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Vehicle Speed Detection Using IR Sensor

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Abstract: The aim of this paper is to describe a reliable speed detection system pertaining to the enhancement of safety on the highways. The number of vehicles continues to rise and the speed of monitoring them is ineffective. Our system makes records using an Arduino based circuit coupled with 2 IR sensors consisting of an IR transmitter and then a photodiode receiver. One of the methods employed to monitor the speed of the vehicle is by measuring the time taken by the vehicle to travel a fixed distance, which is then displayed on a 16x2 LCD. If the speed is found to be exceeding a pre-defined limit, an audible buzzer and visual alert via LED light will be switched on.

Keywords: **Speed Detection, Vehicle Monitoring, Highway Safety, Traffic Control, Accident Prevention**

1. Introduction

Rash driving remains a prime contributor to global road accidents. In India, it is estimated that over 140,000 lives were lost due to road accidents last year as per government data. The growing population has been coupled with an increase in vehicles on the road which has made traffic congestion a big problem along with insufficient measures in place to capture the speeds at which vehicles are moving. This paper proposes a viable approach to the problem of automatic vehicle over-speeding detection.

In this project, an Arduino-based system has been created using two IR sensors (an IR transmitter/LED and an IR receiver/photodiode). Each sensor is placed to one side of the path so that when a vehicle crosses the sensors, the sensors, connected to an interrupt pin on the Arduino, record the time interval between activations and capture the vehicle's movement using the internal timer. Then, the vehicle's speed is calculated with a simple distance-time relationship, and the value is shown on a digital monitor or a 16x2 LCD screen.

The surge in the use of vehicles and the increase in population coupled with uncontrolled driving speeds has led to an alarming increase in road accidents. The mitigation of these accidents largely relies on how well the driving speeds are regulated. To account for this, the current system is designed to identify and warn users about dangerous instances of driving. Exceeding preset speeds (50 km/h for instance) will trigger LEDs to light up, a buzzer to sound, and the speed to be displayed on an LCD screen.

This document explains the circuit design and implementation that includes an Arduino UNO, two IR sensors, 16x2 LCD, and a buzzer, showing how it can be useful in improving road safety and preventing accident cases.

2. Literature Review

2.1 Technologies in Speed Detection:

A combination of technologies are used in contemporary speed detection systems to determine vehicle's movement accurately. Traditional radar systems employ the Doppler principle to estimate speed based on frequency shifts, whilst LIDAR devices use laser light and flight measurement methods to achieve high levels of accuracy.

Additionally, video image processing systematically tracks movement by analyzing successive frames through a trained algorithm. The technology of infrared (IR) sensors provides an inexpensive and reliable method for speed measurement by breaking an IR beam, thus eliminating the problem of motion detection for autonomous devices.

2.2 IR Sensor Pinout:

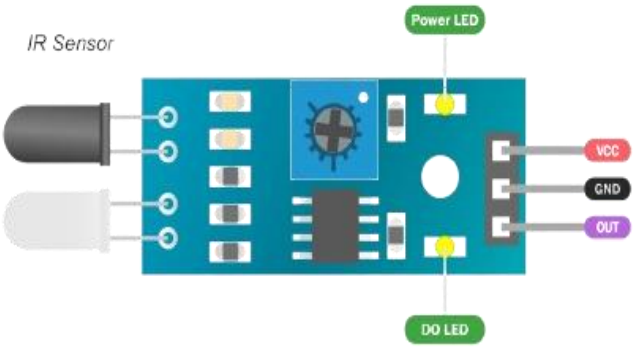

Fig 2.2.1 IR Sensor Pinout

IR sensor modules usually contain two components: the IR transmitter (an IR LED) and the IR receiver (a photodiode or phototransistor). The IR transmitter consists of two pins: the anode, the positive pin which is connected to the power supply through a current-limiting resistor, and the cathode, which is connected to ground. The IR receiver module usually consists of three pins: VCC, the power supply (usually 5V); GND, the ground; and the OUT pin, which gives the output of the sensor. The signal can either be digital (high or low) or analog based on the module.

2.3 Microcontroller-Based Implementations:

Speed detection systems have been revolutionized by microcontrollers like Arduino, which have greatly simplified sensor integration and data handling. They enable real-time data capture, processing, and output on a single, small, and affordable platform. They can easily interface with an array of sensors and output modules, which makes them perfect for designing customizable traffic monitoring systems. In addition to this, their open-source nature aids the development and innovation on this area tremendously.

2.4 Integration with Traffic Enforcement:

Constant traffic violation enforcement relies on the efficient integration of detection systems with alerts. In modern systems, sensor data is immediately connected to enforcement measures such as digital displays, buzzers, and LED indicators. For instance, if a car is detected to be speeding, the system automatically activates the alerts for prompt action from traffic officers. This not only enables real-time monitoring but also improves the mitigation of harmful driving practices by actively enforcing recognition and response to speed violations.

3. Methodology

This project implements an Arduino-based vehicle speed detection system that integrates multiple hardware components to monitor, calculate, and respond to over-speeding incidents in real time.

