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AUTOMATIC VEHICLE OVER SPEED DETECTION AND ALERT SYSTEM ON HIGHWAY USING IOT

Prof. Rahul Bambodkar, Ass Prof, Department of Information Technology, JD College Of Engineering & Management Nagpur, Maharashtra, India
Paresh Zodape, U.G Student, Department of Information Technology, JD College Of Engineering & Management Nagpur, Maharashtra, India
Mahek Tiwari, U.G Student, Department of Information Technology, JD College Of Engineering & Management Nagpur, Maharashtra, India
Kaunen Sheikh, U.G Student, Department of Information Technology, JD College Of Engineering & Management Nagpur, Maharashtra, India
Ashit Nandagawali, U.G Student, Department of Information Technology, JD College Of Engineering & Management Nagpur, Maharashtra, India

Abstract—
Road accidents are a frequent and serious issue, with speeding being a major contributing factor. Increased speed significantly raises the risk of accidents and the severity of injuries. To address this problem, our project focuses on developing an automatic vehicle speed control system specifically for restricted areas. Recent research highlights a troubling rise in accidents near sensitive zones such as hospitals and schools, often due to drivers' impatience. Controlling vehicle speed in these critical areas is crucial for enhancing safety. Our IoT-based solution aims to provide an effective and straightforward design for managing vehicle speeds in high-risk zones like schools, hospitals, and sharp turns. The proposed system utilizes IoT technology to monitor and manage vehicle speed. It features a speed sensor that measures the vehicle's speed and transmits the data to a microcontroller. This microcontroller then sends the information to a cloud-based platform via an IoT gateway. The cloud platform processes the data and provides real-time insights into vehicle speeds, enabling timely interventions and improving road safety**.**

Keywords—
IoT, speed Monitoring, IR sensors, RFID Module, Smart Communication etc.

I. INTRODUCTION

Current research indicates that while there are existing IoT systems capable of controlling vehicle speed to varying extents, many are still in development and not yet fully viable for implementation. Although government regulations like seat belt and helmet laws are in place, there is a notable lack of effective systems specifically designed
to control vehicle speed and reduce road accidents [1].

Our project addresses this gap by developing a speed control system that, while not entirely preventing accidents, aims to significantly reduce their frequency. This system is based on the Arduino Uno R3 microcontroller and incorporates a Radio Frequency (RF) module. The RF module facilitates wireless communication between devices, enhancing the system's capability to transmit and receive data efficiently [2].

The study on car speed detection using IoT technology involves a hardware setup designed to measure the speed of moving vehicles. This device, installed along roadways, utilizes sensors and microcontrollers to detect vehicle speed. The collected data is then transmitted wirelessly to a cloud-based platform for real-time processing and analysis [2][3].

This system's real-time data collection and analysis are crucial for monitoring traffic flow and identifying speeding
vehicles. By leveraging IoT technology, the system enables timely insights that can aid in traffic management and enhance road safety. Ultimately, this study highlights the potential of IoT technology

to improve transportation safety and efficiency.

II. PROBLEM IDENTIFICATION

Vehicle over speeding is a significant contributor to road accidents, injuries, and fatalities worldwide, posing a critical challenge to road safety. Despite established speed limits and traffic regulations, enforcing these measures remains inadequate in many regions due to insufficient real- time monitoring and detection systems. Speeding vehicles are often undetected, leading to an increased risk of crashes, particularly in areas with high traffic density, residential zones, and near schools.

Current methods for speed control, such as static speed cameras and occasional police patrols, are limited in scope and effectiveness. Without continuous, real-time monitoring, many over speeding instances go unnoticed, undermining the deterrent effect of penalties and fines. This lack of effective enforcement not only contributes to repeated violations but also prevents authorities from obtaining comprehensive data for analysis and improvement of traffic management systems [5][6].

A. Existing System

Traffic police manually issue speeding tickets based on observations or random speed checks using radar or LIDAR devices. Officers monitor specific locations, and when they detect vehicles exceeding speed limits, they issue fines or penalties. However, this method has several limitations. Manual enforcement is inconsistent and prone to human error, with officers unable to continuously monitor all areas. It is labor- intensive, requiring significant manpower, and leads to gaps in coverage, as officers can only monitor limited sections of roads at any given time, making widespread and consistent speed enforcement difficult to achieve [4][6].

