IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, May 2025
Impact Factor: 7.67

Accident Prevention and Detection System

Trupti Satarkar[1], Sinhal Shambharkar, Anirudha Sathe, Prof. R. S. Mule
Student, Department of Electronics and Telecommunication
Professor, Department of Electronics and Telecommunication
NBN Sinhgad Technical Institute Campus, Pune, India

Abstract: *Road traffic accidents have, therefore, remained one of the persisting leading causes of public health burdens all over the world, involving millions of deaths and severe injuries annually. The traditional emergency response systems have remained stricken by delay problems in accident detection and notification; hence, the severity of the outcome for the accident victim is increased. One of the recent, novel solutions for the challenge of time delay in expediting the emergency response process is the Emergency Response Delay Management System (ERDMS), a smartphone sensor and cloud-based communication recently proposed for this challenge. This paper will provide clear methods for identifying the key features of the ERDMS. It is divided into two major phases: accident detection, emergency response, and notification. ERDMS may thus easily detect an accident for necessary emergency response without delay since the smartphone uses sensors such as an accelerometer, GPS, and a microphone. The cloud-based communication platform ensures smooth coordination and informs the authorities and designated pre-selected contacts in the event of an accident. The primary focus of ERDMS is on accessibility, and secondly, it is very cheap since it needs very little hardware and relies primarily on smartphone technology. By innovatively changing the way emergency responses are done and using user-centered design principles, the ERDMS bears the enormous potential to save countless lives by helping reduce critical delays in emergency response following road traffic accidents and improving road safety*.

Keywords: Emergency Response, Road Traffic Accidents, Accident Detection, Smartphone Sensors, Cloud-Based Communication, Road Safety

I. INTRODUCTION

Road traffic accidents are, no doubt, a large, consistent, and transparent public health problem due to the millions of deaths and serious injuries caused annually. However, the advent of new technologies and innovations in road infrastructure to ensure safety continues to witness the human toll from road traffic accidents at stubborn levels—more so in middle-income countries, where 80% of the deaths on the road occur in the world. That poses a very urgent necessity to tackle this challenge, therefore pressing governments, organizations, and researchers to look for off-the-wall solutions to improve road safety and speed up emergency response actions. accidents comprises multifaceted efforts, including various aspects: preventing accidents, handling them post-accident, and medicine. However, time determines the outcome of these road traffic accidents and how the emergency response is handled. The implications of such delays are profound on the notification of emergency services, mobilization of medical assistance, and transportation of accident victims to appropriate medical facilities. Conventional emergency response systems have always depended on human intervention to witness an accident, observe and deduce the injuries suffered, and mobilize rescue operations. It saved lives but has inherent delays and inefficiencies built in. In most such accident scenarios, the victims would have been incapacitated, hence not able to call for assistance, or they may not have been able to reach communication gadgets. The statement, therefore, implies that crucial time in initiating response activities is lost, where life is at risk, and the seriousness of injuries will have increased.

Understanding such a gap in the traditional emergency response systems, several scholars have increasingly shown an interest in developing automated technology-based solutions to hasten the emergency response. Modern vehicles are increasingly equipped with built-in emergency response systems that leverage sensors and connectivity features to

ISSN 2581-9429 IJARSCT

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detect accidents and notify emergency services automatically. However, the widespread adoption of these systems remains limited, particularly in low-income communities where access to advanced vehicle technology is limited. The proposed system is a delay-aware accident detection and response system using Raspberry Pi, which is meant to help increase efficiency and provide safety measures on the road while reducing the delay time window. It will correct the most critical challenge of delayed detection and response to an accident, which has in the past resulted in broken limbs and even the loss of life. It also presents a real-time accident-detection approach and a responsive framework exploiting the flexibility and balanced low cost of the Raspberry Pi. The system works by consistently tracking the value of acceleration, status of GPS location, and condition of tilt of the vehicle, which is the input provided by attached sensors to the master board of Raspberry Pi. In the event of rapid impact or other deviations from normal vehicular behavior that conclusively indicate an accident, the system quickly triggers alert mechanisms by informing the emergency services and the appointed contacts. In this way, the system unites all hardware and installed software since sensors and communication modules are integrated into data processing algorithms, making possible fast and reliable recognition of accidents. Visible minimization of response time will save lives.

