shows that the Cu:O ratio is1:1, which suggests that CuO film / NFs is forming with appropriate stoichiometry.

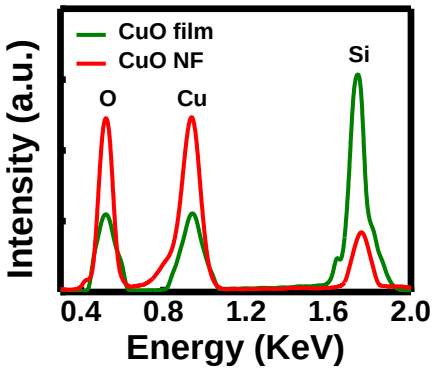

Figure 2: Energy dispersive X-ray spectroscopy of the CuO film and CuO NFs / CuO film grown on Si substrates.

Additionally, the EDAX pattern shows higher traces of Si for the CuO film / n-Si sample as compared to that of the CuO NFs grown sample. The lesser trace of Si for the CuO NFs sample might be linked to the higher density of nanoflowers, thereby covering the entire CuO film and subsequently the Si substrate.

By observing the current voltage characteristics of the p-CuO / n-Si film / NFs heterojuctions in both dark and light conditions, their electrical characterisation has been assessed. The inset of Figure 3(a), displays the schematic of the fabricated device. The plot shows the forward and reverse bias I-V characteristics under dark conditions of the p-CuO/n-Si heterojunction diodes. The measurement of the heterojunction includes the cut in voltage for CuO NFs / Si and CuO film / Si heterojunctions which is measured to be 1.8 V and 2.6 V respectively. Decrease in the cut in voltage for the NFs grown heterojunction might be explained by the existence of the CuO film beneath the NFs. Moreover, Fig. 3(a) shows that, in the presence of forward bias, the dark current rises in case of NFs grown heterojunction due to the presence of nucleation sites beneath it which aids in formation of high quality nanoflowers. Fig. 3(b) shows the I-V plot of the grown heterojunctions under the white light illumination. An obvious photodetection property for both the structures are observed. A ratio of light-to-dark current of 1.92 and 1.66 has been obtained for the p-CuO NFs / n-Si and p-CuO film / n-Si

respectively. The enhanced response of photodetection for the NFs fabricated device is credited for lowering series resistance in contrast to the p-CuO film / n-Si heterojunction.

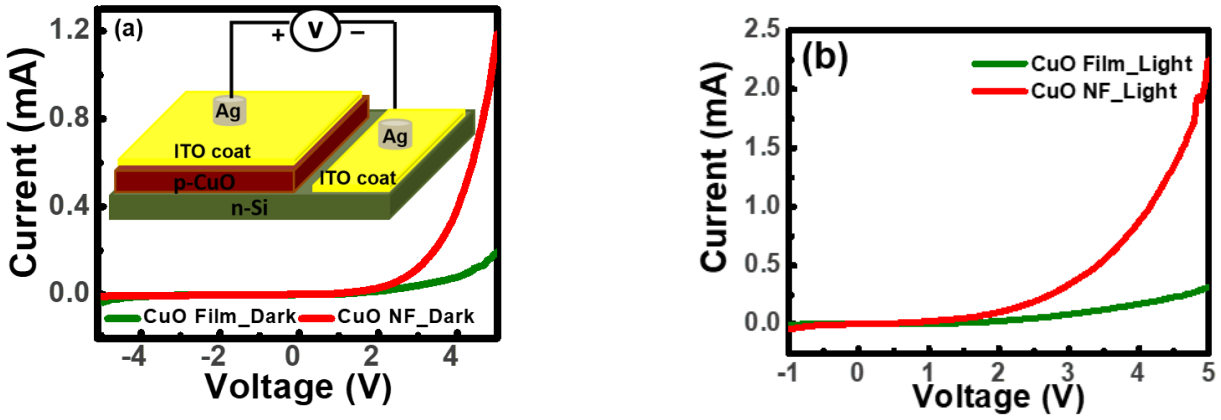

Figure 3: Experimental current voltage plots under (a) dark condition (inset shows the relevant schematic diagram) and (b) light condition.

Conclusion

Study on the comparative performance on the growth of CuO nanoflowers and CuO film on n-Si substrate has been investigated. High resolution FESEM imaging is used to accomplish the morphological characterization and the elemental composition is verified from the energy dispersive X-Ray spectroscopic study. Proper orientation of the grown NFs is attributed to the presence of CuO film beneath it, which acted as nucleation sites. The electrical measurement of the fabricated devices has been performed under both dark and light condition. The current voltage characteristics indicates that the forward current for both the type of samples is contributed by both electron and holes. The fabricated nanodevices under study exhibits excellent photodetecting properties. Comparatively, it is found that the p-CuO NFs / n-Si heterojunction is a inexpensive, promising option for the creation of optoelectronic devices with enhanced functionality.

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IOT Based Home security system

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ABSTRACT
As a vast number of things and devices are being connected to the Internet, the infrastructure of interconnected physical devices, or IoT, is expanding quickly. An affordable home and industrial security system is being developed by us, utilizing the highly beneficial IoT application of home security. By providing a notification to the user, the system will alert the owner to any unwanted entry or each time the door is opened. Upon receiving the notification, the user can proceed with the required actions. A magnetic Reed sensor to check status, a buzzer to sound the alarm, a Wi-Fi module, and an Arduino Uno microcontroller will all be used in the security system. Arduino based home security system uses four sensors namely temperature, smoke, LPG and IR sensor and wireless communication method WI-FI is used here.
Keywords: Arduino Uno, Node MCU,IR sensor, LPG sensor

Introduction

Conventional home security systems provide alarm indicators. But IOT (INTERNET OF THINGS)-based security systems offer increased protection as, in the event of a sensor signal, a text message is sent to a designated number prompting the taking of appropriate action.[1]

More parameters and devices are under our control and observation. Four sensors are used by IOT and Arduino- based home security systems: infrared, temperature, smoke, and LPG sensors. After that, the Arduino, which has a built-in signal converter, receives the data from these sensors. After that, Arduino transmits data to the ESP8266 Wi-Fi module. The ESP8266 chip is used to establish TCP/IP connections, send data, and connect micro- controllers to Wi-Fi networks. The IOT receives the data that these sensors have collected.[2]

The Internet of Things, or IoT, is a network of physically connected items that can share data and communicate with one another without the assistance of a human. The term "Infrastructure of Information Society" has been officially coined for it, as the Internet of Things enables us to gather data from a wide range of sources, including people, pets, cars, and household appliances. Therefore, by installing electronic hardware,

such as sensors, software, and networking gear, in any physical object that can be given an IP address to facilitate data transfer over a network, that thing can be made a component of the Internet of Things.[3]

IoT is distinct from the Internet in that it allows commonplace things with embedded circuits to interact and communicate with one another through the utilization of the existing Internet infrastructure, hence transcending Internet connectivity.[4]

The security system for a smart home is described in our project. Numerous wireless communication techniques, including Wi-Fi and GSM, are supported by this system. To enable consumers to remotely monitor and control their home's security, smart home security makes use of a variety of Internet of Things (IoT) enabled products. In addition to controlling who has access to the doors if they have smart locks, these systems can control the monitoring both inside and outside the house. Four sensors are used by an IOT and Arduino-based home securitysystem: infrared, temperature, smoke, and LPG sensors.

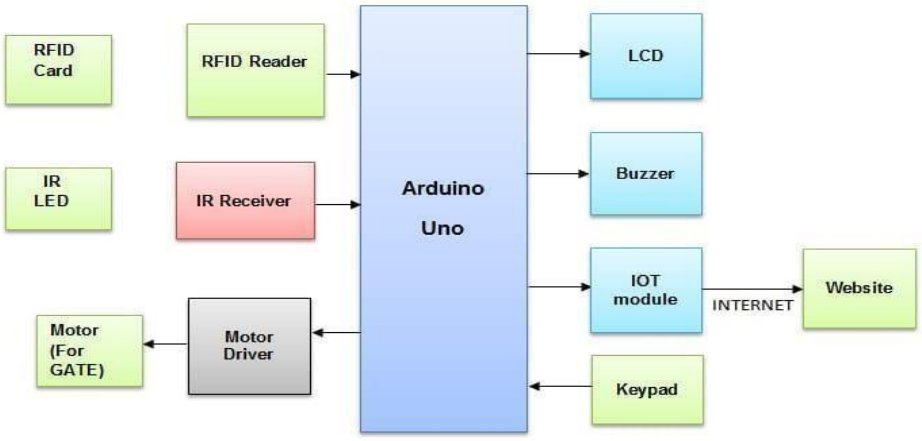

Fig. 1 Diagram for system creation.

Circuit Diagram

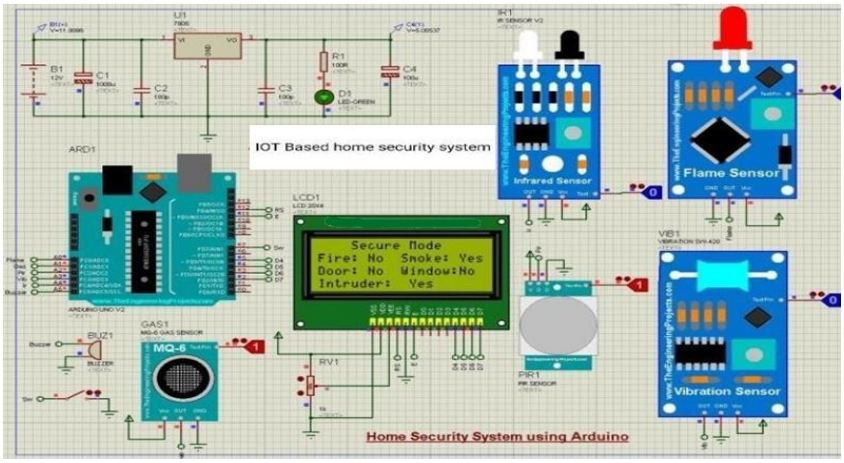

Fig. 2 Diagram for IOT based home security

Working

This device is a simple motion-activated alarm system. The core of it is an Arduino microcontroller. It has connections to two external terminals, a buzzer, a resistor, and a PIR motion sensor. Because the entire device runs on batteries, portability is a breeze. All of the external components can be connected after you have the code. Using a breadboard is the simplest method to accomplish this. We can try things out by creating temporary connections using this.

Sensors and Devices: These systems use various sensors and devices strategically placed around thehome. These can include:

Motion Sensors: Detect movement within designated areas.

Door and Window Sensors: Triggered when doors or windows are opened.

Security Cameras: Monitor specific areas and provide visual feedback.

Smoke and Carbon Monoxide Detectors: Alert about potential fire or gas leaks.

Smart Locks: Control access to doors through digital means.

Data Collection: Sensors collect data on activities or changes in the environment. They detect motion, changes in temperature, door openings, etc.

Connectivity: These devices are connected through a central hub or a home network using technologies like Wi-Fi, Bluetooth, or Zigbee.

Data Processing: The collected data is processed either within the devices or in a central hub. Algorithms analyze this data to determine if there's any unusual activity or potential security threat.

Alerts and Notifications: When the system detects something unusual, it sends alerts or notifications to the homeowner or a security monitoring service. Notifications could be in the form of smartphone alerts, emails, or texts.

Remote Access and Control: Homeowners can remotely access and control these systems using their smartphones or computers. They can arm or disarm the system, check live camera feeds, or receive status updates regardless of their location.

Integration and Automation: These systems often integrate with other smart home devices. For example, when a security camera detects motion, it can trigger smart lights to turn on or start recording.

Response Mechanism: Some systems provide options for automated or manual responses. These could include triggering alarms, contacting emergency services, or allowing homeowners to take appropriate actions, like remotely locking doors.

Continuous Monitoring and Updates: Regular monitoring, system updates, and maintenance are essential to ensure the system's reliability and security.

Hardware Used

Arduino Uno:

Designed to build microcontroller packs for building programmed devices and intelligent objects that can detect and control inquiries in the real world, Arduino is an open-source PC accessory and programming organization and client group. The Arduino extension was first conceptualized at the Interaction Design Institute in Ivrea, Italy. The blueprints for the equipment reference are licensed under a Creative Commons Attribution Share.

Node-MCU:

Figure 2. ESP8266 (WiFi Serial Transceiver).

Based on the popular ESP8266-12E WiFi module, NodeMCU is an open-source development board and firmware. The Arduino IDE or the straightforward and potent LUA programming language can be used to program the ESP8266 WiFi module.

PIR SENSOR

An electrical device called a passive infrared sensor (PIR sensor) detects infrared (IR) light emitted by objects within its field of vision.

Dth 11:

A simple, incredibly affordable digital temperature and humidity sensor is the DHT11. It measures the ambient air using a thermistor and a capacitive humidity sensor before emitting a digital signal on the data pin (no analog input pins are required).

Mq-2

Winsen manufactures the MQ-2 smoke and combustible gas sensor. It has a 300–10,000 ppm detection range for combustible gases. Alarms for gas leaks in homes and smoke and propane detectors with a high sensitivity are its most popular uses.

Buzzer

An audio signaling device, often known as a buzzer or beeper, can be piezoelectric, electromechanical, or mechanical (piezo for short). Buzzers and beepers are frequently used in alarm systems, timers, training systems, and as confirmation of user input, such as mouse clicks and keystrokes.

