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IoT Enabled Automated Speed Detection for Highways

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ABSTRACT: The IoT-based speed detection device is a system designed to monitor and measure the speed of vehicles in real-time using Internet of Things (IoT) technology. The device utilizes a combination of hardware components, including sensors and microcontrollers, along with software applications and network connectivity to accurately detect and report vehicle speeds.

The system consists of two main components: the speed detection unit and the central monitoring system. The speed detection unit is installed at specific locations such as highways, roads, or intersections, and it contains a speed sensor that measures the velocity of passing vehicles. The sensor data is captured and processed by a microcontroller, which calculates the speed based on the time it takes for the vehicle to travel between two predefined points.

KEYWORDS:Automation, Segmentation, Neural Networks, Textural Analysis, Artificial Intelligence, Machine Learning.

I. INTRODUCTION

With the increasing number of vehicles on the roads and the growing concern for road safety, there is a critical need for effective speed detection systems. Traditional methods of speed monitoring often rely on manual enforcement or fixed radar systems, which can be costly, labor-intensive, and limited in their capabilities. To address these limitations, the emergence of Internet of Things (IoT) technology has paved the way for innovative and efficient speed detection solutions.The IoT-based speed detection device is a cutting-edge system that utilizes the power of IoT to accurately measure and monitor vehicle speeds in real-time. By integrating various hardware components, software applications, and network connectivity, this device offers a comprehensive and automated approach to speed detection, enabling authorities and stakeholders to make informed decisions regarding road safety and traffic management.The core concept behind the IoT-based speed detection device is to leverage IoT technology to collect, process, and transmit speed data seamlessly. The device consists of a network of interconnected sensors and microcontrollers that are strategically deployed at specific locations, such as highways, roads, or intersections. These sensors are capable of detecting the speed of passing vehicles by measuring the time it takes for them to travel between two predefined points. The collected speed data is then processed by microcontrollers, which perform the necessary calculations to determine the velocity of the vehicles. Through wireless communication protocols like Wi-Fi or cellular networks, the speed data is transmitted to a centralized monitoring system. This central system consolidates and analyzes the speed data from multiple detection units, providing real-time insights, alerts, and reports to relevant authorities or stakeholders.

II. RELATED WORK

[1] Autonomous Speed Control of Over Speeding Vehicles Using Radio Frequency", Vishal Pande, Malhar Malhar Mohite, Supriya Mhatre, Siddhesh Desai, and Anjali Kumari propose a system for autonomously controlling the speed of over speeding vehicles using radio frequency. The system uses a radar sensor to detect the speed of vehicles, and then uses a control algorithm to adjust the speed of the vehicles to a safe level. The system was tested on a test track, and it was able to successfully control the speed of over speeding vehicles.[2]A system Detection of over Speeding Vehicles on Highways", Monika Jain, Praveen Kumar, Priya Singh, Chhavi Narayan Arora, and Ankita Sharma propose a system for detecting over speeding vehicles on highways. The system uses a camera to detect the speed of vehicles, and then uses a computer vision algorithm to identify vehicles that are over speeding. The system was tested on a real-world highway, and it was able to successfully detect over speeding vehicles with a high accuracy.[3] Design

