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Detection and Accident Prevention of Animals in Railway Track using AI and IoT

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Abstract:
Railway is the most widespread and welcoming transportation system of most of the large cities in the world. The real-time observation and control methods proposed in this research are based on the Internet of Things and function autonomously without external intervention. There are several ways that IoT might improve the railway system. Railway automation has the potential to revolutionize existing legacy systems and significantly reduce railway-related incidents. The proposed method for identifying and recognizing animals and humans has been tried and refined. Implement real-time control and automated monitoring of different parameters relevant to the railway. Build a fully automatic process that reduces human involvement and retains energy.

Keywords: Railway System, Animal Accident, AI, Object Detection, YOLOv3.

INTRODUCTION

Railways are the most widespread and most welcoming transportation system in most of the world cities. Train transport is extensively used for a comfortable and safe journey at a reasonable price. It can be endeavored by people from different lives. Nearly 10,000 billion consignment and More than 5 billion rail passengers traveled all over the world every year. Almost 10,000 billion freight tone kilometers and more than 5 billion Passengers travel by using rail transport all over the world per year. With a track length of 115,000 km, Indian Railways is the largest railway network in Asia and the second largest globally under one management system. The history of the railways in India dates to the 19th century and India's first railway train ran over a 21- mile distance from Mumbai to Thane. The Indian railway system in India is a vital lifeline. Using different logic circuits, lights and fans can be put on off. One of the big problems for the rail industry is accident due to track breakup. A device for detecting obstacles such as animals, cars, bikes, people etc., on the track in the range up to two hundred of meters in advance is also required.

One of the most serious accidents ever is the train accident. Train accidents are usually caused by faulty train signals, faulty lights, failed equipment, safety gates are not in place, unsafe crossings, train driver incompetence and lack of knowledge of people. Several researchers report that a GPS is used to identify and communicate irregularities in the tracks of an in-service car that is fitted with sensors. Since better mobility allows for more trade, transportation has acted as a growth accelerator throughout history. It has always been necessary to significantly enhance the functionality and logic of transit in order to promote economic development. However, the design and operation of transport consume the most energy and have a major impact on the environment, thus the sustainability and safety of transport should be a top priority.

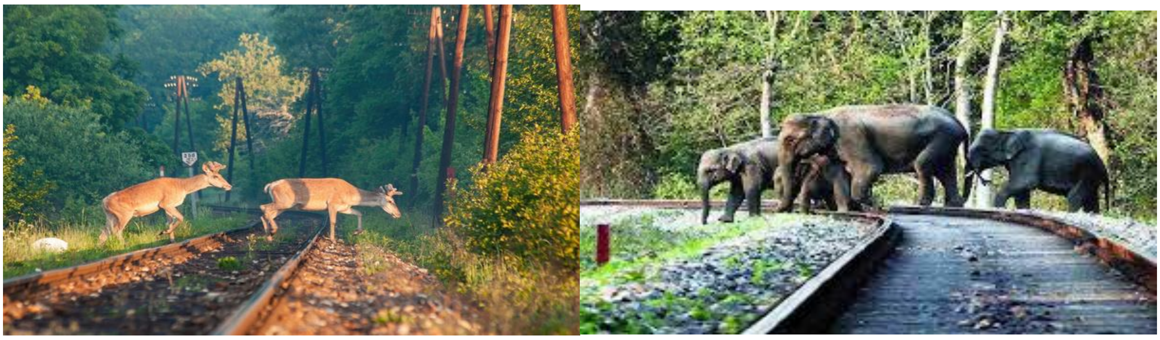

Figure 1.1 Sample Image For Animal Crossing

Animal conservation is very important, and a lot of technology has been applied in many ways to make this happen. Due to the fact that trains are a commonly used mode of transportation in Asian countries, the railway system is even installed across forested areas, disrupting the natural habitats of the surrounding wildlife. Larger animals frequently meet their demise when struck by trains. Tragedies of this kind are common in India, especially in the verdant southern boundaries of the nation. This work addresses the problem by presenting a computer skill technique that locates animals at the root of the issue using implanted recording devices. For this kind of animal detection in photos and videos, the use of an inception model is recommended.