Node-MCU, an open-source firmware and development kit, is based on the ESP8266 Wi-Fimodule. It has numerous real-world applications, including:

1. **Home Automation:** Control lights, appliances, and HVAC systems remotely via a smartphone or webinterface.
2. **IoT Projects:** Create Internet of Things devices for monitoring and controlling various aspects of theenvironment, such as temperature, humidity, and motion.
3. **Smart Agriculture:** Develop systems for monitoring soil moisture, temperature, and humidity tooptimize crop growth and water usage.
4. **Environmental Monitoring:** Build sensors to monitor air quality, pollution levels, and weatherconditions.
5. **Security Systems:** Develop DIY securitysystems with motion sensors, cameras, and alarm systems thatcan send alerts to smartphones.
6. **Industrial Automation:** Control and monitor industrial machinery, processes, and equipment remotely.
7. **Education and Prototyping:** Learn about IoT concepts andprototype projects for academic or personalpurposes.
8. **Remote Control and Monitoring:** Control and monitor devices and systems remotely, such as garagedoors, irrigation systems, and pet feeders.

These are just a few examples, and the possibilities are virtually limitless with Node-MCU and its capabilitiesforwireless communication, sensor interfacing, and microcontroller programming.

NodeMCU is often preferred for IoT-based home security applications over GSM modules forseveral reasons:

1. **Cost: NodeMCU is a low-cost platform compared to GSM modules, making it more affordablefor DIY projects or small-scale deployments.**

2. Wi-Fi connectivity: NodeMCU comes with built-in Wi-Fi capabilities, allowing it to connect to your home network and the internet without the need for additional hardware like a GSM module and SIM card.

3. **Ease of programming: NodeMCU can be programmed using the Arduino IDE, which is user- friendly and widely supported by the maker community. This makes it easier for beginners to get started with IoT projects.**

4. Integration with cloud services: NodeMCU can easily integrate with cloud platforms like AWS IoT, Google Cloud IoT, or MQTT brokers, allowing you to store and analyze data

from your home security system remotely.

5. **Flexibility: NodeMCU is a versatile platform that can be customized and expanded with sensors, actuators, and other components to suit your specific home security needs.**

6. While GSM modules can also be used for home security applications, NodeMCU offers a morecost-effective and user-friendly solution for many IoT enthusiasts and DIYers.

III. Result & Analysis

Key Benefits of IoT-Enabled Home Security: Z zayuiop

We can control and keep an eye on your home's security from anywhere, so you never have to worry about leaving your doors unlocked while you're gone. Even when the system is disabled, get alerts about attempted access or motion around your house. Recognize and interact with guests even while you're not home by keeping your doorunlocked.

Data Analysis:

Performance Evaluation :

Measuring the performance of the system in terms of speed, response time, energy usage, and user satisfaction.

Advantages & Disadvantages

Advantages of IoT (Internet of Things)

The IoT makes things around us more capable and responsive by connecting the physical and digital worlds.IoToffers several benefits in our daily lives. Following are some of its benefits:

Easy Access:

From any location, you may easily obtain the required information immediately and in real time. All you require is a smart device and an internet connection. Therefore, among the benefits and drawbacks of IoT, accessibility is a significant plus. For example, even the most recent research study or business analysis is currently easily accessible.

Quick operation:

A lot of jobs can be completed fast thanks to the data input. IoT, for example, simplifies automation. Additionally, to free up employees' time and energy, astute organizations can automate repetitive processes.

Monitoring Data:

Tracking is the main advantage of IoT while discussing its pros and cons. It can also provide information that was previously difficult to access. For example, knowing that you will eventually need printing sheets could save you another trip to the store. Maintaining a record of product expiration dates further enhances your security.

Disadvantages of IoT

1. Dependency on Technology:

The most important prerequisite for IoT is an internet connection. Therefore, if there is no Internet, it is pointless. As a result, we are becoming more and more dependent on IoT use in our daily lives. If we don't achieve our desired outcome right away, we may become agitated by even the most irrelevant information. The Internet of Things is drastically impairing our capacity for concentration.

2. Operation Complexity:

IoT may seem to do tasks quickly, but a lot of intricate work is being done in the background. If the program unintentionally makes a calculation error, the results of the next steps in the process will be incorrect. Thus, it alsoclarifies why it is challenging to troubleshoot an IoT problem.

3. Less Employment of Low-Educated Workers:

Workers without formal education may lose their jobs as a result of everyday chores becoming more automated. Consequently, it will lead to unemployment throughout society. This issue can arise from any technology, but it can be resolved with education. Consequently, the necessity for human labor will decrease as daily tasks become increasingly mechanized. Employees with less education and laborers will find this difficult.

Conclusion

By integrating various sensors, devices, and smart technologies, IoT-based security systems create a cohesive network that actively monitors, detects, and prevents potential threats. The ability to receive instant alerts and notifications on smartphones or devices empowers homeowners with immediate awareness of security incidentsor irregularities, enabling swift action Beyond intrusion detection, these systems encompass environmental sensorsfor detecting hazards like smoke, fire, or gas leaks, augmenting overall safety. System is developed to integrate differentfacilities such as Security, Automation and Power Monitoring using lOT, Arduino andcomputervision.

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A Comprehensive Review on Cryogenic Grinding

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ABSTRACT

The article aims to improvise the grinding process of elastic materials such as rubber, plastic, composite, metal, wax. These materials are wasted a great deal these days. Certain materials, such as plastic and synthetic rubber, have a negative impact on the environment. In essence, this research will support the responsible handling of the pollutants listed above. For instance, because they are sticky and soft, thermoplastics clump and clog screens when ground into tiny particles at ambient temperature. During the cryogenic grinding process, thermoplastics can be crushed into a powder that is appropriate for electrostatic spraying and other powder processes after being cooled with dry ice, liquid carbon dioxide, or liquid nitrogen. These methods have the advantages of higher productivity through particle size optimization, removal of caked products in the mill, and better fire resistance and product oxidation due to inert grinding.

Keywords : Cryogenic grinding, Cell disruption, Cryo milling, Freezer milling, Polymide

I. INTRODUCTION

The term “Cryogenics” comes from the Greek word meaning to create or produce by cold. It is the study of the growth and behaviour of materials at very low temperatures. It is believed that the freezing process begins at -150°C or below (123 K; -238°C). To obtain extremely low temperature refrigerants, such as (liquid helium 3-3.19K), (liquid hydrogen 20.27K), (liquid neon 27.09 K), (liquid nitrogen 77.36 K), (liquid air 78.8 K), (Liquid Argon 87.24 K), (Liquid oxygen 90.18 K) are used [1]. The most predominant is liquid nitrogen, as it is inert in nature [2]. The cryogenic substance is stored in a Dewar flask. These tanks are low-pressure tanks, designed to maintain operating pressure and liquid phase content by ventilation, insulation or refrigeration. They have high liquid/gas expansion ratios (>700 for most refrigerants) [3]. Applications of cryogenics are numerous in fields ranging from gas liquefaction to biology, medical, space science, manufacturing and materials [3,4].

This paper aims to use these changes in the behaviour of materials to grind them into fine particles [5]. Cryogenic crushing technology can effectively crush most hard materials and can also facilitate the cryogenic recycling of multi-component materials and multi-component wastes. This process can easily overcome

problems encountered in conventional grinding, such as heat generation, tensile stress generation, tool life reduction, grinding machine clogging and gelation, oxidation. The various processes are described as follows:

A. Cryogenic grinding is the process of cooling or freezing materials and reducing them to small particle sizes. Because almost all materials become brittle when exposed to cold. Cryogenic size reduction uses the cold energy available from a defined cryogenic liquid to cool, embrittle and inert materials before and during grinding. This overcomes the difficulties all elastic materials encounter when grinding at room temperature, i.e. because they soften and coalesce into clumps and clog the sieve [5].

B. Grinding with Freezing is a type of cryogenic grinding that uses electromagnetism to grind the sample [6]. The solenoid moves the grinding material back and forth within the vial, grinding the sample to a level suitable for analysis. Since the sample is arc milled at liquid nitrogen temperature (-196°C), this method of grinding is particularly helpful for processing temperature-sensitive materials [7].

C. A cold slurry is used to grind metal particles or other samples, such as volatile materials that are sensitive to temperature, in a manner similar to mechanical grinding or at cryogenic temperatures depending on the processing parameters to obtain the particles have a microscopic structure. The grinding bowl of the cryo-mill performs radial oscillation in a horizontal position. Because of the grinding ball's inertia, the high-energy impact crushes the material sample at the rounded ends of the grinding jar. Throughout the procedure, liquid nitrogen is used to continually chill the jar. Conventional traditional grinding has a number of drawbacks, including excessive heat production, the introduction of tensile residual stresses, a decrease in tool life, and oxidation and related deterioration that clogs and gums up the mill [8].

The freezing process also has a unique ability to recycle difficult-to-separate materials. Freeze grinding is the method of grinding herbs into powder at sub-zero temperatures, from zero to minus 700°F. Herbs and spices are frozen in liquid nitrogen as they are ground. . This process does not damage or change the chemical composition of the plant or grain in any way. The conventional grinding process does not use a cooling system that can reach 200°F.

These high temperatures can reduce volatile and heat-sensitive components in herbs and spices. The freeze-dried grinding process starts with air-dried herbs, instead of freeze-dried herbs. Solid materials are crushed or pulverized using a hammer mill. consumable crusher, granulator or other equipment. Smaller particle sizes are often necessary to improve subsequent solids processing, such as when mixed with other materials. By cooling to cryogenic temperatures with liquid nitrogen, they can become brittle and easily break into small particles. Various studies have been carried out on conventional and cryogenic grinding methods (1-6). A scientifically controlled study using two genotypes of coriander was carried out at the National Seed Spice Research Centre, Ajmer, comparing frozen grinding methods and conventional grinding methods. (7-8) Freeze grinding [6] has been shown to have a significant effect on the active ingredient content of herbs. Test results showed an average increase of 15.6% in the tested ingredients in the four medicinal herbs when cryogenically ground. The range is between 10.7% and 21.8%, which shows that some herbs are more affected than others by the temperature at which they are ground. Cryogenic grinding offers higher production efficiency, lower energy consumption, finer particle size, more uniform particle distribution, lower grinding costs. Does not generate heat, is good for grinding spices and creates an inert atmosphere, eliminating the possibility of oxidation [1,2].

II. Method of Working

The material is cleaned manually. After that it is being added to the hopper. Then it enters the vibratory feeder, which has the capacity to regulate the feed rate, from the hopper's outlet. The screw conveyor is sprayed with liquid nitrogen from the storage container; the conveyor drive's speed may be adjusted to control how long the material stays in the conveyor [2]. When the mill is running, the material is crushed between the studs and emerges as a ground product through an optional filter.

[8,9]. The ground product is gathered in a collecting bin located at the base of the mills. The cyclic process is maintained by sucking the vaporized nitrogen from the mill via the filler assembly in the feedback mill using a centrifugal blower [1].

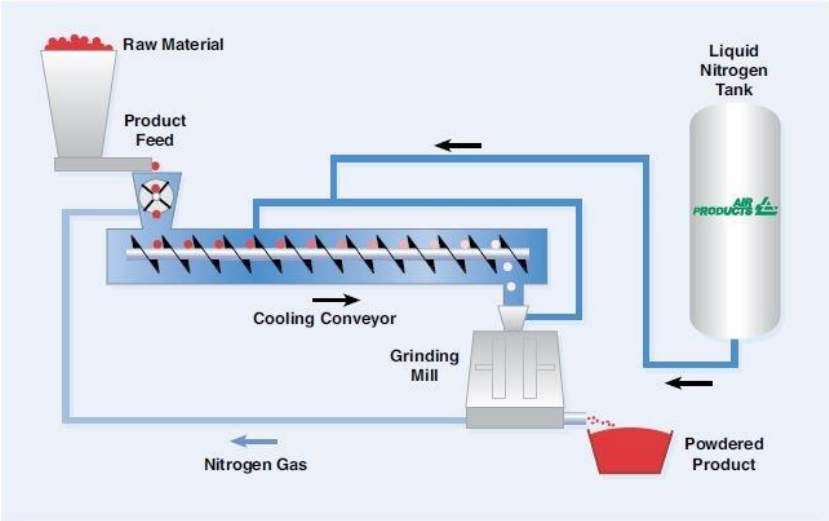

Fig.1 Schematic of cryogenic grinders [10]

A schematic illustration of a different kind of cryogenic grinder that runs on liquid nitrogen is displayed in Fig. 1. This provides a thorough understanding of the parts of a standard cryo-grinder. It consists of a liquid nitrogen container, a dynamometer, flexible piping, a grinder tab, a pressure gauge, a nozzle and a pressure valve in addition to a cover grinding wheel.

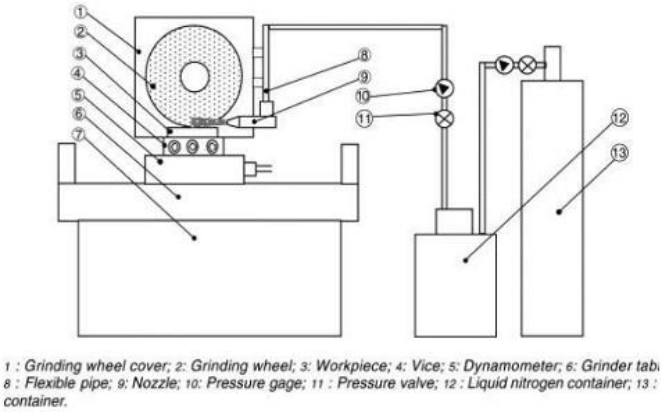

Fig. 2 Schematic of cryogenic grinders [11]

Cryogenic grinders produce particles with a more uniform distribution and a greater output rate. The testing results fluctuate depending on the size and kind of feed material used as well as any modifications made to the cryogenic grinding machine's design [3].

