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Revolutionizing Traffic Control : The Internet of Things in overspeeding detection

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***Abstract*— Overspeeding has become a common traffic violation, often resulting from reckless and irresponsible driving. To address this issue and prevent accidents from occurring, it is essential to implement a system that can detect and report instances of overspeeding to traffic control authorities quickly. Although speed limits are clearly marked on roads, some drivers habitually disregard them. With technological advancements, manual or semi-automatic systems have been replaced with automated ones. This study proposes a novel approach by utilizing the Internet of Things (IoT) to identify and report instances of overspeeding on vehicles equipped with the device. IoT is a method of interconnecting diverse devices to exchange data among them. The proposed system involves designing, developing, and deploying a smart device that detects and alerts relevant authorities whenever a vehicle surpasses the prescribed speed limit. The device uses GSM, GPS technology and employs Arduino hardware. We tested the device in real-time by installing it in a vehicle. The proposed system involves designing, developing, and deploying a smart device that detects and alerts relevant authorities whenever a vehicle surpasses the prescribed speed limit. The device records the speed of the vehicle and compares it with the speed limit of the road. If the vehicle exceeds the speed limit, the device sends an alert to the relevant authorities, including the vehicle's location and speed. This system allows for prompt action to be taken to prevent accidents and ensure the safety of drivers and passengers.**

Keywords*— *Over speeding, Internet of Things, GPS Technology, Arduino, Vehicle Over Speed Detection, Smart Vehicle

I. INTRODUCTION

Reckless driving is a major contributor to accidents worldwide. Despite the significant increase in traffic, the monitoring system for vehicle speed has been compromised. Such reckless driving poses a significant risk to not only the driver and passengers but also to the general public. Although it is a severe problem, the present method of detecting reckless driving through patrol officers lacks efficiency [1]. As stated in [2], increasing speed multiplies the risk of accidents and the potential for injury. A vehicle traveling at high speeds requires a longer distance to come to a stop. It is crucial to develop a system that can detect and report instances of overspeeding. Other factors such as weather conditions and driving at night also affect the accuracy of manual systems.

Based on [5], the number of deaths in India due to road accidents on a daily basis is over four times greater than the total annual death toll from terrorism. In 2022, 139,671 people lost their lives on Indian roads, which amounts to 382 deaths per day. If 57,844 people lost their lives due to overspeeding, approximately 6,969 individuals died due to speeding after consuming alcohol in 2022. The figure below illustrates the number of deaths caused by road accidents.

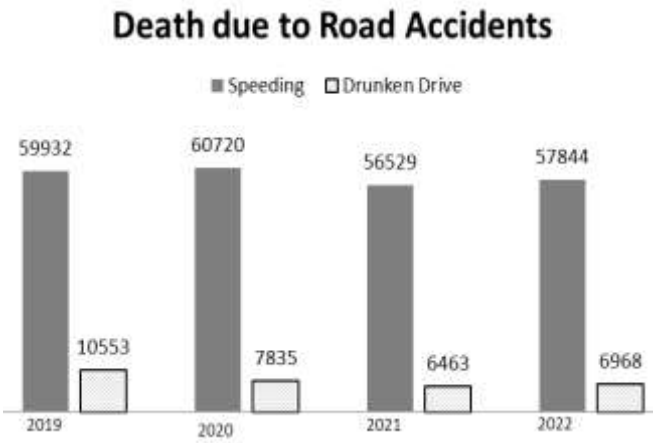


Figure 1: Deaths caused due to accidents in roads
Source: [5]

As depicted in the preceding figure, it is clear that overspeeding is the leading cause of death in road accidents between 2019 and 2022. According to reference [3], overspeeding accounted for 41% of fatalities in accidents, while dangerous or reckless driving was responsible for 32% of fatalities. Other factors that contribute to fatalities in

accidents include vehicle mechanical failures and adverse weather conditions. Maharashtra and Tamil Nadu have reported a considerable number of deaths caused by overspeeding. The figure below illustrates fatal road accidents in 2022 classified by their causes. As per [4], a vehicle traveling at high speed can cause a greater impact during an accident, resulting in more injuries. In the category of driver's fault, over-speeding was responsible for 268,342 out of 403,599 accidents and 73,897 out of 121,126 deaths in 2022.

