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# Smart Speed Monitoring: An IoT Approach to Preventing Over-Speeding Accidents

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**Abstract –** Over-speeding is one of the major causes of road accidents. This makes speed monitoring an essential component of road safety system. This study proposes an IoT based system for detecting over-speed in real time and alerting the drivers. The system integrates IoT-enabled sensors with microcontrollers to measure speed continuously. Whenever speed exceeds a pre-defined limit, Buzzer activates alerting drivers continuously. By implementing sensor-based hardware, the proposed system aims to promote safer driving behaviour, preventing speed related accidents and enhancing overall passengers and road safety.

***Key Words*:** Over-speed, IoT sensors, microcontroller, safety

## 1.INTRODUCTION

The World Health Organization termed the ongoing decade (2011-2020) as the decade of action for road safety and prepares a report "Saving millions of lives". According to this report, every year globally, nearly 1.3 million people are losing their lives due to road accidents and 20-50 million more people getting injured. For the people aged 15-29 years, road accidents are the leading cause of deaths. WHO report says that if proper actions are not being taken, the death toll may increase to 1.9 million per year by 2020 [1].

Active safety systems, with the potential to prevent or mitigate crashes, have contributed to an enhanced level of safety to some extent [2]. The National Highway Traffic Safety Administration (NHTSA) has outlined a crash scenario structure consisting of three primary components: pre-crash, impact, and injury scenarios [6].

According to the official statistics 155,622 persons were killed and 371,884 injured in road traffic crashes in India 2021(NCRB, 2022) corresponds to death rate of 11.4 per 100,000 population [8][9]. In GBD-2010, we estimated that there were 2.2 million injuries in India that warranted hospital admission [10].

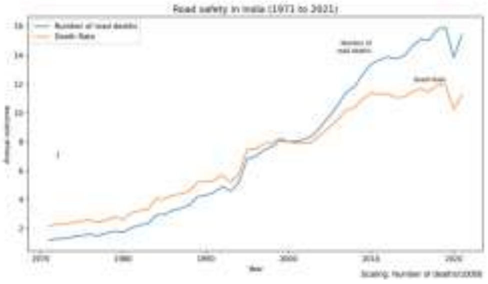


**Fig -1** Number of road deaths and death rate per 100,000 persons in India from 1971 through 2021 (Source: NCRB 2022 & Transport Research Wing 2023).

The proposed idea functions as an active vehicle safety mechanism, designed to monitor the vehicle's operational parameters continuously. This system will enable real Over-speed monitoring and alerting. This system enhances the overall safety of the passenger and driver.

## 2. LITERATURE SURVEY

The main sources of traffic crash data at the national level are the annual reports published by the National Crime Record Bureau (Ministry of Home Affairs) titled Accidental deaths and Suicides in India (NCRB, 2022) [15], and the annual publication of the Transport Research Wing of Ministry of Road Transport & Highways (MoRTH) titled Road Accidents in India (MoRTH, 2022) [16].

In [35], a system is proposed to avoid road accidents and to control the speed of vehicles. Ultrasonic sensors mounted to the car detect obstacles. Cortex ARM M4 with the help of Arduino UNO processes the data and transmits signals to the wiper motor to apply the brakes. In addition, if there is a rear obstacle near the car, the buzzer will immediately notify the driver with an alert.

In [36], the authors have proposed a system which detects vehicles through the ultrasonic sensors and stores in the database with the help of WiFi module in the server and they have also included an alarm system to get into notice of the driver if there is a warning. This system contains GPS which determines the location of the vehicle to the control unit in case if an accident occurred.

A system is proposed in [6] where it can automatically Control the speed of the car by finding speed labels on traffic signs, placed on either side of the road. The proposed system also takes the necessary steps to notify the driver by sending a warning alerts so that the driver can reduce the car speed with respect to the speed limit specified in the traffic sign board.

In [8], the authors have proposed a system to avoid collision in front and rear end using Vehicular Adhoc Network (VANET). This system consists of GPS, Electronic Control Unit (ECU) and connection is established among vehicles in the range of DSRC (Dedicated short-range communication). The speed data and location of following and leading vehicles are calculated and warned to the driver if there is a high chance of collision.