Table 1 Specifications for Cryogenic grinders

Power consumption	Power consumption
160 watts	160 watts
W*H*D	W*H*D

III. Processing Results

The plastic pellets of polyethylene or polyamide are weighed into the mill using a dosing wheel. Normally, the thermoplastics would melt under the grinding heat, making fine-particle grinding impossible. Cryogenic gases, on the other hand, stop this from happening by embrittling the material in a cooling conveying screw. The gas and the plastic that has been cryogenically crushed are gathered in a container [12]. A cellular wheel sluice is used to further process the ground product. After being filtered, the mill gas is expelled after being cleaned. For heat integration, the leftover gas is recycled back into the mill. Thus, the polyamide [8] experimental result employing the Linde cryogenic grinding machine is provided below.

Table 2 Cryogenic grinding for Polyamide

Particle size	Particle size
80µm	80µm
Production rate	Production rate
772 lb./hr.	772 lb./hr.

Specialized for cryogenic grinding is the Cryo-mill. Liquid nitrogen from the integrated cooling system is continuously poured into the grinding jar prior to and during the grinding operation. As a result, volatile components are maintained and the sample becomes embrittled [1,9]. The system is continuously refilled with liquid nitrogen, precisely the right amount via an auto fill system, to maintain the system's temperature at -196°C. A high impact ball milling power produces an ideal grinding efficiency. The auto fill method greatly increases the safety of cryogenic grinding by preventing direct contact with LN2 [3]. For volumes up to 20 ml, the Cryo-Mill is the ideal grinder due to its flexibility, which includes cryogenic, wet, and dry grinding at ambient temperature. Utilizing RETSCH cryo-mills, processed data for Plastic and (Copper + 10%Nb) is noticed [3,5].

The surrounding process typically uses a set of high-capacity conventional crushers and the fed material is ground into small particles [13]. It is common to produce 10 to 30 mesh material using this relatively inexpensive process to produce relatively large scraps. Several crack crushers are often used in series. Typical productivity is 2,000 to 2,200 pounds per hour for 10 to 20 nets and 1,200 pounds per hour for 30 to 40 nets. The finer the desired grain, the longer the material circulates through or through the mill. Additionally, multiple grinding passes may be used to reduce particle size [4].

Actual processes therefore demonstrate that the conventional process produces material with irregular and irregular grain shapes. In addition, this process generates a significant amount of heat in the rubber during processing [7,14]. Extremely high temperatures can degrade rubber quality and if not cooled properly, burning can occur during storage [15,16].

On the other hand, the cryogenic grinding process produces quite smooth fracture surfaces [7]. Little or no heat is generated during this process. This results in less material degradation. In addition, the most important characteristic of this process is that almost all fibres or steel are released from the rubber, resulting in a high usable product yield [17,18].

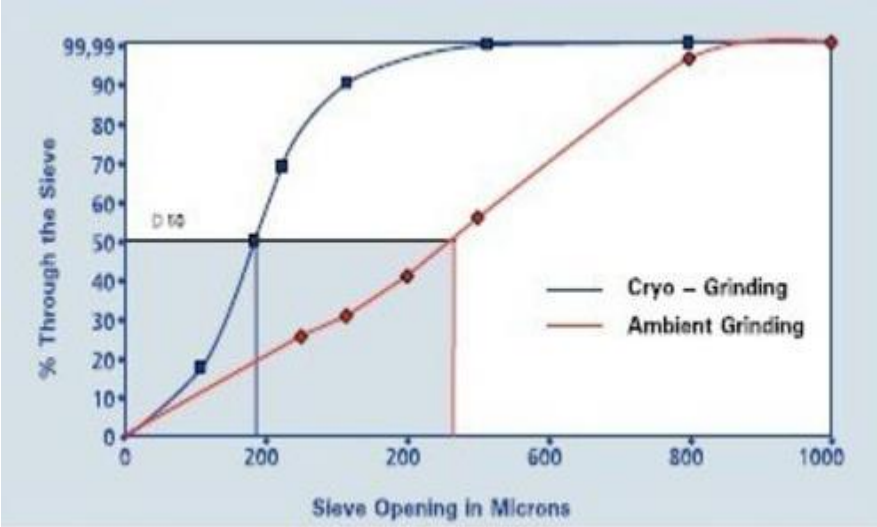

Fig. 3 Comparison between Grinding Process [8]

V. Application of Cryogenic Grinding

❖ Cryogrinding of steel

Cutting zones experience excessive temperature rise due to the significant quantity of heat created during high speed and feed rate machining/grinding. To solve this issue, the grinding site is given liquid nitrogen.

❖ Thermoplastics and Thermosets

In addition to synthetic rubber, nylon, PVC, and polyethylene are frequently utilized in powder form for a range of purposes. [8,2].

❖ Adhesives and Waxes

To avoid some materials becoming sticky and pliable, which cannot be achieved with traditional grinding explosives.

❖ Spices Production

To get the maximum taste, colour and retention of volatile contents (like phenolics, flavonoids, oil content, antioxidant etc.) [8], cryo-grinding is used to crush the spices in powdered form [19,20].

❖ Explosives

To grind the TNT (explosive ingredients) below the point of ignition.

❖ Other uses

- Reducing fine particles for elastomers and thermoplastics.
- In an environment of inert gas, oxidizable materials are best protected.

- Recycling the composite ensures both the separation of individual components and good quality, as does the treatment of manufacturing leftovers.
- Another technique used in microbiology to recover proteins from plant or animal tissues is cryogenic grinding, commonly known as cell disruption.

VI. Conclusion

Based on the research, it can be said that fracture surfaces produced by cryogenic grinding are generally smooth. The method produces little to no heat. As a result, the material deteriorates less. Other than this, the technique satisfies the requirements for fineness and uniform distribution of a specific sized particle; it can be changed with the appropriate configuration of cryogenic grinders. The material is shielded against oxidation and rancidity during manufacture because it is done in an inert atmosphere. In comparison, the energy consumption and cost of the cryogenic grinding process are lower. Additionally, the production rate is increased.

VII. Future Aspects

Given the escalating cost of energy and raw materials, a cost-effective method of recycling difficult and composite materials is through the use of cryogrinding technology. Compared to traditional grinding, it offers a number of important advantages that also raise the product's value. If the cost of liquid nitrogen is not too high, cryogrinding is also a financially feasible option. The method may also be readily expanded to PVC and industrial waste plastics processing to recycle non-biodegradable materials.

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Advances in Solar Thermal Energy : A Review

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ABSTRACT
Solar thermal collectors are a promising technology for reducing reliance on fossil fuels in the industrial sector, thus mitigating the consequences of climate change. This review paper comprehensively evaluates contemporary literature on solar thermal collectors by highlighting their eco-friendliness, energy security benefits, and potential as an alternative to fossil fuels in process heating applications. The article examines the challenges and limitations that impede the global acceptance of solar thermal systems (STSs) in the industrial sector. It also discusses the potential contribution of STSs in achieving sustainable development goals. Furthermore, new engineering applications of STSs are explored, with a focus on design, optimization, materials, and integration with interdisciplinary science and technologies.

Keywords : Solar Thermal Energy, Solar Collectors, Heat Storage, Applications, Renewable Energy

I. INTRODUCTION

On a global scale, the expansion, upgradation, and financial improvement of nations in the industrial sector critically depend on energy as a fundamental necessity. The energy system has undergone substantial transformations since the era of industrialization. With rising wealth and demographics, there is a growing demand for energy across many countries globally. Without improvements in energy efficiency, this escalating demand will lead to a continual increase in global energy consumption, as depicted in Table 1 [1], which illustrates the consumption of various resources worldwide in 2022. Global energy demand is still increasing, although at a somewhat slower rate of about 1% to 2% annually.

A. Importance of solar thermal energy as renewable energy: Solar thermal energy is important in the context of renewable energy as it provides a feasible approach to decrease dependency on fossil fuels, especially in the industrial sector. Solar thermal collectors (SHC) are recognized for harnessing solar energy especially for process heating, providing ecological benefits, energy safety, and a promising replacement of fossil fuels [2].

Table I : Global energy consumption in the year 2022

Energy Consumption Globally	2022 (TWh)	In percentage
Traditional Biomass	11111	6.21

Coal	44854	25.09
Oil	52870	29.57
Natural Gas	39413	22.04
Nuclear Power	6702	3.75
Hydropower	11300	6.32
Wind power	5488	3.07
Solar power	3448	1.93
Biofuels	1199	0.67
Other renewables	2414	1.35

Solar thermal systems provide a more cost-effective solution for process heating than photovoltaic (PV) systems, the use of renewable energy sources can make them a practical substitute for process heating that is based on fossil fuels. The intermittent nature of sunlight is addressed through the use of solar thermal energy storage systems, ensuring a reliable energy supply for industrial processes [3].

Incorporating solar thermal energy in industrial sector globally, can help reduce the usage of fossil fuels and mitigate climate change. Solar thermal energy complements different sources of renewable energy, like solar photovoltaic cell, wind power etc., in achieving a sustainable and diversified energy mix [2].

B. Motivation for exploring diverse applications and methods: The world is moving towards sustainable production and consumption systems, which has resulted in a greater use of renewable energy sources, such as solar power. Technologies like concentrated solar power (CSP) are considered to be one of the capable ways of producing electricity in the future. The intermittent nature of solar energy poses a challenge for its integration into the energy grid. Efficient and affordable thermal energy storage (TES) systems are being explored for CSP applications. These systems offer a reliable and eco-friendly alternative to traditional energy storage methods, making them crucial for the future of clean energy. The development of diverse applications and methods of solar heating power, including TES systems, is motivated by the need to improve the efficiency and reliability of solar power generation and enable its integration into the energy grid [4]. It is imperative to explore diverse applications and methods for thermal energy from the sun to minimize the usage of fossil fuels and mitigate the consequences of climate change. The industrial sector mostly relies on traditional fossil fuels for heat energy, and exploring diverse applications and methods of solar thermal energy is able to generate a strategy that reduces this dependence practically. Solar thermal collectors offer numerous environmental benefits, enhance energy security and have potential as a replacement for fossil fuels, making them a promising technology for various industrial processes [2].

This review paper focuses on identifying the global progress of acquiring solar thermal energy by developing solar collectors, it is also investigated the specific heat and temperature requirements for several industries. It explores the integration of solar systems for industrial process heating and identifies common thermal applications used in industrial processes. The paper discusses the use of thermal energy of sun for industrial

process heating, and examines various studies on the subject. It also discussed the different solar thermal energy extraction technologies and their key characteristics and their application arears.

Thermal Energy requirements for Industrial Processes

Large scale investigation has shown that solar thermal process heating is practical and can reduce 〖CO〗_2 emissions and external costs. Solar thermal systems have potential in various industrial sectors in different countries, such as China and Switzerland, to reduce 〖CO〗_2 emissions and meet process heating demands. Including solar industrial process heat in German enterprises can fulfil a significant part of the heating demand and reduce greenhouse gas (GHG) emissions. Addition of parabolic thermal energy collectors in industry for the application of heat in process has the potential to reduce the cost of heat and GHG emissions. Technologies of collecting Solar thermal energy can play a vital role in heating process at industries, globally [5–7].

Solar thermal energy is produced by converting sunlight into heat. To collect solar radiation, a device called a solar collector is used, as shown in Figure 1. The heat generated by this process can be used for a variety of industrial applications or stored for future use, such as heating water or air for residential or commercial purposes. Process heating systems typically include a heating unit that produces heat and a circulation system that transfers thermal energy to its intended application.

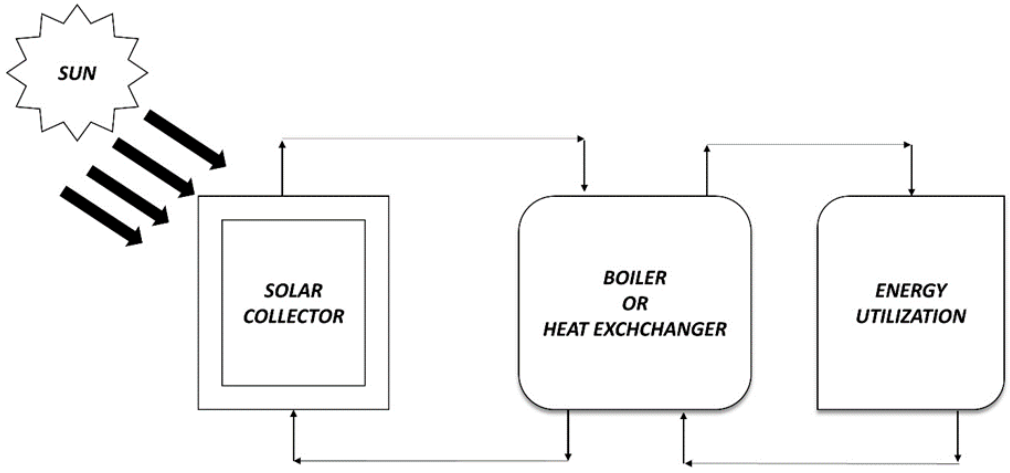

Fig.1 Schematics diagram of working principal of a typical Solar thermal collector

Solar thermal technology has been extensively studied for its feasibility and characteristics. Flat-plate collectors are cost-effective for temperatures under 60°C, whereas evacuated tube collectors (ETC) are more feasible for temperatures greater than 70°C. Researchers from various countries conducted systematic reviews to recommend suitable solar heating systems for different industries. Different collector systems, such as flat plate and concentrating collectors, have been evaluated for their reliability and effectiveness in various climatic conditions for industrial process heat systems. Additionally, a combination of photovoltaic (PV) cells and solar thermal collector systems can minimize fossil fuel use in process heating [8–10].

Solar Thermal Energy and Collectors

Over the past decade, significant progress has been made in solar energy (SE) technologies, offering a range of options with varying costs. The increasing global demand for energy, driven by economic progress, in addition with escalating costs of fossil fuels, presents a critical challenge. Conventional energy sources have limited reserves, necessitating a shift towards sustainable alternatives. Sunlight, as Earth's most abundant energy source,

can be harnessed through various means such as solar thermal energy and photovoltaic cells. While PV cells efficiently convert solar energy into electricity, they are not without limitations, converting only about 15-20% of solar radiation into electrical energy [11].