This study suggests real-time observation and control methods based on the internet of things (IoT) that run autonomously and without outside assistance. There are several ways that IoT might improve the railway system. Railway automation has the potential to revolutionize existing legacy systems and significantly reduce railway-related incidents.

EXISTING WORK

Hamad Alawad et al. (2018) described IOT-based Railway Collision Avoidance Framework. By identifying the rail crack and alerting the authorities and LPs, the technology prevents derailments. The Raspberry-pi-powered IOT platform regularly uploads the track to the data centre and continuously checks its status. The main CPU of the system is the Raspberry Pi. The creation of this proposed system made use of the LED, LCD, and WIFI modules. A sensor is used to initially identify the fracture, and an LCD displays the fracture's state.

Many lives are lost in accidents that happen in the train transportation network. Because railway officials are informed in advance about any defects or cracks, this strategy helps to prevent accidents. In order for them to be fixed and the quantity of accident cases to drop. This study is efficient in terms of money and time. They can be modified and improved upon in line with their intended goals by employing extra techniques.

Brailson Mansingh et al. (2017) presents an experimental model for assessing the structural integrity of railway rails, automated gate opening, and preventing train suicide. The prototype is presently undergoing development, and a number of additional sensors are being added to enable more efficient research and line monitoring. Increasingly sophisticated computational approaches can be used to identify any anomalous activity in the construction of railway tracks.

In order to integrate automated platform bridges into railway crossings and provide fully automated level crossings while reducing the amount of time wasted waiting for trains, the authors, according to [14], performed a comparative study of level crossings that are in use worldwide.

Arun et al. (2013) proposed an effective Train Collision protection and Level Crossing Protection System using Zigbee for implementation in the Indian Railways. The proposed system consisted of four individual modules namely Train Module, Level Crossing Gate Module, Signaling Post Module, and Control Centre Module. The system was designed to ensure the safeguarding of a safe distance of 1 Km between the trains after the emergency brake had been employed in case of mishap occurrence possibility.
Mahesh et al. (2016) proposed an inbuilt android system for trains to prevent train collisions. The system is integrated with ultrasonic and MEMS sensor can send emergency alerts through conventional telecommunication systems like Walkie-Talkies. Their proposed system overcame the drawbacks posed by systems used in Indian Railways and Kongan Railways. The various limitations are high implementation costs, short distance of signal covered and execution difficulties.
Karthick et al. (2017) propose a system that is useful for detecting cracks in the rails. The author mentioned the importance of railway transportation also suggests a methodology for analyzing the rails over which trains are moving. The author also stresses the derailment of trains due to defects over the tracks. The author suggests a system having a crack detection sensor that was placed in the trains to detect any cracks over the rails. If the crack is detected the system slows down the trains and giving an alert to the loco pilots to apply breaks also when possibility of derailment happen, the system alerts the nearby signals not to allow other trains into its track. The author strongly recommended that the system was effectively tested and it can be in real time implemented with the existing system of trains for considering the cracks of rails too.
DoganIbrahim (2016) proposes a system called smart train collision detection system useful in identifying the collision occurrence. The author proposed a system based on RFID tags and readers. Tags are buried on the specific location of rails and the receiver on trains when it's crossing over to identify the physical locations on rails.
Priyanka et al. (2015) proposed an easy Radio Frequency tag (RF tag) fixing solution for the level crossings on the train. This helped in collecting the details about the train timings, train location, level crossing, and density of vehicles going through the level crossing. The information so collected are sent to the database server via IOT. The drawback of this system was that it did not incorporate motion sensor cameras.
Rupali (2018) proposed a train tracker using GPS system for prevention of collisions, train accidents, rail switch errors, work zone in collisions and derailments in Indian Railways. It was also designed to facilitate easy train location on a mobile device, improved safety of maintenance crews and trains, increased situational awareness in railway management systems, automated track surveys and inspections, increased efficiency and capacity for all rail users, and time synchronization for communication systems.
Hideo Nakamura (2016) discussed an architecture that can aid in developing new train control systems based on today's advanced technologies for information and communication. The proposed Unified Train Control System (UTCS) aimed at improving the competitiveness, reliability, cost-effectiveness, and robustness of a train control system. It is a minimal system that does not have a base-point controller.

