*Journal of Science Engineering Technology and Management Science*
*Volume 02, Issue 04, April 2025* *ISSN: 3049-0952*
*www.jsetms.com* *DOI:10.63590/jsetms.2025.v02.i04.132-139*

# REDLIGHT SHIELD: SMART AI SYSTEM FOR SIGNAL AND SPEED VIOLATION CONTROL

**M. K. Chakravarthi, Gunji Vijayaaditya, Gandavarapu Adithya, Kethireddy Mohith Reddy**

*Department of Electronics and Communication Engineering, Geetanjali Institute of Science and Technology, Nellore, Andhra Pradesh, India.*

***To Cite this Article***

*M. K. Chakravarthi, Gunji Vijayaaditya, Gandavarapu Adithya, Kethireddy Mohith Reddy," Redlight Shield: Smart Ai System For Signal And Speed Violation Control", Journal of Science Engineering Technology and Management Science, Vol. 02, Issue 04, April 2025,pp: 132-139, DOI:* http://doi.org/10.63590/jsetms.2025.v02.i04.pp132-139

*Submitted: 09-03-2025* *Accepted: 18-04-2025* *Published: 26-04-2025*

**ABSTRACT**

Traffic rule violations such as overspeeding and signal jumping are major contributors to road accidents and traffic congestion. This project introduces an AI-powered system designed to detect and respond to such violations in real-time. The system combines various hardware components, including an RPS (Regulated Power Supply) for power, an RFID module for vehicle identification, an ESP32 camera for capturing images, and IR sensors (IR1 and IR2) for detecting vehicle movement. The ESP32 microcontroller processes the collected data and communicates with output devices such as an LCD display, LED indicators, a GSM module, a buzzer, and an IoT module. It also integrates with Google Cloud for real-time monitoring and data storage. When a traffic violation is detected, the ESP32 camera captures an image of the offending vehicle, and the RFID module retrieves its identification details. Alerts are then triggered through LEDs, buzzers, and GSM-based notifications sent to traffic authorities or the vehicle owner. Additionally, the collected data is stored in Google Cloud for future analysis, traffic management, and law enforcement purposes. The IoT integration enables remote monitoring, making this AI-driven system an effective tool for enhancing road safety and traffic regulation.

**Keywords:** Traffic Violation Detection, Speed Monitoring System, Signal Jump Detection, Esp 32, Google Cloud.



## 1. INTRODUCTION

AI-driven speed violation and signal jump detection is an advanced traffic monitoring system designed to enhance road safety and enforce traffic laws efficiently. Traditional methods of monitoring traffic violations rely heavily on manual surveillance and basic CCTV systems, which are often inefficient and prone to human errors. This project aims to develop an AI-powered system that automates the detection of speed limit violations and red-light jumping using computer vision and deep learning algorithms. High-resolution cameras and speed sensors will be integrated to capture real-time traffic data, which will be processed using AI models such as YOLO for vehicle detection and Optical Character Recognition (OCR) for automatic number plate recognition (ANPR).

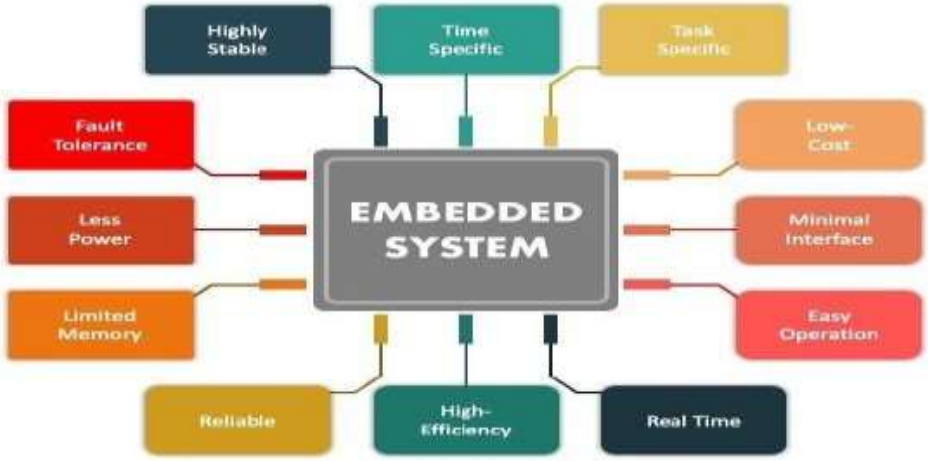


Fig. 1: Embedded system

The system will track vehicle movement, calculate speed, and analyze signal status to identify violations accurately. Once a violation is detected, the system will automatically generate reports and issue fines through a centralized database, reducing the need for manual intervention. Additionally, real-time alerts can be sent to law enforcement authorities for immediate action. The proposed AI-driven solution is scalable and can be deployed in both urban and highway environments to improve road discipline and minimize accidents caused by reckless driving. By leveraging artificial intelligence, this system ensures efficient traffic monitoring, reduces response time, and promotes compliance with traffic regulations, ultimately leading to safer roads and better traffic management.