In contrast, solar thermal collectors are devices that convert solar energy directly into heat, offering a more efficient solution for certain applications. Emerging technologies like solar concentrated photovoltaic thermal (CPVT) and photovoltaic thermal (PVT) systems integrate electrical and thermal outputs, showing promise for increased efficiency. However, these integrated systems are currently limited to research and require further assessment for real-world feasibility before widespread adoption. The market offers a variety of solar thermal collectors, each with its unique characteristics and developmental trajectories. This study offers an overview of the different types of collectors (as shown in Fig. 2) used in solar thermal energy systems worldwide. The paper discusses the latest advancements and challenges in this field [12, 13].

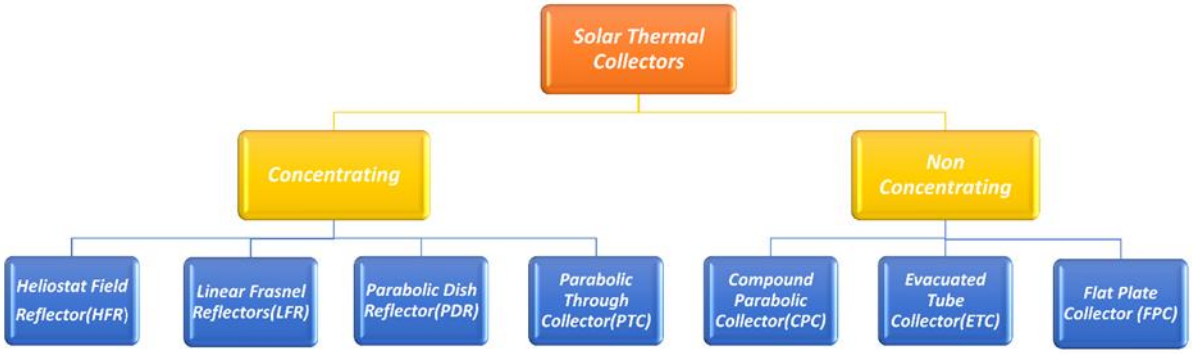

Fig.2 Classification of solar thermal collectors [9, 14]

As indicated from the Fig. 2 solar thermal collectors can be broadly classified in two groups (a) non-concentrating and (b) concentrating solar thermal collectors.

Flat plate collector is a typical example of non-concentration thermal collector as shown in Fig. 3. Thermal energy absorber plats are placed such a manner that solar radiation heats the plates directly and the absorbed heat is transferred through fluid flowing through the copper tubes placed beneath the heat absorber plate.

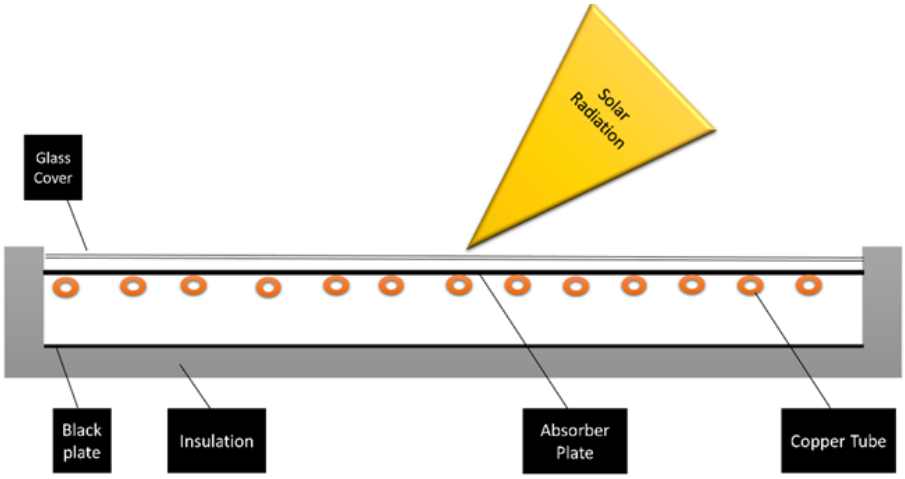

Fig. 3: A Schematic diagram of a non-concentrating type of Solar Collector (Flat Plate Collector)

On the counterpart, in concentrating solar thermal collectors' solar energy is concentrated towards the absorbent and then that is collected and transferred to the intended places. Parabolic Reflector is an example the concentrating type of solar thermal collector and it's working procedure is shown through a schematic diagram Fig. 4. Here, sun lights are reflected and concentrated through a parabolic reflector. A receiver is placed on the concentrating point to absorb the heat energy and subsequently transfer to the intended places.

Use of Solar Thermal Energy in Industries

Solar thermal energy holds potential for various applications from medium to high temperatures (80–240°C), besides its use at lower temperatures. This is an excellent source of direct heat for industrial processes, and a reliable power generator for electricity. Present study focuses solely on the thermal aspects of solar energy systems. A schematic diagram in Fig. 5 illustrates a solar collector system combined with auxiliary sources to supply process heat for various industries with different process needs. However, implementing solar power for industrial use poses several challenges, which will be discussed later in this paper.

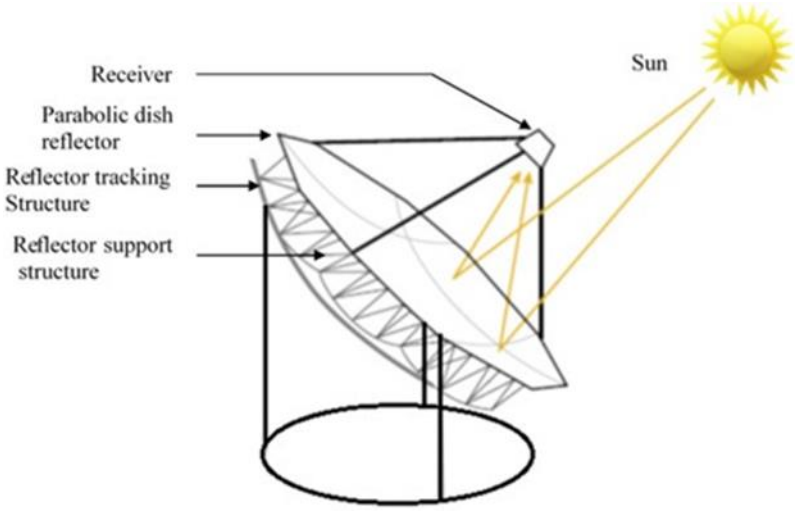

Fig. 4: A Schematic diagram of Concentrating type of Solar Collector (Parabolic Reflector)

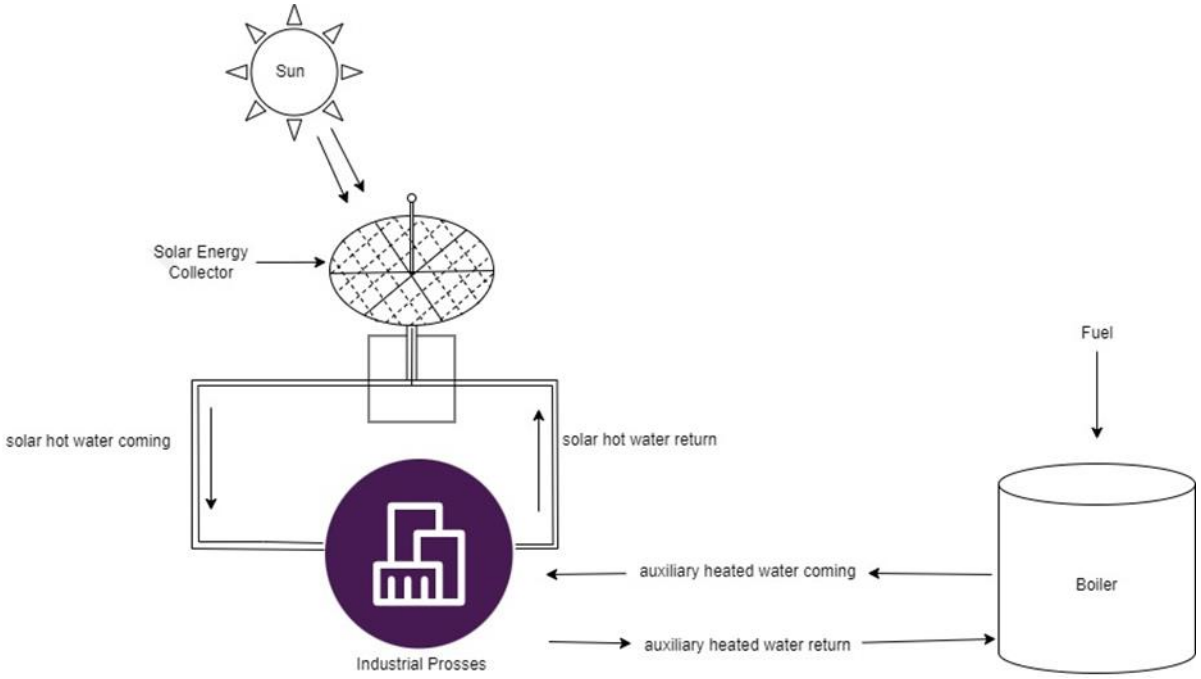

Fig. 5 Integration of solar heat/thermal energy to industrial processes

Many industrial processes use various types of solar thermal collectors to harness the heat energy from the sun [15, 16].

Some potential application areas of heat are as follows:

(a) Food Industry
(b) Automobile Industry
(c) Paper Industry
(d) Textile Industry
(e) Pharmaceuticals
(f) Chemical Products
(g) Agricultural Industry
(h) Mining Industry
(i) Solar Energy

Advantages and Limitations of Solar Thermal Collectors

After analyzing the discussions above, it is clear that solar thermal collectors offer multiple environmental advantages, energy security, and have the potential to replace fossil fuels in industrial process heating applications. Solar energy systems that utilize various collectors have a wide range of applications including space heating and cooling, water desalination, and industrial processes. However, there are specific limitations such as efficiency losses due to dust accumulation, high initial costs, and intermittency of solar radiation for some types of collectors. Additionally, there are significant challenges related to storing the energy produced by solar thermal collectors, as well as the high initial costs associated with them. The Solar Thermal Energy Storage (STES) system faces several challenges and limitations that hinder its widespread adoption as a fossil fuel alternative. Here are some of the major challenges storing the energy:

(a) PCM Leakage: Phase-change materials (PCM) are effective for storing solar heat energy, but there is a risk of leakage once the PCM melts, leading to fluid flow.

(b) Heat Loss: Increased temperature differences between the STES system and surrounding temperatures lead to higher heat losses. Inadequate insulation also contributes to additional heat loss.

(c) Pressure: Water, commonly used in STES systems, has a high vapor pressure, requiring thick containers that increase costs and may lead to leakage issues.

(d) Supercooling: Significant temperature variations during charging and discharging cycles can cause supercooling, particularly with PCM-type thermal storage materials.

(e) Corrosion: In thermal energy storage systems, the use of inorganic materials can lead to severe vessel corrosion over time.

(f) Safety Concerns: Many materials used in these systems pose safety risks, such as in flammability. Organic oils, in particular, can be challenging to handle safely.

Addressing these challenges is crucial for enhancing the efficiency, reliability, and safety of STES systems, results solar thermal energy sources are becoming more feasible options compared to traditional fossil fuel-based energy sources.

Conclusion

The selection of solar thermal technology in industrial processes is primarily driven by temperature requirements. Different solar thermal collectors are distinguished based on their ability to deliver specific temperature ranges. For instance, solar collectors like Compound Parabolic Collectors (CPC), Flat Plate Collectors (FPC), or Evacuated Tube Collectors (ETC), can provide temperatures ranging from 60 to 240°C, 30 to 80°C, and 50 to 200°C, respectively. In cases where existing collectors fall short, cascading or stacking

multiple collectors can be a viable solution to reach higher temperatures. Apart from temperature considerations, other factors such as land availability, temperature load fluctuations, scheduling flexibility, thermal storage capabilities, and integration options play crucial roles in selecting the appropriate solar thermal technology.

Based on this research, the following conclusions are drawn:

The industrial sector's significant energy consumption and greenhouse gas emissions from fossil fuel usage highlight the urgent need for sustainable alternatives. Solar thermal collectors offer a viable solution by harnessing solar energy, contributing to reduced carbon emissions and long-term sustainability.

Solar thermal collectors find diverse applications including space heating and cooling, refrigeration, CCS technology, water desalination, and industrial process heating. Combined systems that utilize both water and air as working fluids exhibit greater efficiency in comparison to individual systems.

Solar thermal energy has the ability to meet the heating demands of various industries, its intermittent nature necessitates the use of energy storage systems to ensure continuous operation.

This study offers key insights for decision-makers to integrate solar thermal energy into industrial processes and promote sustainable development.

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Load Balancing Approaches in Fog Computing : A Systematic Review

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ABSTRACT

Fog computing is the extension of Cloud computing. Whenever comes under the concept of Load balancing, it distributes the n/w traffic to prevent failure caused by overloading a particular resources. Load balancing act as an invisible mediator facilitator between a clients and group of servers, such that any connection request does not get lost. Without load balancing, applications, websites, database and online services would likely fails when demand gets too high. Load balancing uses a predefined pattern known as Load Balancing Algorithm. Load balancing in the fog layer optimizes resource usage, leading to reduced latency and improved quality of service. Many load balancing techniques have been proposed for fog computing. An empirical study has examined these existing methods and presented a hierarchical taxonomy. Moreover, the article offers a detailed annual review and summary of research articles focused on load balancing from 2012 to 2023. In this literature survey, we will explore various load balancing algorithms proposed for fog computing systems.

