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AN INTELLIGENT SURVEILLANCE SYSTEM FOR AUTOMATED DETECTION OF SPEED VIOLATIONS IN URBAN TRAFFIC

P. Hussain, Shaik Imam Vali, Vijay Kumar A, Pavan Teja Mallaiah, Gopaiah N, Anuga Naresh
Department of Electronics and Communication Engineering, Kommuri Pratap Reddy Institute of Technology, Ghatkesar , Medchal, 500088.

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ABSTRACT
Road safety has emerged as a major public concern with the increasing incidence of traffic accidents, many of which are attributed to overspeeding and violations of traffic regulations. To address this issue, the present project introduces an IoT-driven smart traffic enforcement system aimed at the automatic detection and penalization of speed violations. The system employs a combination of technologies including RFID for vehicle identification, IR sensors for speed monitoring, an ESP32-CAM for visual evidence capture, and a GSM module for e-challan dispatch.The process initiates when a vehicle passes through a monitored segment outfitted with two IR sensors positioned at a fixed interval. By calculating the time taken to travel between the sensors, the system determines the vehicle's speed. If the calculated speed exceeds the designated threshold, the ESP32-CAM captures an image of the violating vehicle. Simultaneously, the RFID module retrieves the vehicle's unique ID, linking the violation to a registered owner. The GSM module then transmits a digital fine notification (e-challan) to the owner's mobile number.This solution offers a contactless and automated alternative to traditional traffic policing, minimizing the potential for human error and corruption. It enhances enforcement efficiency while encouraging compliance with speed regulations. The system also generates real-time violation data, contributing to improved traffic analytics and supporting smart city development initiatives. Designed for scalability and affordability, the proposed system is well-suited for deployment in both urban and semi-urban environments.
Keywords: IoT, Speed Detection, ESP32-CAM, RFID, GSM, E-Challan, Smart Traffic System, Real-Time Monitoring, Intelligent Policing, Road Safety.

1. INTRODUCTION

The increasing vehicular population, especially in urban and semi-urban regions, has significantly exacerbated road safety concerns, with overspeeding emerging as a major contributor to traffic-related fatalities, injuries, and congestion. Traditional traffic policing methods, such as the use of handheld speed guns and manual challan systems, are often limited in scope due to their dependency on human operators, susceptibility to inaccuracies, inefficiencies, and potential for corruption. In light of the evolving needs of modern transportation systems and the push for smart city infrastructure, this project proposes a fully automated, IoT-based Speed Violation Traffic Policing system that leverages embedded hardware and wireless communication to detect, document, and penalize speed violations in real time. Central to the system is the ESP32 microcontroller integrated with a camera module (ESP32-CAM), IR sensors for time-of-flight-based speed calculation, an RFID reader for unique vehicle identification, and a GSM module for the generation and transmission of digital challans via SMS. The system is deployed by installing two IR sensors at a predetermined distance along a roadway; as a vehicle crosses both sensors, the system calculates the travel time and thereby derives its speed. If the calculated speed exceeds the permissible threshold, the ESP32-CAM is triggered to capture an image of the vehicle,

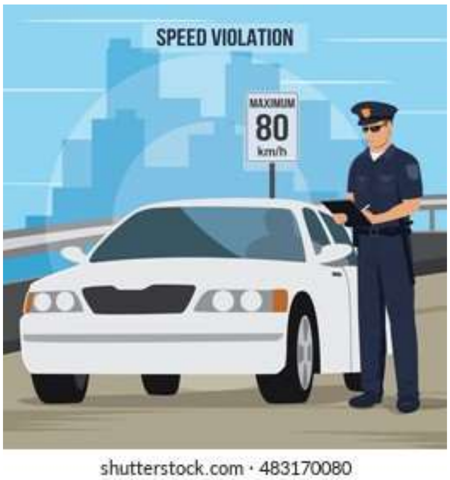

Fig. 1: High speed traffic violation.

