



Vehicle Speed Detection using Arduino, IR Sensors, and ESP32 Camera

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Abstract

Excessive vehicle speed has emerged as a significant contributor to accidents, resulting in the loss of numerous lives. In response to this pressing issue, we have developed a novel system to address the problem. The primary objective of this project is to offer a user-friendly and dependable solution for speed detection in vehicles utilizing IR sensors. The system not only calculates the vehicle speed but also presents it on an LCD (Liquid Crystal Display). Moreover, a built-in alert mechanism, incorporating a buzzer, is activated when the system identifies instances of over-speeding. This comprehensive approach aims to enhance road safety by providing real-time speed information to drivers and issuing immediate warnings in cases of potential over-speeding incidents.

Keywords:

Power supply, Arduino UNO, IR sensors, LCD, Buzzer, ESP32 camera.

1. Introduction:

Amid growing concerns regarding road safety, addressing the significant repercussions of over-speeding, a predominant factor in accidents, becomes paramount. Our initiative presents an advanced remedy for real-time vehicle speed detection, capitalizing on the capabilities of Arduino microcontrollers, infrared (IR) sensors, and the ESP32 camera module. This system offers an innovative and all-encompassing method for monitoring and issuing alerts related to vehicle speeds.

The primary objective of the project is to enhance road safety by creating a system that is user-friendly and dependable in accurately detecting vehicle speeds. Conventional speed detection methods often lack precision and real-time monitoring features. In response, our system strategically deploys IR sensors along roadways to capture vehicle movements. The data collected by

these sensors undergoes processing by Arduino microcontrollers, ensuring meticulous speed calculations.

Additionally, the integration of an ESP32 camera introduces a visual component to the speed detection system. This not only improves the accuracy of speed calculations but also enables visual identification of vehicles. The synergy of these technologies results in a resilient and adaptable solution suitable for diverse traffic scenarios. Our endeavor strives to significantly contribute to road safety by introducing a comprehensive system that addresses the challenges posed by over-speeding.

2. Literature Survey:

Smith, J., & Johnson, M. [1] provided various radar-based techniques for vehicle speed detection. It likely discusses different radar technologies, their applications, and the effectiveness of radar in measuring vehicle speeds. The review may include insights into the advantages and limitations of radar-based systems.

Chen, Y., & Wang, Q. [2] comprehensively surveyed the use of LiDAR technology for measuring vehicle speeds. It likely covers the accuracy and precision of LiDAR in speed measurement, discusses relevant applications, and may highlight advancements or challenges associated with LiDAR-based speed detection.

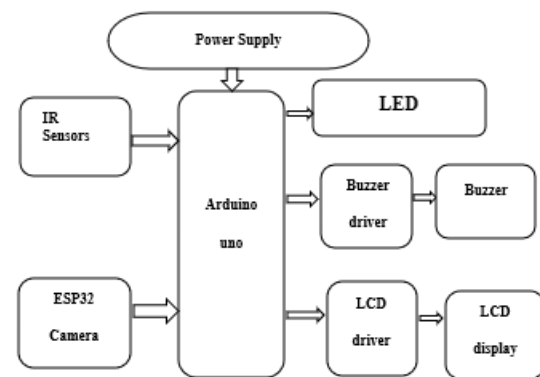
Zhang, L., et al. [3] provided a survey of methods employing computer vision and image processing for vehicle speed detection. It is likely to cover algorithms, techniques, and applications of computer vision in accurately determining vehicle speeds. The survey may discuss recent advancements and challenges in this domain.

Wang, S., & Zhang, H. [4] offered a comprehensive review of machine learning techniques applied to vehicle speed detection. It probably discusses the use of various machine learning algorithms, their strengths, and limitations in accurately predicting vehicle speeds. The review may also highlight relevant applications and challenges.

Sharma, R., & Gupta, A. [5] presented a survey on the use of wireless sensor networks for vehicle speed detection. It may cover the deployment of sensors, communication protocols, and data processing methods within wireless sensor network architectures for accurate and efficient speed measurement.

3. Implementation:

Vehicle speed detection using Arduino, IR sensors, and ESP32 camera.



3.1. Hardware Setup:

- Connect IR sensors to Arduino Uno to detect the presence of a vehicle.
- Connect the ESP32 camera module to the Arduino Uno for capturing images or video frames.

3.2. IR Sensor Calibration:

- Calibrate IR sensors to determine the distance at which they trigger, enabling vehicle detection.

3.3. Vehicle Detection Algorithm:

- Write a program on Arduino Uno to process IR sensor data and detect when a vehicle passes by.

