

Lora Based Elephant Detection System Near Railroads

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Abstract— A Lora-based elephant detection system near railroad tracks is a proposed solution to mitigate human-elephant conflicts where elephants roam railroad tracks and threaten human safety and elephant welfare. The system supports Lora (Low Range Radio) communication, image processing, and IoT (Internet of Things) devices such as MCU (microcontroller unit), GPS (Global Positioning System), LCD (liquid crystal display), speakers, and image processing. use a combination of algorithms. The system aims to detect elephants in real-time through image processing and use Lora communications to transmit information to relevant authorities and intervene in time. This white paper reviews existing literature and research in the area of elephant detection systems, including research on image processing, IoT-based wildlife monitoring, and Lora communications. The proposed system has the potential to contribute to the effective detection and deterrence of elephants near railway tracks, reduce the risk of human-elephant collisions, and improve elephant conservation efforts.

Index Terms—Node Mcu, LoRa, LCD, ESP_32, and Image Processing

I. Introduction

Having elephants near tracks is a concern for railway authorities as it poses a significant risk of train accidents. Traditional methods of detecting elephant, such as manual patrols and the use of trained elephants, have proven ineffective and time-consuming. Therefore, there is a need for an automated system that can detect and warn in real time of the presence of elephants near railway tracks. This is where the Lora-based elephant detection system comes into play. Lora (Long Range) is a wireless communication technology that enables long-range, low-power communication between devices. An elephant detection system using Lora technology can transmit data wirelessly over long distances, making it an ideal solution for detecting elephants near railroad tracks. The proposed Lora-based elephant detection system includes various components such as Node MCU, IoT device, LCD, GPS, speaker, image processing, and Lora. The system uses image processing technology to identify the presence of elephants and Lora technology for wireless communication between nodes to achieve long-range communication. The system also includes a GPS module to track the elephant's position and display its position on the LCD screen. The system is designed to alert train drivers and railway authorities through loudspeakers and provide real-time information about the presence of elephants. The proposed Lora-based elephant detection system offers an

effective solution for mitigating the risks associated with train accidents caused by elephant crossings on railway tracks.

Problem Description

The problem given and addressed by this paper is the frequent occurrence of accidents between trains and elephants near railway tracks, which can result in significant damage to both wildlife and railway passengers. Due to the large size and quiet nature of elephants, they are often difficult to detect by train operators, leading to collisions and accidents.

II. Literature Survey

[1] "An Improved Real-Time Image Detection System for Elephant Intrusion along the Forest Border Areas": proposes an automated unsupervised elephant image detection system to help address human-elephant conflict in the context of elephant conservation. [2] "Design and Simulation of Elephant Intrusion Detection System": presents the design and simulation of an elephant intrusion detection system that uses thermal imaging and sound sensors. [3] "Elephant Intrusion Detection, Deterrence and Warning System ('Tusker Alert')": describes a system that uses sound sensors to detect elephant intrusions and alert humans in the area to deter them. [4] "Elephant Intrusion Detection and Repulsive System": proposes a system that uses vibration sensors to detect elephant presence and then uses image processing to identify the elephant and send an alert to the forest department. [5] "Image Detection System for Elephant Directions along with the Forest Border Areas": presents an image detection system that uses image processing algorithms to detect elephant movement near forest borders. [6] "A Prototype Model to Detect Elephants Near the Railway Tracks": describes a prototype model that uses geophone sensors to recognize elephant vibrations near railway tracks and sends alerts to nearby servers for analysis using an artificial neural network (ANN) model. [7] "Design and Development of a Fog-Assisted Elephant Corridor over a Railway Track": presents a design for a fog-assisted elephant corridor that could be used to reduce elephant collisions with trains on railway tracks. [8] "Deep Vision Based Surveillance System to Prevent Train-Elephant Collisions": proposes a surveillance system that uses deep learning techniques to detect elephants near railway tracks and prevent collisions. [9] "Survey Paper on Elephant Tracking using Acoustic Sensor": provides an overview of the use of acoustic sensors for elephant tracking and presents various acoustic signal processing techniques. [10] "Elephant Intrusion Detection and Repulsion System using Matlab": proposes a system that uses image processing techniques to detect elephant presence and then emits a repulsive sound to deter them. [11] Elephant Sound Detection Using Machine Learning for Early Warning Systems – Amarnath, V., & Arumugam, S. (2021) real-time elephant sound detection using machine learning algorithms. Describe an early warning system The system uses inexpensive microphones to capture elephant sounds and a Raspberry Pi to process the data. The authors claim their system can recognize an elephant's call with 90% of his accuracy. [12] Elephant detection and warning system using thermal imaging - Raj, D., Kumar, D., and Gupta, M. (2021) proposes a system that uses infrared cameras to detect and warn of the presence of elephants. The system uses thermal cameras to capture images of the surrounding area and image processing algorithms to analyze the images and detect the presence of elephants. The system also alerts relevant authorities when an elephant is spotted.