An automated microcontroller crash prevention system in [4] makes use of ultrasonic sensors to perform barrier detection and distance measurements. An ultrasonic transducer with transceiver is installed on the Arduino UNO microcontroller board in the proposed system. Ultrasonic sensor converts sound signals into electrical signals processed by a microcontroller to measure distance. The total time taken to send waves and then to receive them is calculated by considering the speed of the sound. The distance is then calculated by the system operating on the microcontroller. Estimated distance can be used as a vital parameter to generate an audio and visual alert, to perform automatic vehicle speed control and to apply automatic brakes as per the parameters set by the software system.

The novelty of the proposed system which is explained in the next section. When compared to the previous works mentioned in this section is that the major factors that causes accidents such as over-speed and human negligence which is considered in this paper. The main focus of paper is to increase the safety of the passengers and driver by alerting them about over-speed and alert them until speed is under control. The speed and messages are shown on the screen and Buzzer is used for alerting.

## 3.METHODOLOGY

In this paper, the main aim is to design an Overspeed Detection System using IoT components to ensure real-time alerting when a vehicle crosses a safe speed limit. The approach is simple yet practical and focuses on collecting speed data from the vehicle, analyzing it with a microcontroller, and notifying the driver when necessary. This system is completely hardware-based and doesn't require any internet connection, which makes it effective in remote areas too.

### Hardware Components

Fig.2 represents the Arduino UNO which is used as a microcontroller in the system which acts as a brain of the whole system.

**Fig -2** Arduino UNO

**Fig -3** GPS Module

The GPS (Global Positioning System) shown in Fig.3 is responsible for calculating the speed of the vehicle. The GPS module typically outputs data in NMEA (National Marine Electronics Association) format. It updates data at intervals and requires a clear view of sky for optimal satellite connectivity.

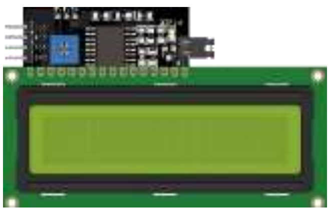

**Fig -4** 16x2 LCD Display

**Fig -5** Buzzer

Fig.4 represents shows a 16x2 LCD connected with an I2C interface module to simplify the wiring and reduce I/O pins connected with Arduino UNO. The I2C module also includes a built-in potentiometer to adjust screen contrast and may have an onboard jumper for enabling or disabling the backlight.

The buzzer module shown in Fig.8 is used to generate the sound by applying "HIGH" logic level to the "IN" pin using Arduino for a specific duration. It will be switched off by applying logic "LOW" level.

### Block Diagram

Fig.6 shows the block diagram of our suggested IoT Based over-speed detection system illustrates how the various components communicate with one another to detect vehicle speed and warn driver if a pre-defined speed limit is crossed. The System is based on Arduino UNO, serves as microcontroller.

The Neo 6M GPS Module continuously tracks the vehicle's speed and sends this data to the Arduino. This real-time speed is then compared to a predefined speed limit (e.g., 70 km/h). If the speed crosses this limit then the Arduino activates a buzzer to warn the driver and displays a warning message on the LCD screen.

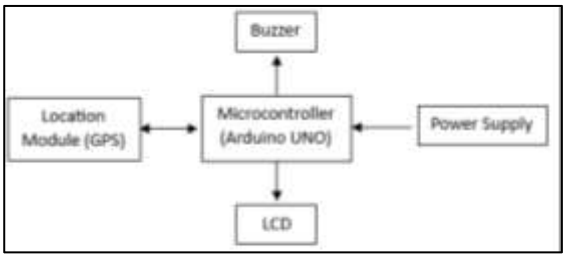


**Fig -6** Block Diagram

The system is simple but highly effective, especially in areas without internet access, since it works entirely on hardware without needing a cloud or app. The buzzer acts as an audible alert, while the LCD helps visually inform the driver of current speed and any overspeed condition.

### Circuit Diagram

The circuit diagram for the speed monitoring system is shown in the below Fig.7. Here GPS module is the main component which gets the vehicle speed and sends to Arduino UNO that is used as microcontroller and process the data and produces the output. GPS module is connected to Arduino UNO through its TX and RX pins (8 and 9) for serial communication, while I2C SDA and SCL pins are connected with A4 and A4 analog pins respectively. The Buzzer is connected with a digital PWM-pin (pin 5), and triggered when overspeed detected.