Fig.1. Existing system

B. Drawbacks

Manual enforcement of speeding through observations or random speed checks is inconsistent and labor- intensive, leading to several drawbacks. The primary issue is limited coverage, as traffic police can only monitor small areas at a time, leaving many locations unmonitored. This creates gaps in enforcement, allowing many over speeding instances to go undetected. Additionally, reliance on human observation increases the possibility of errors and biased judgment. Manual methods are also reactive, only addressing violations after they occur, rather than providing continuous deterrence. Overall, manual enforcement lacks the efficiency and scalability needed for widespread speed regulation [5].

III. FEATURES

- Continuous Speed Monitoring:

Design and implement a real-time IoT-based system using advanced sensors to continuously monitor vehicle speeds on specific highway sections.

- Vehicle Detection Using RFID:

Integrate RFID technology to identify vehicles passing through monitoring zones, linking speed data

to specific vehicle information for effective tracking and enforcement.

- Automatic Over-Speed Detection:

Deploy algorithms to detect vehicles exceeding the prescribed speed limits, ensuring instant and accurate identification of overspeeding incidents.

- Instant Alerts and Notifications:

Design the system to generate automatic alerts for over- speeding vehicles, instantly notifying traffic authorities for immediate action.

- Data Storage and Analysis:

Implement a cloud-based system for storing speed data, enabling long-term analysis of traffic patterns, overspeeding trends, and accident-prone zones.

- Scalability and Efficiency:

Ensure the system is scalable to cover large stretches of highways efficiently, with minimal manual intervention, to enhance overall traffic management.

- Accident Prevention:

Contribute to reducing highway accidents by providing a reliable and automatic solution for vehicle speed control and monitoring.

- Law Enforcement Support:

Support traffic law enforcement by providing real-time data and historical records of speed violations for evidence-based penalty enforcement.

IV. LITERATURE SURVEY

Vehicle speed detection using Arduino and IR sensors is a prominent area of research in the realms of transportation engineering and computer science. Here are some of the notable studies and research papers related to this topic:

Vishal Pande et.al [1] has proposed a framework for Radio Frequency to design a controller to control vehicles speed and display to monitor the zones which can run on an embedded system platform.

Monika Jain [2] proposed a device designed to detect rash driving and alert traffic authorities in cases of violations. This system focuses on early detection and monitoring of aggressive driving patterns. It integrates speed limits set by local authorities and manages overspeed violations through a comprehensive reporting and data management system.

Ni Hlaing et al. [3] developed a system for measuring vehicle speed on roads and highways. When a vehicle exceeds the speed limit, the system sends data to a personal computer, which activates a camera to capture images of the speeding vehicle.

Amarnarayan et al. [4] introduced a speed estimation system aimed at alerting drivers about road conditions. This robust and reliable system utilizes RF-based technology to estimate vehicle speed and detect motion, particularly in urban settings prone to traffic congestion.

Additionally, other researchers [6,9] demonstrated an automatic vehicle speed detection system using Arduino Uno and IR sensors. Their system, tested on actual roads, proved to be both accurate and dependable.

These studies collectively highlight the effectiveness of various technologies, including Arduino and IR sensors, in vehicle speed detection. They underscore the potential of these systems to enhance road safety and mitigate accidents caused by speeding.

V. PROPOSED SYSTEM

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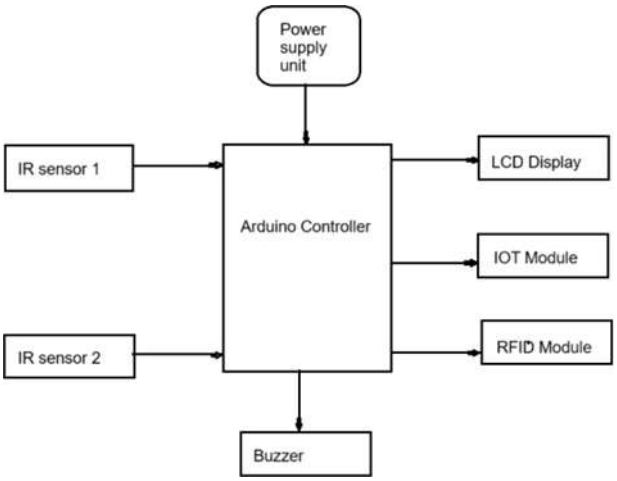

Fig. 1. Block Diagram of system

The Smart Vehicle Overspeed Detector is an advanced system designed to autonomously monitor and manage
vehicle speeds using a combination of RFID and IoT technologies. The system architecture enables efficient and real-time detection of overspeeding vehicles, enhancing road safety with minimal human intervention.

