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Early Warning System to Prevent Animal-Train Collision

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ABSTRACT

The project aims to prevent animal-train collisions by using an image processing system that can identify obstacles on the train tracks, particularly animals. The project utilizes machine learning algorithms to identify the obstacles and send a notification to the train if an obstacle is detected. The system uses an IoT application and Bluetooth transmitter to send a message to the train and trigger a buzzer notification. By utilizing technology, the project hopes to reduce the number of animal-train collisions and improve safety for both humans and animals. The system utilizes machine learning algorithms to identify the obstacles in real-time and send a notification to the train via an IoT application and Bluetooth transmitter. If an obstacle is detected, a buzzer notification will be triggered on the train, alerting the driver to slow down or stop. The image processing system is designed to be highly accurate and efficient in identifying animals on the tracks, even in challenging lighting or weather conditions. The system is trained using a large dataset of images of animals and non- animal objects on train tracks, enabling it to recognize animals of various sizes, shapes, and colors. Overall, the goal of this project is to reduce the number of animal-train collisions and improve the safety of train travel. By leveraging the power of machine learning and IoT technology, this system can provide an effective solution to a pressing safety issue." To accomplish this, the project utilizes an image processing system that is highly accurate and efficient in identifying animals on the tracks, even in challenging lighting or weather conditions. The system is trained using a large dataset of images of animals and non-animal objects on train tracks, enabling it to recognize animals of various sizes, shapes, and colors.

The goal of this project is to reduce the number of animal- train collisions and improve the safety of train travel. By leveraging the power of machine learning and IoT technology, this system can provide an effective solution to a pressing safety issue.

Keywords : Deep Learning, Computer Vision, Object Detection

I. INTRODUCTION

Animal train collisions are a serious problem for the railway industry worldwide, causing severe damage to trains, the loss of animal life and even human death. Despite the implementation of various mitigation measures, the problem persists and requires innovative solutions. In this article, we propose a novel animal train collision avoidance method that uses machine learning and his IoT technology to identify obstacles and alert train units in real time. The proposed system uses infrared sensors mounted on utility poles along the tracks to detect the presence of animals and other obstacles. Once an obstacle is identified, the system captures an image of the object and uses machine learning algorithms to analyse the image to determine.

II. LITERATURE REVIEW

Anton Plotkin, Eugene Papern, 2008,[1] In this paper suggest a new approach to overcome all of the aforementioned drawbacks. They employ a thin, flat magnetic transmitter instead of the conventional transmitting frame. They also employ tiny solenoidal search coils instead of the conventional scleral search coils. The flat transmitter comprises a number of transmitting coils that allow us to monitor not only the orientation of a search coil but also its location. The experiments have shown that the new system allows monitoring of the eye and head motion in archer fish during swimming, targeting, and shooting.

Mike O. Ojo, 2021,[2] In this paper introduce a new application to defend crops from ungulate attacks that takes advantage of the latest technological developments in different ICT areas, such as AI, Edge Computing, IoT and LPWAN. The implementation of the application required the design and development of a complex system for intelligent animal repulsion, which integrates newly developed HW and SW components and allows to recognize the presence and species of ungulates in real time and also to avoid crop damages caused by the ungulates.

Yu-Jen Chen, Yan-Chay Li, Ke-Nung Huang, Ming-Shing Young, 2005,[3] By the fast development of computer technology, more and more data can be processed by computer, the frame grabber is often used to acquire image to computer, and then processes the image by software on computer. The output of this system is in CVBS NTSC video format. It can be displayed on a device that has CVBS input such as a TFT LCD TV.

Zhigang Liu, Yang Lyu, Liyou Wang, Zhiwei Han, 2019,[4] A novel object detection network based on an improved Faster RCNN is proposed. Through the analysis of the factors that influence the detection accuracy for brace sleeve screws and the characteristics of original Faster RCNN, the concepts of discrimination maps and proposal maps are introduced to the improved Faster RCNN. A high precision detection approach, namely an improved Faster RCNN, is proposed to detect the brace sleeve screws in the catenary supporting device of high-speed railways. The brace sleeve screw is too small relative to other devices for traditional methods to detect accurately.