The system has one essential factor of the highest value: it is even sensitive to delay. This makes its capability work more cordially, linking network latencies and delays in communication, enabling it to give priority to the reports distributed in good time. The developed system greatly helps assess and reduce the probable delays in alert dissemination, improving efficiency and responsiveness to emergency settings, especially in congested or out-of-the-way network localities. The platform can further be scalable and flexible in defining other functionalities based on these, like video recording systems, live streaming, and vehicle diagnostics, among others. This documents and analyzes any individual incident for later post-accident investigation and adjustment of insurance claims. The Delay-Aware Accident Detection and Response System is the latest foster kid in town for road safety technology, wholly made possible by the Raspberry Pi's ability to ensure a timely response to vehicular accidents. It gives the system the most critical capability to provide quick detection and rapid response to road accidents, minimizes the nature of injuries and deaths, enhances road safety, and boosts transportation infrastructure and, in turn, the efficiency of emergency services.

II. LITERATURE SURVEY

With a Raspberry Pi camera and a controller, sometimes known as a "smart roads persecution," drivers can navigate roadways more precisely and safely than ever. Providing safety, reducing power use, and reducing traffic are the main goals of rational road design. Modern technology such as light and sound sensors, cameras, motion detectors, an interactive lighting system, star roads, and night glow may make this happen. Problems with traffic, such as gridlocked roads and times when it takes too long to get from one location to another, are common in India and may be very frustrating. Recent studies have introduced linked car technology, which poses challenges when implemented on public roadways. Donating some innovative but low-value road technology as part of this endeavor. Utilizing motion sensors and lightweight sensors helps reduce power waste from street lighting. As part of this initiative, sending footage to a control room where someone may press a button in case of an accident or disruption.[1]

Every one of us is very concerned about safety. No one likes to feel unsafe while they are on the road. This project details an automated system for tracking cars and their drivers. Installing this security system could not be easier. It is both simple and valuable. This program interfaces with a heart rate monitor to check the driver's heart rate and employs a Raspberry Pi as its controller. In an abnormality, the vehicle will halt to prevent more harm. This module is used for safety reasons. Four vibration sensors are also linked to detect accidents, and the specifics of their locations will be updated using an Internet of Things module. The GPS module is used to record precise location data. [2]

A significant focus of traffic monitoring systems is the automated identification of traffic accidents. Safer driving behaviors, better traffic management, less careless driving, and faster emergency responses are all possible outcomes. Because it offers a dependable, automated, and quick accident detection system, computer vision has the potential to be a lifesaving approach for automatic accident detection. This system can enhance emergency response times. This research suggests an ensemble model that employs the YOLOv8 method to efficiently and accurately identify events—YouTube video sequences with different lighting situations to test the model framework's resilience. Training on the

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open-source Crash Car Detection Dataset yielded a suggested model with a mAP of 96.1%, a recall of 98.0%, and an accuracy of 93.8%, all considerable improvements over the previous values of 91.3%, 87.6%, and 93.8%, respectively. Experimental findings utilizing actual traffic video data reveal that the suggested technique is successful in real-time traffic surveillance applications. [3]

The suggested programmed accident detection system may rescue those unfortunate enough to be involved in accidents. The proposed system is so intuitive that even someone without technical training should be able to learn how to use it. Hardware and software components make up the system. Equipped with sensors for detecting accidents, the equipment unit is mounted in the car and controlled by an Arduino board. However, the code is Android software that drivers install on their smartphones; this app gives drivers a point-by-point map. Low cost, security, and user-friendliness are the main advantages of this system. The method proposed in this study lessens the number of people killed in accidents. [4]

This article introduced an Accident Detection and Location System that uses GPS and GSM technologies to report road accidents quickly and offers a reliable technique for detecting them. Using the Raspberry Pi as the primary controller for the system was the key innovation in setup. It is commendable that the system's reaction time is at most 20s. To improve the system in the future, a more precise accident detection process should be added and tested with simulated real-world automobile accidents. [5]