SYSTEM METHODOLOGY

Proper network planning, power management, and robust software implementation are key to ensuring the system’s reliability and efficiency.

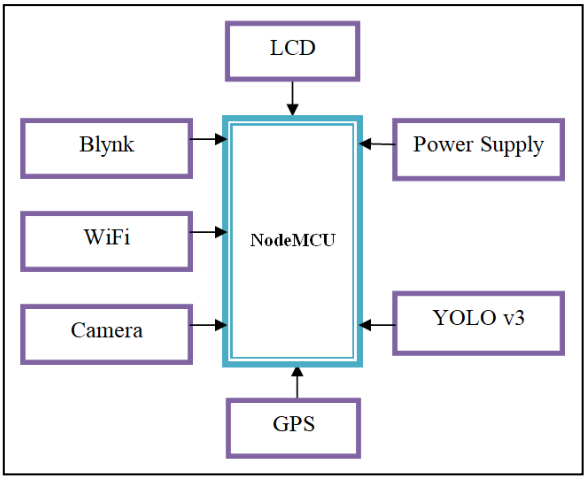

Figure 3.1 Block Diagram

Camera: Integrating a camera into an animal detection and accident prevention system on railway tracks significantly enhances the system's capability to detect animals accurately and in real-time. The camera module captures images or streams video.

NodeMCU: NodeMCU is a Microcontroller for controlling sensors and communication. The camera module connected to the NodeMCU captures images or streams video of the railway tracks. To implement a system for the detection and prevention of animal accidents on railway tracks using a NodeMCU, this is low-cost and open-source IoT platform. Integrate with communication modules like GPS for SMS alerts, or use email notifications. Implement a notification system to alert railway authorities or activate automated braking systems. Implementing an animal detection and accident prevention system on railway tracks using NodeMCU involves integrating hardware components with a server-based machine learning model. The NodeMCU captures and transmits images to a server where the YOLOv3 model processes them for animal detection. If an animal is detected, the system sends alerts to prevent accidents. Regular maintenance, updates, and handling environmental challenges are key to the system's reliability and effectiveness.

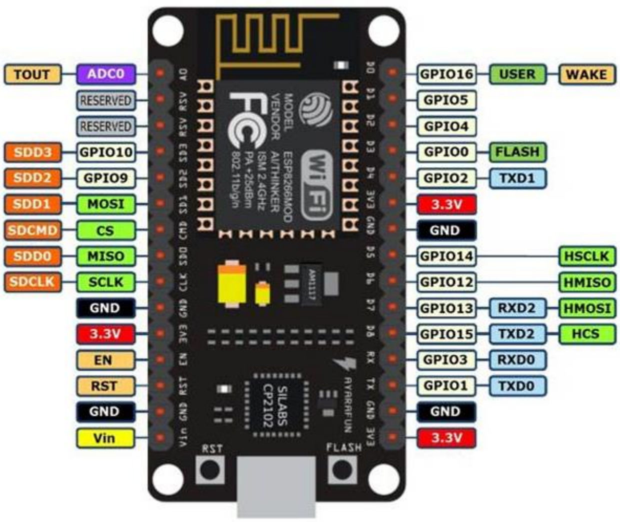

Figure 3.2 Node MCU

Power Supply: A well-designed power supply system is crucial for the reliable operation of an animal detection and accident prevention system on railway tracks. Solar power offers a sustainable solution, while hybrid systems provide redundancy. Proper sizing, installation, and maintenance of power components will ensure continuous and effective operation of the system. Incorporate fuses, surge protectors, and robust connectors to handle harsh environmental conditions. Automatically switch to railway power when battery levels are low. This system used a hybrid charge controller that can handle inputs from both solar and railway power. Monitor power levels and switch between power sources using relays or solid-state switches.

WiFi: Integrating WiFi connectivity into an animal detection and accident prevention system on railway tracks involves careful planning of the network infrastructure, reliable power supply, and robust software for image processing and alerting. By addressing the challenges of connectivity, power management, and environmental factors, you can create an effective and reliable system to enhance railway safety. The proposed system installs WiFi APs along the railway track at intervals that ensure continuous coverage. The distance between APs depends on the terrain and obstacles, but typically ranges from 100 to 300 meters.