We will examine their strengths and weaknesses, as well as their performance in different scenarios. This survey aims to provide insights into the state-of-the-art techniques for load balancing in fog computing, which can help researchers and practitioners to choose the most suitable algorithm for their specific use cases.

Keywords : Cloud computing, Fog computing, Load Balancing, Resource management, IoT

INTRODUCTION

Load balancing algorithms play a vital role in optimizing the performance of fog computing systems by efficiently distributing workloads among fog nodes. Due to the fast expansion of the Internet of Things (IoT) and edge computing, fog computing has surfaced as a viable solution for managing the escalating

volume of data produced by IoT devices. However, effective load balancing is necessary to ensure that the fog nodes can handle the workload without being overwhelmed, which can result in degraded performance and increased latency. In this literature survey, we will explore various load balancing algorithms proposed for fog computing systems. We will examine their strengths and weaknesses, as well as their performance in different scenarios. This survey aims to provide insights into the state-of-the-art techniques for load balancing in fog computing, which can help researchers and practitioners to choose the most suitable algorithm for their specific use cases.

Load Balancing Algorithms: Literature survey

In this section, we have discussed various load balancing algorithms that have been proposed by different researchers to implement load balancing in fog computing.

Nitin Kumar Mishra and Nishchol Mishra [1] demonstrated a load balancing technique based on aspect of building practical execution of a single processor and ensuring that the processing workload is distributed equally among all available resources. In the context of fog computing, load balancing algorithms are essential for efficiently utilizing the resources available in fog nodes.

Harshit Gupta and Kalicharan Sahu [2] developed a load balancing method inspired by Honey Bee behavior. This technique aims to enhance the response time of client applications by effectively utilizing available resources. These algorithms work by distributing the workload among different nodes or servers in a way that optimizes resource utilization and reduces response time. This can help prevent overloading of certain nodes and improve the overall performance of the system.

Ratan Mishraand & Anant Jaiswal [3] defined a load balancing algorithm based on Ant colony optimization, inspired by the foraging behaviour of ants. This approach has been utilized to address a range of optimization challenges, such as load balancing within fog computing environments. ACO is used to find the optimal solution by simulating the behaviour of ants in finding the shortest path between their nest and a food source.

Anil Singh and Nitin Auluck [4] talked about an ILP-based algorithm that considers minimum hop distance (MHDL), minimum load, and minimum distance aspects. This algorithm is defined the scheduling the workload among different fog nodes.

Wang et al. [5] discussed an algorithm of fog node problem based offloading load balancing to improve the resource allocation by balancing computation between fog nodes and the cloud while reducing energy consumption. The framework considers the processing capabilities of fog nodes, the amount of data to be transferred, and the energy consumed by the nodes. By offloading tasks to fog nodes instead of relying solely on fog resources, the framework improves response time, reduces network traffic, and ensures efficient resource utilization.

Pereira et al. [6] improved a Dynamic load balancing. It refers to the process of distributing tasks or workload across a network of devices that differ in their processing capabilities, storage capacity, and communication bandwidth.

Subhan Tariq and colleagues [7] developed a load balancing technique that incorporates cloud and fog computing, using a priority-based approach. In priority-based load balancing the highest priority-based job will be the first choice for choosing the fog by load balancer.

Koushik Dasgupta et al. [8] demonstrate a Genetic based load balancing strategy which is used to locate the best possible solution for a large search space. The algorithm comprises three main operations: replacement, genetic operation, and selection. These operations work together to optimize the solution and find the most efficient outcome.

Bin dong et al. [9] firstly introduced a dynamic and adaptive load balancing technique for large and dynamic file systems by using a centralised system. They have been proposed a SALB (Self-Active Load Balancing) algorithm to overcome the limitations of traditional load balancing algorithms.

Huankai Chen et al.[10] & Shyam Singh Rajput et al.[11] designed a min-min algorithm to manage the load. It is a heuristic algorithm that works by selecting the task with the smallest estimated completion time and assigning it to the resource with the lowest estimated completion time.

Kumar Nishant et al. [12] proposed a Throttled load balancing algorithm which worked on the VM selection mechanism in their Throttled Algorithm to improve its performance. Specifically, they suggest selecting the next available virtual machine (VM) based on its state when a new request arrives, instead of simply assigning it to the next available VM.

Dr. Amit Agarwal & Saloni Jain [13] defined a modified priority-based algorithm called Generalised priority algorithm. It assigned the task according to priority as well as processing power of the virtual machine of the network.

L.D.Dhinesh Babu and P. Venkata Krishna [14] introduced a load balancing concept for fog computing inspired by the behaviour of honeybees. It is bio-inspired load balancing algorithm that mimics the foraging behaviour of honey bees. In fog computing, the HBB algorithm is used to balance the workload of fog nodes by considering the available resources and the tasks' processing requirements. The HBB algorithm helps to improve the overall system performance and minimize the response time of user requests.

Elsharkawey et al. [15] performed an operation on workload using Real-time efficient (RTES) algorithm. This algorithm is commonly used in time-sensitive applications such as process control, robotics, multimedia, and telecommunications.

C Dsouza et al. [16] demonstrated Max-Min algorithm. The Max-Min algorithm is similar to the Min-Min algorithm in that it aims to minimize the execution time of tasks, but it differs in that it starts with the tasks that have the longest completion time.

Venkateshwarlu Velde & B. Rama [17] performed load balancer by using Opportunistic load balancing algorithm (OLB) which tries to keep busy every node using resource management of workload. This algorithm tries to every node in working condition.

Menon H et al. [18] introduced a new algorithm to manage the workload as Graph re-partitioning and mapping-based load balancing algorithm. The authors presented a runtime system that is adaptive and comes with an automatic load balancing mechanism.

Verma and colleagues [19] presented multiple load balancing approaches in their paper, covering both hardware-based and software-based methods. They provided an overview of load balancing algorithms, including techniques like load balancing inspired by honeybee behaviour and genetic- based algorithms for load balancing tasks.

Katyal and Mishra [20] explored two primary tasks associated with load balancing, namely resource allocation or provisioning and resource scheduling. They assessed the performance and efficiency of load balancing algorithms based on these tasks. The authors evaluated the performance of various load balancing algorithms by using the CloudSim simulator. They measured the effectiveness and efficiency of the algorithms in terms of factors such as response time, throughput, and resource utilization.

Kalraand Singh [21] introduced algorithms utilizing various meta-heuristic optimization techniques, used to solve complex problems that are difficult to solve using traditional optimization techniques.

Ahmad AA AlKhatibet et al.[22] demonstrated a random algorithm. The data centre unit selects one of the available virtual machines at random after the VMs are selected. The unit arranges the order of the virtual machines in a circular manner, and any VM that receives a request is moved to the bottom of the list.

In the below table, we have summarised the existing load balancing algorithm present in fog computing.

Table 1: Summary of existing load balancing in fog computing

Authors	Year	Load Balancing Approaches	Explanation
Nishchol Mishra & Nitin Kumar Mishra [23]	2015	A systematic workload distributed load balancing among processors	Improving the performance by redistributing work load among the fog network framework.
Harshit Gupta & Kalicharan Sahu[24]	2015	Load Balancing based on Honey Bee behaviour	Improve the response time by ensuring maximum utilisation of available assets.
Ratan Mishra & Anant Jaiswal[25]	2012	Ant colony optimization based load balancing	Ant colony optimization is employed to address load balancing challenges within fog computing.

Anil Singh and Nitin Auluck[26]	2019	MHDL (Minimum Hop Distance and Load) and the minimum distance heuristic algorithm	Load balancing aware scheduling ILP (LASILP) proposed for solving of workload.
Wang et al.[27]	2019	Task offloading challenge utilizing Stackelberg game theory	Economy-based task offloading approach
Pereira et al.[28]	2019	Dynamic load Balancing	Task distribution in heterogeneous environment
Subhan Tariq et al.[29]	2018	Load balancing with priority emphasis in cloud and fog environments	In priority based load balancing the highest priority based job will be the first choice for choosing the fog by load balancer.
Kousik Dasgupta et al.[30]	2013	Genetic-based algorithm load balancing strategy	Strategy which is used to locate the best possible solution for a large search space.
Bin dong et al.[31]	2012	A dynamic and adaptive load balancing strategy	Adaptive load balancing technique for large and dynamic file systems by using a centralised system.
Huankai Chen et al.& ShyamSingh Rajput et al.[32]	2013 2016	Min-Min Algorithm	Heuristic algorithm that works by selecting the task with the smallest estimated completion time and assigning it to the resource with the lowest estimated completion time.
Kumar Nishant et al.[33]	2012	Throttled Load Balancing Algorithm	VM selection mechanism in their Throttled Algorithm to improve its performance
Dr. Amit Agarwal & Saloni Jain[34]	2014	Generalized Policy Algorithm	It assigned the task according to priority as well as processing power of the virtual machine of the network.
L.D.Dhinesh Babu & P.Venkata Krishna[35]	2013	Honey bee behaviour inspired load balancing algorithm	It is bio-inspired load balancing algorithm that mimics the foraging behaviour of honey bees.
Elsharkawey et al.[36]	2018	(RTES) Real-time efficient algorithm	RTES algorithm is to effectively balance the workload in a real-world scenario where tasks need to be completed within a defined time frame, while also maximizing network utilization and throughput.
C Dsouza et al.[37]	2015	Max-Min Algorithm	The Max-Min algorithm aims to minimize the execution time of tasks, similar to the Min-Min algorithm, but with the difference that it starts with the tasks that have the longest completion time.
Venkatesh warlu Velde & B. Rama[38]	2018	Opportunistic Load Balancing Algorithm(OLB)	Opportunistic load balancing algorithm (OLB) which tries to keep busy every node using resource management of workload. This algorithm tries to every node in working condition.

Menon H et al.[39]	2015	Graph re-partitioning and mapping-based load balancing algorithm	Load balancing system that is automatic and adaptive in runtime.
Vermaet al.[40]	2015	Load balancing with hardware and software components	Workload depends on the Hardware and the software of the VM.
Katyal & Mishra[41]	2014	Resource management and scheduling	Effectiveness and efficiency of the algorithms in terms of factors such as response time, throughput, and resource utilization.
Kalraand Singh[42]	2015	Meta-heuristic optimization techniques	Solve complex problems that are difficult to solve using traditional optimization techniques.
Ahmad AA AlKhatibet et al.[43]	2020	Random algorithm	The data centre unit selects one of the available virtual machines at random after the VMs are selected.

Result Analysis & Discussion

A: Taxonomy of Algorithms

There are various load balancing strategies that have been proposed in the literature to achieve this. However, due to the diversity of the Fog environment, it is challenging to classify and compare the different load balancing strategies. Therefore, a taxonomy of load balancers can provide a useful framework for organizing and comparing different load balancing strategies in Fog computing. This literature survey aims to present a comprehensive taxonomy of load balancers in Fog computing based on different factors such as balancing criteria, architecture, communication, and deployment. Based on the various research papers, we summarise the taxonomy of the load balancer in fog computing using a flowchart.

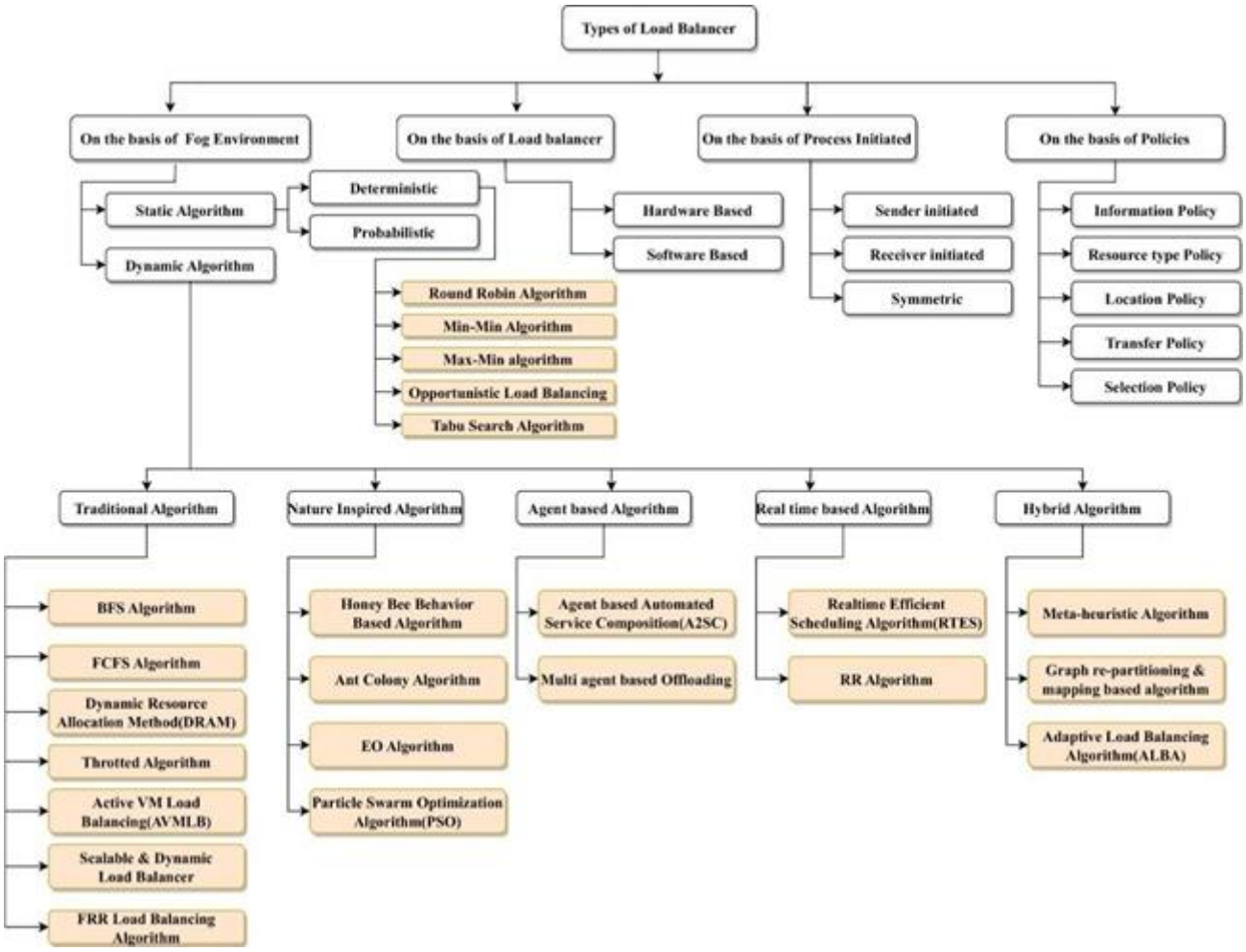

Figure 1: Show the Load Balancing Taxonomy and the Algorithm applied in fog computing.