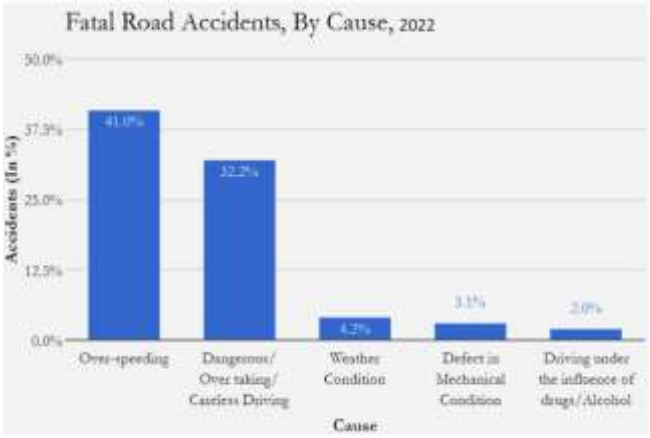


Figure 2: Fatal Road BY Cause in 2022-Source: National Crime Boards Bureau

[6] has suggested that the issue of overspeeding requires the development of a new approach to manage the traffic system and prevent road accidents. Real-time traffic management through the Internet of Things (IoT) can be a solution. The IoT is a network that connects physical devices over the internet and provides rapid and precise results. The IoT system stores the entire database on a computer, which is accessed and utilized as per the needs and requirements.

According to [7], the IoT system enables the components to be accessed remotely, reducing human interference and making it more cost-effective. The IoT connects various devices through the internet using sensors that transmit a vast amount of data. According to [8], the Internet of Things (IoT) connects physical objects and virtual environments, enabling communication between them. Smart city vision aims to use advanced communication techniques to manage the city and its citizens, and IoT-based intelligent transportation systems play a critical role in achieving this goal by improving traffic management efficiency and safety, reducing management costs, and enhancing data transmission.

As [9] notes, IoT has several advantages in traffic management, including traffic control, human proximity detection, theft prevention, emergency response, accident avoidance, and autonomous vehicles. However, it also has some disadvantages, such as network failure and security concerns. Enabling IoT in vehicles could lead to whole-vehicle automation and improve traffic management, according to [10]. This concept can be extended to all modes of transportation, revolutionizing how various modes of transport interact.

Overall, the use of IoT is considered an effective way to manage traffic and improve road travel for everyone in the future. [11] proposes using IoT to manage traffic more efficiently by providing continuous updates of satellite data to a centralized server for analysis and determining diversion paths and waiting times based on traffic intensity. [16] suggests using IoT-based traffic and vehicle monitoring systems to address traffic congestion and accidents, which are a significant concern for urban areas. The proposed system utilizes radio frequency identification with clustered systems and can identify parking spaces, control traffic lights, and prevent vehicle theft.

In [12], an innovative traffic management system that leverages IoT and machine learning algorithms is proposed. The system incorporates supervised learning techniques and big data analytics based on Hadoop to assess traffic patterns and identify optimal road standards. It also includes features such as identifying potential parking locations and preventing vehicle theft. In [17] numerous large cities of India, traffic congestion is a significant problem that is commonly managed through traffic lights. Nevertheless, traditional traffic control systems are inadequate to respond to alterations in traffic density in real-time, causing augmented traffic congestion and air pollution. As a solution to this issue, an intelligent traffic management system that employs the Internet of Things (IoT) has been suggested to help traffic officers make informed decisions..

