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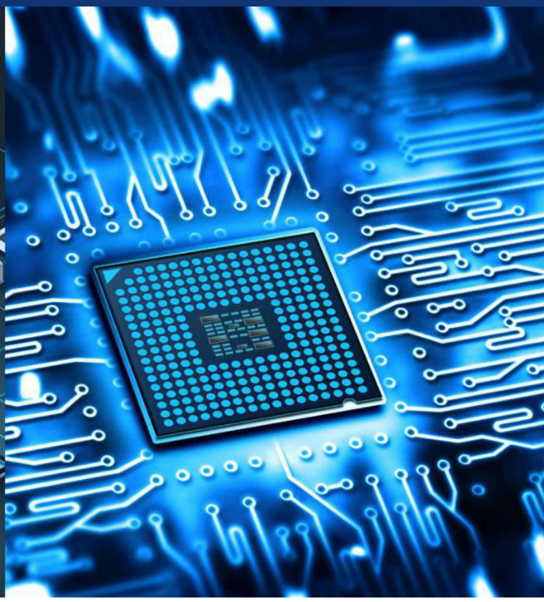

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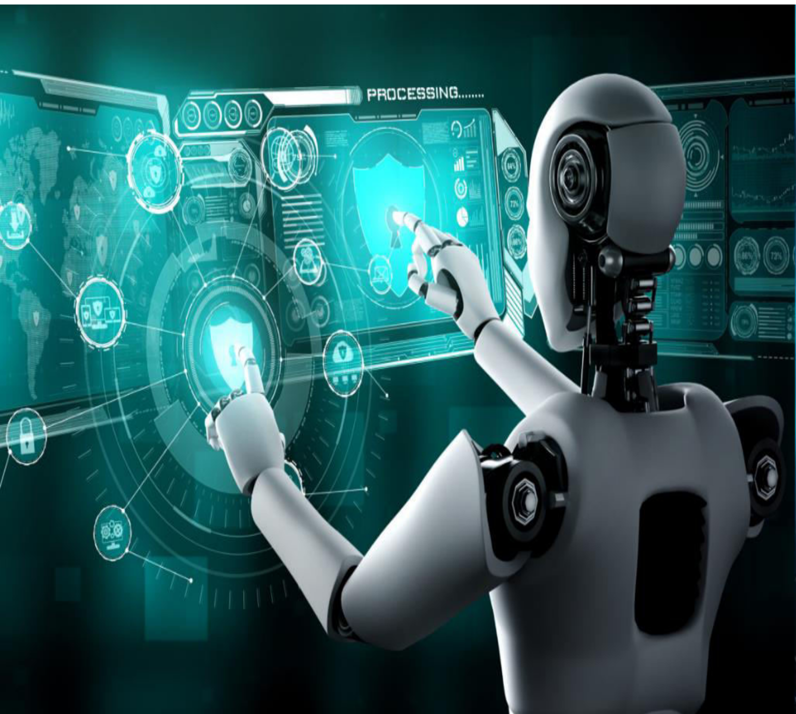


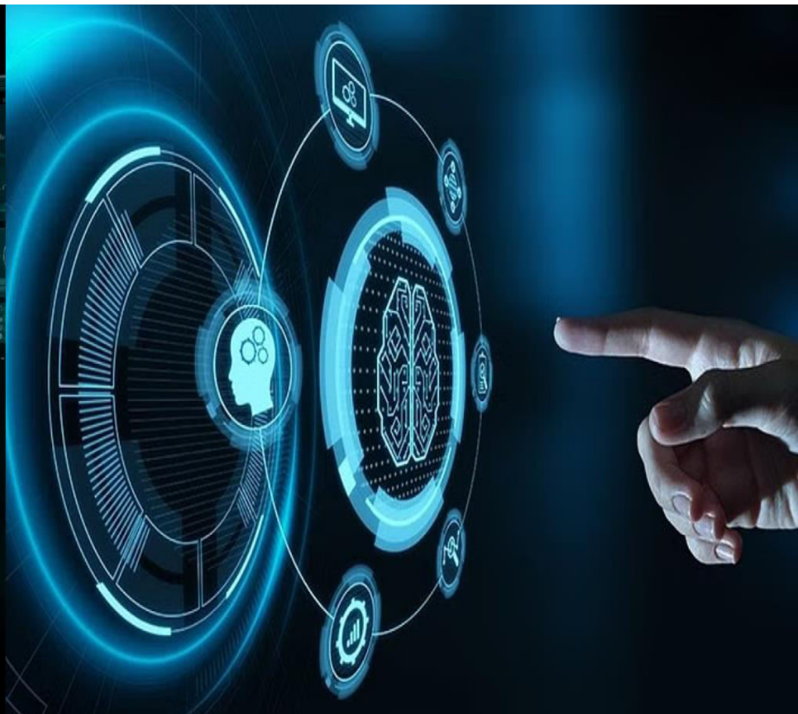

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# Design and Implementation of Object Crossing Detection for Train using ANN Algorithm