while the RFID reader identifies the vehicle through a passive RFID tag. The GSM module then sends an SMS-based e-challan containing the violation details, fine amount, and optionally, a link to the captured image to the registered mobile number associated with the vehicle. This contactless solution enhances transparency, accuracy, and reliability in traffic enforcement by eliminating the need for manual intervention, thereby minimizing human error and enhancing public trust. The solution also enables real-time record-keeping and centralized traffic law enforcement, allowing traffic authorities to monitor trends and assess compliance patterns. From a technical standpoint, the project integrates widely available, low-cost components in a synchronized architecture that ensures efficient resource utilization while maintaining high performance and reliability. Its modular nature allows easy upgrades, such as cloud-based storage for large-scale data analysis, integration of machine learning models for number plate recognition and behavioral predictions, GPS modules for precise geolocation tagging of violations, and the development of web-based dashboards for centralized, multi-location traffic management. The societal impact is equally significant: automated enforcement not only deters overspeeding but also fosters a culture of accountability among drivers, reduces road accident rates, and improves overall traffic flow. The system supports data-driven policy-making through long-term storage and analysis of violation records, which can be utilized by urban planners and traffic authorities to identify high-risk zones and optimize traffic regulations. Furthermore, the solution is energy-efficient and adaptable for remote or rural deployments by incorporating solar panels and battery-operated units. Its compatibility with Smart City frameworks and potential for integration with other intelligent transportation systems (ITS) marks this project as a forward-looking initiative poised to redefine road safety standards and modernize traffic enforcement across diverse environments.

2. LITERATURE SURVEY

Amit Sharma introduced an automatic number plate recognition system using image processing and Raspberry Pi, aiming to reduce manual intervention in traffic management. The system enabled automatic challan generation for unauthorized vehicles.[1] P. Kumar and S. Das proposed a vehicle speed monitoring system using IR sensors and microcontrollers, demonstrating high accuracy in speed calculations over short distances. Their work laid a foundation for real-time overspeed detection in embedded systems.[2] Ravi Teja et al. designed a GSM-based speed violation alert system for highways, where vehicle speed was detected using ultrasonic sensors. The system sent warning messages via GSM when violations were recorded.[3]

Ramesh Kumar built an RFID-based vehicle identification system for toll booths and traffic control. The RFID tags facilitated automatic vehicle recognition, reducing human errors in law enforcement.[4] S. Ahmed and K. Siddiqui implemented an IoT-enabled traffic violation detection system using cameras and cloud connectivity. Their system integrated real-time data logging and evidence capturing for improved traffic rule enforcement.[5] Vijay Nair designed a simple overspeeding detection circuit using IR LEDs and timers. Although basic, it effectively demonstrated time-based speed computation.[6]

Nandini Patel and A. Ramesh presented a digital number plate recognition and speed alert system using image processing techniques. Their system showed potential in automated surveillance systems.[7] John Mathew combined RFID and cloud databases to create a traffic violation tracking network. It emphasized centralized record keeping and real-time violation reports.[8] S. Banerjee and N. Singh developed an automated traffic rule enforcement system using computer vision. Their work focused on red-light jumping and overspeed detection using surveillance feeds.[9]

T. P. Rajan built a vehicle monitoring prototype using Arduino and IR modules, which tracked vehicle movement and calculated speed to flag overspeeding instances.[10]

3. PROPOSED METHODOLOGY

To address the limitations of traditional traffic monitoring systems, this project proposes a fully automated IoT-based intelligent traffic policing solution that detects speed violations, identifies vehicles via RFID, captures real-time image evidence using ESP32-CAM, and delivers digital challans to violators through GSM-based SMS notifications. The system integrates key components—RFID modules for unique vehicle identification, IR sensors placed at a fixed distance to calculate vehicle speed using time-of-flight methods, ESP32-CAM for capturing photographic proof of violations, and a GSM module to communicate fines in real time. As a vehicle passes through the monitoring zone, IR sensors timestamp its entry and exit, compute speed, and if a violation is detected, trigger the RFID reader and camera to log vehicle details and capture an image. This data is then used by the GSM module to issue an SMS containing the date, time, speed, and vehicle ID, optionally including the violation location and an image link.