## 2. LITERATURE SURVEY

Zhang et al. [1] – An AI-based traffic monitoring system was developed to detect speed violations using real-time data analysis. The system integrated computer vision and deep learning to accurately assess vehicle speed and identify violations. By processing live traffic footage, it ensured efficient monitoring and quick detection of offenders. Advanced algorithms were employed to enhance accuracy and minimize false detections. The system was designed to operate in various environmental conditions, ensuring reliability. Law enforcement agencies benefited from automated violation detection, leading to improved road safety.

Kumar et al. [2] – An IoT-enabled enforcement system was proposed, utilizing cloud computing to monitor traffic violations. The system provided real-time updates to traffic authorities, ensuring efficient law enforcement against speed and signal violations. By leveraging advanced data processing, it enabled quick identification of offenders. The integration of IoT devices enhanced monitoring accuracy and reliability. Automated alerts facilitated prompt action by law enforcement agencies. The system contributed to improved traffic management and road safety.

Lee and Park [3] –The use of blockchain technology was explored for securing traffic violation records. A blockchain-based system was implemented to ensure tamper-proof storage of speed violations and signal jumps. By preventing unauthorized modifications, the system enhanced transparency and reliability. Decentralized data storage improved security and reduced the risk of manipulation. Law enforcement agencies benefited from a verifiable and immutable record- keeping system. The approach contributed to a more accountable and efficient traffic management system.

Chen et al. [4] –An AI-driven predictive model was developed to identify high- risk traffic zones prone to speed violations and signal jumping. Machine learning algorithms were employed to analyze historical traffic patterns and predict future violations. By processing vast datasets, the alerts provided timely notifications to law enforcement agencies.system enhanced the accuracy of risk assessment. Real-time data analysis allowed authorities to implement preventive measures effectively.

Singh et al. [5] –A dynamic penalty pricing system based on AI was proposed to adjust fines for repeat offenders. The model analyzed real-time traffic congestion data and past violations to ensure fair and effective penalty enforcement. By considering violation history, it imposed higher fines on habitual offenders, promoting compliance. Machine learning algorithms enhanced accuracy in identifying repeat violations. Real- time data processing allowed immediate penalty adjustments. Cloud computing facilitated secure data storage and efficient system operation. IoT integration improved monitoring and ensured reliable violation detection. Automated alerts informed drivers about penalties, discouraging reckless behavior. The system aimed to enhance road safety and reduce traffic violations. Law enforcement agencies benefited from an adaptive and data-driven approach to traffic regulation.

Patel et al. [6] –A cloud-based violation tracking system was introduced to provide real-time updates on speed violations and signal jumps. The system integrated with traffic cameras and AI- powered image recognition to accurately identify offenders. Real-time data processing enabled quick detection and reporting of violations. Cloud computing ensured secure storage and seamless access to violation records. Machine learning algorithms enhanced recognition accuracy and minimized false detections. IoT-enabled sensors improved monitoring capabilities and data collection efficiency. Automated alerts notified law enforcement agencies for prompt action. The system was designed to function across various traffic conditions and locations. Advanced analytics helped identify high-risk areas for better enforcement strategies. Integration with mobileapplications allowed drivers to access violation records instantly.

Wang et al. [7] –An AI-powered optimization framework was developed to monitor and reduce traffic violations. The model incorporated real-time speed data and predictive analytics to enhance enforcement efficiency. Machine learning algorithms analyzed historical traffic patterns to identify high-risk zones. Real-time data processing allowed dynamic allocation of traffic law enforcement officers. Cloud computing ensured seamless data storage and retrieval for better decision-making. IoT-enabled sensors improved accuracy in monitoring speed violations and signal jumping. Automated alerts provided timely notifications to authorities for quick intervention. Advanced analytics helped in optimizing patrol routes and resource distribution. The system was designed to function in diverse traffic conditions, ensuring adaptability. AI-driven insights enabled proactive measures to prevent violations before they occurred. Law enforcement agencies benefited from a data- driven approach to traffic regulation. The implementation of the framework aimed to improve road safety and compliance with traffic laws.