**Nandini K[1], Shajitha Begam A[2], Ishwariya V[2], Priyanka A[2]**

Assistant Professor, Department of CSE, P.S.V College of Engineering and Technology, Mittapalli, Krishnagiri, India

UG Scholar, Department of CSE, P.S.V College of Engineering and Technology, Mittapalli, Krishnagiri, India

UG Scholar, Department of CSE, P.S.V College of Engineering and Technology, Mittapalli, Krishnagiri, India

UG Scholar, Department of CSE, P.S.V College of Engineering and Technology, Mittapalli, Krishnagiri, India

**ABSTRACT -** Vehicle crossings at busy intersections or restricted zones pose significant safety risks due to potential collisions with pedestrians, vehicles, and obstacles. This research proposes a smart vehicle crossing object detection and alert system that integrates Artificial Neural Network (ANN)-based computer vision with embedded hardware for real-time hazard identification and warning. The system uses the YOLOv3 deep learning model to detect and classify objects from live video feeds, distinguishing between safe and hazardous entities with high accuracy in various lighting conditions. Upon identifying a threat, a voice alert is generated using the pyttsx3 library to notify drivers and pedestrians instantly, thereby enhancing situational awareness and reducing accident risk The hardware implementation consists of a Nano microcontroller that serves as the central control unit. A regulated 5V power supply via a 7805 voltage regulator powers the system. Object detection data is communicated to the microcontroller through a serial communication interface. Based on detection results, the microcontroller actuates gear motors through a motor driver board to control physical barriers or alert systems. Additionally, a buzzer provides an immediate audio signal, and an LCD displays real-time status updates. This hardware-software integrated system is reliable, cost-effective, and scalable, designed to improve public safety at vehicle crossings using AI-powered object detection and responsive alerts

**KEYWORDS:** Object Detection, Artificial Neural Network (ANN), YOLOv3, Vehicle Crossing Safety, Real-Time Monitoring, Computer Vision, Hazard Classification, Voice Alert System, Domain: AI

## I. INTRODUCTION

Vehicle crossing With the rapid increase in vehicular traffic and urbanization, ensuring safety at vehicle crossings, especially in busy intersections and restricted zones, has become a critical challenge. Traditional methods, such as traffic signals and manual monitoring, are often insufficient to prevent accidents caused by unexpected obstacles like pedestrians, vehicles, or foreign objects. In this context, the integration of intelligent object detection systems has gained prominence for enhancing road safety. This project presents a smart vehicle crossing detection and alert system that utilizes an Artificial Neural Network (ANN) and the YOLOv3 deep learning model to detect and classify objects in real time. The system processes video feeds to identify potential hazards and triggers immediate alerts through voice announcements and visual indicators. By combining computer vision with embedded hardware control using a Nano microcontroller, the system offers an automated and responsive solution for accident prevention. It features motor control for physical safety mechanisms, an LCD for visual feedback, and a buzzer for local alerts, all powered by a regulated power supply. This intelligent system aims to minimize human intervention while maximizing awareness and response to potential threats at vehicle crossings.

## II. LITERATURE REVIEW

**''Conditional weighted ensemble of transferred models for camera based onboard pedestrian detection in railway driver support systems"** This is a method for detecting pedestrians on railway tracks using onboard cameras. The system utilizes an ensemble approach, where multiple models (trained in different conditions or on different data) are combined to improve detection performance.

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**" An improved deep learning algorithm for obstacle detection in complex rail transit environments''** This algorithm is tailored for complex and dynamic environments, leading to more accurate detection of obstacles under varying conditions like weather, lighting, and different track conditions, which are crucial for ensuring safety in rail transit systems.