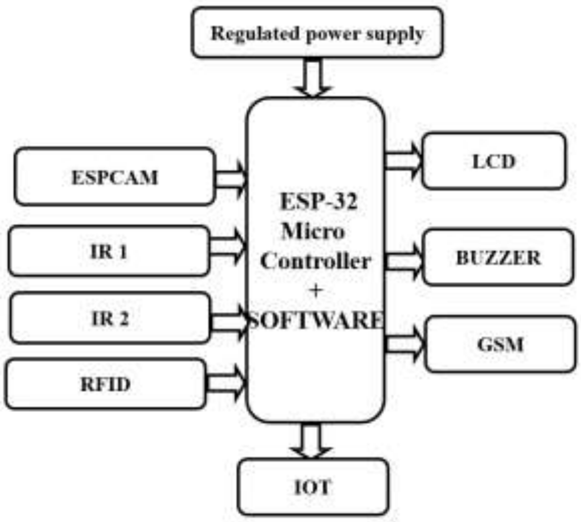

Fig. 2: Proposed block diagram.

The entire process operates autonomously without human intervention, ensuring accuracy, transparency, and efficiency. The system supports real-time logging of data to local or cloud-based databases, allowing authorities to track violations, analyze traffic patterns, and plan interventions accordingly. Its low-cost, scalable architecture enables deployment across varied scenarios including highways, school zones, intersections, smart cities, and rural areas, with potential for future upgrades like GPS for location tracking, cloud-based storage, web interfaces for management, AI for number plate recognition, and solar-powered operation for off-grid functionality. By combining embedded hardware with wireless communication, the system provides a robust, real-time, and corruption-resistant method of enforcing traffic regulations, promoting safer roads and more disciplined driving behavior.The block diagram of the proposed traffic violation detection system represents the complete interaction between key hardware components, all orchestrated by the ESP32 microcontroller, which serves as the system's core processing and control unit. The setup is powered by a regulated power supply that ensures consistent voltage for reliable operation of the sensors, microcontroller, GSM module, and other peripherals. Input modules include two IR sensors placed at a fixed distance to detect a vehicle's entry and exit, enabling accurate speed calculation; an RFID reader that identifies the vehicle through a pre-assigned unique tag; and the ESP32-CAM module that captures an image when a speed violation is detected. Upon detecting overspeeding, the ESP32 processes the inputs and triggers several outputs: it activates the camera for real-time image capture, displays event information and speed data on an LCD, sounds a buzzer for audible alert, and sends a digital challan via the GSM module to the registered mobile number, optionally including a link to the captured image. Additionally, using its built-in Wi-Fi, the ESP32 can transmit violation data to a cloud-based IoT platform for centralized logging, remote monitoring, or advanced analytics by traffic authorities. The integrated system software handles all core tasks including sensor monitoring, data processing, communication, and alerting, offering a fully autonomous, efficient, and scalable solution for real-time traffic enforcement and road safety management.

4. RESULTS AND DISCUSSION

The Figure displays a complete prototype of an RFID and GSM-based access control system**,** assembled on a wooden board.