GPS: To integrating GPS into an animal detection and accident prevention system on railway tracks enhances the system's effectiveness by providing precise location data for detected animals. The GPS module provides real-time location data. This allows for more accurate and timely alerts, improving overall railway safety and acquiring location data. Captured images and GPS coordinates are sent to a server or cloud platform for processing. If an animal is detected, alerts co

ntaining GPS coordinates are sent to railway authorities for prompt action. Implement a notification system to alert railway authorities or activate automated braking systems with the GPS coordinates included.

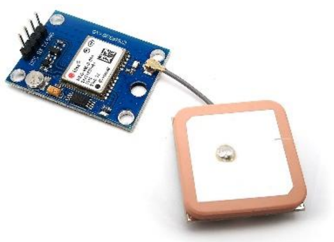

Figure 3.3 GPS Module

LCD: Integrating an LCD into an animal detection and accident prevention system on railway tracks provides a useful interface for real-time monitoring and status updates. The proposed work used 16x2 LCD for displaying status and alerts for immediate local awareness. This addition improves local monitoring capabilities and ensures that critical information is immediately accessible to on-site personnel.

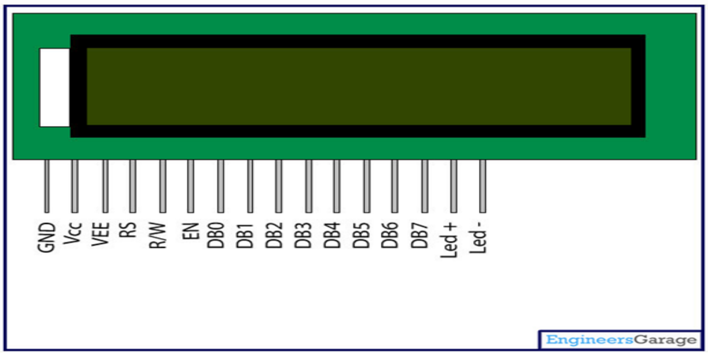

Figure 3.4 LCD Pin Diagram

Blynk App: This research work is to creating an application for the detection and accident prevention of animals on railway tracks using Blynk involves integrating various sensors, microcontrollers, and communication technologies to detect animals and alert train operators or automated systems. Create a dashboard on the Blynk app to receive real-time alerts, monitor sensor data, and control preventive measures.

YOLO v3: This work used YOLO - V3 for detecting animals on railway tracks involves several steps, including data collection, model training, and integration with a prevention system. One type of one-stage technique that converts target identification into a regression issue is called YOLO (You Only Look Once). When compared to Faster R-CNN, YOLO obtains location and category predictions directly. At the output end, YOLO-V2 adds convolutional layers in place of fully connected layers (FC). Furthermore, YOLO-V2 utilizes Batch Normalized New Features Extraction Network (Darknet19). The proposed system collects images and videos of railway tracks with and without animals. Sources can include existing datasets, manually captured images, or public domain footage. Modify the YOLO configuration files (cfg) for the custom dataset. Adjust the number of classes to reflect the types of animals and other objects to detect. Resize images to match the input size expected by YOLOv3. Develop a notification system to alert train operators or automated systems when

animals are detected on the tracks. Validate the proposed model on the test set. Fine-tune hyperparameters, hence animals might move unpredictably, requiring the system to handle motion blur and rapid movements. The proposed system should be able to detect different animal species that might appear on the tracks. Using YOLOv3 for detecting animals on railway tracks can significantly enhance safety and prevent accidents. Proper implementation, training, and integration with real-time alert systems are crucial for effectiveness. Regular updates and maintenance of the system will ensure its reliability in diverse conditions.

Essentially, the network is composed of 1 × 1 or 3 × 3 convolutional kernels. It's named Darknet53 since it has 53 convolutional layers in it. YOLO-V3 utilizes the feature pyramid network (FPN) concept. For every input picture, the network performs a five-time down sampling operation. After the feature extraction process, the resultant feature map is down-sampled by 32×, making it 1/32 of the original image's size. The last three down-sampled layers are then sent by YOLO-V3 to the detection layers in order to find targets. YOLO-V3 forecasts on three different scales. The three scales, which are 13 x 13, 26 x 26, and 52 x 52 measures. The feature maps are then concatenated. Similarly, this work used the same reasoning for feature maps that have been 8× and 16× down-sampled.