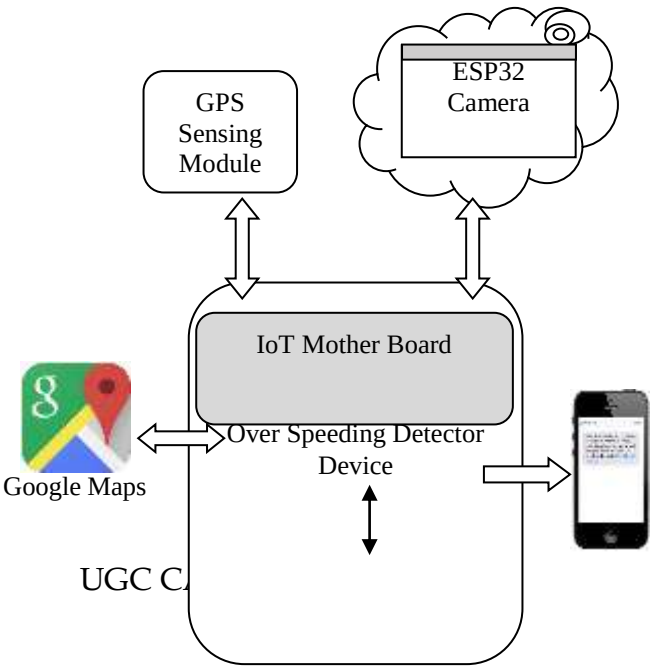
A novel approach to traffic management has been proposed utilizing IoT in [13], incorporating an intelligent traffic controller that comprises Pi-Camera, Arduino, IR sensors, and Radio Frequency Identification. The Arduino serves as the primary tool for controlling the system, while IR sensors determine traffic density and Radio Frequency Identification facilitates zero traffic for emergency vehicles. Two modes of system control have been proposed in the study: manual with human involvement and automatic without human intervention.

[14] In metropolitan and smart cities, traffic congestion is a major problem, particularly during peak business hours, leading to delays in travel and pollution. In order to address these concerns, intelligent control frameworks have been introduced that operate according to traffic automation

protocols. This study proposes an improved traffic monitoring and control framework that employs swift information transmission to manage traffic delays and mitigate accidents caused by congestion. [15] A new approach to managing traffic in rapidly developing Indian cities has been proposed using an IoT-based traffic light controller. Real-time traffic density management is used to supervise traffic density, with components comprising of IR sensor, Arduino, and an LCD display. The corresponding information is displayed on-site to provide early updates and avoid traffic jams.

II. DESIGN OF THE SYSTEM

The objective of this study is to present and put into operation a newly designed device named the "Over Speeding Detector." This device uses the state-of-the-art technology called the "Internet of Things" (IoT) to track and monitor the speed of vehicles. The Over Speeding Detector is installed in cars and comes with advanced features that facilitate the sharing, recording, and storing of data on the speed of the vehicle. The Over Speeding Detector's system architecture is represented in the diagram below, which shows the device's components and their interconnections. The device is equipped with sensors that monitor and detect the vehicle's speed, which is then transmitted to a central unit for processing and analysis. The processed data can be easily shared, recorded, and stored for future reference or analysis. The implementation of the Over Speeding Detector can significantly enhance road safety by providing real-time monitoring of vehicle speeds. With the data collected from this device, authorities can better enforce speed limits and implement road safety measures to prevent accidents caused by over-speeding. Additionally, the Over Speeding Detector can be used by individuals to monitor their driving habits and improve their driving skills, leading to a safer and more responsible driving culture.



Mobile
Phone

Figure 3: System Architecture

Google Maps provides a wide range of services that can be incredibly useful for drivers looking to navigate roads accurately and efficiently. One of these services is the "Snap to Roads" feature, which helps identify the optimal road geometry based on a provided set of GPS coordinates. This feature is particularly useful when GPS signals are weak, and the device may not be able to pinpoint the precise location on the road. Another feature offered by Google Maps is "Nearest Roads," which provides an accurate road division for a given set of GPS coordinates. This is particularly useful when a location is not easily identifiable or when drivers need to know which road they are on accurately. The "Speed Limits" feature on Google Maps is yet another useful tool that can help drivers stay within the legal speed limit. It provides the positioned speed limit for a specific road segment, making it easier for drivers to avoid speeding tickets and other traffic violations. In combination, these services can be particularly helpful for ensuring accurate and efficient navigation for drivers. By plotting GPS coordinates onto the road geometry, determining individual road divisions, and identifying the speed limit for specific road segments, drivers can navigate roads with confidence and avoid potential hazards. These services are also incredibly useful for transportation and logistics companies, who can use them to plan and optimize their routes, saving time and money.