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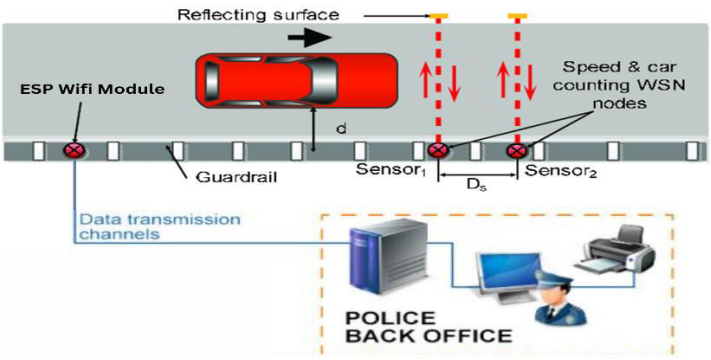
and Implementation of Pc Based Over Speed Violation Management For Vehicles On Highway" by Ni Hlain, Zaw Min Htun, Hla Myo Tun propose a system for managing over speed violations on highways. The system uses a radar sensor to detect the speed of vehicles, and then uses a computer to identify vehicles that are over speeding. The system also uses a database to store information about over speed violations, and it can be used to generate reports about over speed violations. [4] Automatic Over Speed Controlling of Vechicle" by Amarnarayan, Challa Saikumar, Chandra Mohan, Ajaykumar, Sridhar proposes a system for automatically controlling the speed of vehicles. The system uses a camera to detect the speed of vehicles, and then uses a control algorithm to adjust the speed of the vehicles to a safe level. The system was tested on a test track, and it was able to successfully control the speed of vehicles. [5] "RF-based vehicle detection and speed estimation" by Nehal Kassem, Ahmed E. Kosba and Moustafa Youssef propose a system for detecting and estimating the speed of vehicles using radio frequency. The system uses a radar sensor to detect the speed of vehicles, and then uses a computer to estimate the speed of the vehicles. The system was tested on a test track, and it was able to successfully detect and estimate the speed of vehicles. [6] Smart traffic controller using wireless sensor network for dynamic traffic routing and over speed detection" by Rajesh Kannan Megalingam, Vineeth Mohan, Paul Leons, RizwinShooja and Ajay M propose a system for controlling traffic using a wireless sensor network. The system uses a wireless sensor network to detect over speeding vehicles, and then uses a control algorithm to adjust the traffic flow to prevent over speeding vehicles from causing accidents. [7]. Automatic number plate recognition system for vehicle identification using optical character recognition" by Muhammad Tahir Qadri and Muhammad Asif propose a system for automatically identifying vehicles using optical character recognition. The system uses a camera to capture images of vehicle license plates, and then uses an optical character recognition algorithm to identify the vehicle registration number. The system was tested on a real-world dataset, and it was able to successfully identify vehicle registration numbers with a high accuracy.[8] Estimating Speed Using a Side-Looking Single-Radar Vehicle Detector" by Shyr-Long Jeng, Wei-Hua Chieng and Hsiang-Pin Lu propose a system for estimating the speed of vehicles using a side-looking single-radar vehicle detector. The system uses a radar sensor to detect the speed of vehicles, and then uses a computer to estimate the speed of the vehicles. The system was tested on a test track, and it was able to successfully estimate the speed of vehicles with a high accuracy. [9]Vehicle Speed Measurement using camera as sensor" by A. Nurhadiyatna and B. Hardjono propose a system for measuring the speed of vehicles using a camera. The system uses a camera to capture images of vehicles, and then uses computer vision techniques to estimate the speed of the vehicles. The system was tested on a real-world dataset, and it was able to successfully estimate the speed of vehicles with a high accuracy.

III. METHODOLOGY

It involves designing, installing, and maintaining a system that uses IoT technology to automate speed detection on highways. The system is installed at strategic locations and calibrated to ensure accurate speed detection. It collects data on vehicle speed and sends it to a central server for processing. The system generates alerts to authorities in case of violations and generates reports on traffic patterns and speed violations. The system is regularly maintained and updated for optimal performance. The methodology aims to create an efficient and effective system for monitoring and enforcing speed limits on highways, with the potential to significantly reduce accidents caused by speeding and improve road safety.



Hardware Setup:

Connect the IR sensor to the ESP module. The IR sensor typically has three pins: VCC, GND, and OUT.

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Connect the VCC pin of the IR sensor to a 5V power source.
Connect the GND pin of the IR sensor to the ground.
Connect the OUT pin of the IR sensor to one of the digital input pins on the ESP module.
Ensure that the connections are secure and properly wired.