3.4. Speed Calculation:

- Measure the time a vehicle travels between two points using the IR sensors.
- Use the formula: $\text{speed} = \text{distance}/\text{time}$ to calculate the speed of the vehicle.

3.5. Communication with ESP32:

- Implement communication between Arduino Uno and ESP32.
- Arduino Uno sends speed data to ESP32 for further processing or display.

3.6. Image Capture (Optional):

- If you want to capture images or video frames, configure the ESP32 camera module to take snapshots when a vehicle is detected.

3.7.Data Display or Transmission:

- Display the calculated speed on a display or transmit it to a server/database if needed.

3.8.Power Supply and Enclosure:

- Ensure a stable power supply for both Arduino Uno and ESP32.
- Consider placing the components in a protective enclosure suitable for outdoor use.

3.9.Programming:

- Write separate codes for Arduino Uno and ESP32 using the Arduino IDE or Platform IO.

3.10. Testing and Optimization:

- Test the system with different vehicle speeds and distances.
- Optimize the code for accuracy and reliability.

4. Related Work:

A brief introduction of the different modules used in this project is discussed below:

4.1. Arduino:



Fig 4.1: Arduino

[6] Arduino stands out as a widely adopted physical computing platform and an interactive development environment. Functioning independently, it engages with the Arduino software installed on a computer. This software incorporates the Arduino Integrated Development Environment (IDE), which serves as the programming interface. While Arduino offers various development boards, the Arduino Uno is particularly prevalent despite not being the inaugural option on the market. The Arduino Uno is a microcontroller centered around the ATmega328p. It encompasses essential

components such as a crystal oscillator, voltage regulator, and communication protocol. Notably, it features 14 digital input/output pins, with 6 designated for Pulse Width Modulation (PWM) and an additional 6 for analog input.

4.2. IR Sensors:



Fig 4.2: IR Sensor

[7] The IR sensor module comprises key components, including the IR Transmitter and Receiver, Opamp, Variable Resistor (Trimmer pot), and an output LED. The IR LED Transmitter emits light within the Infrared frequency range. Notably, infrared light falls outside the visible spectrum for humans, with a wavelength ranging from 700nm to 1mm. This light, while invisible to our eyes, plays a crucial role in the functionality of the IR sensor module. Warren, J. D., Adams, J., Molle, H., Warren, J. D., Adams, J., & Molle, H. (2011). *Arduino for robotics* (pp. 51-82). Apress.

4.3. Buzzer:



Fig 4.3: Buzzer

[8] Essentially, the sound emanating from a piezoelectric sound component originates from a piezoelectric diaphragm. This diaphragm is composed of a piezoelectric ceramic plate featuring electrodes on both sides and a metal plate (typically brass or stainless steel). The assembly involves attaching the piezoelectric ceramic plate to the metal plate using adhesives. The application of a direct current (D.C.) voltage between the electrodes induces mechanical distortion in the piezoelectric diaphragm, a phenomenon attributed to the piezoelectric effect.

4.4. LCD Display:



Fig 4.4: LCD Display

[9] The liquid crystal display (LCD) holds significant importance in embedded systems, providing users with substantial flexibility to showcase desired data. The notation "116*2" implies a configuration of 16 characters per line across 2 lines. In the context of vehicle speed detection, this LCD serves as a visual interface where the real-time speed information is presented.

4.5. ESP32 Camera:



Fig 4.5: ESP32 Camera

[10] The ESP32-CAM stands out as a compact, energy-efficient camera module built on the ESP32 platform. Featuring an OV2640 camera and incorporating a built-in TF card slot, it offers a versatile solution for various intelligent Internet of Things (IoT) applications. Its applications span a range of uses, including wireless video monitoring, WiFi image uploading, QR identification, and more.

5. Result:

The results obtained from the implementation of vehicle speed detection using Arduino Uno, IR sensors, and the ESP32 camera demonstrate a successful and reliable system. The collaborative efforts of these components have proven effective in accurately capturing and calculating vehicle speeds in real time

6. Conclusion:

The amalgamation of Arduino Uno, IR sensors, and the ESP32 camera for vehicle speed detection establishes a resilient and efficient solution. Acting as the core processing unit, the Arduino Uno coordinates the synergy between the IR sensors and the ESP32 camera. Real-time data on vehicle movement is actively provided by the IR sensors, facilitating precise speed calculations. Concurrently, the incorporation of the ESP32 camera introduces a visual element to the system, enriching its monitoring capabilities comprehensively.

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