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Intelligent Traffic Rules Violation Detector

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Abstract: This project presents a Traffic Rules Violation Detection System using Raspberry Pi, Pi Camera, and a sound sensor. It detects unauthorized license plates, exhaust modifications, and dangerous stunts like wheelies in real time. Deep learning and computer vision techniques are used for video and audio analysis. The system automates violation detection, reducing human effort and enhancing traffic rule enforcement.

KEYWORDS: HSRP detection, Number plate recognition, vehicle violation detection ,image processing.

I. INTRODUCTION

Traffic rule violations is a growing threat to road safety, especially in high-density urban areas. Manual enforcement is often unreliable, limited by human error, and ineffective in detecting specific violations like unauthorized number plates, modified exhausts, and reckless stunts.

This project proposes an intelligent traffic violation detection system using Raspberry Pi, Pi Camera, and a sound sensor. The system identifies three major violations—non-standard HSRP plates, exhaust modifications, and stunts such as wheelies—using real-time video and audio analysis powered by deep learning.

Raspberry Pi handles data processing, while the Pi Camera captures visual data and the sound sensor detects illegal noise levels. The system uses OCR for plate verification, classification algorithms for identifying exhaust tampering, and motion analysis for stunt detection. Violation records are stored digitally, helping reduce manual workload and allowing quicker response from authorities.

II. LITERATURE REVIEW

In 2024, M.-J. Hao et al. proposed a Greenshields model-based fuzzy logic system for highway traffic congestion prediction, utilizing vehicle speed and traffic flow as inputs to assess congestion levels without the need for large datasets, offering a lightweight and adaptive solution for Intelligent Transportation Systems (ITS) [1] In 2024, Yang Ren introduced an intelligent vehicle violation detection system combining human-computer interaction and computer vision, using Kalman filtering and image preprocessing techniques to achieve over 98% accuracy in detecting traffic violations in real-time while [2] In 2024, Dr. B. Hari Krishna developed a deep learning-based traffic rule violation detection model employing YOLOv3 and convolutional neural networks (CNNs) to identify common infractions such as helmetless riding, red-light jumping, and lane violations, supported by an ANPR module for issuing real-time alerts to violators [3]. In 2024, Madhuravani S. et al. proposed an AI-powered helmet detection system using YOLOv7 for identifying motorcyclists without helmets and other common violations in Indian traffic conditions, and suggesting scope for expansion into speed and reckless driving analysis using the same video feed [4] In 2024, S. S. Wankhede and P. Bajaj et al. designed a YOLOv5-based vehicle violation detection model introducing a profile point system ranging from -5 to +5 for each vehicle owner, aimed at improving traffic

regulation in Bangladesh with real-time object detection,[5] **J. Jin and Y. Deng et al. 2023** proposed a system for detecting over-speeding, helmet violations, and triple riding, integrating license plate recognition for automated violation processing and fine alerts[6]. **S. S. Wankhede, P. Bajaj et al. 2023** implemented the YOLOv5 model for real-time traffic violation detection, improving vehicle identification and speeding detection, enhancing road safety in Bangladesh [7]. **S. A. Elsaygher Mohamed et al. 2022** designed a vehicle violation detection system based on human-computer interaction and computer vision. This system uses Kalman filtering for tracking vehicles and providing useful information to drivers via human-computer interaction. The system aims to improve traffic safety and reduce monitoring costs[8]. **P. Srinivas Reddy, Ramesh O., et al. 2022** proposed a system using YOLOv3 for detecting traffic violations such as helmetless riding, seatbelt violations, and red light jumping. They addressed challenges like detection during nighttime and weather conditions, while suggesting optimizations for improving algorithm efficiency and reducing computational time [9]. **Mr. K. A. Patil, Ashish Chougule et al. 2021** designed a system using CCTV footage to detect traffic violations. The system incorporates the R-CNN algorithm for violation detection and aims to reduce the workload of traffic officers by automating the monitoring process [10].

III. PROPOSED METHADODOLOGY

This paper presents a real-time vehicle monitoring and alert system aimed at improving traffic regulation through sound violation detection and number plate verification. The system employs OCR to extract license plate information, which is then validated against an HSRP database using CSV-based matching. Simultaneously, a sound sensor monitors noise levels, identifying vehicles exceeding permitted thresholds and issuing alerts accordingly.