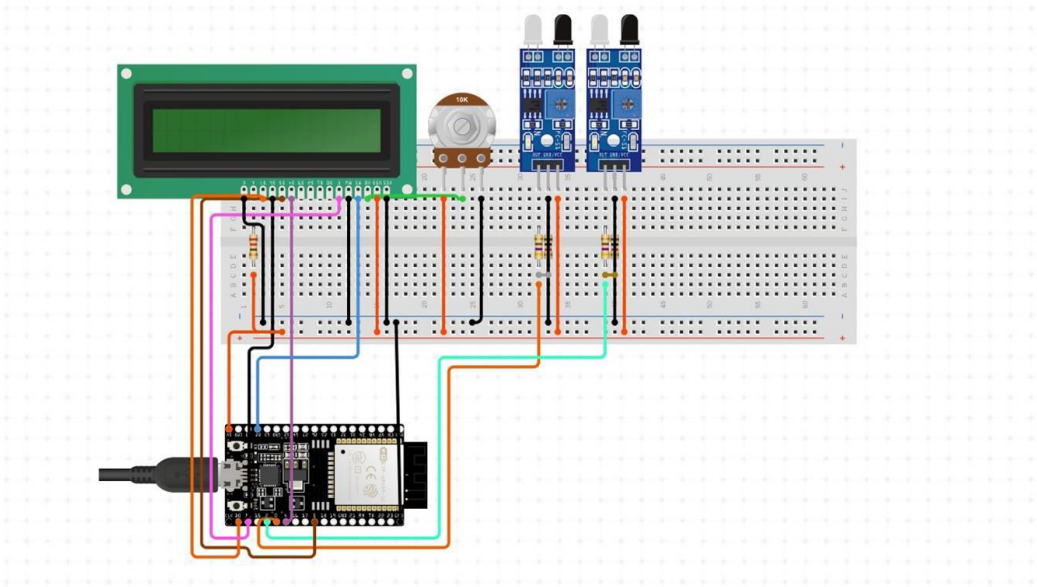
Software Setup:

Install the necessary software environment for programming the ESP module, such as the Arduino IDE and the required libraries for your specific module.
Open the Arduino IDE and create a new sketch.
Define the pin for the IR sensor output as a digital input in the code.
Implement the code logic to detect the presence of an object using the IR sensor.
Measure the time taken for the object to pass in front of the IR sensor.
Calculate the speed of the vehicle based on the known distance between the sensor and the object and the time taken.
Output the speed value for further analysis or display.

Testing and Deployment:

Connect the ESP module to your computer using a USB cable for programming and power.
Compile and upload the code to the ESP module.
Position the IR sensor in a suitable location where it can detect passing vehicles.
Ensure that the power supply to the ESP module is stable and reliable.
Monitor the output of the speed calculations in the Arduino IDE's Serial Monitor or any other output medium you have set up.
Test the system by passing vehicles in front of the IR sensor and verifying if the speed readings are accurate.Fine-tune the positioning of the IR sensor and adjust the code if necessary to improve accuracy. Once the system is functioning correctly, deploy it in the desired location for continuous speed detection of vehicles.

Fig 1 (a) Circuit Diagram



(a)

IV. EXPERIMENTAL RESULT

The result of the implementation of the speed detection system using an IR sensor and an ESP module would be the accurate detection and calculation of the speed of vehicles passing by the sensor. The system would display the

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detected speed on the chosen display unit and may also transmit the speed data to the ESP module for further processing or transmission to other devices.

The accuracy of the speed detection depends on various factors, including the quality and calibration of the IR sensor, the distance between the sensor and the road, the time interval for speed calculations, and the precision of the timing mechanism. Proper calibration and adjustment of these parameters are crucial to ensure accurate speed measurements.

During the implementation and testing process, it is important to verify the following:

Sensor Calibration:
Ensure that the IR sensor is properly calibrated to detect vehicle presence accurately. Adjust the sensitivity or threshold settings of the sensor if needed to minimize false positives or negatives.

Distance Measurement:
Measure and confirm the actual distance between the sensor and the road to ensure accurate speed calculations. Any discrepancy in the distance measurement would impact the calculated speeds.