B: Analysis of Literature study

In the previous section, we covered existing load balancing algorithms used in fog computing. This section, however, will focus on additional algorithms related to experimental setups, as well as their advantages and disadvantages in terms of their performance. We have summarized the review of the research paper in the below table and also analyzed their simulation techniques.

Table 2: Summary of the experimental setup of the researcher

Article	Main Idea	Evaluation	Tool
[44]	Load balancing algorithm using hill climbingapproach in fog system	Simulation	CloudAnalyst
[45]	Load optimization through heuristic Min-conflicts method	Simulation	CloudAnalyst
[46]	Load management approach utilizing AHP method for Multiple Gateways in fog computing	Simulation	MATLAB
[47]	Load-based resource management for fog cluster nodes	Simulation	Not-Mentioned
[48]	A heuristic virtual machine (VM) scheduling mechanism for load balancing	Simulation	CloudSim
[49]	SDN-based load balancing in cloud/fog environments	Simulation	Not-Mentioned
[50]	SDN-driven load balancing in fog/cloud infrastructure	Simulation	MATLAB
[51]	A fog/cloud system and big medical data based on bat algorithm considering load balancing	Simulation	MATLAB
[52]	Load management for large-scale machine-type communications in fog networks	Simulation	Not-Mentioned
[53]	Load distribution based on the Shortest Job First (SJF) approach	Simulation	CloudAnalyst
[54]	Load-aware resource allocation in fog/cloud environments	Simulation	CloudSim
[55]	Effective data replication considering load balancing	Simulation	CloudSim
[56]	Load distribution using metaheuristic techniques in fog-cloud environments	Simulation	Java
[57]	Load balancing method for load stabilization in fog environment	Simulation	CloudAnalyst

[58]	State-based load balancing method for SG energy management in fog	Simulation	CloudAnalyst
[59]	Integration of fog-cloud based system for load balancing by applying bin packing and genetic methods	Simulation	CloudAnalyst
[60]	A load balancing strategy based on genetic algorithm and Q- learning in the fog-based healthcare system	Simulation	MATLAB
[61]	Load distribution mechanism in live fog systems employing neural network and fuzzy logic algorithms	Simulation	iFogSim
[62]	Load distribution approach in a massive fog environment	Simulation	iFogSim
[63]	Fuzzy logic-based load balancer for fog environments	Not-Mentioned	Not-Mentioned

Conclusion & Future Scope

In conclusion, this systematic review paper has explored a wide range of load balancing techniques in fog computing. Through an in-depth analysis of research articles published between 2012 and 2023, we have identified various strengths and weaknesses of these techniques. The review highlights the importance of load balancing in optimizing resource utilization, reducing latency, and enhancing the overall quality of service in fog computing environments. Our comprehensive examination of different load balancing algorithms provides valuable insights for researchers and practitioners to make informed decisions regarding the selection and implementation of suitable techniques for specific use cases. Moving forward, further research and experimentation are warranted to address emerging challenges and improve the effectiveness of load balancing solutions in fog computing systems.

Overall, the future scope of load balancing techniques in fog computing is rich with opportunities for innovation and advancement, paving the way for more efficient, reliable, and scalable fog computing infrastructures.

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Writer identification & Verification from individual handwriting using Deep Learning

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ABSTRACT

Identifying words in Bengali and English from handwriting poses a significant challenge, yet it is not a new problem. Its applications span various domains, including forensic analysis, historical documents, and ancient manuscripts. Deep learning methodologies have emerged as superior feature extractors from extensive and diverse datasets, offering remarkable and unexpected predictions of patterns compared to conventional approaches. Our study focuses on employing a deep transfer Convolutional Neural Network (CNN) to identify writers using handwritten text line images in both English and Bengali languages. We conducted an evaluation of different freeze layers within the CNN model, namely Conv3, Conv4, Conv5, Fc6, Fc7, and a fusion of Fc6 and Fc7, to assess their impact on the writer identification rate. This paper pioneers the application of transfer learning by leveraging the ImageNet dataset as the base dataset and a specific dataset as the target dataset. To mitigate the risk of overfitting, we applied data augmentation techniques such as contours, negatives, and sharpness adjustments using text-line images from the target dataset. Additionally, we employed the sliding window approach to create patches as input units for the CNN model.

Utilizing the VGG16 architecture, we successfully extracted discriminating visual features from multiple representations of image patches generated through enhanced pre-processing techniques. Our results indicate the highest accuracy achieved thus far, reaching up to 92.78% for English and 92.20% for Bengali using the freeze Conv5 layer.

Keywords: Bengali Word Recognition, ImageNet, CNN, VGG16 Model, Deep Learning

I. INTRODUCTION

This paper focuses on using deep learning techniques to recognize Bengali characters and numerals from scanned image datasets. Bengali is the fourth most spoken language globally and the second most in India, with over 200 million speakers. English, on the other hand, is vital internationally, being the primary language in 104 countries. The project utilized the VGG16 model within deep convolutional neural network frameworks for accurate recognition, contributing significantly to improving existing approaches in this field.

Figure 1: Bengali Alphabets

II. Experimental

As information distribution has evolved, handwritten Bengali documents have become challenging to convert due to reliance on manual typing. This slow process is time-consuming and requires significant manpower. Each handwritten document is unique in style, making it difficult to comprehend, especially given the complex arrangement of characters and compound forms.

II.A: Background Study

Neural Network Overview: Deep learning is a type of machine learning that utilizes multiple layers of processing units to extract and transform features. Each layer builds on the output of the previous one, creating a hierarchy of abstract concepts. This approach, resembling the stages of processing in our brains, employs gradient descent and backpropagation for training. Unlike traditional pattern recognition, which relies on handcrafted features and simpler classifiers, deep learning uses neural networks with multiple layers for feature identification and processing.

There are two types of Neural Networks:

(i) Feedforward Neural Networks process signals from input to output without loops or feedback. They are straightforward and commonly used for pattern recognition, following a bottom-up or top-down approach.

(ii) Feedback Neural Networks allow signals to move in both directions due to loops in the network. They are dynamic, continuously changing until reaching equilibrium. These networks are also known as interactive or recurrent, with recurrent typically referring to feedback in single-layer setups.

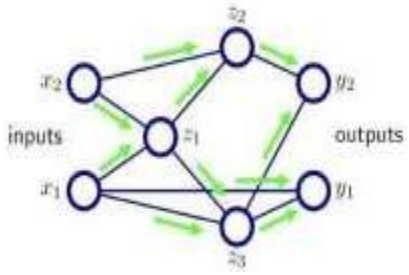


Figure 2: Feedforward Neural

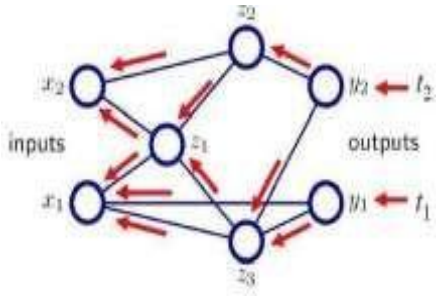


Figure 3: Feedback Neural Network

Network Training: Networks are trained using two methods: (i) Basic Training involves trial and error, adjusting random link weights to improve network behavior. If accuracy drops, changes are undone and new adjustments are made. (ii) The Back Propagation Algorithm optimizes network weights to minimize total error across the training set.

Patterns learned and network responses fall into two paradigms, Associative Mapping, where the network generates specific patterns in response to certain inputs. Whenever another particular pattern is applied on the set of input units.

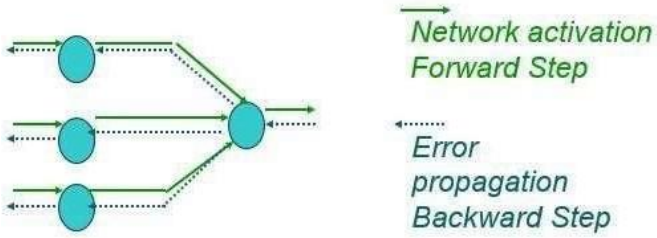


Fig 4: Back propagation of error and forward activation of network.

II.B: Methodology

P.P Roy and colleagues [1] introduced a deep learning method for identifying isolated Bengali handwritten compound characters. They utilized a supervised greedy layer-wise training of Deep Convolutional Neural Networks (DCNNs) and integrated the Respro algorithm to expedite convergence during training. Their findings were compared against results from standard shallow learning methods with preset features and conventional DCNNs. The study demonstrated that supervised DCNN layers surpassed previous standard shallow learning models like SVMs and similar-generation DCNNs in performance.

On the other hand, M. M. Rahman et al. [2] proposed a novel CNN-based approach for Bengali handwritten character recognition. Their method starts by normalizing handwritten character before employing CNN for individual character classification. Unlike earlier works, this model does not rely on any feature extraction method. It incorporates two convolutional layers and two subsampling layers, with experimental results displaying its superiority over previous non-CNN-based systems.

Convolutional Neural Networks (CNNs) [3][4] share similarities with traditional Neural Networks in that they consist of neurons with adjustable weights and biases. Each neuron receives inputs, performs a dot product, and may apply a non-linear function afterward. The overall network still computes a single differentiable score function from raw image pixels to class scores, and it incorporates a loss function like SVM or Softmax in the final layer. Techniques for learning regular Neural Networks are also applicable to CNNs.

CNN architectures are specifically designed for image inputs, allowing for the incorporation of image-specific properties into the network's structure. This design choice enhances the efficiency of the forward function implementation and significantly reduces the network's parameter count [5].

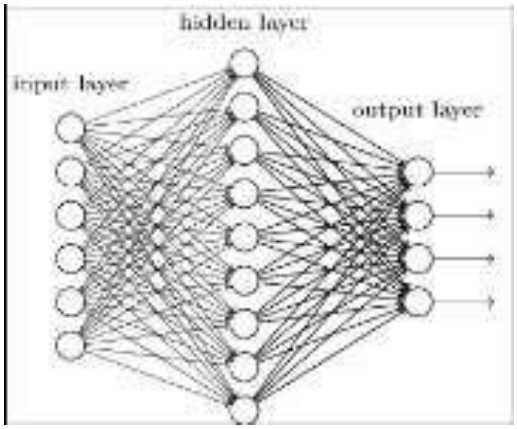


Figure 5: Ordinary Neural Network

II. C: Result Analysis & Discussion

Data set & Pre-processing:

The handwritten texts are scanned into images, and these images are processed to remove any noise present. Subsequently, the passages are segmented into images of individual words using methods outlined by Mendal et al. These word-sized images are then organized into folders according to a specific structure.The Given Dataset Contains Five Writer pairs.

- Five writer pairs are given in English & Bengali languages
- Each writer pair contains nearly 100 sub folders containing two individual authors.
- Each subfolder contains training & testing dataset, which contains average 90 scanned images respectively.
- Each scanned image contains Bengali text & symbols.
- Each image is in. Tiff format.

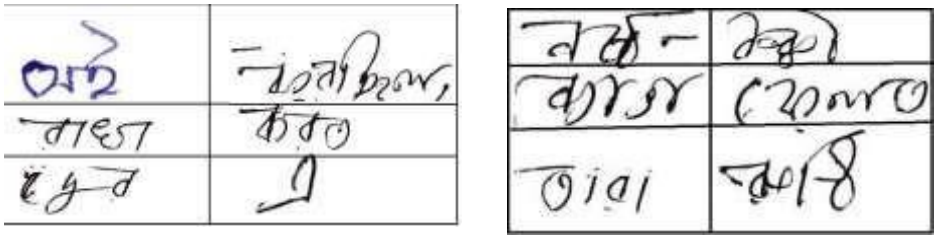


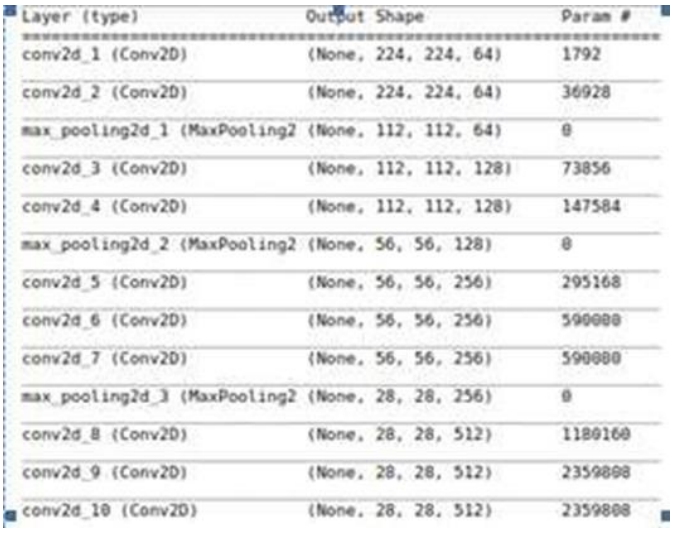
Figure 6(a) & 6(b): Given dataset containing Bengali Word

Steps for Model Selection, Training & Evaluation

- All the necessary libraries for implementing VGG16 have been imported using the Sequential method to create a sequential model. ImageDataGenerator from keras.preprocessing has been imported to easily import data with labels into the model. This class provides functions for rescaling, rotating, zooming, flipping, etc., without affecting the data stored on disk. The data is labelled automatically based on folder names, making it ready to be passed to the neural network.
- RELU activation is used for both dense layers of 4096 units to avoid forwarding negative values. The final dense layer with 2 units and softmax activation predicts between two classes, dog and cat.
- The model is compiled using Adam optimizer with a learning rate of 0.001 to reach the global minima during training. ModelCheckpoint and EarlyStopping methods from keras are imported, and callback functions are passed to fit_generator. ModelCheckpoint saves the model based on validation accuracy, while EarlyStopping stops training if there is no improvement in validation accuracy after a certain number of epochs.
- fit generator is used with ImageDataGenerator to pass train and test data, setting batch sizes with steps_per_epoch and validation steps. After executing this, the model begins training, displaying training/validation accuracy and loss.