Most of these systems rely on cloud computing, management, and storage. There should be no delays in life-threatening circumstances, and the centralization and distance of cloud resources might lead to increasing delays, which raises severe questions regarding their practicality in such scenarios. Fog computing is a new middleware paradigm that moves cloud-like resources closer to end devices, which helps with latency. This is why this system presents the idea of an Emergency Response and Disaster Management System (ERDMS), a low-cost system for accident detection and response that considers delays and uses the advanced capabilities of smartphones and fog computing. To identify occurrences, an Android app that uses smartphone sensors is created. A course of action is developed upon the detection of an accident. The first step is to use the GPS to find a local hospital. After receiving the accident report, the hospital's emergency room sends an ambulance to the crime scene. Also, the victim's relatives and friends are notified about the accident. The available fog nodes in the vicinity handle the calculation. In addition, iFogSim is used to simulate the proposed method and compare its performance with that of cloud data centers and fog nodes. [6]

This article compares and contrasts emerging approaches to vehicle accident detection that use the Internet of Things (IoT), discussing its features, pros, and cons. Smart accident detection systems aim to reduce deaths in the case of failure by balancing automation and autonomy with human monitoring and intervention. This ensures that the system can perform its job successfully most of the time. In the event of human error, such a system needs to be able to make amends. Reduced hardware requirements and ease of implementation characterize the top accident detection systems. The most significant challenge to implementing and widely using such systems is the hardware requirements, which would make them economically unfeasible. Strong contact lines between for-profit businesses and humanitarian groups are essential for successfully implementing this system. Many lives can be saved if private enterprises and governments collaborate to adopt this approach. [7]

This paper details our unitized ideas for improving and outperforming the automobile counting process. Improving vehicle detection systems often involves using a backdrop removal strategy. The new method eliminates the unnecessary components, allowing for a more accurate method of identifying various vehicles. On top of that, use the information from the previous frame to follow moving objects. The proposed method can more precisely follow and tally moving vehicles even in bad weather, such as at night, during snowstorms, or in dusty circumstances. It may improve considerably by upgrading to a newer version of the Raspberry Pi. The outcome is a dramatic decrease in processing time. Due to the large number of traffic on highways, occlusions are prevalent. Therefore, two vehicles are combined into one. A strong gust of wind might blow the camera to bits. Because of this, it becomes more challenging to recognize cars. Possible plans include installing an alarm system. [8]

This process has two parts: first, an Internet of Things (IoT) kit is used for accident detection; second, a model based on deep learning is employed to authenticate the IoT model's output and carry out the rescue operation. The Internet of Things (IoT) module detects an accident. After using a force sensor to quantify the impact on the automobile, it uploads all relevant data to the cloud and a GPS module to evaluate the vehicle's speed. Phase two involves activating the rescue module and minimizing the false detection rate using pre-trained models, namely VGGNet and InceptionResNetV2. The deep learning module has a rescue module that becomes triggered when it detects an accident. It then sends information to the closest police station, hospitals, and relatives. One may apply the Haversine formula to get the shortest distance between two places. The experimental findings demonstrate that, compared to InceptionResNetV2, ResNet-50 is the superior model for accident detection due to its greater recall rate and test accuracy for the accident class. Applying the suggested model to a toy automobile allows us to evaluate its real-world performance. [9]

Among the leading causes of death, road accidents must be included. One major component in the survival rates after an accident is the time it takes for emergency medical services to reach the event scene. Death rates may be reduced, and more lives can be saved if medical facilities are sent to the site of the accident as soon as possible. Accident Detection Using Raspberry Pi is one way to avoid such holdup; it notifies the proper authorities when an accident occurs. The technology mainly detects accidents using vibration sensors and sends alarm messages to the appropriate locations. Location, amount of alcohol, disposal of seat belt, speed, and number of passengers are all details that are included in the alert message. At the outset, GPS diligently records the latitude and longitude readings from the satellite and saves them[1]. Sending a message to an enabled GSM handset is necessary for vehicle tracking. Additionally, it is engaged when the vibration sensor linked to the Raspberry Pi controller detects an accident. After turning on GSM, it will receive the most recent value of the user's latitude and longitude and communicate that information to an emergency server set up in advance. [10]

