

Anomaly Detection on Railway Track and Safety Monitoring Using Deep Learning

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Abstract: Railway safety is a critical concern as accidents may occur due to obstacles, human intrusion, animals, or vehicles present on railway tracks. Traditional monitoring methods mainly rely on manual inspection, which is time-consuming and not suitable for continuous real-time monitoring. With the advancement of artificial intelligence and computer vision, automated systems can analyze video data and detect potential hazards on railway tracks more efficiently. This paper presents a deep learning-based anomaly detection system for railway track safety monitoring using Convolutional Neural Networks (CNN) and the YOLOv8n object detection model. The proposed system processes real-time and stored video inputs to detect objects such as humans, animals, and vehicles on railway tracks. Detected objects are highlighted using bounding boxes, and hazardous situations trigger visual alerts along with a beep sound.

Keywords: Deep Learning, YOLOv8, Railway Safety Monitoring, Anomaly Detection, Object Detection.

I. INTRODUCTION

Railway systems play an essential role in transportation by enabling efficient movement of passengers and goods across long distances. Despite technological advancements in railway infrastructure, accidents caused by obstacles on tracks, human intrusion, and vehicles crossing railway lines continue to pose significant safety challenges. Such incidents may lead to serious accidents, causing loss of life and property.

Traditional railway monitoring methods rely mainly on manual inspection and human surveillance. Railway staff periodically inspect tracks to identify potential hazards such as fallen objects, animals, or unauthorized persons on railway lines. However, these manual approaches are labor-intensive and cannot provide continuous monitoring across long railway networks.

With the rapid development of artificial intelligence and computer vision technologies, automated monitoring systems have emerged as an effective solution to improve railway safety. Deep learning models can analyze visual data captured from surveillance cameras and automatically detect abnormal objects present on railway tracks. By detecting hazardous situations in real time, these systems allow railway authorities to take immediate preventive action.

In this work, a deep learning-based anomaly detection system is proposed for railway track monitoring. The system utilizes Convolutional Neural Networks (CNN) for feature extraction and the YOLOv8 object detection algorithm for identifying objects present on railway tracks. The model detects objects such as humans, animals, and vehicles and highlights them using bounding boxes. If a hazardous object is detected on the track, the system triggers an alert with an audio warning.

II. RELATED WORK

Several studies have explored the use of computer vision and machine learning techniques for railway safety monitoring. Early approaches relied on traditional image processing techniques such as background subtraction, edge detection, and motion detection to identify obstacles on railway tracks. However, these techniques were sensitive to lighting conditions and environmental changes, which limited their accuracy.

Recent advancements in deep learning have significantly improved detection performance in surveillance. Convolutional Neural Networks (CNNs) have demonstrated strong feature extraction capabilities for image classification and object detection tasks. CNN-based models such as Faster R-CNN, SSD, and YOLO have been widely used for detecting objects in complex environments.

The YOLO (You Only Look Once) family of object detection models has gained popularity due to its high detection speed and accuracy. YOLO models perform object detection and classification simultaneously in a single pass through the neural network. This allows real-time detection of multiple objects in a video stream.

The latest version, YOLOv8, provides improved performance compared to previous versions by using advanced feature extraction techniques and optimized network architecture. These characteristics make YOLOv8 suitable for real-time railway track monitoring systems.

Comparison of Object Detection Methods for Railway Monitoring:

Method	Advantages
Traditional Image Processing	Simple implementation, low computational requirements
CNN-based Detection	Strong feature extraction capability for images
Faster R-CNN	High object detection accuracy

III. DATASET AND SAMPLE IMAGES

Railway anomaly detection systems require datasets containing images or videos of railway tracks under various environmental conditions. These datasets typically include objects such as humans, animals, vehicles, and other obstacles present on railway tracks. Some publicly available datasets include railway obstacle detection datasets containing annotated images with bounding boxes around different objects. These datasets help train deep learning models to identify hazardous objects on railway tracks. In this project, input data consists of video streams and stored videos containing railway track environments.

Frames extracted from these videos are analyzed by the YOLOv8 model to detect anomalies. The dataset used for testing includes railway track scenes recorded under different lighting conditions and backgrounds. These scenes include normal railway tracks as well as tracks containing obstacles. Such variation in the dataset helps improve the robustness and generalization capability of the deep learning model.