Ping Li, 2020,[5] This paper proposes a novel method called MPDD for key component defect detection of rolling stocks.

Peng Dai, 2021,[6] Develop the semantic segmentation network RFOD Lab (Railway Foreign

Object Detection Lab) through which the pixel-level information of foreign objects on the track bed can be extracted out of track images. In addition, the mask generated by the network can be filtered according to the contour area to avoid false alarms, and then the pixel information of foreign objects can be obtained. Moreover, the attention mechanism is introduced for the backbone network of the model, to aggregate the context information of images. The semantic segmentation network for the anomaly detection of the ballastless track bed is a method of supervised anomaly detection based on sample data.

Xinyu Du, 2020,[7] Whole inspection system for plug defects, including the hardware for image acquisition and the software for the change detection framework. Thus, the VIS with the change detection framework can tremendously alleviate maintenance engineers work compared with traditional manual detection.

Cristian Wisultschew, 2021,[8] In this work, real-time and accurate object detection and tracking implementation using raw 3D point cloud data provided by a low-resolution LIDAR is presented. High accuracy in the detected object spatial location is achieved by using this complex sensor.

Jithu G. Panicker, Mohamed Azman, Rajiv Kashyap, 2019,[9] The LoRa wireless technology plays a vital role in IoT/M2M applications. LoRa enabled devices do not require much power to function due to the narrow bandwidth at which they operate to transmit signals. The low-frequency spectrum (unlike Wi-Fi, Bluetooth, etc) enables these devices to communicate through longer distances in comparison to the other conventional communication technologies.

K. Rajalashmi, 2021,[10] The elephant tracking system is becoming increasingly progressively significant in animal reserves and it is more protected than other. It is the real- time, to improve the relations between human and the animals. The information and equipment together make synchronization data which are captured by an onboard camera and a LiDAR sensor, respectively. The MSP framework enables to detect both large objects such as forward trains and small objects on the railway track such as toolkit, suitcase and pedestrians. The experiments show that the MSP network achieves accurate segmentation of railway track.

J. Jesus Garcıa, Jesus Urena, 2010,[13] A proposal of a multisensory system for obstacle detection on railways has been proposed, based on the complementary use of IR and US barriers, achieving high reliability. In this paper, apart from the use of two different sensor technologies, the reliability of the detection system has been increased. A robust encoding scheme based on mutually orthogonal complementary sets of sequences has been implemented. Second, a fuzzy controller has been included to combine the information given by the two sensors (IR and US). It generates a value for the certainty of the existence of objects considering some external agents, such as visibility and wind speed that can affect the sensor measurements.

Yu-Jen Chen1, Yan-Chay Li2, Ke-Nung Huang, 2005,[14] The fast development of computer technology, more and more data can be processed by computer, the frame grabber is often used to acquire image to computer, and then processes the image by software on computer. The output of this system is in CVBS NTSC video format. It can be displayed on a device that has CVBS input such as a TFTLCD TV.

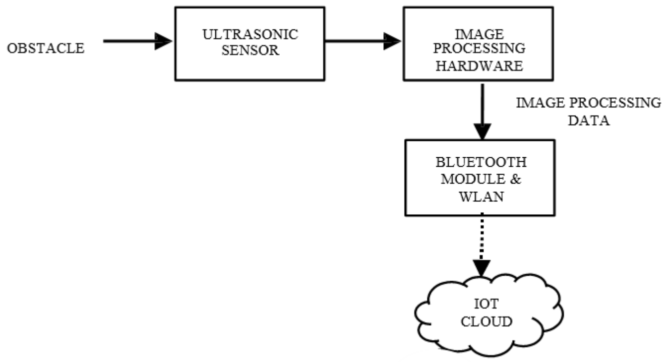
Mr.M.Nakkeeran, Dr.D.Sivaganesan, R.Donsia Siromi, 2018,[15] The existing method of this project is Roadside Animal Detection System (RADS).It is an innovative project designed to help protect wildlife traveling near US 41 from just west of the entrance to the Skunk Ape Research Headquarters and Trail Lakes Campground to just east of Turner Road (1.3

miles).RADS provide early warning to drivers about the presence of large animals near the highway.