Delays in reporting accident locations and casualty details to the proper authorities are a leading cause of fatalities. By integrating the Internet of Things (IoT) into the current accident warning system, the suggested approach aims to address these problems. Combining a Raspberry Pi with several sensors, a GPS transmitter, and a camera yields a workable solution. At the outset, sufficient personal health data was stored on a central computer for easy recovery from an accident. In the event of an accident, this system is set up with an auto-alert module that will transmit the required information. Here, visual processing is used to identify the accident, pinpoint its position using a Raspberry Pi, and communicate it via message. [11]

An innovative road persecution system uses a Raspberry Pi camera and a controller to make driving safer, a unique apparatus integrated into a motor vehicle. Providing safety, reducing power use, and slowing traffic are the main goals of intelligent road design. Modern victimization technologies like lightweight sensors, inaudible sensors, cameras, motion detectors, interactive lighting systems, star roads, and glow-in-the-dark may enforce this. The problems with Indian road traffic, such as jams, potholes, and the unpredictability of journey times, are severe, awful, and deafening. Scientists have just introduced linked car technology, which is challenging to implement on roadways. Usually, low-value revolutionary technologies for smart roads are given during this initiative. Motion and lightweight sensors help reduce power loss from street lighting, a significant problem. As part of this initiative, send footage to a control room where someone may press a button in case of an accident or disruption. [12]

Delays in locating victims and relaying such information to the appropriate authorities are responsible for the tragic loss of life in traffic accidents. The National Crime Records Bureau (NCRB) reported 682,985 accidents documentable in 2018. Every year, 172,736 people lose their lives in road accidents in India. As time goes on, the figure keeps going up. Reducing the number of fatalities caused by traffic accidents is the primary goal of the suggested solution. The GCP transmitter, the Raspberry Pi RIFD receiver, and the crash sensors work together to provide an effective solution for accident detection. In particular, to recover from an accident, a central server is set up with all of the people's competent medical information. By integrating the Internet of Things (IoT) into the current car warning system, the suggested work provides a practical answer to the problem of data transfer ease. This centralized server includes an auto-emailing module that notifies pre-set emergency contacts of the victim's whereabouts and other pertinent details in the event of an accident. [13]

The railways provide the most cost-effective and convenient option for long-distance and local travel. Additionally, the railway network distributes the vast majority of India's transportation. Regarding railway track crossings and undetected cracks in the Indian railway system, accidents remain the top worry. Most train accidents that result in the loss of lives and economic damage happen on railway tracks due to flaws in the tracks. Consequently, improved track-detecting technology is required, ideally robust, cost-effective, and steady. This article aims to provide a technique for detecting defective train tracks. Using a dynamic strategy that integrates a wheel encoder module to transmit alarm messages, including position information and GSM, this study delves into railway track fracture detection using image processing. All of these gadgets are managed and coordinated by a Raspberry Pi 4. This research uses image processing technology to identify railway track cracks, which helps avoid derailments. [14]

In this article, look at the Internet of Things (IoT) and suggest a use case that might save thousands of lives. To correctly detect a traffic collision, IoT with machine learning techniques and visual processing. If an accident has occurred, the device will transmit the relevant metrics to a server over the internet based on the results of the machine learning model that was trained using data collected from the various sensors (e.g., accelerometer, gyroscope, camera, etc.). With edge computing, processing requests locally rather than relying on a central server structure significantly improves performance. Response time is further optimized in this way. When the data reaches an edge server, it uses the GPS data to find the closest hospitals and police stations. Then, it notifies those entities and the user's registered phone number. It turns into a technology that saves lives in this manner. [15]