Li et al. [8] –A smart grid-integrated enforcement system was proposed to enhance traffic law enforcement through coordinated data analysis. AI was utilized to balance enforcement efforts based on the frequency of speed violations and signal jumping incidents. Real-time data processing enabled accurate identification of high-risk areas. Machine learning algorithms analyzed historical trends to optimize resource allocation. Cloud computing facilitated secure data storage and seamless access to violation records. IoT-enabled sensors improved monitoring accuracy and provided real-time updates. Automated alerts allowed law enforcement agencies to take immediate action against offenders. Advanced analytics helped in distributing enforcement personnel efficiently. The system was designed to adapt to varying traffic conditions for maximum effectiveness. AI-driven insights enabled predictive enforcement strategies to prevent violations. Law enforcement agencies benefited from a scalable and data-driven approach to traffic management.

## 3. PROPOSED SYSTEM

The project presents a working model of an AI-driven speed violation and signal jump detection system aimed at improving traffic law enforcement. The primary objective is to enhance road safety by automating violation detection using artificial intelligence and computer vision techniques. The system integrates real-time video analysis, machine learning algorithms, and IoT- based

communication to efficiently detect traffic rule violations. The proposed system operates using high-resolution cameras and deep learning models to identify vehicles violating speed limits or running red lights. Speed detection is performed using image processing techniques, calculating vehicle velocity over a predefined distance. For signal jump detection, the system monitors traffic lights and tracks vehicle movement to determine rule violations. The system is implemented using YOLO (You Only Look Once) for object detection, OpenCV for image processing, and a cloud-based database for storing violation records. Captured data, including vehicle images, timestamps, and violation types, are sent to an automated penalty system, which processes fines and sends notifications to registered vehicle owners. The Internet of Things (IoT) module facilitates real-time updates to law enforcement authorities and traffic management centers, ensuring timely action. This AI-driven approach minimizes human intervention, increases accuracy, and provides a scalable solution for urban traffic management.

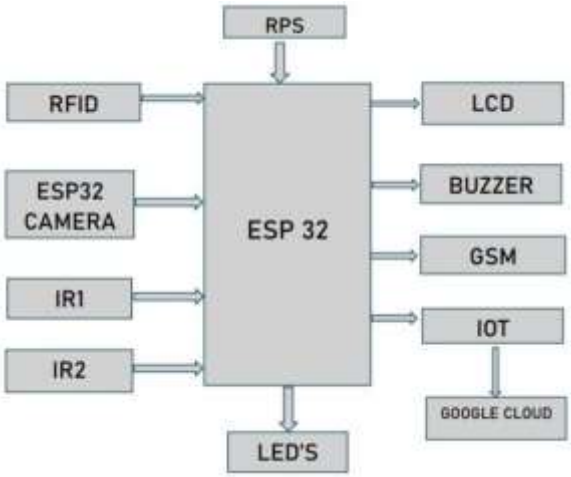


Fig. 2: BLOCK DIAGRAM.

The system architecture consists of multiple interconnected components, each playing a crucial role in detecting speed violations and signal jumps. The ESP32 microcontroller serves as the core processing unit, managing data from various sensors and modules. An ESP32 camera is used for capturing real-time images of vehicles, which are analyzed for detecting rule violations. processing unit, managing data from various sensors and modules. An ESP32 camera is used for capturing real-time images of vehicles, which are analyzed for detecting rule violations. Infrared (IR) sensors are placed strategically to track vehicle movement and determine speed. The radio frequency identification (RFID) module is included for vehicle authentication and tracking. The system also integrates an LCD display to provide live s tatus updates. A buzzer is triggered when a violation is detected, alerting authorities in real-time. The GSM module is responsible for sending automated notifications regarding violations.