III. METHODS AND MATERIAL

A. Block Diagram

Transmitter Unit



Receiving Unit

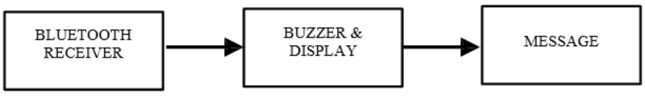


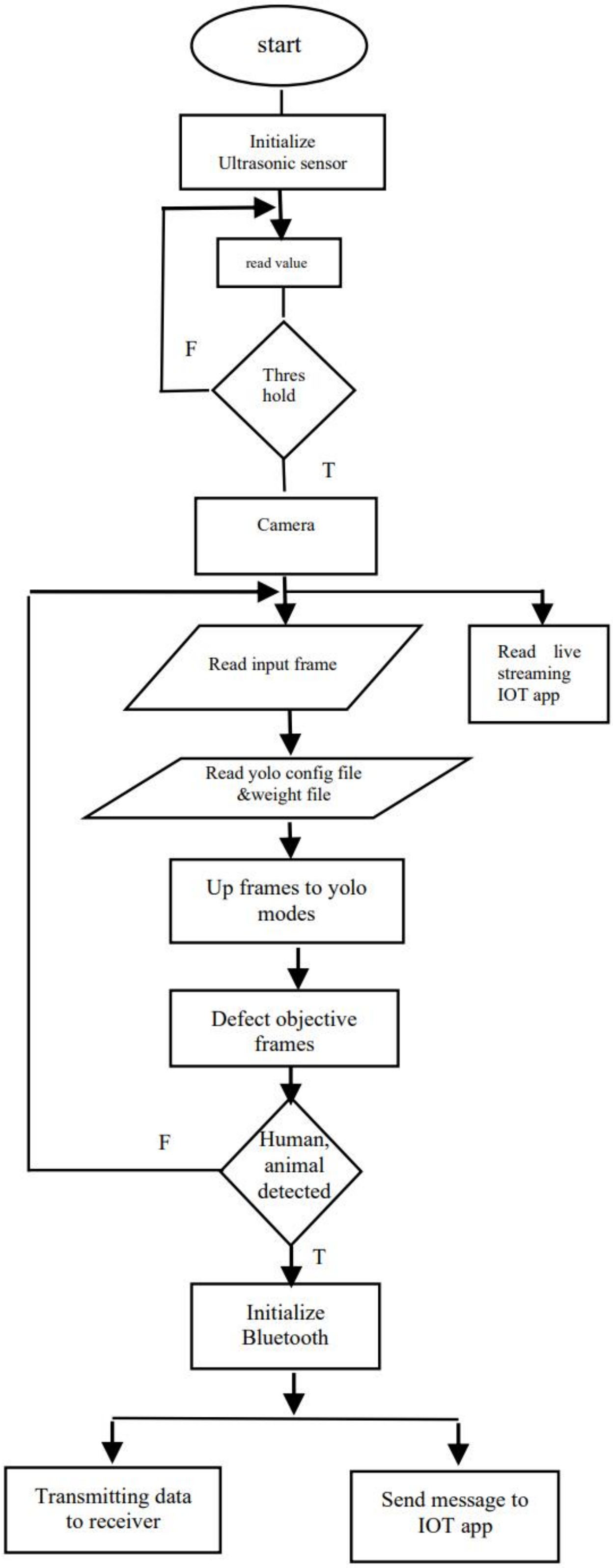
Fig.1 Block Diagram

B. Working

The block diagram fig.1 consists 2 input that are the ultrasonic sensor and ESP32 camera module. The sensor that can be used to obstacle identification and the sensor that can be measure the distance between the train and obstacle. The ESP32 Wi-Fi camera module that can be used for image capturing the ESP32 camera easily interfacing with microcontroller. The image of the obstacle that can be identified by using Deep learning. The obstacle is identified then the transmitter section send a SMS to the train unit by using Bluetooth transmitter. The message that can be send with the help of IOT mobile application. The input data are saved on the IOT cloud. Then the message can be sent by using transmitter, the receiving section having a Bluetooth receiver that receive the message and to produce an alert notification and displays the obstacle on the screen.