The YOLO-v3 structure is shown in Figure 3.

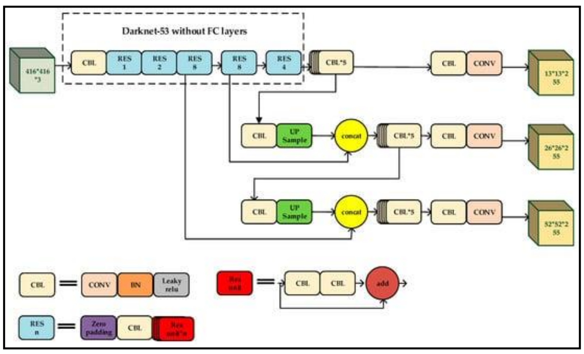

Figure 3.5 The Network Of YOLO - v3

IMPLEMENTATION

Software For Object Detection: Spyder is an Integrated Development Environment (IDE) for data analysis in Python. While it isn't specialized software for object detection, there are numerous algorithms and libraries in Python that can be utilized for object detection within Spyder.

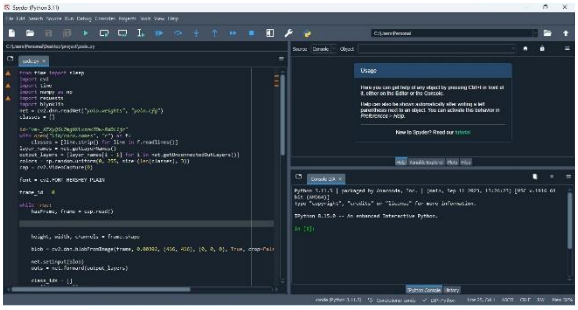

Figure 4.1 Spyder IDE

Python: Python is a high-level, interpreted programming language that is extensively used in web development, data analysis, machine learning, and automation. It offers a simple, easy-to-learn syntax, a comprehensive standard library, and a vibrant community that maintains a wide array of third-party libraries and frameworks.

RESULTS

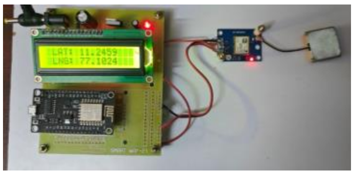

Figure 5.1 Proposed Prototype

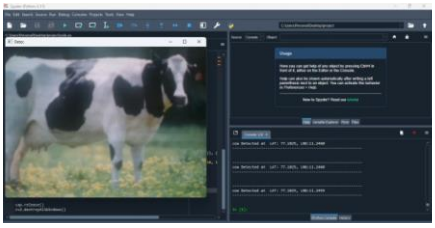

Figure 5.2 IOT Based Output Of Cow Detected

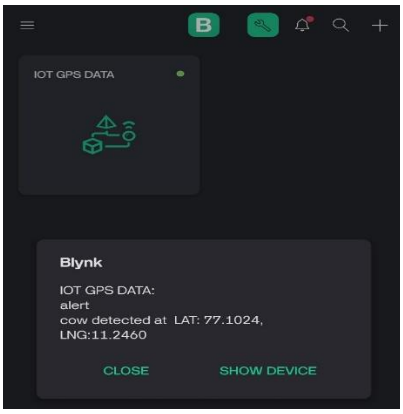

Figure 5.3 IOT Based Output From Mobile Device

CONCLUSION

Nowadays, a lot of effort is made to support the preservation of wildlife, and contemporary technology may surely help in this endeavor. When coupled, machine learning and the internet of things might achieve a lot in this field. The proposed prototype model is able to recognized animals and humans. If there were any animals on or near the rail track, they were detected using a machine learning model. For this particular method, the YOLOv3 model has shown to be the most successful due to its great accuracy and low true negative interest. To prevent an imminent collision and protect the welfare of the animals, the simulation might be utilised to create an alarm both on the spot and in a train that passes down the line. Future development and training of comprehensive data will make it possible to avoid classifying quasi-species, which will lead to a zero rate of non-instances for the other categories of organisms.

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