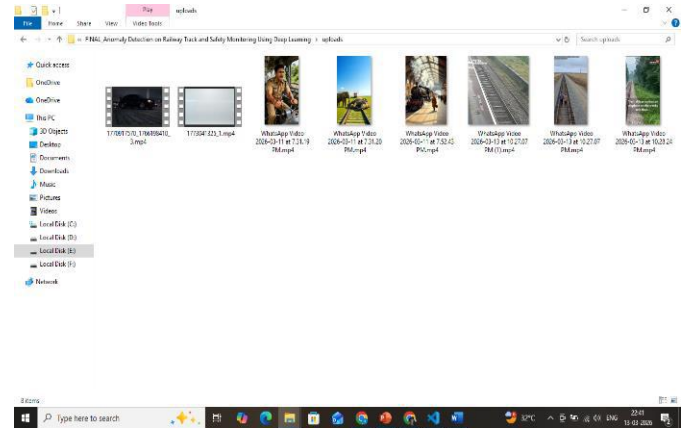


Fig: Testing Dataset

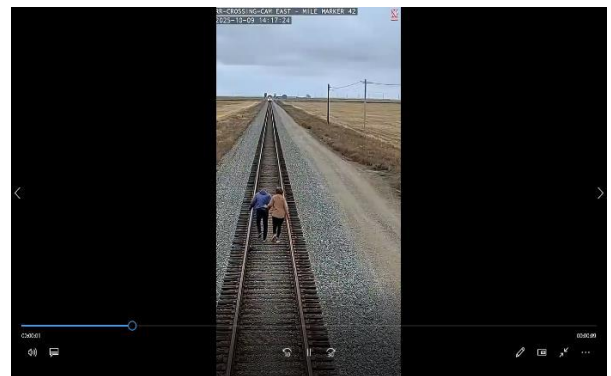


Fig: Video Footage

To prepare the dataset for processing, videos are converted into individual frames using OpenCV. Each frame is then resized and normalized before being passed to the detection model. This preprocessing step ensures that the input images match the required format for YOLOv8 object detection.

The presence of multiple object categories in railway environments increases the complexity of the detection task. Therefore, the deep learning model must be capable of distinguishing between safe and unsafe situations by analyzing detected objects and their positions on the railway track.

IV. PROPOSED SYSTEM

The proposed system aims to detect anomalies present on railway tracks using deep learning-based object detection. The system processes video frames captured from surveillance cameras and identifies objects that may pose a threat to railway operations.

Tools and Technologies Used:

Tool	Purpose
Python	Programming language
OpenCV	Video processing
YOLOv8 (Ultralytics)	Object detection
PyTorch	Deep learning framework
VS Code	Development environment

The system processes video frames and detects objects using YOLOv8. If a human, animal, or vehicle is detected on the railway track, the system displays a bounding box around the object.

Green bounding box: Safe condition

Red bounding box: Hazard detected

When a red alert occurs, the system generates an audio beep warning to notify railway authorities.



Fig: Example object detection results showing bounding boxes around detected objects.

VII. RESULTS AND DISCUSSION

The system was tested using several railway track videos containing different scenarios such as humans walking near railway tracks, animals crossing tracks, and vehicles near railway crossings.

The YOLOv8n model successfully detected objects in real time and generated alerts when anomalies were identified. The system demonstrated the ability to detect multiple objects simultaneously and provide real-time warnings.

During testing, the system was able to analyze each video frame efficiently and identify objects present on or near the railway track. The detection results were displayed visually on the output video along with object labels and confidence scores. When a hazardous object such as a human or animal was detected within the railway track region, the system generated a red alert along with an audio beep to notify the user.

The experimental results showed that the proposed system performs effectively under different environmental conditions including daylight and moderate lighting variations. The real-time detection capability allows the system to continuously monitor railway tracks and detect dangerous situations without human intervention.