C. Flow Chart

Transmitting Section



Receiving section

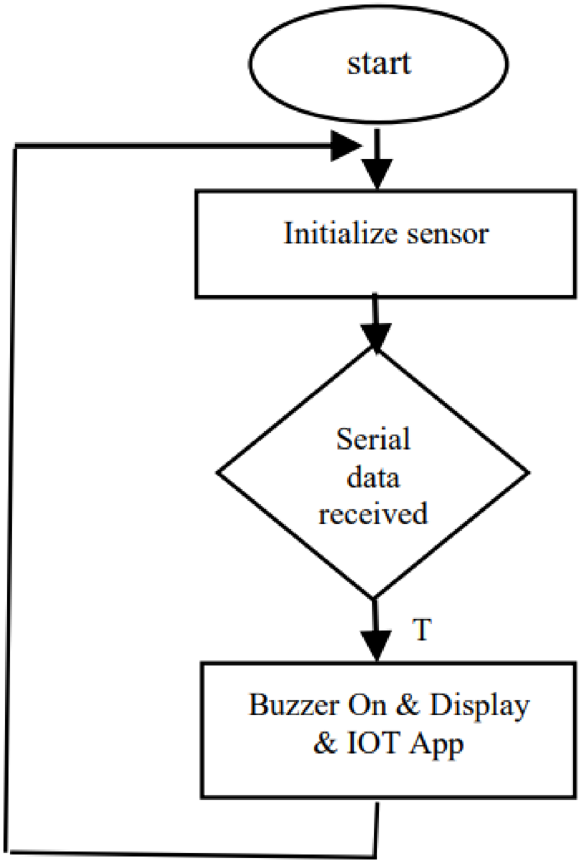


Fig.2 Flow Chart

D. CNN Based object detection

Yolov3 is a general convolutional neural network (CNN) based object detection algorithm that can be used for realtime object detection tasks. The basic steps involved in using

Yolov3 for object detection:

Data Collection and Annotation: Collect images for the objects you want to detect and annotate them using the annotation tool. This generates a dataset containing images and their corresponding captions.

Training Data Preparation: Split the dataset into training, validation, and testing sets. Resize the images using a tool such as Opencv and create label files in Yolov3 format.

Model Configuration: Yolov3 has a pre-trained configuration file that you can be used to train the model.

Training: Train Yolov3 model on dataset using a GPU. Depending on the size of your dataset and the comple xity of your model, the training process can take hours or even days.

Model Evaluation: Once trained, evaluate the model on the validation set to measure its performance.

Tune the hyperparameters and repeat the training process if necessary.

Object Detection: Detect objects in new images or videos using the trained Yolov3. The model outputs the coordinates of the bounding boxes around the objects and their class probabilities.

Post-Processing: Apply non-maximum suppression (NMS) to eliminate redundant bounding boxes and improve the detection accuracy.

Yolov3 is a powerful object detection algorithm that can detect multiple objects in real-time with high accuracy.

However, it requires significant computational resources and deep learning to implement effectively.

E. BLYNK APP Application

IoT-based solutions that have been researched for tracked object detection such as B. Monitor tracks using cameras and sensors to detect anomalies and problems. These systems can be integrated with machine learning algorithms to automatically analyse data and identify potential problems in real time.

For example, video cameras can be placed along the track to capture images and videos of train and track conditions.

These cameras can then be connected to a cloud-based platform for processing and analysis, where machine learning algorithms can be used to detect truck impediments and issues such as cracks and deformations. This allows rail companies to identify and address potential safety issues before they cause accidents or disruptions.