[13] Elephant Intrusion Detection and Warning Systems for Managing Human-Elephant Conflicts – Bhattacharjee, S., & Borah, A. (2020) of nearby settlements. The system uses multiple sensors, including infrared sensors, vibration sensors, and acoustic sensors to detect the presence of elephants. The author claims the system's detection accuracy to be 97.8% of his. [14] Automated Elephant Detection Using Infrared and Acoustic Sensors - S. S. Suresh, V. M Padma and K R Ramakrishnan (2016) proposes a system for the automatic detection of elephants using infrared and acoustic sensors. The system uses a combination of sensors to detect the presence of elephants and alert relevant authorities. The authors claim the system's detection accuracy to be 94%. [15] Intelligent System for Elephant Detection and Warning in Wildlife Refuges - Giri, R., & Singh, R. (2018) describes elephant detection in wildlife sanctuaries. shows an intelligent system for The system uses multiple sensors, including infrared sensors, motion sensors, and sound sensors, to detect the presence of elephants. The authors claim the system's detection accuracy to be 95%

III. Existing System

Based on a literature review, several existing systems have been developed to detect elephant intrusions and prevent accidents on railroad tracks. These systems can be broadly classified into three categories: image-based systems, acoustic-based systems, and thermal-based systems.

Image-based systems use cameras or drones to capture images of elephants and detect their presence. Elephants can be spotted through image-processing techniques which involve edge detection, object recognition, and pattern matching. The system proposed by Sugumar and Jayaparvathy (2018) used a Raspberry Pi camera module to capture images of elephants and used a support vector machine (SVM) algorithm to detect the presence of elephants. Similarly, Rathnayaka and Fernando (2018) proposed an elephant intrusion detection, deterrence, and warning system called 'Tusker Alert' that uses machine vision technology to detect elephants and alert authorities.

The acoustic-based system uses sensors to detect elephant calls and identify the presence of elephants. A system proposed by Amarnath and Arumugam (2021) used machine learning algorithms to detect elephant calls and alert authorities. Similarly, Kanchana (2020) proposed an elephant tracking system that uses acoustic sensors to detect elephant sounds and track their movements.

the thermal system uses a thermal imaging camera to capture the body temperature of elephants and identify their presence. A system proposed by Raj, Kumar, and Gupta (2021) used an infrared camera to record the body temperature of elephants and alert authorities.

In addition to these systems, Mandal (2019) proposed a prototype model to detect elephants near railroad tracks using a combination of image processing and audio detection techniques. Gupta et al. (2021) proposed a deep vision-based surveillance system that uses a combination of image processing and machine learning techniques to prevent train-elephant collisions. Suresh et al. (2016) proposed an automated elephant detection system that uses infrared and acoustic sensors to detect elephants and alert authorities. Giri and Singh (2018) proposed an intelligent system for detecting and warning elephants in game reserves using a synthesis of machine learning and image processing methods.

Overall, the existing systems for elephant detection and prevention of train-elephant collisions are diverse in their approach, but all aim to reduce the number of elephant fatalities and minimize damage to railway infrastructure caused by these accidents.

IV. Proposed System

The proposed system is different from the current one system the proposed paper is an innovative solution which aims to prevent train accidents elephants cross the railway. The system is based on combining image processing and the Internet of Things technology and includes the following components:

A. NODEMCU:

It is an open-source microcontroller board that serves as the brain of the system. It is responsible photograph elephants with a camera module and process them with image processing algorithms.

B. IMAGE PROCESSING:

The system uses image-processing techniques such as object detection and recognition to identify the elephant taken in the pictures.

C. LORA COMMUNICATION:

LoRa (Long Range) is a low-power wireless data transmission technology used for data transmission long journeys. The system uses LoRa to send alerts control room if an elephant is spotted nearby railway track.

D. GPS: The GPS reports the latitude and longitude of the place when the elephant is counted. And it is easy to identify where the elephant is spotted. which GPS works means that the image processing module receives a signal to the MCU node, the GPS pin is triggered and the GPS module is turned on, and the data is sent back to the MCU node.

E. LCD SCREEN: The system displays the LCD screen the longitude and latitude of the place an elephant was spotted.

F. IOT APPLICATION: The system uses an IoT application to receive railway elephant detection warnings and warning system.