The core of the system comprises RFID technology and IoT sensors strategically placed along highways. RFID readers are employed to detect and identify vehicles by reading their number plates or unique identification tags.

As vehicles pass through the designated monitoring zones, these readers capture their identification information and record their speed using integrated sensors.

The system operates autonomously, continuously monitoring vehicle speeds without requiring manual oversight.

When a vehicle exceeds the prescribed speed limit, the system instantly logs the event, including the vehicle's speed and the precise timestamp from the server. This data is crucial for accurate enforcement and record-keeping.

Upon detecting an overspeeding incident, the system wirelessly transmits the recorded data to a centralized server. This server acts as the repository for all speed monitoring data, where it is securely stored and processed. The centralized server allows traffic authorities to access real-time and historical overspeeding information remotely.

Authorities can review the logged data, including speed records and timestamps, to identify and issue fines to the vehicle owner. This automated process reduces the need for manual intervention and enhances the efficiency of traffic law enforcement. Additionally, the system supports long-term data analysis, enabling traffic managers to identify patterns, assess traffic flow, and optimize speed management strategies.

Overall, the Smart Vehicle Overspeed Detector provides a scalable and efficient solution for automatic speed monitoring and enforcement, contributing significantly to road safety and accident prevention.

VI. **FLOW DIAGRAM**

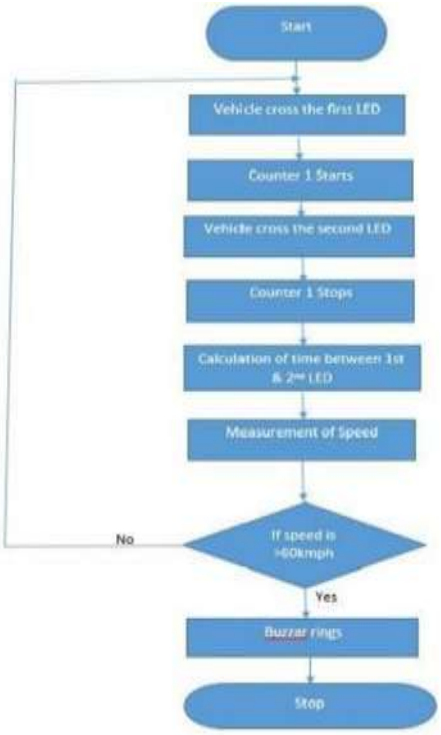

Fig. 2. Flow Diagram of system

Requirements:

- IR Sensor for speed detection
- Arduino Controller for processing and control
- RFID System for vehicle identification
- IoT System for data transmission and alerting authorities
- Timer for precise speed measurement
- Known Distance between two detection points
- Internet Connection for data transmission.

Step-by-Step Process:

Initialize IR Sensor and Arduino:

- Set up the IR sensor for speed detection.
- Connect the IR sensor to the Arduino microcontroller.
- Initialize libraries for IR sensor detection and input handling on Arduino.
- Calibrate the sensor for precise detection of objects passing through the detection zone.

Connect RFID System:

- Set up the RFID system to identify vehicles.
- Attach the RFID reader to the Arduino controller.
- Initialize libraries and configure the system to capture vehicle data from RFID tags.
- Ensure the RFID reader correctly identifies the vehicle and sends data to the Arduino.

Calculate Speed:

- Use the **IR sensor** to detect when a vehicle passes through two detection points.
- Measure the time taken for the vehicle to travel between these points using the timer.
- Calculate the speed based on the known distance and recorded time.

Alert Authorities via IoT:

- Send the calculated speed and vehicle information (from RFID) to the IoT system.
- The IoT system will transmit this data to a central server for monitoring.
- The server logs the vehicle's speed, along with a timestamp of when the overspeeding occurred.