**"Research on Foreign Object Intrusion Detection for Railway Tracks Utilizing Risk Assessment and YOLO Detection"** In this survey it has an approach to enhance the detection and risk assessment of foreign objects on railway tracks. The authors propose integrating MobileNetv3 with Transformer to create a novel backbone feature extraction network, MobileNetV3-CATr, aiming to reduce model complexity. They introduce a BiFPN-Lite module for effective feature fusion without increasing complexity and utilize YOLO Head to classify foreign objects. An improved track detection method is also adopted, employing least squares to establish track linear equations and delineate risk zones. The method is validated on a self-constructed dataset, demonstrating a 3.7% improvement in mean average precision (mAP) compared to the baseline model, and achieving a good accuracy in track edge segmentation.

## III. METHODOLOGY

### A. EXISTING SYSTEM

The existing systems The existing systems for managing safety at vehicle crossings primarily rely on traditional traffic management solutions, such as traffic lights, road signs, and static surveillance cameras. While these systems provide basic monitoring and control, they lack real-time object detection and hazard identification capabilities and Some existing systems employ motion detection or simple rule-based algorithms, which are limited in their ability to classify objects accurately or respond dynamically to potential dangers. These limitations make them less effective in preventing accidents, especially in complex or high-traffic environments. Furthermore, existing systems often fail to provide immediate alerts to drivers and pedestrians, resulting in delayed responses to hazardous situations. The lack of scalability and adaptability in these systems further restricts their efficiency in addressing evolving safety challenges at vehicle crossings.

### B. DISADVANTAGE

1. The existing systems for vehicle crossing safety have several notable disadvantages that limit their effectiveness. One significant drawback is their reliance on static traffic management tools, such as traffic lights and road signs, which do not adapt dynamically to real-time conditions.
2. These systems lack the capability to detect and classify objects, making them unable to distinguish between pedestrians, vehicles, and other obstructions.
3. Additionally, the use of basic motion detection or rule-based algorithms often results in low accuracy and false alerts, especially in complex or crowded environments.

### C. PROPOSED SYSTEM

The proposed system is a smart vehicle crossing object detection and alert mechanism that combines artificial intelligence with embedded hardware to enhance safety at intersections and restricted zones. At the core of the system is the YOLOv3 deep learning model, which is used for real-time object detection and classification. The model processes live video feed data to identify pedestrians, vehicles, or any obstructions near the crossing area and categorizes them as safe or hazardous based on a reference database. Once a hazardous object is detected, the system triggers immediate alerts using the pyttsx3 text-to-speech library to deliver voice warnings. The hardware architecture includes a Nano microcontroller, which serves as the central control unit. It receives input via serial communication and manages various output components such as a buzzer for audio alerts, an LCD for visual status updates, and motor drivers for operating gear motors that may control physical barriers. A 7805 voltage regulator ensures a stable 5V power supply to all components. The entire system is designed to be responsive, low-power, and scalable, capable of operating in both day and night conditions. This AI-driven solution aims to provide real-time awareness and preventive action to reduce the likelihood of accidents at vehicle crossings.

### D. ADVANTAGES

1. The proposed system offers several advantages that enhance safety and efficiency at vehicle crossings.
2. By utilizing the YOLOv3 deep learning model, it ensures high accuracy and speed in real-time object detection and classification, making it suitable for dynamic environments.

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3. The integration of an Artificial Neural Network (ANN) algorithm improves the system's decision-making capabilities, enabling reliable hazard identification.
4. The use of the pyttsx3 library for generating immediate voice alerts ensures timely communication of potential dangers, reducing response time.
5. Additionally, the system is designed to be scalable and adaptable, allowing it to be implemented across various intersections and zones with minimal customization.
6. Its ability to function effectively in diverse environmental conditions, such as different lighting scenarios, further enhances its practicality. Overall, the system is user-friendly, cost-effective, and capable of significantly reducing accident risks at vehicle crossings.
7. Additionally, a mail alert system is integrated to notify concerned authorities or users about detected hazards, enabling swift action to mitigate risks.