The number of accidents is rising, paralleling the increased demand for automobiles. Expressways and other fast-paced roadways discourage drivers from pulling over to assist a casualty. Victims of accidents that occur on remote roads also die because they do not get prompt medical assistance. The incidence of these fatalities is on the rise for these reasons. This study presents a system that, when placed in cars, can automatically identify accidents and contact the closest hospital. That will help get people to the accident scene faster, which might save lives. [16]

The idea of an IoT-based innovative city model on Raspberry Pi is the center of this research. Using Raspberry Pi, it evaluates the planning and execution of an IoT-based smart city. The overarching goal is to use Raspberry Pi to build an urban IoT system that can solve home problems and help bring smart city dreams to life. One of the most essential parts of the technology that the innovative city model uses is the Raspberry Pi. The principles of the Internet of Things help dissect the procedures that determine Raspberry Pi's capabilities. The Internet of Things (IoT) is crucial when designing an innovative city model, especially in emerging nations like India. This study examines the many low-cost operations using the smart city paradigm and the functionalities of the Raspberry Pi. [17]

This article demonstrates that the time it takes for an emergency medical facility to be set up and operational after an accident significantly impacts the victim's chances of survival. By minimizing the amount of time spent at the site of an accident, medical practitioners aim to lower the death rate. The accident identification system, built on Raspberry Pi, may notify emergency personnel of impending calamities. Response times are reduced as a result of this. Upon mistake detection, the vibration sensor relays the pre-programmed message to the appropriate individual. To notify emergency services properly, it is crucial to understand the circumstances surrounding an accident and identify all parties involved. Using GPS allows for acquiring very accurate satellite latitude and longitude coordinates. You have to communicate with the GSM device via message before it can begin tracking the car. It is also possible to detect problems using the vibration sensor on the Raspberry Pi controller. [18]

Globally, the density of train traffic has grown due to the railway sector's rapid expansion. Because of this, the number of rail accidents has increased. Several elements that reduce the likelihood of rail accidents are presented in this research. Automated speed control in curves, collision detection, fire detection (including the ability to automatically detach couches in the event of a fire), management of railway gates, and track continuity are all part of it. This system uses infrared sensors, a Raspberry Pi, a GSM module, a GPS module, and other embedded devices. [19]

The methods of accident detection and their potential future applications are examined in this study. Due to increasing traffic and drivers' carelessness, most accidents now occur on roadways. The authorities or loved ones often need to be notified promptly, including the ambulance and the family. The wounded individual is accidentally delayed in receiving assistance because of this. The event revolves around road accidents. The project's eventual goal is to transmit a message from a computer within the vehicle system to pinpoint the vehicle's exact location. In most cases, we may not be able to identify the precise location of the accident as it is unknown. We want to prevent such situations with our GPS-enabled real-time vehicle tracking and accident detection initiative. [20]

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III. PROPOSED SYSTEM

The block diagram of the proposed system is presented in Fig.1.

Emergency Response Delay Management System (ERDMS) is a fancy method designed to detect road accidents rapidly. It also intends to use smartphone sensors, cloud-based communication, and practical data processing algorithms for rapid emergency response. This section delves into the technical intricacies of ERDMS, elucidating each phase and component in detail.

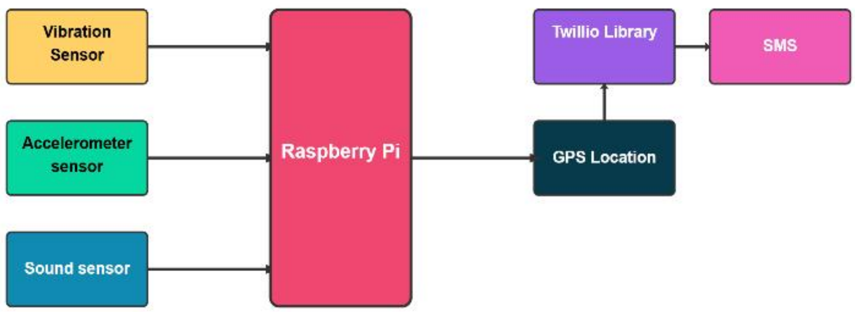

Fig 1. Block diagram of proposed delay-aware accident detection and response system

A. Accident Detection Phase

The foundation from where the Accident Detection of ERDMS is based within the system, taking leverage of smartphone sensors for the innate ability to discern and identify a road traffic accident as it unfolds in real-time. The main sensors in the device include accelerometers, GPS, and a microphone, whose primary function is to record vital data in the event of an accident.