3.1 Vehicle Detection and Speed Measurement:

The system uses an IR sensor functioning as a proximity detector to recognize when a vehicle approaches the intersection. The sensor sends a signal to the Arduino as the vehicle breaks the IR beam, allowing it to timestamp the event and capture the number of frames taken during the event. During the process, the temporal data, along with the set distance between the detection points, is used by the Arduino to calculate the speed using the standard distance and time relationship.

3.2 Audio Alert Mechanism:

A crucial component of the system is the buzzer, which is a sound-emitting signaling device that indicates to the concerned parties whenever there is a vehicle that is over-speeding beyond the set speed limit. Upon detection of an over-speeding condition, the Arduino activates the buzzer in order to notify other individuals nearby the device of the infringement.

3.3 Circuit Diagram

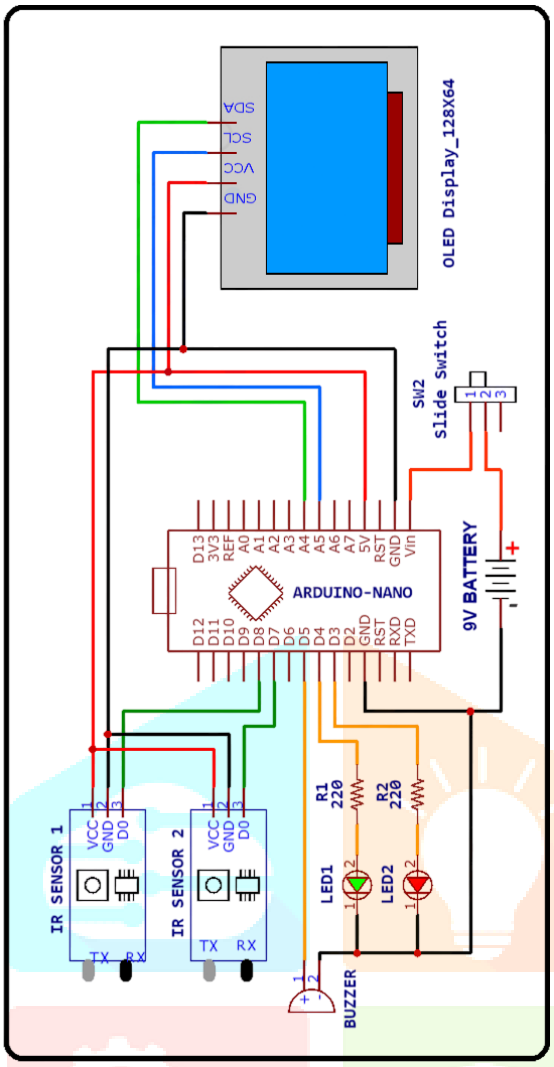

Fig 3.3.1

3.4 GPS Integration for Vehicle Localization:

To provide real time location details which are important in case the vehicle crosses the speed limit, a GPS module is integrated into the system. The module uses signals from multiple satellites for precise calculation of geographic coordinates such as latitude and longitude. Once Arduino establishes that a vehicle is crossing the speed limit, the system turns on the GPS module to log the position. Afterward, this information is processed by the microcontroller and either stored or transmitted for further action. Having a high accuracy GPS module makes it easy for law enforcement to retrieve the vehicle's location which saves time and eases intervention as well as improves traffic control and road safety. In addition, the ability of the module to track its position makes sure that even when the vehicle is moving at there is always the latest location available.

3.5 GSM Integration for Automated Communication:

The system uses GSM technology for automated messaging to ensure quick communication with enforcement agencies. Global System for Mobile Communications (GSM) is a standard that has existed for a long time primarily because of its ability to transmit voice and data over cellular networks. In this project, the moment the Arduino detects an over-speeding event, the GSM module is automatically activated to send an SMS alert. Critical information such as the value of the car's speed and its GPS position are stored in this message. The alerts are easily sent through cellular networks ensuring that the vehicle's location is not an issue. This allows law enforcement to receive information on speed violations in real time and take action, which leads to better traffic control and improved road safety.

3.6 System Reset and Continuous Operation:

To allow for quick recovery of the Microcontroller, a reset switch has been placed within the system. It is possible to make use of the reset switch after every detection event to reinitialize the microcontroller. This allows the system to get back into its default working state without manual reprogramming. This feature makes sure that there is readiness within the system for traffic monitoring without errors resulting from excessive execution of the same operations within the system.

3.7 Integration and User Interface:

The core of the system is the Arduino UNO board which provides excellent process capability as well as numerous digital and analog input/output pins for different sensors and modules. In addition to these, there has been included a 16x2 LCD module which forms the graphical user interface(s) thus improving systems functionality. The module displays the real-time speed of the vehicle that enhances user interaction and provides immediate display confirmation of the detected speed.

3.8 System Calibration and Testing:

The detection of speed was integrated in the system and the system was calibrated and tested for performance issues. The positioning of the IR sensors was set with their turns for proper supply of power and the distance between sensor locations was measured accurately. The controlled tests using vehicles with known velocities was used to refine the timing of the Arduino and the response of the sensors. Adjustments in sensor position and software aid parameters were made to ensure dependable performance.

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