**E. DESIGN OF THE SYSTEM**

The system integrates both hardware and software components to create a comprehensive hazard detection and alert mechanism, particularly for enhancing safety at vehicle crossings. The system begins by capturing real-time video feed through a camera, which is then pre processed by resizing, normalizing, and enhancing the images .Using the YOLOv3 deep learning model, objects in the video are detected and classified as either safe or hazardous. Upon identifying a hazardous object, the system generates voice alerts using the pyttsx3 library and plays audible warnings to pedestrians and drivers. Simultaneously, the alert signal is communicated to the nano microcontroller via serial communication. The microcontroller, powered through a regulated 5V supply using a 7805 regulator, processes the alert and activates connected hardware components. This includes operating gear motors through a driver board to control physical barriers or warning mechanisms, such as gates or signals. Additionally, the system uses an LCD display to show real-time information and a buzzer to reinforce the alert with sound. This hybrid design leverages AI-based object detection with embedded hardware control to provide a scalable, responsive, and efficient safety solution.

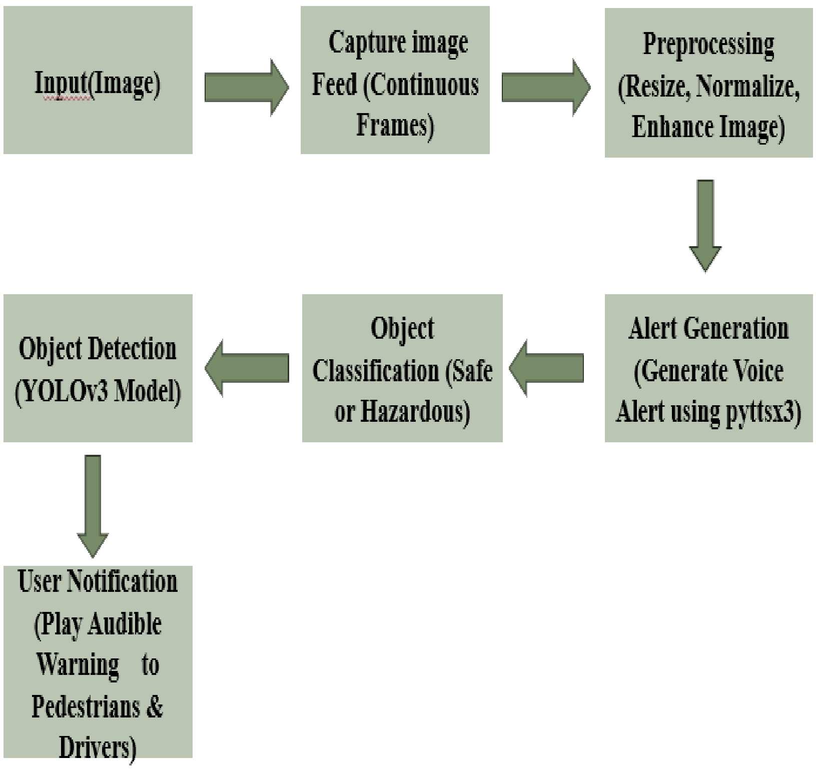


Fig 1

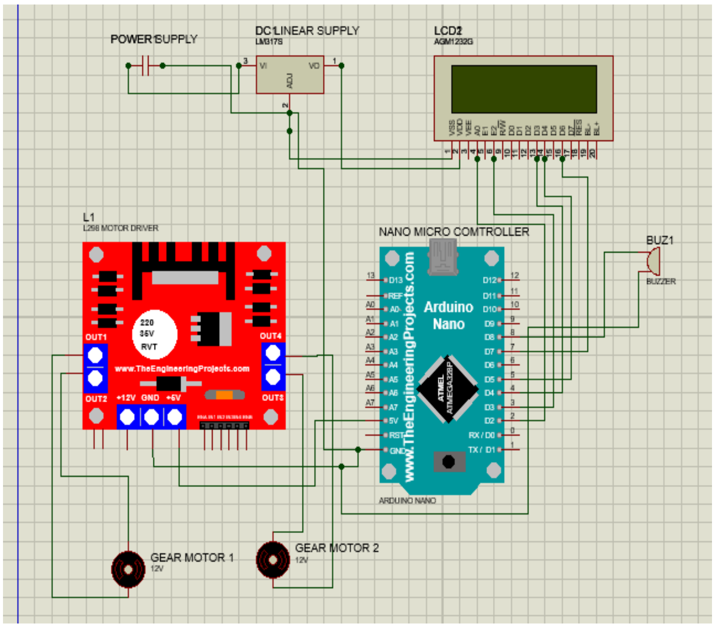


Fig.2

Fig.1 depicts software-based Vision system on image processing and AI to detect hazards and generate alert using real-time monitoring feeds Fig.2 depicts hardware-based design to control and alert during hazardous situations likely at vehicle crossings

## IV. IMPLEMENTATION

### MODULE DESCRIPTION

**1. Input Module**

The system captures real-time video footage of the railway crossing using a high-definition camera. It analyzes environmental conditions to adjust for daytime and nighttime visibility. Preprocessing techniques such as resizing and normalization enhance the quality of the captured frames. Frames are extracted at specified intervals for timely object detection and classification.