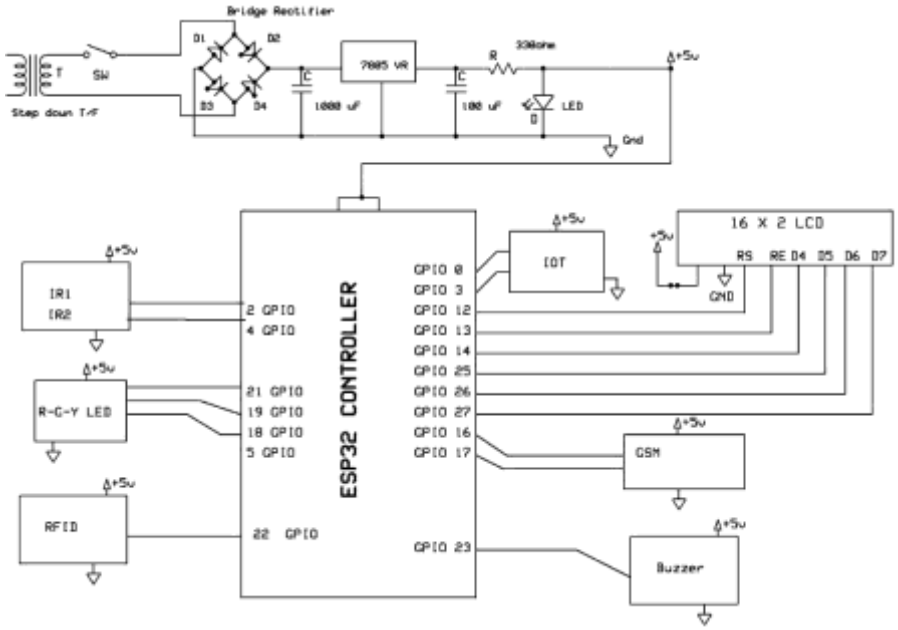


Fig. 3: SCHEMATIC DIAGRAM

The regulated power supply ensures a stable 5V DC voltage to all system components. A step- down transformer reduces AC voltage, which is then converted to DC using a bridge rectifier. A voltage regulator maintains consistent power delivery, protecting the system from fluctuations. The input section consists of infrared sensors and an RFID module. The infrared sensors detect vehicle movement and measure speed, helping to identify violations. The RFID module is used for vehicle authentication and tracking purposes. The output section provides real-time feedback and alerts. The LCD display shows status messages, while the buzzer is triggered when a violation is detected. LED indicators signal different system states, such as traffic signal status and violation alerts. The processing unit is centered around the ESP32 microcontroller, which controls data flow between the input and output sections. It processes sensor data, identifies violations, and communicates with external modules. The microcontroller also interfaces with the display and alert systems.

**ADVANTAGES**

Automates traffic rule enforcement without manual intervention. Ensures high accuracy in speed and signal violation detection. Provides real-time alerts for immediate action. Stores violation data securely on the cloud. Reduces workload for traffic authorities. Processes data quickly using ESP32 microcontroller. Scalable for deployment in multiple locations. Enhances road safety by enforcing strict traffic rules. Enables automated fine management with RFID integration.

## 4. RESULTS AND DISCUSSION

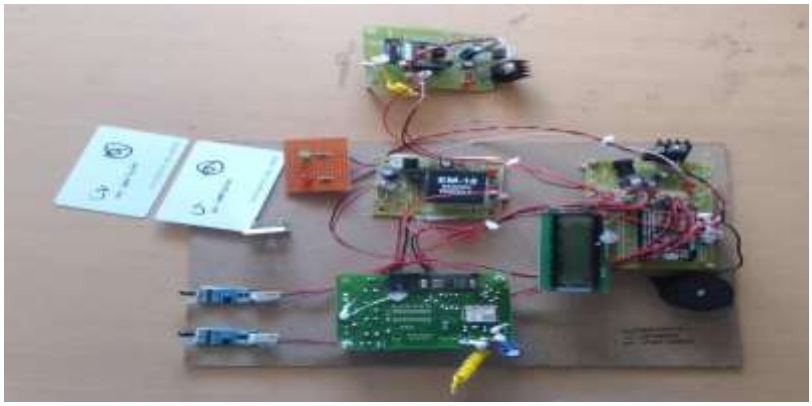

Fig. 4: Hardware Equipment

The hardware setup of the project consists of multiple components integrated to detect speed violations and signal jumps. The main components include an EM-18 RFID reader module, infrared sensors, a microcontroller board, an LCD display, a buzzer, and supporting power circuits. The RFID reader is responsible for vehicle identification, while the infrared sensors are placed to detect vehicle movement. The microcontroller processes the data from the sensors and RFID module to determine


Fig. 5: Title of the project on LCD

he LCD display in the project shows the detected traffic violations in real-time. When a vehicle exceeds the speed limit or jumps a signal, the LCD displays messages such as "Speed Violation" and "Signal Jump." This provides immediate feedback on the detected traffic offenses, ensuring that the violations are recorded and can be monitored.

Fig. 6: Website for Remote Monitoring.

The remote monitoring system is designed to display recorded violations on a web-based interface. The website provides a tabular representation of the detected violations, showing details such as vehicle identification, violation type, speed, and timestamp.

## 5. CONCLUSION

The AI-driven speed violation and signal jump detection system enhances traffic law enforcement by leveraging machine learning and computer vision technologies. By automating the detection of speed limit breaches and red-light violations, the system minimizes human intervention, reducing errors and improving efficiency. Real-time monitoring and instant violation alerts ensure prompt action, contributing to safer roads. Additionally, the integration of AI enables scalability and adaptability for different traffic environments. This project demonstrates the potential of AI in traffic management, paving the way for smarter and more effective law enforcement solutions.