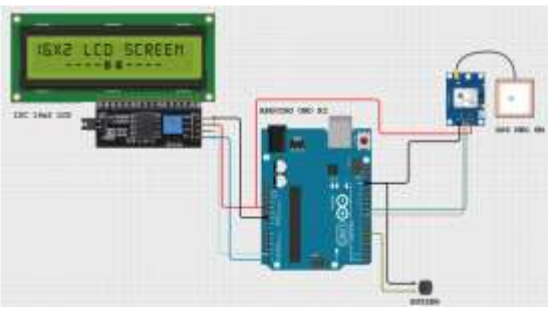


**Fig -7** Circuit Diagram

Every component is powered directly through the Arduino's 5V output which gets power from external source.

## 4.PROPOSED METHOD

The proposed work is a road safety system consisting of real-time hardware-based over-speed detection of vehicle and alerting driver. This system consists of different modules functioning together to ensure the correct and rapid response and preventing measures.

**Working Principle**

The system uses a GPS module to constantly track the speed of the vehicle. GPS not only provides location data but also calculates how fast the vehicle is moving. This speed data is sent to an Arduino UNO, which is the microcontroller acting as the brain of the system. The Arduino then compares the real-time speed value with the predefined speed limit set in the code (for example, 70 km/h).

If the current speed goes above the set limit then the Arduino triggers a buzzer and updates the LCD display to show a warning message to the driver. The buzzer acts as a sound alert while the LCD helps the driver monitor the speed easily. This makes the system user-friendly and easy to understand while driving.

**Flowchart**

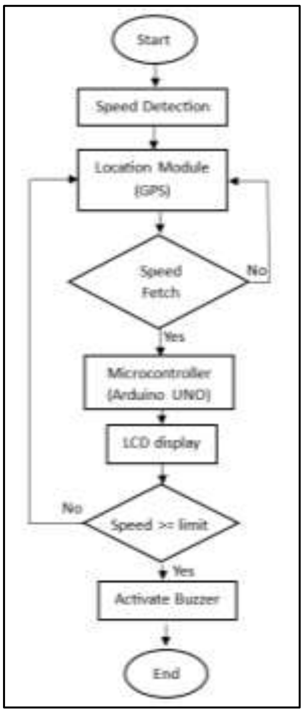


**Fig -8** Flowchart

The Fig.8 represents the flowchart of the system showing how data is flowing from one module to another. The flow starts with the GPS Module where at first speed is fetched at a regular interval sends this speed data to the microcontroller. Once Arduino UNO gets the speed data it displays the speed on the LCD and then checks if it is over-speed limit or not using the code given to it. If speed exceeds a certain pre-defined limit then Arduino triggers the Buzzer "ON" and it continues till speed is higher than the limit. Once speed is in range buzzers automatically stopped by the Arduino UNO.

## 5.RESULTS & ANALYSIS

This section presents the outcomes obtained from implementing the proposed system along with the critical analysis of its performance and effectiveness. The result is discussed according to objective discussed above.

**Circuit Implementation**

This is the first part of the result which shows the implementation of the circuit in physical form. Here Location module or GPS module, LCD display and Buzzer is connected with Arduino UNO as discussed above in the circuit diagram. Fig.9 represents the system hardware circuit with real modules.

**Fig -9** Over-speed monitoring system

**LCD Display**

Initially, when the device is turned on all the modules and Arduino UNO are set to LOW, i.e 0 and LCD is a 16x2 display and it is represented in a matrix form in which the message is displayed. The Fig.10 shows the initial message where speed is low and there is no other message on the screen.


**Fig -10** Speed displayed on LCD

Whenever speed goes above the limit then the Buzzer is activated and LCD displays the message "Over-speed alert!" on the screen. This message displayed continuous on the screen until speed is again normal or lower that speed-limit


**Fig -11** Over-speed Alert

Table-1 outlines the testing outcomes of the over-speed detection feature of the system. The purpose of this test id to assess whether the system accurately identifies the responds to speeds exceeding a predefined speed-limit. This analysis consists a speed range spans from 5 km/h to 100km/h intervals. Each speed is tested five times to correctly evaluate the system performance and alert mechanism.