To take advantage of the services offered by Google Maps, a GPS Sensing Module is required. This module allows for the detection and processing of GPS signals that are used to determine the location and other information about the device. The GPS (Global Positioning System) is a network of satellites that orbit the Earth at an altitude of approximately 20,350 km. Each satellite circles the planet twice a day, providing worldwide coverage. These satellites broadcast radio signals that contain information about their location, status, and precise time (t1), which are based on atomic clocks installed on-board. The GPS Sensing Module receives these signals from the satellites and processes them to determine the precise location and other relevant information about the device. This location data is then used by Google Maps to provide accurate and up-to-date

information about the user's location, such as the nearby roads, speed limits, and other relevant details. GPS technology has revolutionized the way we navigate and explore the world around us, making it easier than ever to travel and find our way. It has applications in a wide range of fields, from transportation and logistics to outdoor recreation and emergency services. With the help of GPS technology and the Google Maps services, users can navigate their way with confidence, knowing that they have access to accurate and reliable information about their location and surroundings.

GPS devices receive radio signals from a constellation of satellites orbiting the Earth. The GPS device notes the exact time of arrival (t2) of each radio signal and calculates the distance to each satellite using the speed of light (c), which is over 299,792 km/second. By measuring the distance to multiple satellites, the GPS device can determine its own precise location on the Earth's surface. The distance to the satellite is calculated by subtracting the time the signal was transmitted by the satellite (t1) from the time it was received by the GPS device (t2). This time difference is then multiplied by the speed of light to obtain the distance between the GPS device and each satellite. By measuring the distance to three or more satellites, the GPS device can triangulate its position and determine its precise location on the Earth's surface. GPS technology has a wide range of applications, including navigation systems such as Google Maps. With GPS technology, navigation systems can provide real-time location information and accurate directions to users. In addition to navigation, GPS technology is also used in surveying, agriculture, logistics, search and rescue operations, and many other applications. Overall, the GPS system has revolutionized the way we navigate and explore the world around us. By providing accurate and reliable location information, GPS technology has made it easier for people to travel and explore the world, and has opened up new possibilities for a wide range of industries and applications.

The Global Positioning System, or GPS, consists of a network of satellites orbiting the Earth at a distance of approximately 20,350 km, completing two full orbits per day to provide worldwide coverage. These satellites broadcast radio signals containing information on their precise location, status, and accurate time, which is based on onboard atomic clocks. A GPS receiver utilizes these radio signals to determine its location on the Earth's surface. To calculate its distance from a satellite, the GPS receiver notes the exact time of arrival (t2) of the radio signal and calculates the travel time of the signal through space. This travel time is the difference between the satellite's broadcast time (t1) and the time the signal is received (t2). The distance between the GPS receiver and a satellite is then calculated using the formula distance = speed x time, where speed is the speed of light (c), which is more than 299,792 km/second. By measuring the distance to multiple satellites, the GPS receiver can triangulate its position and determine its exact location on the Earth's surface. GPS technology has become an essential part of our lives, with a wide range of applications in fields such as transportation, surveying, and outdoor recreation. The accuracy and reliability of GPS technology have revolutionized the way we navigate and explore the world around us, making it easier and safer for people to travel and explore new places.

Once a GPS device receives signals from four or more satellites, it can use geometry to determine its precise location in three dimensions on Earth. This technology is used in various applications, such as navigation systems like Google Maps, to provide real-time location information and accurate directions. Some GPS applications also offer speed limit warnings. The more measurements taken during a journey, the more accurate the overall speed reading will be. However, there is a debate over whether the speed indicated by a GPS receiver may be higher than the vehicle's speedometer. To address this issue, most modern GPS receivers are equipped with the OBDII port, which can collect speedometer readings and provide a means of verifying the vehicle's speed

The Global Positioning System (GPS) receiver is equipped with a cellular modem to transfer information to the Speed limiter motherboard via an internal connection, typically at intervals of one minute. However, the transmission frequency can be adjusted as required. The Speed limiter motherboard processes this data to aid compliance with speed limits..

