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Train Accident Prevention Using Image Processing

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1.Abstract

In this proposed project, we present a system that uses image processing technology along with Geo-fencing methods to avoid train accidents, particularly in the identified controlled and sensitive areas. The YOLOv8 algorithm model is used to detect obstacles on the railway track, while a Geo-fencing module identifies whenever the train is located near a predefined danger zone. An alert system is included to notify the operator through buzzer, LED, or on-screen messages. Additionally, the RailTel network is utilized for reliable communication. This embedded system approach aims to enhance safety and prevent accidents in railway environments.

2. INTRODUCTION

Railway safety is a critical issue, as accidents often occur due to obstacles on the track, human or animal crossings, and entry into unsafe or accident-prone zones. Traditional monitoring methods depend heavily on manual observation, which is slow and prone to errors. With advancements in real-time video analysis, automated systems can now play a major role in preventing such incidents.

This Project proposes a real-time train accident prevention system that combines YOLOv8-based object detection with GPS-based geo-fencing. A trackside or onboard camera continuously captures video, which is processed on an edge device to detect humans, animals, vehicles, and other obstacles. At the same time, a Geo-fencing module identifies when the train enters predefined danger zones. The system provides instant alerts through LEDs, buzzers, and on-screen messages, while the RailTel communication network sends notifications to the Train Control Centre and the driver's COPILOT dashboard. By integrating GPS, and reliable railway communication, this system enhances situational awareness and significantly improves railway safety

3.LITERATURE REVIEW

[1] Train Accident Prevention Using Sensor & Arduino
Authors: R. L. Soni, P. D. Chandurkar, A. L. Potle, M. K. Gurmule, P. S. Sontakke, D. D. Bhongade, and P. Suramwar
Year: 2025, This Study presents an Arduino Nano–based train accident prevention system using ultrasonic sensors for real-time obstacle detection on railway tracks. The system provides immediate alerts through buzzers and LED indicators, and includes a Processing IDE interface for visualizing detection data. The prototype demonstrates effective detection within a 1-meter range and offers a low-cost solution compared to traditional railway safety systems. Future enhancements include IoT integration and machine learning for improved reliability.

[2] Enhancing Railway Safety Using YOLOv8 for Obstacle Detection and Accident Prevention, Authors: A. Marzuqa, A. Shameem, M. Fathima, and A. Sonya, year: April 2025
This paper proposes a real-time railway safety system using YOLOv8, cameras, and PIR sensors for detecting humans, animals, and obstacles on tracks. A Raspberry Pi processes the data and sends alerts through MQTT/HTTP protocols to railway control Centers. An LCD screen provides on-site detection status for the operator. The system also uses GPS and live surveillance to improve coordination between authorities. By integrating multiple sensing and communication technologies, the solution enhances response time and reduces the risk of collisions.

[3] Obstacle Detection on Railway Tracks Using Image
Shuang Gao, 2023, This study integrates a dense attention mechanism with the Mask R-CNN framework to improve the detection of foreign objects on railway tracks. The method enhances accuracy in identifying potential hazards for railway safety monitoring.

[4] Alert Mechanisms for Accident Prevention, Authors:
A. Lisowski, M. Stencel, and P. Szymański, Year: 2021
The authors propose a deep learning-based video processing method to monitor critical railway zones and generate real-time alerts for train operators when potential threats are detected near rail crossings.