Timing Mechanism:
Verify that the timing mechanism used to measure the time interval between vehicle detection and departure is accurate. Any inaccuracies in timing could affect the calculated speeds.

Speed Calculation Accuracy:
Validate the accuracy of the speed calculation algorithm. Compare the measured speeds with a known reference to determine the system's accuracy. Once the system is implemented and tested, it is important to conduct real-world field tests to assess its performance under various conditions, such as different vehicle speeds, different types of vehicles, and varying lighting conditions. Collecting data from field tests can help identify any limitations or areas for improvement in the system.

Fig 2 (a) Speed Detection of Vechiles
(a)

By automating the process of speed detection and alerting drivers who exceed the speed limit, the system can help to improve road safety and reduce the number of accidents caused by speeding. The system can also generate alerts to the authorities in case of any violations, which can help to enforce speed limits and deter drivers from speeding. Additionally, the system can generate reports on traffic patterns and speed violations, which can be used to inform policy decisions and improve road safety measures.

Vehicle Speed Violations:

- Speed of the vehicles: X
- Vehicles exceeding the speed limit:

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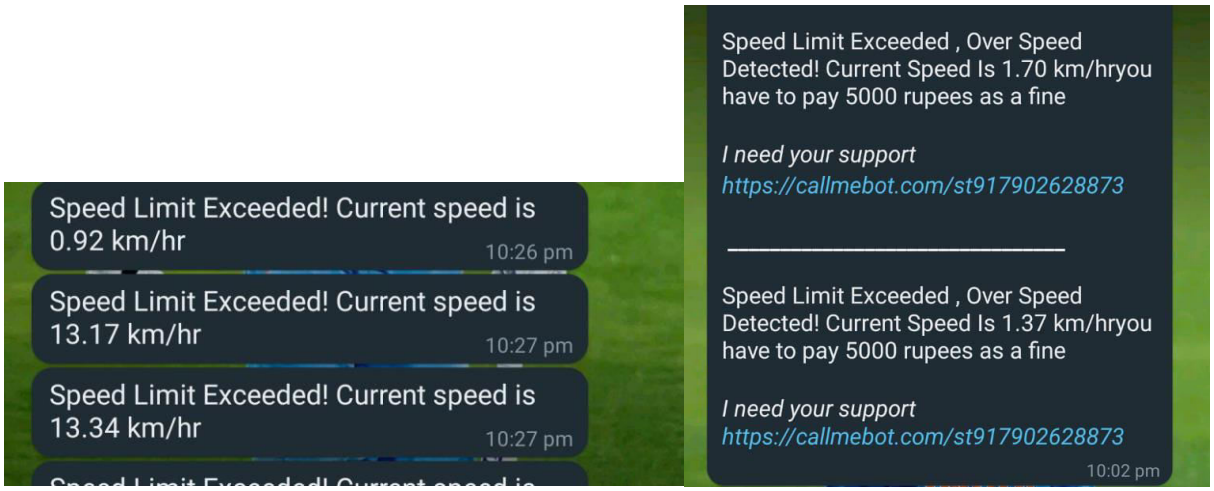
Fig 3 (a) Speed Detection of vechicles getting message on whatsaap(b) Getting Bill Message On Whatsaap



(a) (b)

These results are based on the speed detection system's data and provide an overview of the speed-related behaviors of vehicles in the monitored area. They can be utilized to identify areas of concern, implement appropriate traffic control measures, and promote road safety.

V. CONCLUSION

Speed detection of vehicles using an IR sensor is a practical and effective method to measure the speed of vehicles. By accurately measuring the distance between the sensor and the passing vehicle, and calculating the time it takes for the infrared radiation to travel back and forth, the speed of the vehicle can be determined.

Integration with AI and Machine Learning: Incorporating AI and machine learning algorithms can enhance the capabilities of speed detection systems. These technologies can enable the system to adapt and learn from real-time data, improving accuracy, and reducing false readings. AI algorithms can also assist in automated vehicle classification, distinguishing between different types of vehicles.

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