III. WORKING OF THE OVER SPEED DETECTING DEVICE

The system employs a clever use of big data to determine if a vehicle is exceeding the speed limit based solely on the vehicle's speed. This is achieved by the GPS device, which calculates the vehicle's speed using the aforementioned formula and then sends this data to a program within the motherboard.

The mainboard consists of two components: a web server and a persistent service that tracks the incoming GPS data. The self-hosted web page on the web server has a user-friendly interface that requires input from the user. The user must input their mobile number for the high-speed alert to be sent, the speed limit in kilometers per hour (as an integer

input), and then click the "save" button. By analyzing this data, the system can accurately determine whether the vehicle is exceeding the set speed limit and issue a warning to the driver via the designated mobile number. This not only helps drivers adhere to speed limits and avoid accidents but also contributes to safer and more efficient road transportation.

Enter the Mobile Number :

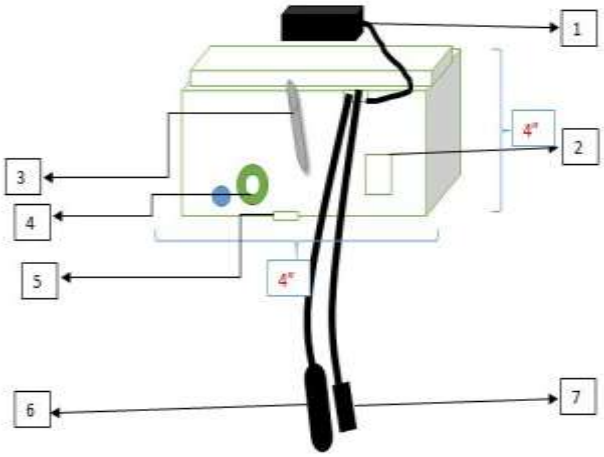
The monitoring program performs several important functions in ensuring that the vehicle stays within the specified speed limit. Firstly, it closely watches for the speed data being sent from the GPS device. Secondly, it calculates the revolutions per second based on the circumference of the wheel and converts it into speed, using data obtained from the OBD port if available. This calculated data is then cross-validated against the GPS speed data to ensure accuracy.

Furthermore, the software verifies the GPS speed information with the speed limit figure that was inputted into the web-based software. If the GPS speed surpasses the speed limit, a minor procedure is initiated, causing the cellular modem board adjacent to the speed limiter motherboard to activate. This transmits a text message alert to the mobile number that was entered and saved via the web-based software..

The software consistently sends text message notifications until the vehicle's speed drops below the speed limit indicated on the web application. The program then reverts to monitoring the GPS data. This process guarantees that drivers receive warnings when the vehicle surpasses the speed limit, promoting road safety and reducing the likelihood of accidents. The self-hosted application can be conveniently accessed through a PC or mobile browser, and the speed limiter works as a Wi-Fi access point. After connecting the device to the speed limiter's Wi-Fi network, users can enter the URI provided in the instructions to access the application. Required data can be inputted and saved by clicking "Save." Subsequently, the application collects and stores data in a file on the speed limiter's motherboard..

The monitoring system relies on the data collected and saved in a file by the web application to verify the speed limit and identify the mobile number to receive SMS alerts. This ensures the accurate utilization of the data from the web application, and enables the monitoring system to promptly report any violations of the speed limit to the designated mobile number.

III. INSTALLATION & IMPLEMENTATION



1 GPS receiver
2 Space for light indication
3 Mobile Unit Antenna
4 Mobile unit hard reset button
5 SIM slot
6 12 volts min 2 amp DC power input slot
7 05 volts 2 amp DC power input slot

Fig 4: Practical Implementation

The following section outlines the steps taken in the implementation of an IoT-based system to detect over speeding in smart vehicles, along with the achieved outcomes:

Step 1: The initial step is to ensure that a SIM card with sufficient SMS balance is inserted into the provided slot.