**Table -1:** Experimental analysis for speed monitoring

| Test No. | Speed (km/h) | System Status | Result |
|---|---|---|---|
| 1 | 5 | Normal Speed | No Alert |
| 2 | 5 | Normal Speed | No Alert |
| 3 | 5 | Normal Speed | No Alert |
| 4 | 5 | Normal Speed | No Alert |
| 5 | 5 | Normal Speed | No Alert |
| 6 | 10 | Normal Speed | No Alert |
| 7 | 10 | Normal Speed | No Alert |
| 8 | 10 | Normal Speed | No Alert |
| 9 | 10 | Normal Speed | No Alert |
| 10 | 10 | Normal Speed | No Alert |
| 11 | 15 | Normal Speed | No Alert |
| 12 | 15 | Normal Speed | No Alert |
| 13 | 15 | Normal Speed | No Alert |
| 14 | 15 | Normal Speed | No Alert |
| 15 | 15 | Normal Speed | No Alert |
| 16 | 20 | Normal Speed | No Alert |
| 17 | 20 | Normal Speed | No Alert |
| 18 | 20 | Normal Speed | No Alert |
| 19 | 20 | Normal Speed | No Alert |
| 20 | 20 | Normal Speed | No Alert |
| 21 | 25 | Normal Speed | No Alert |
| 22 | 25 | Normal Speed | No Alert |
| 23 | 25 | Normal Speed | No Alert |
| 24 | 25 | Normal Speed | No Alert |
| 25 | 25 | Normal Speed | No Alert |
| 26 | 30 | Normal Speed | No Alert |
| 27 | 30 | Normal Speed | No Alert |
| 28 | 30 | Normal Speed | No Alert |
| 29 | 30 | Normal Speed | No Alert |
| 30 | 30 | Normal Speed | No Alert |
| 31 | 35 | Normal Speed | No Alert |
| 32 | 35 | Normal Speed | No Alert |
| 33 | 35 | Normal Speed | No Alert |
| 34 | 35 | Normal Speed | No Alert |
| 35 | 35 | Normal Speed | No Alert |
| 36 | 40 | Normal Speed | No Alert |
| 37 | 40 | Normal Speed | No Alert |
| 38 | 40 | Normal Speed | No Alert |
| 39 | 40 | Normal Speed | No Alert |
| 40 | 40 | Normal Speed | No Alert |
| 41 | 45 | Normal Speed | No Alert |
| 42 | 45 | Normal Speed | No Alert |
| 43 | 45 | Normal Speed | No Alert |
| 44 | 45 | Normal Speed | No Alert |
| 45 | 45 | Normal Speed | No Alert |
| 46 | 50 | Normal Speed | No Alert |
| 47 | 50 | Normal Speed | No Alert |
| 48 | 50 | Normal Speed | No Alert |
| 49 | 50 | Normal Speed | No Alert |
| 50 | 50 | Normal Speed | No Alert |
| 51 | 55 | Normal Speed | No Alert |
| 52 | 55 | Normal Speed | No Alert |
| 53 | 55 | Normal Speed | No Alert |
| 54 | 55 | Normal Speed | No Alert |
| 55 | 55 | Normal Speed | No Alert |
| 56 | 60 | Normal Speed | No Alert |
| 57 | 60 | Normal Speed | No Alert |
| 58 | 60 | Normal Speed | No Alert |
| 59 | 60 | Normal Speed | No Alert |
| 60 | 60 | Normal Speed | No Alert |
| 61 | 65 | Normal Speed | No Alert |
| 62 | 65 | Normal Speed | No Alert |
| 63 | 65 | Normal Speed | No Alert |
| 64 | 65 | Normal Speed | No Alert |
| 65 | 65 | Normal Speed | No Alert |
| 66 | 70 | Over Speeding | Alert Sent |
| 67 | 70 | Over Speeding | Alert Sent |
| 68 | 70 | Over Speeding | Alert Sent |
| 69 | 70 | Over Speeding | Alert Sent |
| 70 | 70 | Over Speeding | Alert Sent |
| 71 | 75 | Over Speeding | Alert Sent |
| 72 | 75 | Over Speeding | Alert Sent |
| 73 | 75 | Over Speeding | Alert Sent |
| 74 | 75 | Over Speeding | Alert Sent |
| 75 | 75 | Over Speeding | Alert Sent |
| 76 | 80 | Over Speeding | Alert Sent |
| 77 | 80 | Over Speeding | Alert Sent |
| 78 | 80 | Over Speeding | Alert Sent |
| 79 | 80 | Over Speeding | Alert Sent |
| 80 | 80 | Over Speeding | Alert Sent |
| 81 | 85 | Over Speeding | Alert Sent |
| 82 | 85 | Over Speeding | Alert Sent |
| 83 | 85 | Over Speeding | Alert Sent |
| 84 | 85 | Over Speeding | Alert Sent |
| 85 | 85 | Over Speeding | Alert Sent |
| 86 | 90 | Over Speeding | Alert Sent |
| 87 | 90 | Over Speeding | Alert Sent |
| 88 | 90 | Over Speeding | Alert Sent |
| 89 | 90 | Over Speeding | Alert Sent |
| 90 | 90 | Over Speeding | Alert Sent |
| 91 | 95 | Over Speeding | Alert Sent |
| 92 | 95 | Over Speeding | Alert Sent |
| 93 | 95 | Over Speeding | Alert Sent |
| 94 | 95 | Over Speeding | Alert Sent |
| 95 | 95 | Over Speeding | Alert Sent |
| 96 | 100 | Over Speeding | Alert Sent |
| 97 | 100 | Over Speeding | Alert Sent |
| 98 | 100 | Over Speeding | Alert Sent |
| 99 | 100 | Over Speeding | Alert Sent |
| 100 | 100 | Over Speeding | Alert Sent |