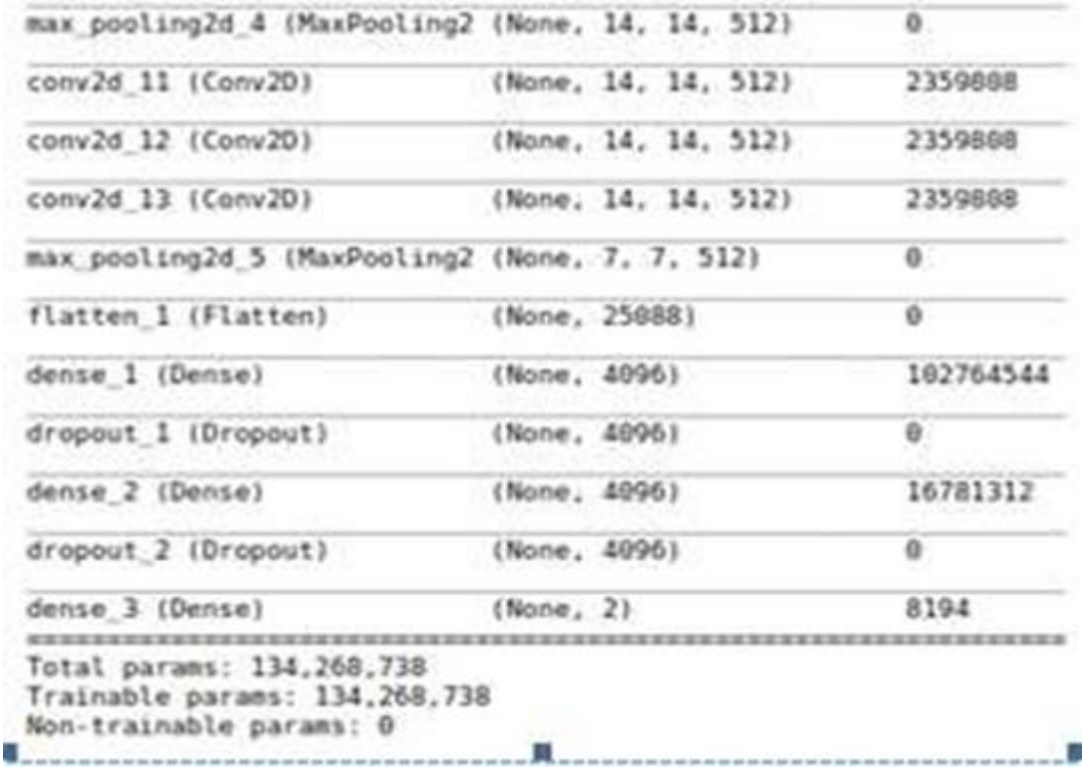
Defining CNN Model: Training & Testing Phase

VGG16 is a Convolutional Neural Network (CNN) architecture renowned for winning the ILSVRC (ImageNet) competition in 2014, remaining a benchmark in vision models. Its standout feature is its focus on 3x3 filter convolution layers with a stride of 1, always employing same padding, and 2x2 filter max-pooling layers with a stride of 2. This pattern repeats consistently throughout the architecture. At its end, there are 2 Fully Connected (FC) layers followed by a SoftMax for output. The "16" in VGG16 signifies that it has 16 layers with weights, making it a sizable network with approximately 138 million parameters.



Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 224, 224, 64)	1792
conv2d_2 (Conv2D)	(None, 224, 224, 64)	36928
max_pooling2d_1 (MaxPooling2	(None, 112, 112, 64)	0
conv2d_3 (Conv2D)	(None, 112, 112, 128)	73856
conv2d_4 (Conv2D)	(None, 112, 112, 128)	147584
max_pooling2d_2 (MaxPooling2	(None, 56, 56, 128)	0
conv2d_5 (Conv2D)	(None, 56, 56, 256)	295168
conv2d_6 (Conv2D)	(None, 56, 56, 256)	590080
conv2d_7 (Conv2D)	(None, 56, 56, 256)	590080
max_pooling2d_3 (MaxPooling2	(None, 28, 28, 256)	0
conv2d_8 (Conv2D)	(None, 28, 28, 512)	1180160
conv2d_9 (Conv2D)	(None, 28, 28, 512)	2359808
conv2d_10 (Conv2D)	(None, 28, 28, 512)	2359808

Figure 7 : Diagrammatic representation of the Convolutional Neural Network model



max_pooling2d_4 (MaxPooling2	(None, 14, 14, 512)	0
conv2d_11 (Conv2D)	(None, 14, 14, 512)	2359808
conv2d_12 (Conv2D)	(None, 14, 14, 512)	2359808
conv2d_13 (Conv2D)	(None, 14, 14, 512)	2359808
max_pooling2d_5 (MaxPooling2	(None, 7, 7, 512)	0
flatten_1 (Flatten)	(None, 25088)	0
dense_1 (Dense)	(None, 4096)	102764544
dropout_1 (Dropout)	(None, 4096)	0
dense_2 (Dense)	(None, 4096)	16781312
dropout_2 (Dropout)	(None, 4096)	0
dense_3 (Dense)	(None, 2)	8194

Total params: 134,268,738
Trainable params: 134,268,738
Non-trainable params: 0

Figure 8: Training & Testing data model

Training the model with the dataset is performed using a fit method. The epochs are predefined or they can use a call back method to stop the training when losses to do improve further. The accuracy of the model is then tested.

EPOC H	LOSS	ACCURACY	VAL_LOSS	VAL_ACCURACY
1	0.1884	0.9583	0.3279	0.8750
2	0.1570	0.9375	0.6257	0.6562
3	1.2979	0.5417	1.2213	0.4688
4	0.2122	0.9375	0.2211	0.8750

5	0.2975	0.8542	0.5048	0.8125
6	0.2324	0.9062	0.5037	0.8125
7	0.1884	0.9583	0.3279	0.8750
8	0.1923	0.8736	0.5563	0.8945
9	0.2013	0.9153	0.4531	0.8874
10	0.1922	0.9245	0.6522	0.7189

Table 1: Summary of Variation of Loss & Accuracy through epochs

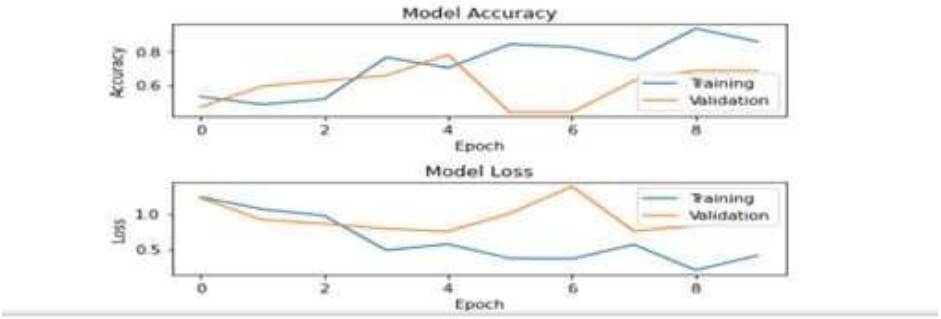


Figure 9: Accuracy and Loss graph on training and validation data

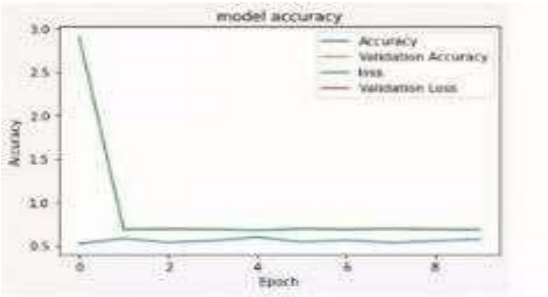


Figure 10: Accuracy Graph for writer pairFinal accuracy attend after methods nearly 91.22%.

III. Conclusion

This research topic explores methods to classify Bangla and English handwritten characters. CNNs prove more efficient than other ML approaches and perform well on diverse datasets, highlighting system versatility. CNNs, inspired by animal visual cortex organization, connect neuron patches for improved performance in digitizing Bangla characters. Increased hardware support could enhance accuracy further.

IV. Future Scope

Using a larger, varied dataset improves the model's ability to learn class features effectively. The web interface simplifies model interaction and enables real-time validation. While the system excels at classifying individual Bangla alphabet letters, it lacks the capability to detect character sequences. This could be explored in the future but requires complex implementation.

Expanding the dataset to include more numeric digits and compound letters could enhance model performance significantly. It would be intriguing to observe the model's classification accuracy with a broader range of Bangla characters.

Lastly, gaining a thorough understanding of deep learning concepts allows for the development of customized neural networks for broader tasks.

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Design and Structural Analysis of Engine Piston

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ABSTRACT
In this work, a design of structural model of a piston has been developed by using Ansys. This study explores the crucial process of choosing engine piston materials, highlighting the significant influence these choices have on durability and performance. It is clear from comparing aluminum 7050, cast iron, and aluminum 6061 that each material has unique mechanical and thermal qualities that meet a variety of engineering requirements. Key mechanical parameters including maximum von Mises stress, strain, deformation, and principal stress are evaluated. Aluminum 7050 exhibits greater stress resistance and deformation characteristics, while cast iron offers a balanced strength-deformation profile. Aluminum 6061 serves as a moderate alternative. This study highlights the importance of informed material selection for optimal piston performance and reliability.
Keywords: Engine Piston, Structural Analysis, Ansys, Deformation, Von Mises Stress

INTRODUCTION
A key component of internal combustion engines, the piston acts as an essential connection between the engine cylinder's energy conversion mechanism and the fuel-air combination. The need for advanced engineering techniques increases as engines keep improving for better performance, efficiency, and reduced emissions. Computer-Aided Engineering tools have become essential resources in the design, analysis, and performance optimization of pistons in recent years. Their essential importance in the development of modern pistons of engine is shown by their incorporation into the engineering process.

Using Computer-Aided Engineering technologies, Sathishkumar et al. [1] carried out a comparison investigation to identify the best material for car pistons. They compared materials made of cast iron and aluminum alloy to examine stress distribution in particular engine configurations. Finding the best material for high-performance car pistons was the goal of the investigation. In order to choose the optimum material and optimize piston geometry, Jain et al. [2] used the finite element method (FEM) to conduct structural analysis on four distinct aluminium alloy pistons. Their research entailed estimating the highest possible stress and strain in order to choose the best aluminium alloy material.

Shinde et al. [3] concentrated on using ANSYS and solid modelling tools to analyze the structural behavior of pistons at high combustion gas pressures. A comparative investigation of pistons composed of various materials was included in the study in order to determine which material could tolerate the highest gas

pressure. Due to its many industrial uses and high technological value, aluminum and its alloys have attracted a lot of interest recently. This is as a result of its beneficial characteristics, which include its low density, excellent corrosion resistance, desirable tensile strength, good heat conductivity, and high cast ability [4-7]. The transition of the automobile industry from bullock carts to electric cars demonstrates the continuous quest of luxury, comfort, and environmental sustainability. This quest has led to the development of cutting-edge materials such as aluminium hybrid metal matrix composites, which are used in brake and piston applications. Paul et al.[8] examined the durability and performance of the vehicles, particularly in situations involving urban traffic. Using ANSYS software, Liu et al. [9] presented a finite element analysis of diesel engine pistons under thermal, mechanical, and thermo-mechanical loads. The analysis revealed areas of stress concentration and verified that the piston's strength satisfies operational requirements. The combustion chamber bulge's top and the contact regions between the piston, pin seat, and piston showed the highest temperatures and stress concentrations. Kumar [10] developed a piston's structural model. In this research, the vibration properties of the piston and rings are studied together with their inherent frequency and vibration mode.

Using Ansys, a structural model of a piston has been designed in this work. With an emphasis on maximum von Mises stress, strain, deformation, and principal stress, this study aims to assess the mechanical performance of aluminium 7050, cast iron, and aluminium 6061 in engine piston applications. The goal of the study is to identify the best material in terms of performance and durability.

MODELLING OF PISTON

When designing a piston, several important requirements must be considered. Firstly, the piston needs to be able to withstand high mechanical loads and temperatures encountered during operation of engine. It should possess excellent strength, stiffness, and durability to make sure longevity and reliability. Additionally, the piston design should support efficient heat transfer to prevent overheating and thermal reduction. It also must have less friction to optimize engine performance and fuel efficiency. The piston's weight and inertia should be carefully balanced to minimize vibrations and reduce stress on the components of engine. In addition, the selection of materials is essential for optimum performance of engine. Ultimately, in order to achieve the best possible balance between performance, costs, and sustainability, parameters including cost-effectiveness, manufacturing feasibility, and environmental impact should direct the design process. In this analysis, the materials chosen for examination include aluminum alloys (specifically Al 7050 and Al 6061) as well as cast iron. The thickness of piston (t in mm) is written by [11]

$$t = D\sqrt{3p/16\sigma} \quad (1)$$

Where, p= maximum pressure in N/mm², D = outside diameter of the piston in mm. and σ =permissible tensile stress for the material of the piston in N/mm².