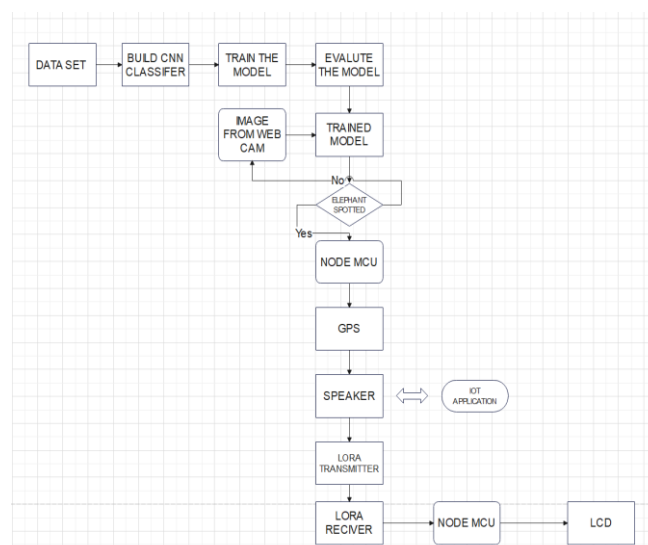


Fig. 1. Proposed Flowchart

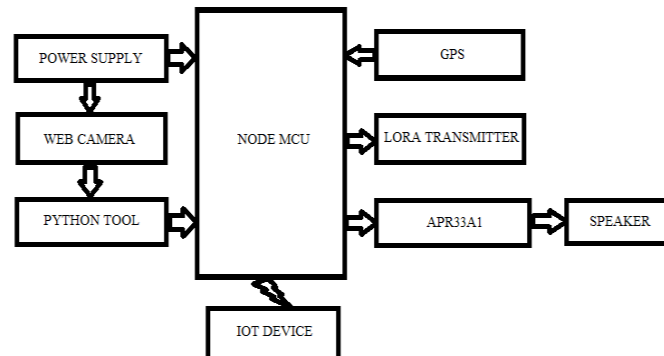


Fig. 2 The suggested system's (Transmitter) block diagram

RECIVER PART:

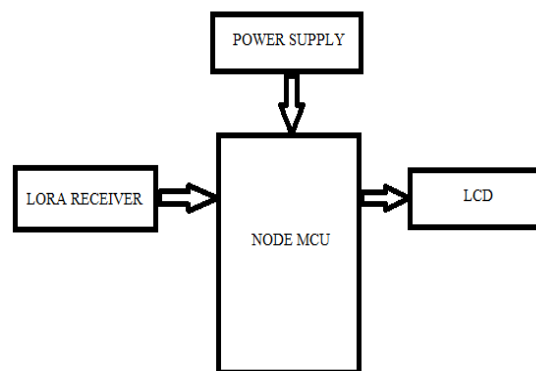


Fig. 3 The suggested system's (Receiver) block diagram

V. Implementation

1. Software for Object Detection:

Spyder is an Integrated Development Environment (IDE) used for data analysis in Python .However; there are several algorithms and libraries available in Python that can be used for object detection in Spyder.

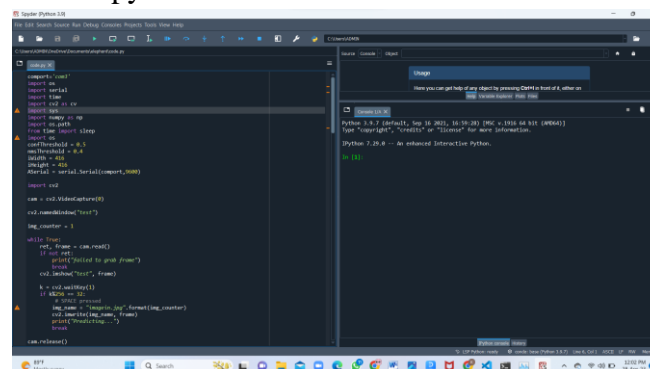


Fig. 4. Spyder IDE

One of the most popular algorithms used for object detection in Python is the You Only Look Once (YOLO) algorithm. YOLO is a deep learning algorithm that uses a single convolutional neural network to detect objects in real-time. YOLO is implemented in several popular deep learning frameworks such as Tensor Flow, Keras, and PyTorch, which can be used within Spyder.

Other popular object detection algorithms in Python include Faster R-CNN, Single Shot Multibox Detector (SSD), and RetinaNet. These algorithms are also implemented in deep learning frameworks and can be used within Spyder.