Step 2: Place the GPS antenna, which is a concealed black square piece, either on the dashboard of the vehicle or on the bonnet outside. It can be affixed to metal surfaces because of its internal magnet.

Step 3: The Processing Unit and GPS unit should be powered up using the automobile charging unit, providing 5 v 2 amps and 12 v 2 amps respectively. Alternatively, a battery with sufficient amperage can be used.

Step 4: Press and hold the green button for 2 to 3 seconds after powering up. This is essential to avoid any difficulty and reset the mobile unit.

Step 5: Allow 4 to 5 seconds for the device to acquire the mobile phone tower and satellite for fixing.

Step 6: Observe a flashing button every two seconds and one red light blinking continuously. This indicates that everything is ready to go.

Step 7: Connect to the wireless network named "iotserver" using a mobile phone and enter the password. This will enable browsing of the network.

Step 8: To access the web application on the mobile phone, open the browser and type the following URL: http://192.168.0.10:8080/Index. The webpage will appear, and users can input the necessary details. It's important to note that only integer values should be entered in the alert cell number and speed limit fields. Any additional characters or spaces will cause the application to malfunction. After inputting the details, click on "save", and a message "OK" will be displayed, indicating that the information has been successfully saved.

Step 9: Once the vehicle is started, users can enjoy their ride. If the speed limit is exceeded, an SMS will be automatically sent to the cell number entered in the app, providing timely notification to the driver to slow down. This feature ensures the safety of both the driver and other passengers on the road.

The IoT-based system has several advantages over traditional systems. It provides real-time data and can be accessed remotely, enabling traffic control authorities to respond quickly to overspeeding violations. The system also reduces the need for manual intervention, which can be time-consuming and prone to errors. Additionally, it can be integrated with existing traffic management systems, making it more efficient and cost-effective.

IV. TROUBLESHOOTING AND MAINTENANCE

1 Check the power connections for appropriate amperes using a multi meter.
2 After finishing step 3 see inside through the spaced provided.

No red light	Check the power
Blinking blue light with blinking green light and static red light	Power off and on the instrument and long press the green button for two to three seconds
No blinking blue	Satellite is not fixed place the instrument in open air
Two blinking blue lights one static red light	Normal works perfect

3 SMS is not going
   a. Check sim is correctly inserted in the slot
   b. Check for SMS balance
   c. Check for validity of sim card
   d. Re do step two (2) of troubleshooting.
   e. Check for the proper number entered through application
   f. Check for the valid speed limit entered through application
4 Application is not opening in mobile.
   a. Check for WiFi connection restart the instrument and wait for few seconds and check the availability of Access point **iotserver.**
   b. Remember to enter proper password iotserver123