Fig.12 displays the graph of the impact magnitude versus the alert response rate, showing the percentage of times an alert was sent successfully sent at each speed level. The graph provides the clear visualization of the system's performance.

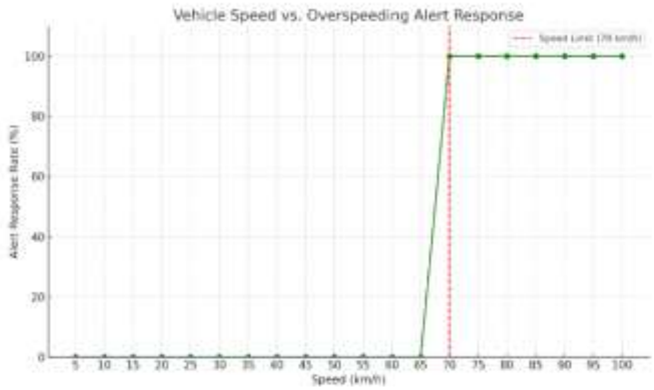


**Fig -12** Graphical representation for result analysis

From the graph it is clear that whenever the speed is below the speed limit which is 70 km/h the response rate is 0%, meaning no alert but as speed exceeds the limit alert is sent to driver through LCD and Buzzer. This shows that the system correctly identifies speed and avoids any false alarm.

For the further reference every result is uploaded on drive along with a video of the system working, result table and all related results. Follow the link:
[https://drive.google.com/drive/folders/1k00HuSUeZ6xvztCjYsg16_C9ORZ0f7fa?usp=sharing](https://drive.google.com/drive/folders/1k00HuSUeZ6xvztCjYsg16_C9ORZ0f7fa?usp=sharing)

## 6. CONCLUSION & FUTURE WORK

The aim of this paper is to develop an IoT based system to prevent vehicle collision and over-speeding of vehicles. The GPS module plays the vital role in preventing accidents by detecting the speed of the vehicle and alerting driver to slow down. An attempt has been made in this paper to reduce the accidents and save lives. The proposed system is designed, implemented and tested with prototype.

We intend to implement the proposed system on real-time cars in near future. Most of the accidents happen when a vehicle goes out of control or due to reckless driving and over-speeding causes collision with others. This prototype helps by alerting drivers about their over-speed every time so that speed is normal and chances of accidents goes down. In future, the proposed system can be enhanced with a voice bot for warning drivers along with assisting them to maintain different speed limits at different areas and streets.

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