The results are communicated via a Telegram bot, which displays automated messages for non-HSRP number plate detections and sound violations, including associated fines. The system also accounts for incorrect or missing data, ensuring resilience against input anomalies. With accurate real-time identification and automated enforcement capabilities, this solution supports traffic compliance and pollution control efforts. When integrated with surveillance and alert systems, it can significantly enhance urban traffic monitoring and environmental regulation

A. BLOCK DIAGRAM

The system architecture illustrated in the block diagram centers around a Raspberry Pi, which acts as the main processing unit for monitoring sound levels and capturing visual data. It is designed to detect potential violations such as noise pollution or illegal vehicle behavior through integrated sensing and alert mechanisms. The sound sensor records environmental audio data, which is then converted from analog to digital format using the MCP3008 ADC module. This conversion is essential as the Raspberry Pi processes only digital inputs.

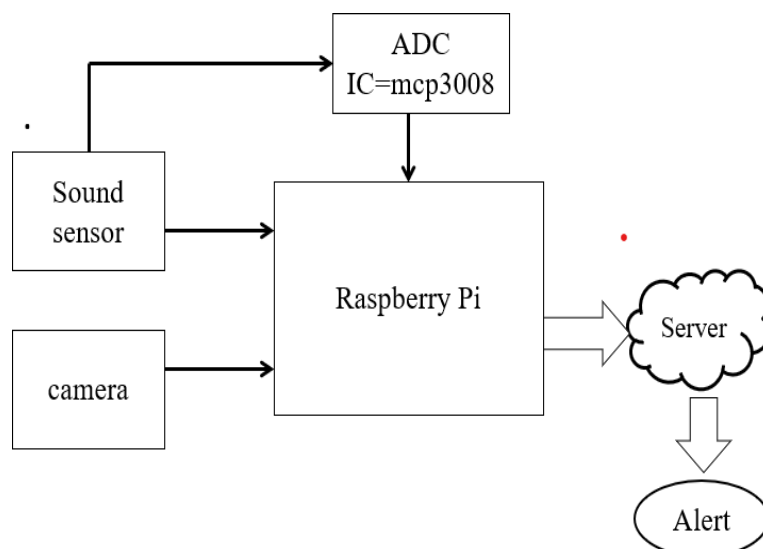


Fig.1 Block Diagram of Traffic Violation Detector

In parallel, the camera module continuously captures real-time video or images, providing visual confirmation of the detected incident. Both sensor inputs are handled by the Raspberry Pi, which processes the incoming data streams to identify threshold breaches, such as excessive sound levels or illegal activities like bike stunts.

Once a violation is confirmed based on predefined criteria, the Raspberry Pi communicates with a connected server. The server is responsible for generating and forwarding alerts, which can be sent via messaging platforms such as Telegram or stored for further analysis. This communication pathway ensures timely reporting of violations to relevant authorities or systems.

The integration of audio and visual sensing, along with digital processing and server-based alerting, enables a reliable and low-cost solution for real-time traffic monitoring and law enforcement support. This model is scalable and can be extended to function as part of a broader smart city surveillance infrastructure.

B.FLOW CHART

This system is designed to monitor and identify traffic violations such as missing registration plates, excessive noise levels, and illegal bike stunts. By using sensors and surveillance inputs, the system collects and analyzes data in real-time to detect violations and issue alerts. It aims to support safer roads and stricter enforcement of traffic regulations through automation and smart monitoring

The operation begins with the system collecting data through components like sound sensors and video inputs. One of the first checks is for the presence of an HSRP (High-Security Registration Plate). If a vehicle lacks a valid HSRP, the system flags it and sends out an alert. This step ensures that vehicles comply with mandatory number plate standards, which are essential for identification and legal verification.