RESULTS

Fig 5: Status Display on Lcd

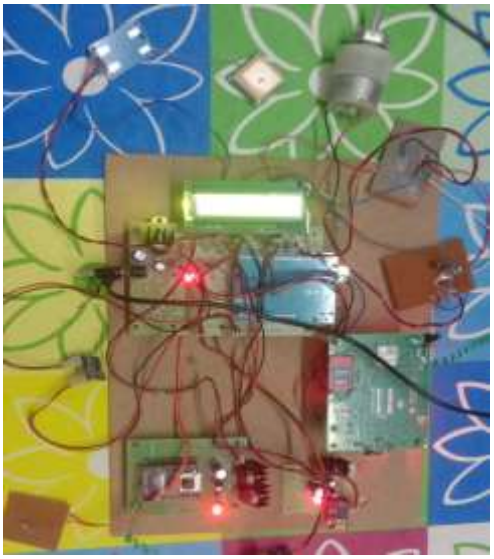


Fig 6:Practical Implementation of Hardware module

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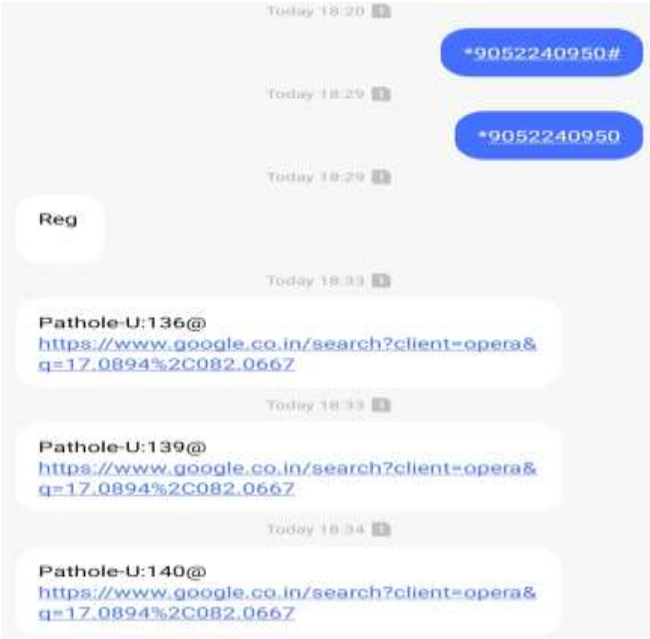

Fig 7: Message received for pathhole detected

Fig 8: GPS Signal monitoring

S.No	U	Pathole	Vib	MEMS	Vehicle_Speed	Location	Date	
1	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:56:45
2	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:55:58
3	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:55:16
4	102	Pathole	Vib-OFF	MEMS_Stable	Vehicle-Stop	Location	Location	2023-06-16 18:54:33
5	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:53:51
6	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:53:08
7	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:52:26
8	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:51:43
9	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:51:01
10	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:50:18
11	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:49:36
12	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:48:54
13	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:48:11
14	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:47:29
15	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:46:46
16	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:46:04
17	102	Pathole	Vib-OFF	MEMS_Stable	Vehicle-Stop	Location	Location	2023-06-16 18:45:21
18	102	Pathole	Vib-OFF	MEMS_Stable	Vehicle-Stop	Location	Location	2023-06-16 18:44:39
19	102	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:43:56
20	103	Pathole	Vib-OFF	MEMS_Accident	Vehicle-Stop	Location	Location	2023-06-16 18:43:14

Fig 9: IoT server cloud storage & updates

V. CONCLUSION

Road accidents are one of the major causes of accidental deaths, with over speeding being a leading cause. Various measures have been implemented to curb this problem, but some approaches are not effective. The aim of this research is to develop a highly efficient and user-friendly device that can help detect and prevent over speeding. By utilizing radio frequency, the Over Speeding Detector device can easily obtain data related to the vehicle and make tracking simpler. The implementation of Internet of Things (IoT) technology in this device can aid in reducing over speeding and potentially lead to its widespread use on roads in the future. This innovative solution has the potential to significantly reduce the number of accidents caused by over speeding and save countless lives.

VI. FUTURE WORK

In the future, our focus is on enhancing the entrepreneurial process and adding new features to the speed monitoring system. We also plan to introduce a stronger business plan to make it more effective. Some of the key aspects that we could incorporate into the project include:

Plate detection of a car moving with a more specific speed limit: We utilized low-cost devices and cameras for the proposed system. However, we can improve the system by using advanced cameras, IoT devices, and software technologies to make it capable of detecting number plates and identifying vehicles traveling at speeds exceeding the speed limit.

Vehicle missing between the endpoints: We could add features that generate alerts to traffic police if a vehicle passes one entrance point but does not cross the next points. This would help investigate why the vehicle is missing and respond quickly in case of accidents or other mishaps.

Adding other features and using advanced technologies to handle big data: We could implement some advanced development platforms and services to the system to enable it to handle big data effectively. We could detect the color, model, and direction of the vehicle and store the entire system in Amazon cloud storage for efficient and effective functionality.

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