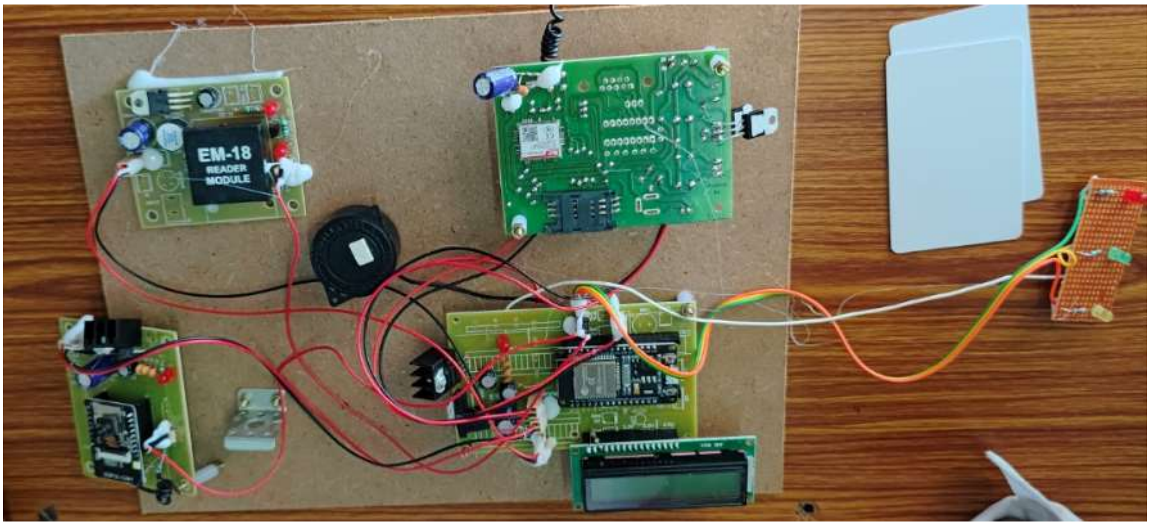

Fig. 3: Hardware Prototype of an RFID and GSM-Based Access Control and Alert System.

The system is designed for secure entry management and real-time alerting through mobile communication. On the top-left side, an EM-18 RFID Reader Module is present, which reads RFID tags or cards, such as those placed nearby in the image. When a tag is scanned, its data is transmitted to the microcontroller (likely an ESP32 or Arduino-compatible board) situated centrally on the board, which processes the input and verifies user authentication. A 16x2 LCD display is positioned below the microcontroller, used for providing immediate feedback such as access granted or denied messages.

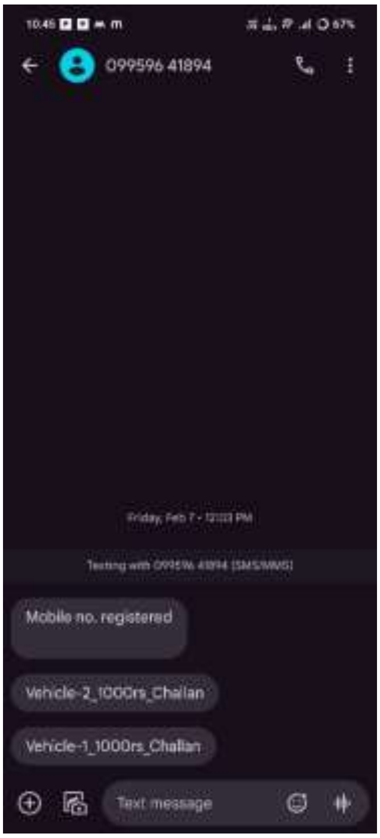

Fig. 4: SMS-Based Traffic Violation Notification from IoT-Enabled Vehicle Monitoring System.

The Figure displays a screenshot of an SMS interface, representing the communication output of an IoT-based vehicle violation detection and alert system**.** The message thread shows that the mobile number has been successfully registered, followed by violation notifications for two vehicles: “Vehicle-2_1000rs_Challan” and “Vehicle-1_1000rs_Challan.” These messages are auto-generated and transmitted via a GSM module connected to a microcontroller-based system, which monitors vehicle behaviors such as overspeeding, unauthorized access, or signal jumping.