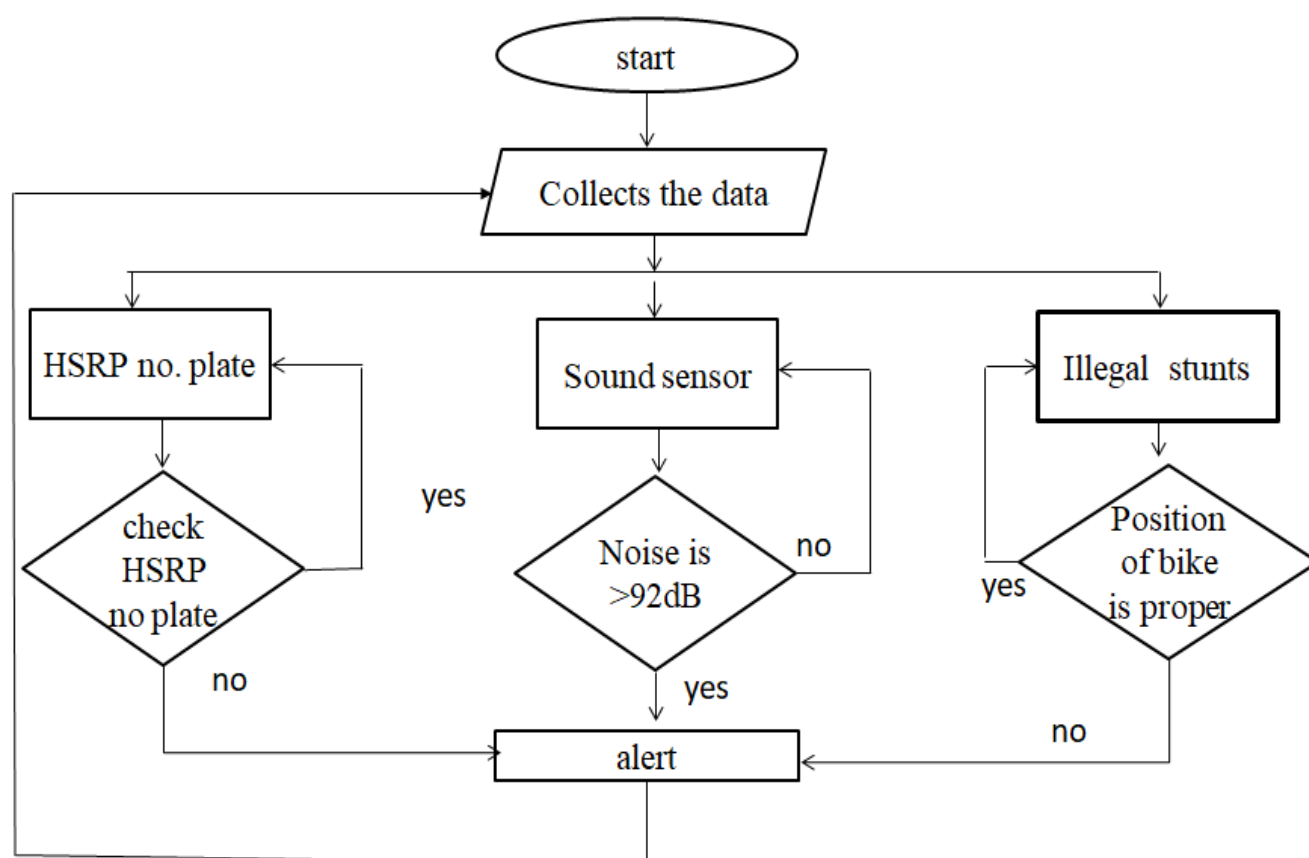


Fig 2 Flow Chart of Traffic Violation Detector

In parallel, a sound sensor monitors the noise level produced by the vehicle. If the noise exceeds a threshold value of 92 decibels, which indicates potential noise pollution or aggressive driving, the system triggers an alert. This helps in identifying vehicles that may be modified to produce excessive sound or are being driven in a way that disturbs public peace.

Another important aspect of the system is its ability to detect illegal bike stunts. By analyzing the position and movement of the vehicle, the system determines whether a bike is performing dangerous or unauthorized stunts. If such behavior is detected, the system generates a warning and logs the event for further action. In cases where no violation is observed, the system continues monitoring without issuing any alerts.

Throughout the process, the system operates automatically, making decisions based on predefined rules and sensor feedback. If any of the monitored conditions are violated, the system responds by generating alerts that can be sent to traffic authorities or recorded for further investigation. This not only aids in traffic rule enforcement but also helps reduce risky behavior, promoting safer road use for everyone.

IV. RESULTS

The project displays results by identifying non-HSRP number plates, exhaust sound violations, and illegal stunts like bike wheeling. It uses OCR, sound sensors, and image classification to detect and log these violations. The results highlight the system's ability to support automated traffic enforcement