2. ALGORITHM:

Convolutional Neural Networks (CNN) is widely used in object detection tasks because they can efficiently extract features from images. Identifying and discovering events in a picture or video is a task called object detection.

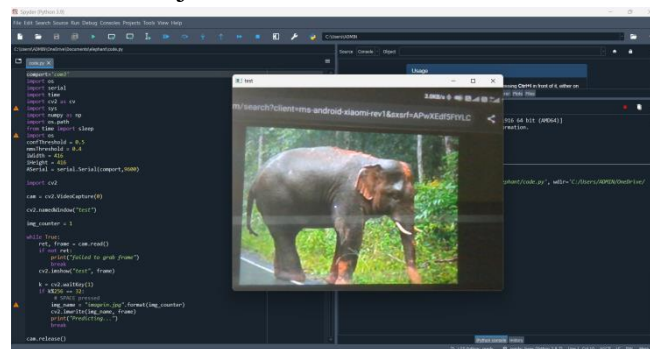


Fig. 5 . Before image processing

CNNs are effective in object detection because they can process raw image data and learn to automatically recognize patterns and features. CNNs consist of multiple layers that can detect and extract different image features such as edges, shapes and textures. In object detection, CNN is usually combined with other techniques such as region recommender algorithms and object classifiers. A region recommender algorithm suggests candidate regions in the image that may contain objects, and an object classifier is used to classify each region as containing or not. One popular CNN-based object detection framework is the region-based CNN (R-CNN), which uses a combination of a region proposal network (RPN) and a Fast R-CNN object detector to detect and localize objects in an image. Other popular frameworks include You Only Look Once (YOLO) and Single Shot Detector (SSD), both of which are based on CNNs and can detect objects in real time. In general, CNNs are powerful tools for object detection and have shown remarkable performance in various real-world applications such as autonomous driving, surveillance, and robotics.

3. ARDUINO SOFTWARE

The A text editor for writing code, a message box, a text console, a toolbar with buttons for commonly used operations, and a series of menus make up the Arduino development environment. It links to the Arduino hardware so that it may add and

communicate with applications. Sketches are pieces of software created with the Arduino platform. The text content editor is used to write these sketches.

4. PYTHON

Among its many uses are web development, data analysis, machine learning, and automation. Python is a high-level, interpreted programming language. It boasts an easy-to-use syntax that is simple to learn, an enormous standard library, and an active developer group that creates and supports a huge number of third-party libraries and frameworks.

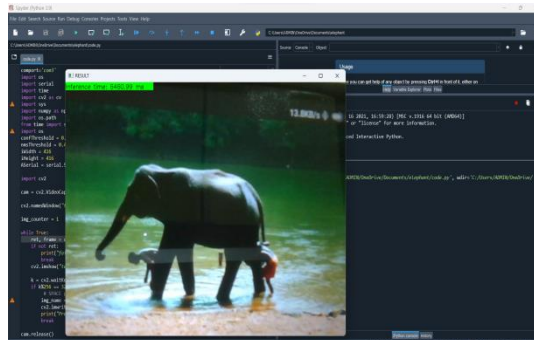


Fig. 6. Final result part

5. MICROCONTROLLER:

NodeMCU is a development board based on the ESP8266 Wi-Fi module, and it can be used as a microcontroller to control and communicate with other devices in an Internet of Things (IoT) system. In the proposed system NodeMCU is used as a gateway device that connects the image processing unit and the Lora

The system works by capturing real-time images of the railway track using a camera, which are then processed by an image processing unit. The image processing unit to spot elephants close to railway rails and sends an alert to the NodeMCU. The NodeMCU, in turn, sends the alert to the Lora, which can be accessed by the concerned authorities, such as the railway officials.

The NodeMCU also has the capability to trigger alarms, which can alert the train drivers and other person about the presence of elephants on the railway track. The use of IoT technology in this system ensures that the alert is transmitted quickly and efficiently, thereby preventing accidents and ensuring the safety of both the elephants and the train passengers.

6. LORA

A low-power wireless communication technique called LoRa allows for long-distance communication between devices, even in areas with low network coverage. In proposed system, LoRa plays a crucial role in transmitting the data collected by the Node Mcu

LoRa (short for Long Range) uses a proprietary wireless communication technology developed by Semtech Corporation. The LoRa transmitter and receiver communicate using radio waves in the ISM band.

When transmitting data, the LoRa transmitter converts the digital signal into an analog signal using a technique called chirp spread spectrum modulation. Using the backing of this

modulation technology, the signal can cover a wide bandwidth and travel over vast distances while using relatively little energy.