4.Methodology

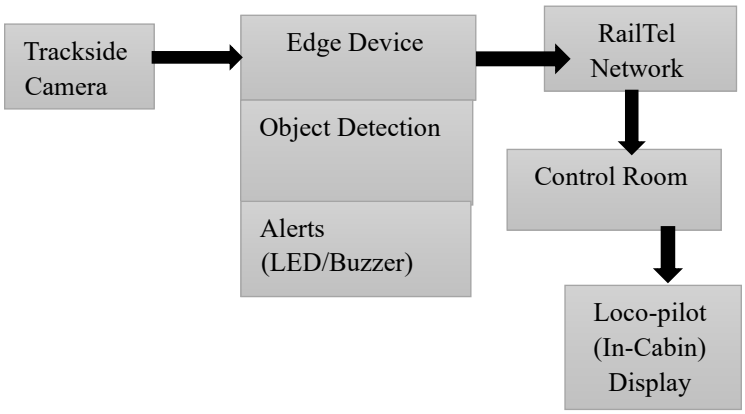

Fig. 4.1 Block Diagram

The proposed system follows a multi-stage pipeline integrating real-time image processing, object detection, geo-fencing, and wireless communication to ensure early and reliable detection of Objects on railway tracks. The overall methodology is designed to operate directly on the trackside or onboard environment, providing immediate alerts to both the train operator and the central monitoring Centre.

The process begins with a trackside or locomotive-mounted camera that continuously captures live video of the railway track. These video frames are transmitted to an edge processing device, such as a laptop or embedded computing unit, which performs all computations locally to minimize latency. The edge device executes YOLOv8-based object detection, which is trained specifically on railway-related classes including humans, animals, vehicles, rocks, fallen trees, and track obstructions. This enables the system to identify a wide range of real-world threats that commonly occur on railway lines. Once an object is detected, the system performs distance estimation using bounding box measurements to approximate its proximity to the track. If the detected object is within an unsafe threshold distance, the system triggers immediate local alerts.

In parallel, the edge device continuously evaluates the train's geographic position using GPS data and performs a geo-fencing check. A circular or polygonal geo-fence is defined for danger-prone locations using latitude and longitude coordinates—for example, a 300-meter radius around LAT 15.426777, LON 74.740303. Using the Haversine formula, the system calculates the train's distance from the geo-fenced zone. If the train enters the predefined region, the system generates a Danger Zone Alert, independent of object detection, thereby providing predictive safety in accident-prone areas.

Both object-based and geo-fencing alerts are first conveyed to the locomotive crew through local warning mechanisms, including an LED indicator, buzzer, and on-screen messages. To extend situational awareness beyond the train, the system employs a RailTel communication module that securely transmits alert data to the Train Control Centre using the dedicated Indian Railways communication backbone. The control Centre visualizes warnings through the copilot dashboard, which displays live map positioning, object detection results, and zone entry notifications. This ensures that both the crew and centralized operators receive synchronized, real-time safety information

This integrated methodology enables fast, reliable, and network-assisted accident prevention by combining on-device intelligence with railway-grade communication infrastructure. The approach is scalable, low-latency, and suitable for deployment across diverse railway environments.

5.RESULT

Implementation of the proposed work is demonstrated with the prototype model using the reference Longitude and Latitude (LAT 15.426777, LON 74.740303). During the implementation two modes of object detections were implemented First, before entering the identified zone named as GEOFENCED area which alerts the LOCOPILOT of the train as depicted in Fig 5.1 and Second is the zone after entering the GEOFENCED area where, if an object is detected the alert system is enabled by BUZZER and LED at the object side and LOCOPILOT respectively the same is depicted in Fig 5.2

Fig:5.1

Fig:5.2

6.Conclusion

The proposed system effectively combines YOLOv8-based object detection and Geo-fencing to provide real-time alerts for railway safety. It accurately identifies obstacles, detects danger zones, and delivers timely warnings to both the train operator and the control Centre through the RailTel network. The results show that the system can significantly reduce accident risks and improve overall train safety.

7.Future Scope

The proposed system can be further enhanced to make it more practical and applicable for real-time railway systems. Some of the future improvements and expansions include:

1.Cloud Based Data and Alerts: All data such as object geofence entries, and location history can be stored in the cloud. Real-time alerts can be sent to control Centers through the internet or IoT networks

2.GSM or IOT Based Communication

The system can use GSM or LoRa modules to send SMS or IoT. notifications to train operators, nearby stations, or railway control rooms in case of emergency alerts

8.REFERANCE

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