Overall, the Blink App is not directly applicable to railway track object detection, there are other IoT-based solutions that are being explored for this purpose, with the goal of improving safety and efficiency in the railway industry.

IV. PRELIMINARY DATA COLLECTION AND RESULT

Object detection using YOLOv3, testing data refers to a dataset of images or videos that are used to evaluate the performance of the trained YOLOv3 model on new and unseen data.

The testing data is separate from the training and validation data and is used to verify that the model can generalize well to new data and can detect objects accurately in real-world scenarios.

The testing data typically consists of a large number of images or videos that contain the types of objects that the model was trained to detect. These images or videos may contain various lighting conditions, backgrounds, and angles, which can make the object detection task more challenging.

To test the YOLOv3 model, the testing data is passed through the trained model, and the model's performance is evaluated based on how well it can detect the objects in the images or videos. The evaluation metrics may include precision, recall, F1 score, and mean average precision (mAP), which provide a measure of the model's accuracy and effectiveness.

Overall, the testing data plays a critical role in evaluating the performance of the YOLOv3 model and ensuring that it can accurately detect objects in real-world scenarios.

A. Data collection

Collecting data of animals on railway tracks for use with YOLOv3 involves the following steps:
Selecting the animal classes: The first step is to identify the types of animals that are commonly found on railway tracks, such as deer, dogs, cows, or other animals.

Collecting images: Once classes of animals have been identified, images of those animals need to be collected. This can be done by photographing animals on or near railroad tracks or by searching for images online. It is important to ensure that the images are diverse and representative of the animals to be identified.

Labelling the images: Once you have collected the images, the next step is to label them using a labelling tool.

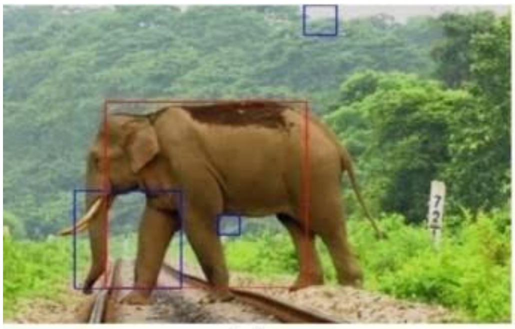
To do this, a bounding box is drawn around the animal and assigned an appropriate class designation.
Dataset Organization: After labelling the images, we need to split the dataset into training, validation, and test sets.

The training set is used to train the YOLOv3 model, the validation set is used to optimize the models hyperparameters, and the test set is used to evaluate the performance of the model.

Training the YOLOv3 model: Once the dataset is ready, you can train the YOLOv3 model using a deep learning framework such as TensorFlow or PyTorch. The model can be trained using transfer learning by using a pre-trained model on a large dataset such as ImageNet or by training the model from scratch.

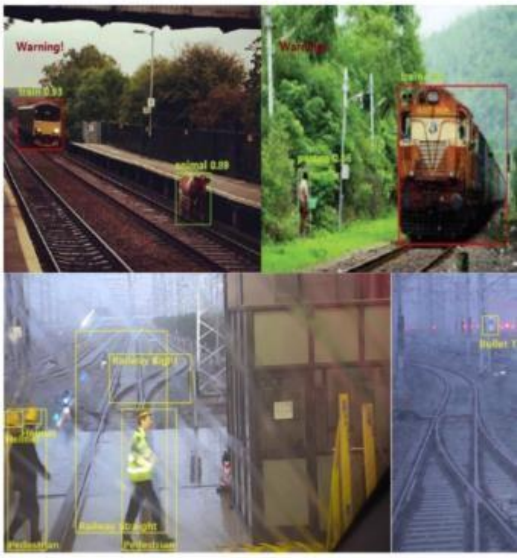
Evaluating the model: After training the model, the performance of the model should be evaluated using the testing dataset. This involves calculating metrics such as precision, recall, and F1 score to measure the accuracy of the model in detecting the animals.