**2. Segmentation Module**

The segmentation module processes the preprocessed frames to isolate objects of interest within the railway crossing area. It employs techniques such as thresholding and contour detection to delineate boundaries of detected objects, including pedestrians and vehicles. This segmentation allows for more accurate object detection by focusing on relevant regions of the image. The segmented output is then fed into the object detection algorithm for further analysis and classification.

**3. YOLO Algorithm Module**

The YOLO algorithm is used to detect and classify food items in real-time from meal images, offering quick and accurate identification without manual input. It processes images in a single pass, making it ideal for mobile applications. This allows users to log meals instantly and effortlessly.

**4. Database Module:**

The database module stores reference data, including predefined categories of objects (e.g., pedestrians, vehicles) and their associated characteristics. It maintains historical data on detected objects and alerts generated, enabling performance analysis and system improvement. The module also stores user feedback and incident reports to enhance the model's accuracy over time. This structured data supports the training and fine-tuning of the object detection algorithms, ensuring the system adapts to various conditions and scenarios

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**5. Output module:**

The output module generates real-time alerts based on the classification results of detected objects, distinguishing between safe and hazardous situations. It utilizes the pyttsx3 library to produce audible voice alerts, warning pedestrians and vehicle drivers of potential dangers at the railway crossing. Additionally, the module displays visual notifications on a user interface, providing clear information about detected hazards. The outputs are designed to ensure prompt awareness and enhance safety at railway crossings.

## V. RESULT

The smart vehicle crossing object detection system successfully identified pedestrians, vehicles, and obstacles in real-time using the YOLOv3 model. It accurately classified objects into safe or hazardous categories, ensuring timely detection of potential risks. The system generated immediate voice alerts using the pyttsx3 library, providing clear warnings to both pedestrians and drivers. It performed reliably in busy, dynamic environments, with high accuracy and speed during daytime conditions. The integration of AI and voice communication improved safety awareness at vehicle crossings. The system was scalable and adaptable to various traffic conditions. Testing confirmed its effectiveness in reducing accident risks. Overall, it demonstrated its potential to enhance public safety at vehicle crossings.