## REFERENCES

[1] Zhang et al. – An AI-based traffic monitoring system was developed to detect speed violations using real-time data analysis. The system integrated computer vision and deep learning to accurately assess vehicle speed and identify violations. By processing live traffic footage, it ensured efficient monitoring and quick detection of offenders. Advanced algorithms were employed to enhance accuracy and minimize false detections. The system was designed to operate in various environmental conditions, ensuring reliability. Law enforcement agencies benefited from automated violation detection, leading to improved road safety.

[2] Kumar et al. – An IoT-enabled enforcement system was proposed, utilizing cloud computing to monitor traffic violations. The system provided real-time updates to traffic authorities, ensuring efficient law enforcement against speed and signal violations. By leveraging advanced data processing, it enabled quick identification of offenders. The integration of IoT devices enhanced monitoring accuracy and reliability. Automated alerts facilitated prompt action by law enforcement agencies. The system contributed to improved traffic management and road safety.

[3] Lee and Park–The use of blockchain technology was explored for securing traffic violation records. A blockchain-based system was implemented to ensure tamper-proof storage of speed violations and signal jumps. By preventing unauthorized modifications, the system enhanced transparency and reliability. Decentralized data storage improved security and reduced the risk of manipulation. Law enforcement agencies benefited from a verifiable and immutable record- keeping system. The approach contributed to a more accountable and efficient traffic management system.

[4] Chen et al. –An AI-driven predictive model was developed to identify high- risk traffic zones prone to speed violations and signal jumping. Machine learning algorithms were employed to analyze historical traffic patterns and predict future violations. By processing vast datasets, the system enhanced the accuracy of risk assessment. Real-time data analysis allowed authorities to implement preventive measures effectively. Predictive insights enabled better resource allocation for traffic enforcement.

[5] Singh et al. –A dynamic penalty pricing system based on AI was proposed to adjust fines for repeat offenders. The model analyzed real-time traffic congestion data and past violations to ensure fair and effective penalty enforcement. By considering violation history, it imposed higher fines on habitual offenders, promoting compliance. Machine learning algorithms enhanced accuracy in identifying repeat violations. Real- time data processing allowed immediate penalty adjustments. Cloud computing facilitated secure data storage and efficient system operation. IoT integration improved monitoring and ensured reliable violation detection. Automated alerts informed drivers about penalties, discouraging reckless behavior.

The system aimed to enhance road safety and reduce traffic violations. Law enforcement agencies benefited from an adaptive and data-driven approach to traffic regulation.

[6] Patel et al. –A cloud-based violation tracking system was introduced to provide real-time updates on speed violations and signal jumps. The system integrated with traffic cameras and AI- powered image recognition to accurately identify offenders. Real-time data processing enabled quick detection and reporting of violations. Cloud computing ensured secure storage and seamless access to violation records. Machine learning algorithms enhanced recognition accuracy and minimized false detections. IoT-enabled sensors improved monitoring capabilities and data collection efficiency.

[7] Wang et al. –An AI-powered optimization framework was developed to monitor and reduce traffic violations. The model incorporated real-time speed data and predictive analytics to enhance enforcement efficiency. Machine learning algorithms analyzed historical traffic patterns to identify high-risk zones. Real-time data processing allowed dynamic allocation of traffic law enforcement officers. Cloud computing ensured seamless data storage and retrieval for better decision-making. IoT-enabled sensors improved accuracy in monitoring speed violations and signal jumping. Automated alerts provided timely notifications to authorities for quick intervention. Advanced analytics helped in optimizing patrol routes and resource distribution. The system was designed to function in diverse traffic conditions, ensuring adaptability. AI-driven insights enabled proactive measures to prevent violations before they occurred. Law enforcement agencies benefited from a data- driven approach to traffic regulation. The implementation of the framework aimed to improve road safety and compliance with traffic laws.

[8] Li et al. –A smart grid-integrated enforcement system was proposed to enhance traffic law enforcement through coordinated data analysis. AI was utilized to balance enforcement efforts based on the frequency of speed violations and signal jumping incidents. Real-time data processing enabled accurate identification of high-risk areas. Machine learning algorithms analyzed historical trends to optimize resource allocation. Cloud computing facilitated secure data storage and seamless access to violation records. IoT-enabled sensors improved monitoring accuracy and provided real-time updates. Automated alerts allowed law enforcement agencies to take immediate action against offenders.