Speed Monitoring and Alerts:

- If the vehicle's speed exceeds the set limit, trigger the system to alert the authorities.
- The IoT system will notify authorities through the server, providing details like vehicle ID, speed, and time.

Review and Fine:

- Authorities can log in to the system, review the overspeeding data, and issue fines to vehicle owners accordingly.

VII. ADVANTAGES

- Provides continuous, real-time monitoring of vehicle speeds, ensuring timely detection of overspeeding incidents.
- Operates independently of human intervention, reducing the need for manual enforcement and increasing efficiency.
- Automatically generates and transmits alerts for overspeeding vehicles, enabling prompt action by authorities.
- Utilizes RFID and IoT technologies for precise vehicle identification and speed measurement, reducing errors and false positives.
- Centralized server stores and processes data, allowing for easy access, retrieval, and analysis of speed records.
- Easily scalable to cover extensive highway stretches, accommodating varying traffic volumes and road conditions.

VIII. RESULT AND DISCUSSION

Fig. 3. Project Model

The proposed system successfully integrates IR sensors, RFID technology, an Arduino microcontroller, and IoT capabilities to monitor vehicle speed, identify vehicles, and alert authorities about overspeeding incidents. Through real-time speed calculation, the system demonstrates significant potential in addressing traffic management and enforcing speed limits. The IR sensors provide accurate detection of vehicles at two designated points, while the Arduino controller precisely records the time taken for a vehicle to travel between them. With the distance between the two points known, the system calculates speed efficiently, leveraging the timer's high accuracy. The results show that the IR sensors and Arduino microcontroller provide a reliable solution for measuring vehicle speed within acceptable error margins.

The RFID component successfully identifies vehicles, adding an essential layer of information for authorities to use when tracking violations. The integration of the IoT system allows seamless data transmission to a central server, enabling authorities to monitor overspeeding vehicles remotely. The system transmits relevant information, including vehicle ID, calculated speed, and the time of the violation, thereby creating a digital log that enhances the accountability and transparency of traffic enforcement.

In terms of discussion, while the system provides efficient monitoring, some challenges were noted. The accuracy of speed calculation relies on precise distance measurement and sensor calibration. Environmental factors, such as poor lighting or weather conditions, can impact the IR sensor's performance. Additionally, data security in IoT transmission is crucial, as any breach could compromise sensitive vehicle information. Further enhancements, such as integrating additional sensors or cameras, could improve detection accuracy, while implementing encryption in the IoT system would ensure data integrity. Overall, this system offers a scalable solution to aid traffic authorities in enforcing speed limits, reducing road accidents, and encouraging safer driving practices.

IX. **Future Scope**

- Enhance the system by integrating it with broader smart traffic management systems, including adaptive traffic signals and congestion management.
- Implement advanced analytics and machine learning to predict traffic patterns, identify high-risk zones, and optimize enforcement strategies.
- Extend the system's application to urban settings, including city streets and residential areas, to improve overall traffic safety.
- Explore the integration of V2X communication technologies to enable direct communication between vehicles and the traffic management system.
- Develop and implement robust privacy protection protocols to address concerns related to data collection and vehicle identification.
- Improve accessibility by providing mobile and cloud-based platforms for authorities to monitor and manage data remotely.
- Combine the system with automated enforcement tools, such as automated ticketing and electronic fines, to streamline the enforcement process.

X. **Conclusion**

This study emphasizes the critical role of automated vehicle speed control in enhancing road safety and reducing accidents. With India being one of the leading countries in road accidents, primarily due to speeding in restricted zones, implementing a vehicle speed control system is vital. Recent research indicates that such systems significantly mitigate accidents caused by drivers neglecting roadside speed limit signs.

The proposed system utilizes advanced smart zone speed control technology, integrating IoT-based solutions to monitor and regulate vehicle speeds automatically. By deploying high-performance hardware, the system provides a superior alternative to traditional methods, effectively addressing the issues of overspeeding in high-risk areas.

Simulation results demonstrate that this system offers enhanced performance and reliability compared to existing solutions. The proposed IoT-based vehicle control system not only ensures cost-effectiveness but also improves safety by preventing accidents through real-time speed regulation. This approach addresses the critical need for efficient speed management, ultimately contributing to reduced accident rates and safer roads.

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