- Accelerometer: The accelerometer serves as the primary sensing device for abrupt variations in acceleration, which characterize collision events associated with road traffic accidents. ERDMS has a threshold-based approach to the accelerometer, where pre-defined thresholds are made, triggering algorithms for accident detection. The accelerometer data is flagged every time it crosses some predefined threshold, suggesting probable accidents and needing extra analysis and validation.
- GPS sensor: Together with the accelerometer, it is meant to help provide the location data necessary for accurately localizing accidents and coordinating emergency responses. ERDMS, therefore, uses the precision positioning attributes of GPS technology to attain very high-fidelity geographic coordinates of the accident location. The location data serves as an essential input to the following stages of emergency response: it helps identify which hospitals and medical facilities are located nearby and will thus be easy to dispatch.
- Microphone: The microphone is probably the smartphone's most evident peripheral sensor. Despite being used mainly as an output sensor, its function can be utilized in cases of accident detection, collecting essential data from the auditory system. Moreover, the ERDMS system is configured with audio analysis algorithms that can recognize exact patterns of sounds about accident events; hence, it will help refine accuracy and further strengthen the capability of accident detection. The system ensures complete coverage of accident detection due to integrating multi-sensor data; hence, it tries to reduce false positives or negatives.

B. Emergency Response and Notification Phase

- From successfully detecting a road traffic accident, ERDMS switches smoothly to the Emergency Response and Notification phase, where necessary actions are started for fast emergency response and notification to the involved people. Key steps in this phase are accident localization, coordination with emergency services, and dissemination of notifications.
- Localization of the accident: If an accident has been detected, ERDMS will then use the GPS location data to accurately localize where the accident occurred and inform medical facilities and emergency services closest

to this location. Gejson specifications of the best routes and distances have been made through geospatial algorithms and mapping services from nearby hospitals, police stations, and ambulance dispatch centers. Such a localization process is basic for reducing response time and guaranteeing timely medical intervention on behalf of accident casualties.

- Emergency Service Coordination: After identifying the location of the accident, the ERDMS coordinates with the relevant parties concerned in the emergency services, which would involve the hospitals, police, and ambulance services. Such cloud-based communication platforms can be easily interfaced with an automatic dispatch notification containing the accident's details, including the location coordinates, severity assessment, and other necessary data collected from smartphone sensors. Real-time, in this respect, designates the transmission of these notifications to the assigned emergency contacts and service providers. This will effectively see emergency respondents and resources deployed to the accident scene.
- Notification: Besides coordinating the emergency service, ERDMS distributes the notification to family, friends, and emergency contacts already defined in the database. It sends automated alerts to the contact through SMS and pushes notification technologies up to date about the accident's event and the injured person's status. Moreover, ERDMS has several user preferences and can be customized. Users may add their notification channels and specify the groups from which they want personalized emergency alerts.

C. System Hardware Integration:

- Integrating all sub-components from hardware—smartphones with Raspberry Pi controllers to auxiliary sensors—is to smoothen, at the core, the ERDMS in offering robust accident detection and emergency response capabilities. A Raspberry Pi is a primary central control unit that interfaces with smartphone sensors and provides the required capabilities in processing, analyzing, and communicating tasks for the collected data. Among such auxiliary sensors, apart from accelerometers and vibration sensors, other sensors augment the capabilities of smartphone sensors for detecting accidents with better accuracy and reliability.
- The ERDMS methodology is a synergy of advanced sensor technologies, cloud-based communication platforms, and efficient synthesis of data processing algorithms that synergize emergency response processes and thereby contribute to mitigating critical delays associated with road traffic accidents. ERDMS is committed to this paradigm shift in practices, offering scalable and cost-effective user-centric solutions ensuring road safety enhancement and life-saving through technically detailed attention and a robust system architecture design.