By following these steps, you can collect data of animals on railway tracks and use it to train and test a YOLOv3 model for detecting these animals. The model can then be used to improve railway safety by alerting train operators of potential animal hazards on the tracks.



(a)

(b)



(c)

Fig.3 Animal Detection

Both day and night data were collected using the Esp32 camera for training purposes. The image into a grid of cells and predicts bounding boxes and class probabilities for each cell. Each bounding box prediction includes the coordinates of the box (x, y, width, height) and a confidence score that indicates how likely it is that the box contains an object.

After the bounding box predictions are made, YOLOv3 uses non-maximum suppression to remove redundant or overlapping boxes. Only the box with the highest confidence score is kept for each object. The algorithm then classifies each object based on the predicted class probabilities for each cell. Each cell predicts a set of class probabilities, one for each class in the dataset.

The final output of YOLOv3 is a set of bounding boxes and class probabilities for each detected object in the input image.

B. Preliminary testing of detection and hardware unit

The data collected from the railway track and surrounding area was used to generate offline results. Based on preliminary qualitative analysis, it appears that the CNNbased detection method is capable of accurately detecting animals, despite differences in skin color and variations in lighting conditions. These preliminary results were used to adjust the hyperparameters of the YOLO V3 model, in order to achieve reasonable accuracy and frame rate.

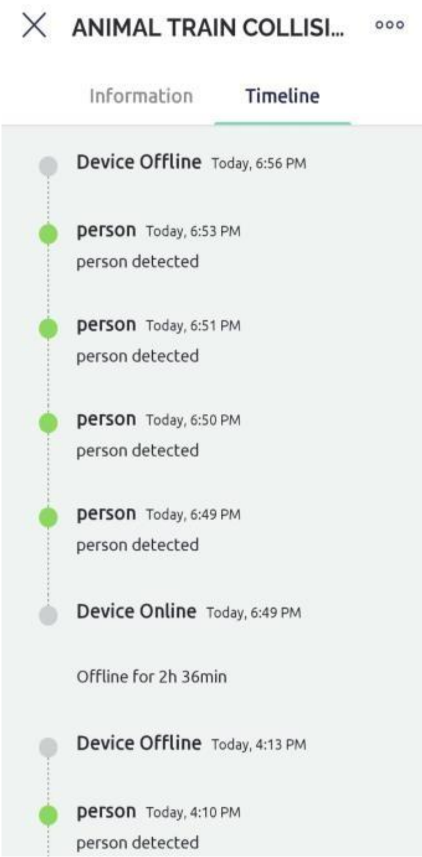


Fig.4 Early Warning Mobile Application

To conduct a real-time test of the detection system and mobile app based early warning system, the hardware unit was mounted on the train unit and electric post of the railway track. The framework was evaluated both during the day and night, and it was found that it accurately detected obstacles under both conditions (as shown in the Fig.3). However, this preliminary output highlights the need for more training data to perform a more quantitative analysis of the proposed method. Despite this, the proposed technique shows promise for visual detection of animals on railway tracks. The early warning system, which includes the mobile app, is a critical safety measure for railway authorities to prevent accidents and injuries caused by animals on the tracks.

V. FUTURESCOPE AND CONCLUSION

Early warning system to prevent animal-train collisions is a important area of research and development with great potential for the future. As transportation networks continue to expand and encroach upon wildlife habitats, the risk of animal-train collisions is increasing. As a part of response, various technologies and strategies have been developed to prevent these collisions, such as animal detection systems, warning signs, and speed limits. However, there is still a need for a more comprehensive and effective early warning system that can detect animals on or near the tracks well in advance of an approaching train. A future research potential in this area is the development of advanced sensor technology that can detect animals. In summary, the development of comprehensive early warning systems to avoid animal train collisions is a key area of research and development with significant future potential. By leveraging advanced sensor technology, AI and machine learning algorithms, and partnerships with transportation companies and conservation groups, we can work towards a future where collisions are a thing of the past.

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