Fig 3

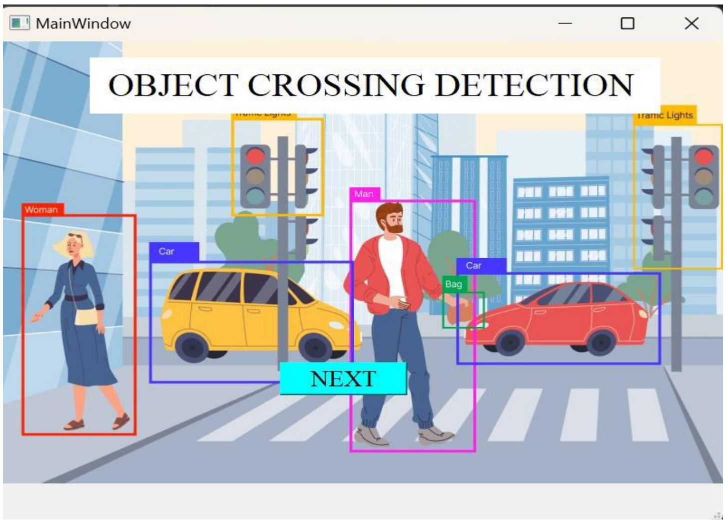


Fig 4

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Fig 5

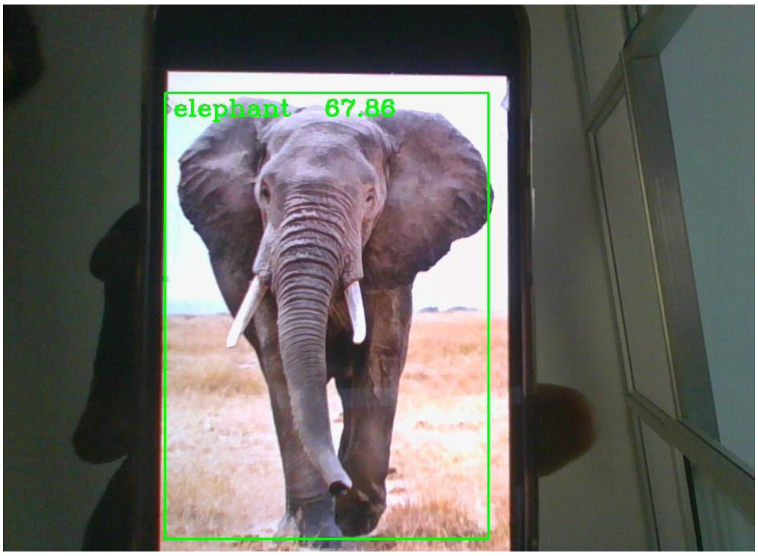


Fig 6

Fig 3 This image presents the hardware implementation of the system, showing essential components like the microcontroller (likely an Arduino Nano), buzzer, LCD display, and power supply. It represents the embedded side of the system, where visual alerts, audio signals, and motorized safety controls are physically executed in response to the detection data processed by the AI model Fig 4 depicts the graphical user interface (GUI) of the object detection system in action. The system is identifying different objects—such as pedestrians and vehicles—using bounding boxes and labels in a real-time video frame. The "NEXT" button indicates the system is likely in a testing or setup mode, allowing the user to move through the interface. This visual representation highlights how YOLOv3 detects and classifies multiple objects for further alert processing. Fig 5 displays the login screen for accessing the system's administrative or user interface. The presence of fields for "USERNAME" and "PASSWORD" ensures that only authorized personnel can operate or configure the system. This adds a layer of security and control, making sure that the intelligent crossing system is protected from unauthorized access. Fig 6 This figure demonstrates the system's capability to detect unusual or unexpected obstacles, such as an elephant, which may appear on or near vehicle crossings—particularly in rural or forest-adjacent areas. The detected object is labeled and highlighted with a bounding box, showcasing the system's versatility and effectiveness in recognizing various object types beyond common traffic elements.

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## VI. CONCLUSION

In conclusion, the proposed smart vehicle crossing object detection and alert system leverages advanced Artificial Intelligence techniques, specifically the YOLOv3 model, to ensure enhanced safety at busy intersections and restricted zones. By detecting and classifying objects in real-time, including pedestrians, other vehicles, and potential obstructions, the system provides immediate hazard alerts to vehicle drivers and pedestrians. The integration of a voice alert system using the pyttsx3 library ensures timely warnings, reducing the risk of accidents. The system's design prioritizes both accuracy and speed, ensuring its

applicability in real-world environments where quick decision-making is crucial. With its robust object detection capabilities, the system not only enhances public safety but also offers scalability for widespread adoption in urban areas. While the current implementation demonstrates promising results, future work may focus on refining the model for even higher accuracy in varied environmental conditions and expanding the system’s capabilities with more advanced sensors or AI models. Overall, this smart alert system represents a significant step toward improving pedestrian and vehicle safety in urban settings through the innovative application of AI and real-time monitoring technologies.

## VII. FUTURE WORK

To enhance the performance and scalability of the proposed object crossing detection system, several future improvements can be considered. One major enhancement involves integrating the system with IoT technology, allowing real-time monitoring and remote alert management by railway authorities. Upgrading the current object detection model from YOLOv3 to more advanced versions such as YOLOv8 or vision transformers could significantly improve detection accuracy and speed. Incorporating multi-sensor fusion—using thermal cameras, LiDAR, and standard visual sensors—can make the system more reliable under challenging environmental conditions like low light, rain, or fog. Additionally, the ability to track objects and predict their movement would help in providing early warnings and allow for better decision-making. Another vital extension would be the integration of the system with an autonomous train braking mechanism, enabling automatic speed reduction or emergency stopping in case of hazard detection. Deploying edge computing devices at crossings would reduce processing delays and improve system responsiveness. Moreover, expanding the dataset with diverse real-world scenarios and enabling continuous model training would help maintain high accuracy across various conditions. Finally, developing a mobile application to notify nearby pedestrians, drivers, and railway operators about potential threats can enhance public engagement and safety at a broader level

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