IV. RESULT

The results of the proposed system are presented in this section. The proposed system is written in Python and may be used to generate code. First, the system is initialized, including the Raspberry Pi module, accelerometer, and vibration sensor. When the accident occurs, the inbuilt GPS receives the signal from the internet and sends the latitude and longitude values to the receiver. The Raspberry Pi gets the message and then begins sending the message to emergency server numbers using the Twilio library. If an accident happens while traveling, the vibration sensor and accelerometer detect it, signaling the system to send an alarm message to the local hospital, police station, and relative's phone numbers provided in the software, as shown in Fig.2.

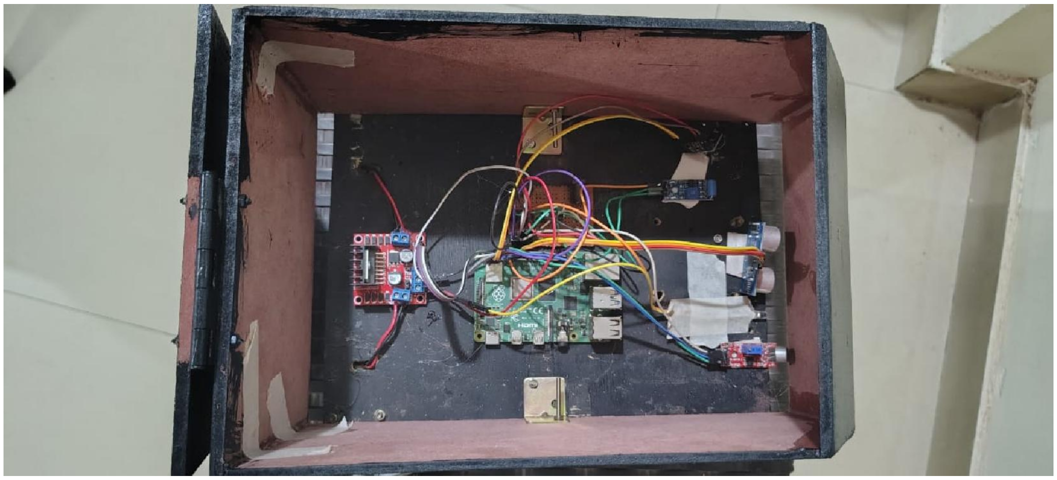

Fig 2. Interfacing of Vehcile Tracking System using Raspberry Pi

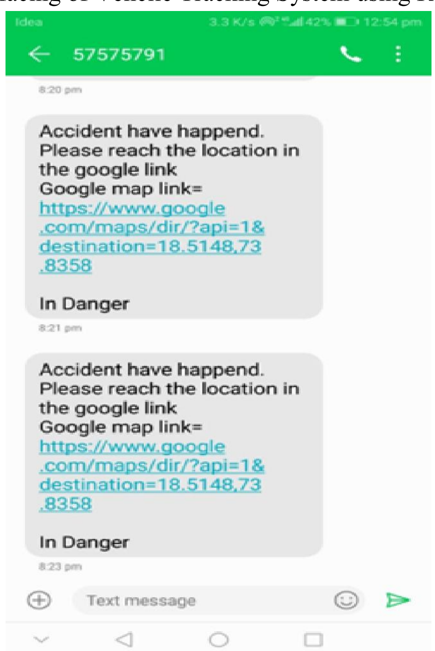

Fig 3. Alert SMS to the nearest hospital, police station, and relatives phone number

The following test cases are performed, and the resultant outcome is tabulated in Table I.