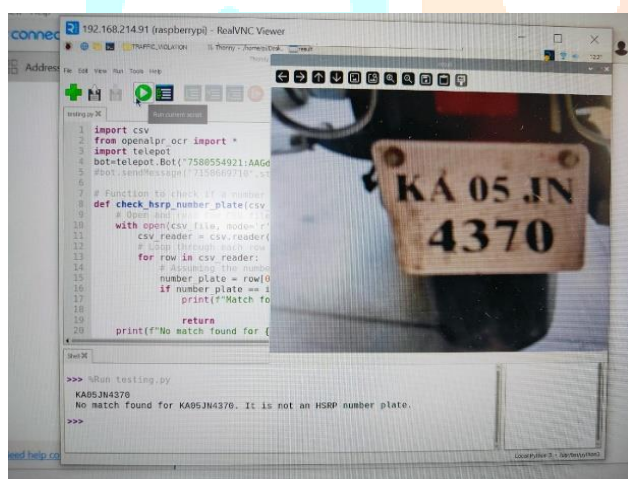


Fig.3 Snapshot of result obtained for vehicle without HSRP

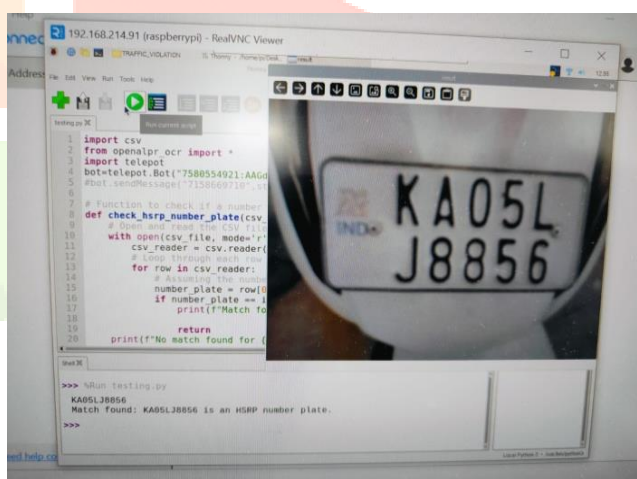


Fig.5 Snapshot of result obtained when spotting a stunt

Figure 3 and 4 validates the system's ability to differentiate and confirm valid HSRP plates from non-standard ones based on database matching. The figure 4 demonstrates the successful detection of an illegal bike stunt—bike wheeling—using the proposed system. The system accurately detects and classifies number plates into HSRP and non-HSRP using OCR and CSV-based verification. It is effective in recognizing standardized HSRP formats and can be extended to issue automated fines for violations. This low-cost, automated solution could significantly aid in traffic enforcement, pollution control, and vehicle compliance verification, especially when integrated with live surveillance and alert systems.

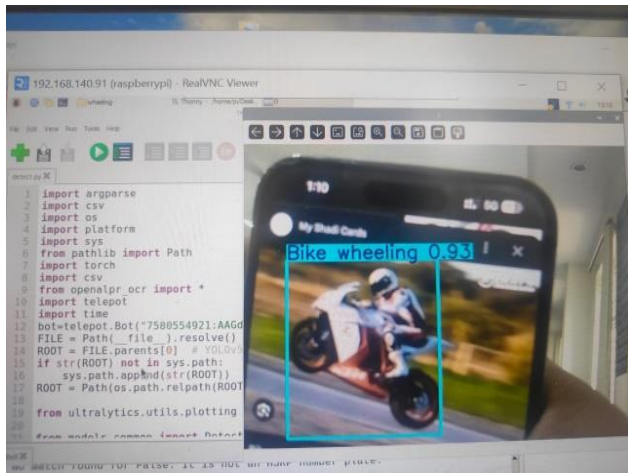


Fig.5 Snapshot of result obtained when spotting a stunt

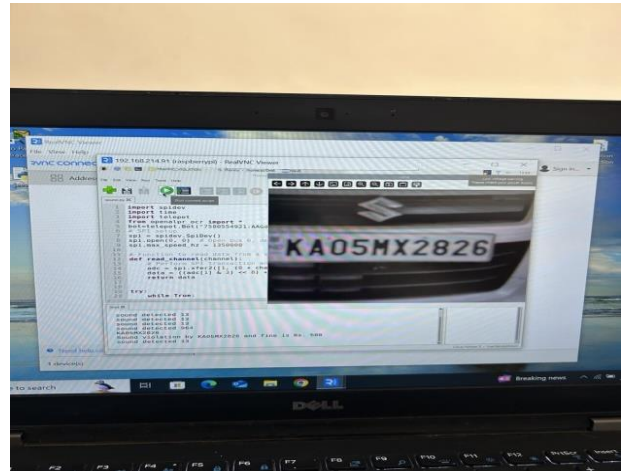


Fig.6 Snapshot of result obtained exceeding legal exhaust sound limit

Figure 5 and 6 validate the system's ability to detect and classify traffic violations based on sound and visual analysis. The figure 3 demonstrates the successful detection of a noise pollution violation caused by an abnormal exhaust sound, where the system accurately identifies the vehicle number using OCR and generates an automated fine. The figure 4 highlights the detection of an illegal bike stunt—bike wheeling—through image classification using deep learning. The system processes the video input, detects the stunt with high confidence, and tags the violation accordingly. This integrated approach combining sound sensors, OCR, and object detection models provides a low-cost, automated solution for traffic monitoring and enforcement. The system can be extended to work with live surveillance feeds to support real-time alerts and automatic fine processing, thereby aiding in effective traffic regulation and road safety