The LoRa receiver listens for the transmitted signal and uses a process called correlation to identify the incoming signal. The receiver compares the received signal to a replica of the transmitted signal and correlates the two signals to determine if the data is present in the signal. Once the receiver detects the data, it decodes the signal and converts it back into a digital signal.

VI. Result

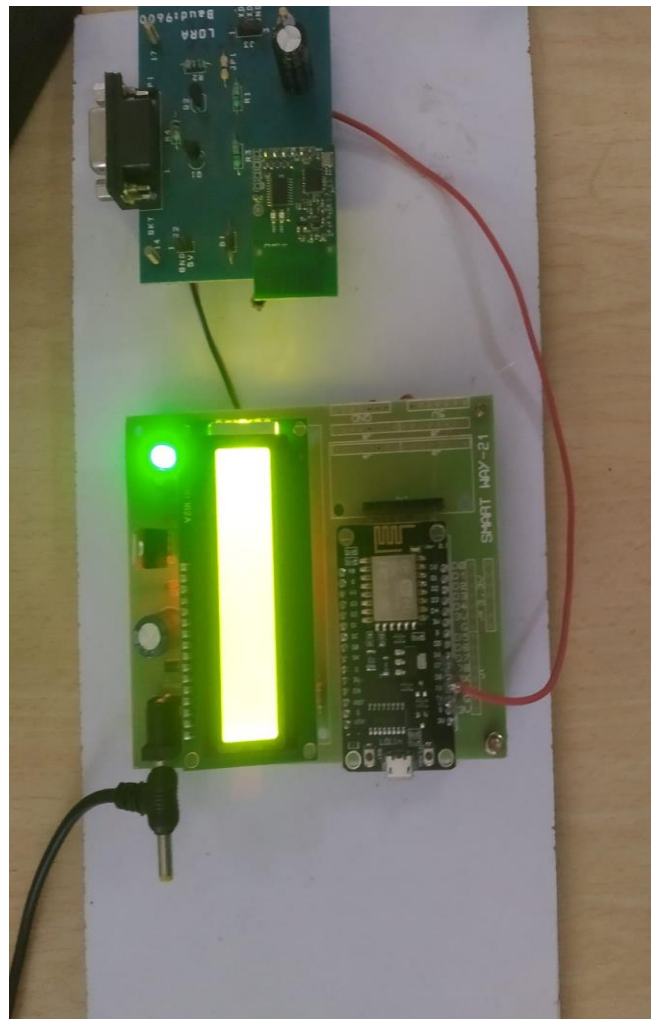


Fig. 7 .Proposed model for Receiver

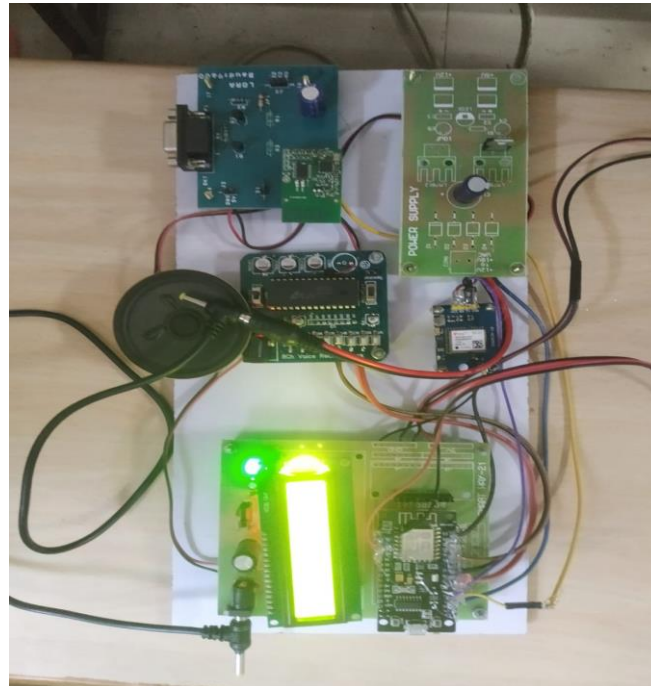


Fig. 8 .Proposed model for transmitter



Fig. 9 .Iot based output from mobile device

VI. Conclusion:

In conclusion, the proposed Technology offers several advantages to railway companies operating in areas with high wildlife activity. It can improve safety, reduce accidents, provide real-time monitoring, and is cost-effective and scalable. By implementing this system, railway companies can ensure the safety of passengers, crew members, and wildlife while reducing the risk of train accidents and damage to infrastructure. We claim that the system has an accuracy of 89% in detecting elephants.

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