Test case No.	Test case	Operation performed
1	Vibration sensor low + accelerometer low + Low sound	SMS not send
2	Vibration sensor Low + accelerometer Low + Sound High	SMS sent with location
3	Vibration sensor Low + accelerometer High + Low sound	SMS sent with location
4	Vibration sensor low + accelerometer High + High sound	SMS sent with location
5	Vibration sensor High + accelerometer Low + Low sound	SMS sent with location

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6	Vibration sensor High + accelerometer Low + Low High	SMS sent with location
7	Vibration sensor High + accelerometer High + Low sound	SMS sent with location
8	Vibration sensor High + accelerometer High + High sound	SMS sent with location

The test cases outlined in Table I encompass a comprehensive evaluation of the Emergency Response Delay Management System (ERDMS) under various simulated accident conditions. Each test case represents a distinct combination of sensor readings from the vibration sensor, accelerometer, and sound detector sensor to assess the system's responsiveness and accuracy in initiating emergency notifications. For instance, Test Case 1 examines the scenario where all sensor readings indicate low activity, resulting in the system refraining from sending an SMS notification. Test cases 2 through 8, on the other hand, lead to the situation where it "receives several sets of low and high readings from sensors in random combinations, with various vibration levels and sounds. A system that will promptly activate an SMS notification after detecting high acceleration from the accelerometer or an alarming sound by the sound detector sensor, containing the location information to the relevant authorities and contacts in each case. These tests are critical to validate the functionality and performance of ERDMS, ensuring the effectiveness of accurately detecting accidents and providing quick emergency response. Such tests will be subjected to validation and fine-tuning, thus refining and optimizing ERDMS to provide robust and reliable emergency response capabilities for saving lives and improving road safety in real operating conditions.

IV. CONCLUSION

The Emergency Response Delay Management System (ERDMS) significantly furthers the cause of road safety and emergency response. The system uses smartphone sensors and communication-based in the cloud to be the most cost-effective solution in a proactive posture toward reducing critical delays associated with emergency responses post-road traffic accidents. ERDMS simulated within the Proteus software shows that the system has a reliable way of accident detection, can activate emergency notifications in real-time, and thus help in the fast mobilization of respective contact emergency services.

In the virtual environment, the simulation sheds much light on how well the functionalities of the system work, as well as their reliability and performance in various scenarios using Arduino microcontrollers, vibration sensors, sound detector sensors, accelerometers, and GSM modules. To do so, the ERDMS parameters are optimized, iteratively proceeding from testing to optimization to be the most effective under real-life conditions. The other quality that ERDMS bears and shows is some user-centric design philosophy, among them accessibility, affordability, and user privacy. The new system will ensure that it can cater to the population without social bindings by using smartphone-based technology and a near-zero requirement for any new hardware. In addition, the option to put a personalized notification in case of an accident or add predefined contacts may be helpful in the system, which ensures that the victim is helped by his support network in due time.

The ERDMS system thus has enormous prospects to revolutionize emergency response practices and, hence, can save many lives from succumbing worldwide. The ERDMS system relates the detection of accidents to providing timely medical help, therefore working toward recognizing safer roads for healthy societies. A beacon of hope for government, organizational, and community road safety initiatives, amongst one of their most innovative, is finding ERDMS as a transformative solution to meet the urgent challenges of road traffic accidents. All these point out that the research, development, and implementation of ERDMS would be bettered with continued effort since they can make a palpable difference in the lives of accident victims and contribute to a more resilient and sustainable future.

V. ACKNOWLEDGMENT

It is indeed a great pleasure and moment of immense satisfaction for we to present a Project Stage-I report on “Accident Prevention and Detection System ” amongst a wide panorama that provided us inspiring guidance and encouragement, we take the opportunity to thanks to thanks those who gave us their indebted assistance. We wish to extend our cordial gratitude with profound thanks to our internal guide Prof. R. S. Mule for her everlasting guidance. It was his/her inspiration and encouragement which helped us in completing our Project Stage-I.

We wish to extend our sincere thanks to Prof. Kantilal B. Kharat, Project Coordinator for evaluation of project time to time and guidance. Our sincere thanks and deep gratitude to Dr. Makarand M. Jadhav, Head of Department for necessary infrastructure at department level. Also extend thanks to all staff members and to all those individuals involved both directly and indirectly for their help in all aspect of the Project Stage-I.

At last but not least we express our sincere thanks to Dr. Shivprasd P. Patil, Principal/Director for providing us required support and infrastructure.

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