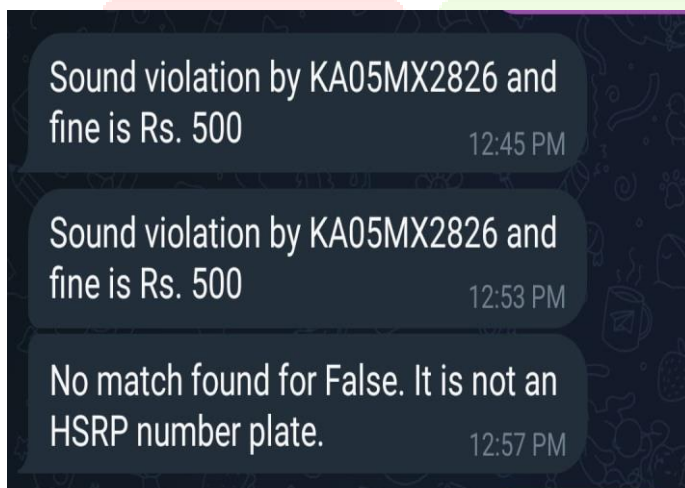


Fig.8 Snapshot of result sending alert exceeding legal exhaust sound limit

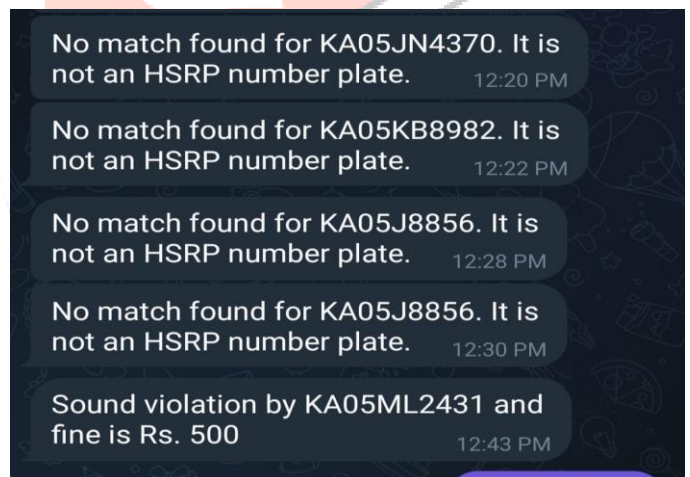


Fig.7 Snapshot of the result received alert of non HSRP number plates

Figure 7 and 8 show the Telegram bot responses for sound violation alerts and non-HSRP number plate detections. The system flags vehicles generating excessive noise and assigns fines accordingly. It also verifies number plates against an HSRP database, identifying non-compliant entries. These results demonstrate real-time alerting and automated traffic enforcement capabilities

V. CONCLUSION

The Intelligent Traffic Rules Violation Detector enhances road safety by integrating AI, computer vision, and IoT for real-time traffic monitoring and enforcement. Utilizing a Raspberry Pi 4, YOLOv5 for vehicle detection, and Open ALPR for license plate recognition, the system automatically detects violations like non-HSRP plates and tampered exhausts. Noise sensors add an extra layer of detection for sound-based offenses. Real-time notifications through Telegram ensure immediate fine issuance. Despite challenges like environmental noise and hardware limitations, the system's scalable and modular design allows for future improvements such as AI optimizations and cloud integration, making it suitable for wide deployment in urban areas to streamline traffic enforcement and enhance road safety.

VI. FUTURE SCOPE

The future development of the Intelligent Traffic Rules Violation Detector can incorporate advanced AI and deep learning models to improve the precision of vehicle behavior recognition, including better differentiation between intentional and accidental violations. Integration of GPS and cloud platforms can enable location-based violation analytics and centralized data storage for large-scale monitoring. Enhanced connectivity through 5G or LoRa can ensure real-time alerts without network delays. Future versions could also feature facial recognition for identifying repeat offenders, as well as integration with e-challan systems and traffic department databases for seamless penalty processing. Moreover, using solar-powered modules could enable sustainable deployment in remote or power-deficient areas.

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