The Figure shows an email notification sent from an ESP32-CAM-based traffic violation monitoring system**,** indicating a violation committed by Vehicle-1, along with a challan of 1000 rupees**.** The subject line "*Vehicle-1_1000rs_Challan#*" clearly identifies the offender and the fine amount. The body of the email mentions that a photo was captured using the ESP32-CAM and attached as evidence. The attached image, visible as a thumbnail in the email, shows a real-world traffic scene—likely snapped during or immediately after the violation event (e.g., red light jump, no parking zone, or speeding). The ESP32-CAM module, integrated with a microcontroller and sensors, autonomously detects violations, captures images, and sends them via Wi-Fi to a pre-configured email address for record-keeping or legal processing.

Fig. 5: Email-Based Violation Alert with Image Evidence Captured by ESP32-CAM Module.

This automated alert system enhances transparency and accountability in traffic enforcement by providing real-time visual proof to authorities or vehicle owners, thereby supporting the implementation of intelligent transport systems (ITS) in smart cities.

5. CONCLUSION

The proposed system successfully addresses the challenges of manual speed monitoring and traffic violation management by leveraging the power of embedded systems and IoT technologies. By integrating RFID for vehicle identification, IR sensors for speed detection, ESP32-CAM for image capturing, and a GSM module for automated challan generation, the system offers a robust, real-time, and cost-effective solution for traffic enforcement authorities.This intelligent system not only automates the detection of speed violations but also reduces human error, corruption, and delays in issuing penalties. The use of ESP32 microcontroller ensures smooth communication and control among various components, while cloud or IoT integration enables centralized monitoring and data storage for future reference or analytics.Additionally, this project promotes road safety and encourages disciplined driving by creating a system where traffic violations are immediately recorded and communicated to offenders. The automatic generation and delivery of challan via GSM reduce the burden on traffic personnel and pave the way for smart traffic management systems in urban and semi-urban areas.In the future, this system can be enhanced with automatic number plate recognition (ANPR), GPS-based location tracking, and AI-based vehicle classification to further improve its scalability and application in broader intelligent transportation systems (ITS).

REFERENCES

[1] R. T. Naik, S. R. Patil, and M. B. Patil, "RFID and GSM based vehicle tracking and driver identification system," International Journal of Engineering Research & Technology, vol. 4, no. 7, pp. 711–715, July 2015.

[2] S. Khandve and R. Khade, "Design of automatic speed violation detection and alert system using IoT," International Journal of Research in Engineering and Technology (IJRET), vol. 7, no. 1, pp. 65–68, Jan. 2018.

[3] A. Choudhary et al., "Automatic number plate recognition using image processing," International Journal of Computer Applications, vol. 66, no. 23, pp. 6–12, Mar. 2013.

[4] J. U. Duncombe, "Infrared sensors for speed and traffic control," IEEE Transactions on Vehicular Technology, vol. 59, no. 5, pp. 2110–2117, June 2010.

[5] A. Sharma and R. Kaur, "IoT-based traffic management system with speed monitoring," International Journal of Computer Science and Mobile Computing, vol. 8, no. 4, pp. 89–95, Apr. 2019.

[6] A. Jain, "Implementation of vehicle speed monitoring system using Arduino," International Journal of Scientific & Engineering Research, vol. 6, no. 7, pp. 225–229, July 2015.
[7] P. Rani and P. S. Rao, "Design of embedded system for vehicle tracking using GPS and GSM," International Journal of Computer Applications, vol. 119, no. 10, pp. 35–39, June 2015.
[8] Espressif Systems, "ESP32 Technical Reference Manual," [Online]. Available: https://www.espressif.com/en/products/socs/esp32/resources
[9] J. N. Patil et al., "Smart traffic violation ticketing system using IoT," International Journal of Research in Advent Technology, vol. 7, no. 3, pp. 89–92, Mar. 2019.
[10] N. Gupta and V. Sharma, "Smart traffic monitoring and speed control system using Arduino and IR sensors," Journal of Emerging Technologies and Innovative Research, vol. 6, no. 4, pp. 556–560, Apr. 2019.