Each metal has different properties in respect to strength and allowable tensile stress. Al 7050, an aluminum alloy, is very strong and has an allowed tensile stress level that permits it to withstand significant mechanical strain without breaking. Another aluminium alloy, Al 6061, shows excellent strength as well, however just less than Al 7050. But when compared to cast iron, both aluminium alloys often show greater tensile strengths. Conversely, cast iron provides a combination of advantages. Cast iron is well known for its

remarkable compressive strength and resistance to deformation, even though its tensile strength is not as high compared to that of aluminium alloys.

RESULTS AND DISCUSSION

The simulation is started with Ansys, and it then provides results for every material that are used in this work, showing important properties such as maximum deformation, maximum von Mises stress, maximum von Mises strain, and maximum primary stress that are required for the design of engine piston. As part of the structural study, the top surface of the piston is subjected to 7 MPa of pressure. In the study of optimizing the performance and durability of an engine piston, the selection of material plays an essential part. This work discuss the contrast analyses of three materials: aluminium 7050, Cast Iron, and aluminium 6061, based on key parameters such as maximum equivalent (von Mises) stress, maximum equivalent elastic (von Mises) strain, maximum deformation, and maximum principal stress as shown in figure 1, figure 2 and figure 3 respectively.

The highest or maximum von Mises stress for aluminium 7050 is 29.199 MPa, which shows that it can withstand significant mechanical force without breaking. Cast Iron follows with a slightly lesser highest von Mises stress of 20.898 MPa, showing that it is a material with significant strength but slightly lower compared to aluminium 7050. Aluminium 6061 shows a comparable maximum von Mises stress of 20.431 MPa to Cast Iron, making it as a suitable substitute with similar stress resistance. Aluminium 7050 displays the highest maximum von Mises strain at 4.0746×10^{-4}, suggesting that this material can experience more deformation under applied load. Cast Iron follows with a slightly lower von Mises strain of 3.3939×10^{-4}, indicating its capability to withstand deformation but to a lesser amount than aluminium 7050 material. Aluminium 6061 exhibits the maximum von Mises strain at 3.1359×10^{-4}, suggesting its comparatively lower capacity of deformation under similar loading conditions. The maximum deformation of aluminium 7050 is the highest at 1.5007×10^{-2} mm, indicating that it can experience significant deformation without losing structural stability. Cast iron shows a slightly lower maximum deformation of 1.1632×10^{-2} mm, it can also undergo deformation under stress in comparison to aluminium 7050. With a maximum deformation of 1.123×10^{-2} mm, aluminium 6061 is showed as a substitute with comparatively less deformation characteristics than cast iron and aluminium 7050. With a maximum principal stress of 14.736 MPa, aluminium 7050 has the maximum stress, showing its capacity to withstand significant mechanical loads without affecting structural stability. In comparison to aluminium 7050, cast iron has a slightly small maximum principal stress of 11.289 MPa, indicating its good strength but lesser stress resistance. Compared to cast iron and aluminium 7050, aluminium 6061 has the lowest maximum principal stress which is 9.942 MPa, indicating that this material with comparatively lesser stress resistance.

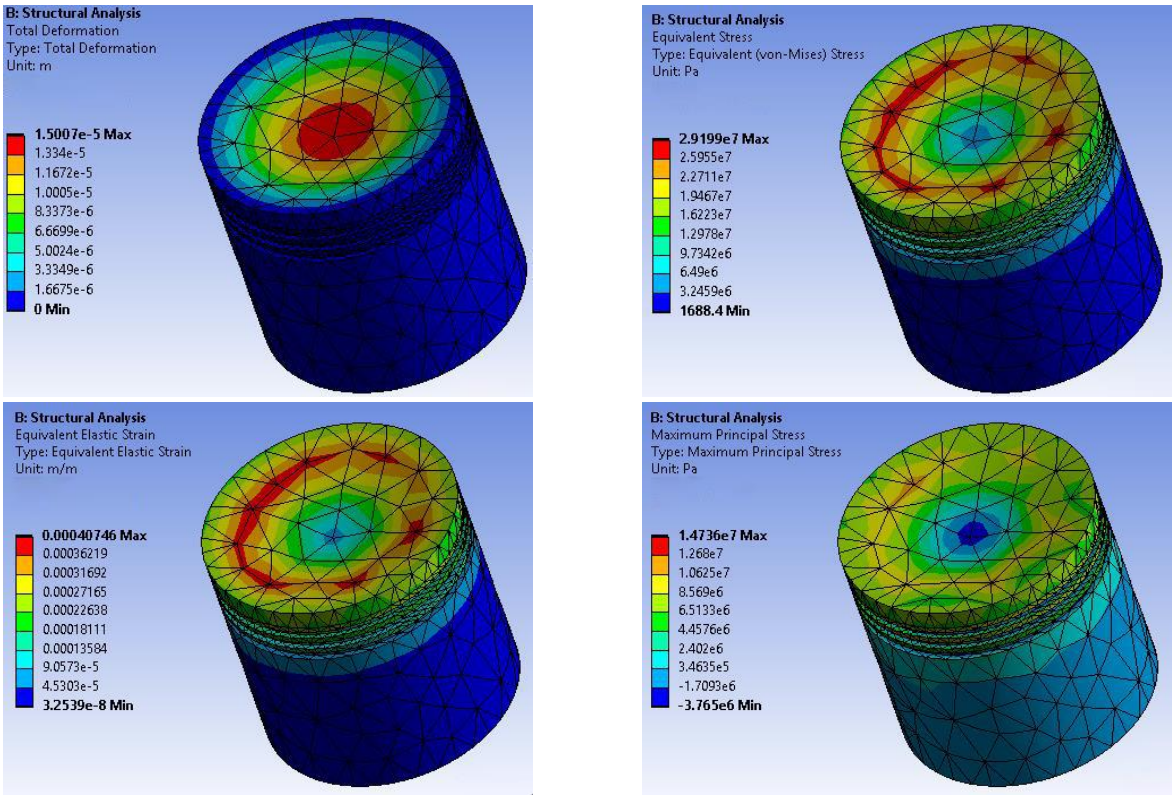

Fig. 1 Structural analysis of aluminium7050

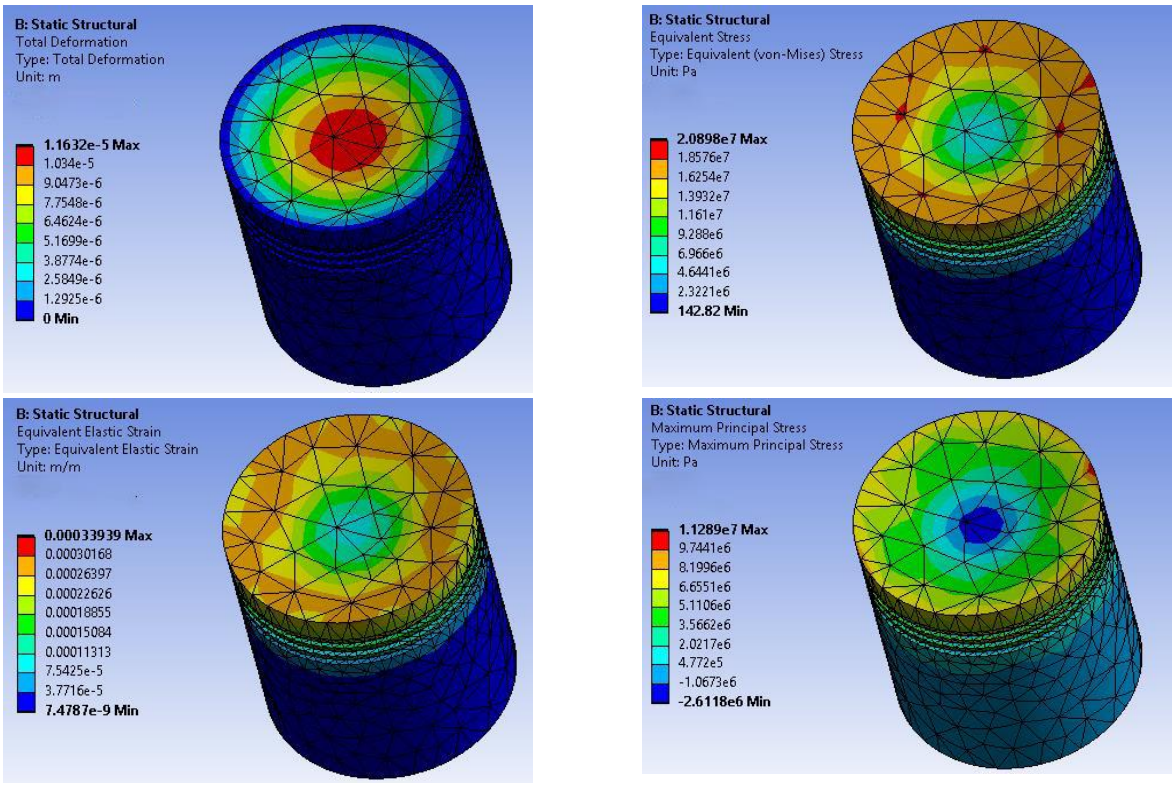

Fig. 2 Structural analysis of cast iron

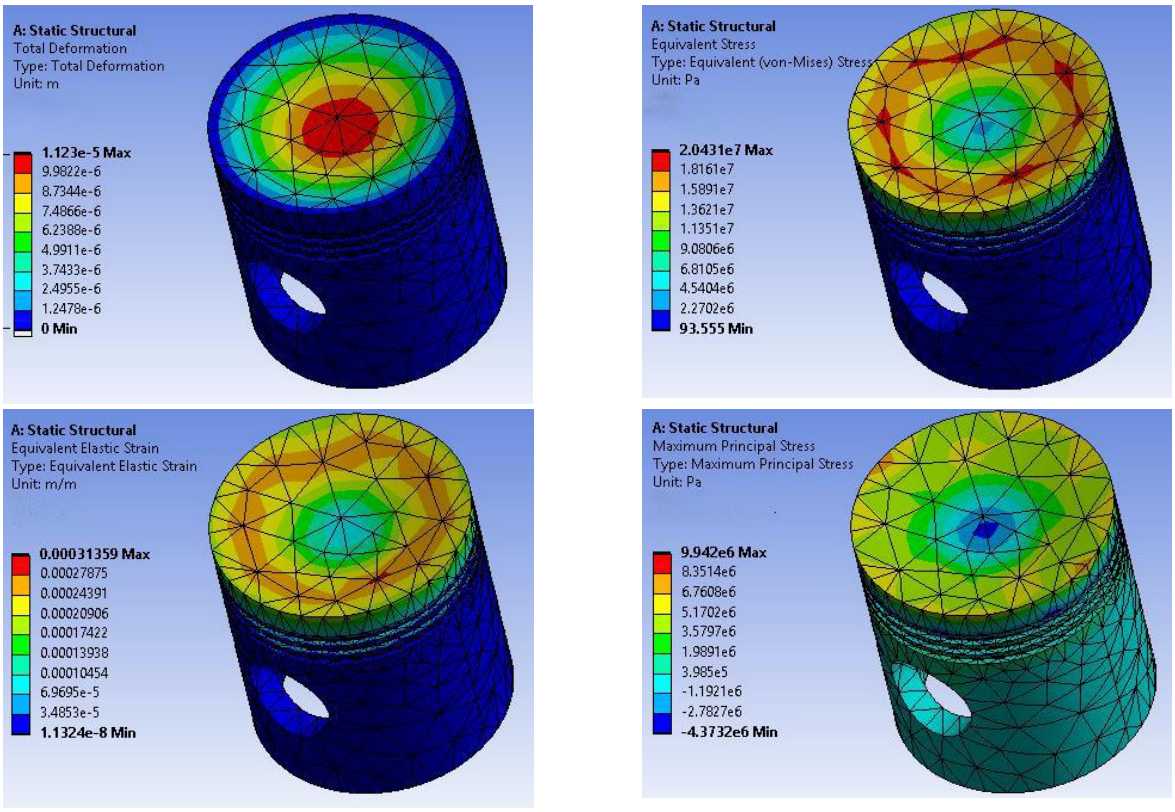

Fig. 3 Structural analysis of aluminium 6061

The specific requirements and choices in terms of mechanical properties like stress resistance, deformation, and rigidity examine the material choice for the piston of engine. Cast iron provides a balance between strength and deformation capacity, whereas aluminium 7050 gives significant stress resistance and deformation properties. On the other hand, aluminium 6061 offers a good substitute with intermediate mechanical qualities.

Conclusion

In conclusion, the selection of material for engine pistons is an important requirement that significantly impacts performance and durability. Through the comparative analysis of aluminium 7050, Cast Iron, and aluminium 6061, it is evident that each material shows unique mechanical properties. Aluminium 7050 stands out with its excellent stress resistance, and deformation capacity, making it suitable for applications demanding high mechanical loads. Cast Iron presents a balanced combination of strength and deformation capacity. Aluminium 6061 provides a feasible alternative with moderate mechanical properties, suitable for specific applications where a balance between performance and cost-effectiveness is desired. The selection of material is determined by the particular needs, choices regarding mechanical properties, and operating circumstances. In order to select the best material that provides the required performance and longevity of engine pistons, engineers must carefully consider these variables.The study is limited to the structural analysis of four different aluminium alloy pistons. Further research can be conducted to analyze a wider range of materials and designs for pistons in different types of engines

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