Key observations from the experiments include:

- High detection speed suitable for real-time monitoring
- Accurate detection of humans, animals, and vehicles
- Effective alert generation through visual and audio signals
- Capability to process both live camera feeds and stored

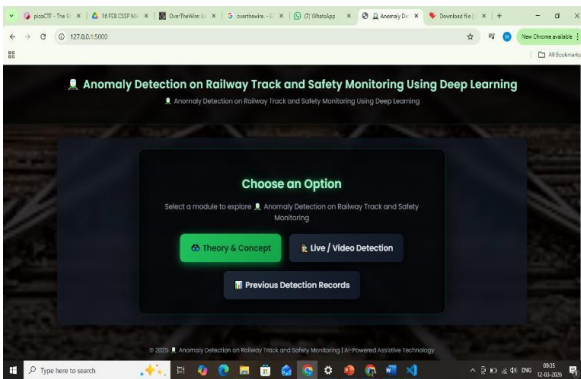
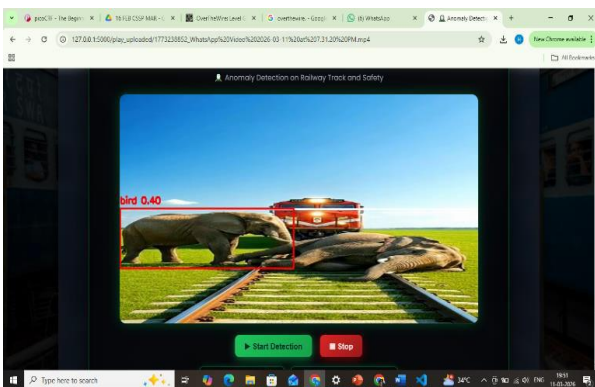


Fig: Interface of the Project



videos

These results indicate that the proposed system can significantly improve railway safety by providing automated monitoring and early hazard detection.

VIII. CONCLUSION

This paper presents a deep learning-based anomaly detection system for railway track safety monitoring using CNN and YOLOv8. The system analyzes video frames from surveillance cameras to detect objects such as humans, animals, and vehicles on railway tracks. The YOLOv8n model enables accurate real-time detection with low computational requirements and generates visual and audio alerts when hazardous objects are identified.

Experimental results show that the system can detect multiple objects in real time under different environmental conditions. Using bounding boxes and confidence scores helps clearly identify detected objects and improves monitoring efficiency. The system can help reduce railway accidents by providing early warnings, and future work may include IoT integration, larger datasets, and deployment on edge devices for large-scale monitoring.

REFERENCES

- [1] A.Bochkovskiy, C. Wang, and H. Liao, "YOLOv4: Optimal Speed and Accuracy of Object Detection," 2020. Available: <https://arxiv.org/abs/2004.10934>
- [2] G. Jocher, A. Chaurasia, and J. Qiu, "Ultralytics YOLOv8 Documentation," 2023. Available: <https://github.com/ultralytics/ultralytics>
- [3] Ultralytics, "Introducing YOLOv8 – Next Generation Object Detection Model," 2023. Available: <https://www.ultralytics.com/blog/introducing-ultralytics-yolov8>
- [4] D. Reis et al., "Real-Time Flying Object Detection with YOLOv8," 2023. Available: <https://arxiv.org/abs/2305.09972>
- [5] Ultralytics YOLOv8 GitHub Repository. Available: <https://github.com/ultralytics/ultralytics>
- [6] Z. Zhang et al., "Rail-5K: A Real-World Dataset for Rail Surface Defects Detection," 2021. Available: <https://arxiv.org/abs/2106.14366>
- [7] H. Hayre, "Automatic Railroad Track Inspection," IEEE Transactions on Vehicular Technology, 2020. Available: <https://ieeexplore.ieee.org>
- [8] M. Wang, K. Li, X. Zhu, and Y. Zhao, "Detection of Surface Defects on Railway Tracks Based on Deep Learning," IEEE Access, 2022. Available: <https://ieeexplore.ieee.org>
- [9] Ultralytics Documentation, "YOLOv8 Model Training and Deployment Guide." Available: <https://docs.ultralytics.com>
- [10] OpenCV Documentation, "Open Source Computer Vision Library." Available: <https://opencv.org>
- [11] PyTorch Documentation, "PyTorch Deep Learning Framework." Available: <https://pytorch.org>

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