Smart Accident Detection and Emergency Notification System with GPS and GSM Integration

Rajat Amat, Sunil Mallick, Priyanka Suna

Abstract*: In the aftermath of an incident, numerous valuable lives are tragically forfeited due to the lack of timely and adequate emergency response services. Hence, there arises a necessity for a device to be installed in vehicles that are capable of detecting any untoward incidents and promptly notifying the nearest emergency services providers such as hospitals, ambulance services, and police stations. This paper outlines the development of an Internet of Things (IoT)-based device that comprises an Arduino UNO R3 microcontroller, an accelerometer sensor, a GPS module, and a GSM module. Real-time information about the accident's location, time, and date are sent using GPS and communicated to the emergency service provider through GSM. Upon receiving this crucial information, the emergency service provider can promptly take appropriate action, thereby potentially saving numerous lives affected by the accident.*

Keywords*: Internet of Things, GSM, GPS, Accident Detection*

I. INTRODUCTION

Due to the frequent occurrence of accidents and the challenges involved in providing immediate assistance in severe situations, an automated system capable of monitoring and alerting us about accidents while on the road is essential, particularly with the aging global population and associated issues like inadequate medical facilities at accident sites and ineffective accident detection systems [1]. A system that detects accidents and promptly alerts rescue teams for assistance is required on a vehicle. The system will be used for accident detection and notification and utilizes GPS technology to accurately pinpoint the location of the involved vehicle. Once the system detects an accident, it automatically sends the latitude and longitude coordinates to the nearest emergency service provider for immediate action [2]. The system employs both GPS and GSM technologies to determine the location of the vehicle and send an emergency alert message to the relevant parties, including the police, family members, and ambulance services. Specifically, GPS is used for location tracking, while GSM is used for sending alert messages with precise location details to the designated recipients [3]. In remote areas where accidents occur and no one is present to report them, this system can be a life-saving technology. With its ability to detect accidents and alert emergency services promptly, this system can enable a quick response, potentially saving lives in critical situations [4]. The system makes decisions and transmits information to the user's smartphone, which is linked with an accelerometer through GPS and GSM modules. Text messages containing the location of the accident are sent to nearby medical facilities and contacts in the user's network. By providing precise details about the location of the accident, the application can expedite response times and potentially save lives [5]. This low-cost system is designed to provide accurate information about the position and status of an automobile, making it a valuable tool in a range of scenarios, such as tracking or monitoring vehicles. Additionally, this system can be adapted to other applications where information is required infrequently and at unpredictable intervals [6]. The introduction of an official risk detection model that integrates sensor and contextual data by leveraging smartphones, sensors, network connectivity, and web services. This system provides the necessary conditions to alert first responders and deliver accurate results [7]. The system can quickly detect accidents and send notifications to nearby emergency services, providing critical information about the location and severity of the accident. This alerting system is built on a mobile application that can provide real-time updates on the accident location, enabling emergency responders to arrive on the scene quickly and potentially save lives [8]. Prompt medical attention is critical in the event of an accident, but response times can be delayed when emergency services are not immediately notified. To address this issue, the proposed research aims to develop an automated system that can rapidly alert family members in the event of an accident, enabling them to provide swift assistance and potentially save lives [9]. The healthcare and automobile industries are exploring ways to leverage the Internet of Things (IoT) to improve communication in emergencies. By leveraging IoT technology, this system can greatly improve the speed and accuracy of communication in critical situations, potentially saving lives and reducing the severity of injuries [10].

II. LITERATURE REVIEW

A system is designed to create an alarm when an accident occurs using Arduino, sensors, GSM, and GPS technology.

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The alarm is activated automatically, and the system sends information about the accident, including the vehicle number and other details, to the nearest police station and hospital along with a Google Maps link to the accident scene [1]. The proposed system incorporates an accelerometer to provide information on the rapid acceleration of the vehicle. Once these readings reach threshold values, the Arduino will send a signal to the GPS module to fetch the current location. This information, along with the location of the accident and the speed of the bike, will be sent to the appropriate authorities via the GSM module to ensure that help arrives on time [2]. The system consists of a single-board embedded system that is equipped with Global System for Mobile Communication (GSM) and Global Positioning System (GPS), along with a microcontroller. By utilizing GSM and GPS technologies, the system is capable of tracking the vehicle and providing the most up-to-date information about ongoing trips [3]. The system monitors information from the accelerometer and vibration sensor, which allows it to recognize when a severe accident has occurred. Once detected, the system sends an alert message informing about latitude and longitude data, sensed or measured by the GPS module, and sends the information to the police control room, any rescue team, or the car owner through the GSM module. This enables the police to immediately trace the location of the accident and take the necessary actions after receiving the emergency message [4]. The system is designed to make decisions and send information to a smartphone that is connected to the accelerometer through GSM and GPS modules. This can save precious time and enable quick medical attention to be provided to those involved in the accident [5]. The GPS receiver is responsible for receiving location information from satellites in the form of latitude and longitude. The microcontroller processes this information, and the processed information is then sent to the user/owner using a GSM module. [6]. Automatic accident detection systems and alerts can reduce response time by immediately notifying emergency personnel and providing data for analysis [7]. A model that uses the Internet of Things (IoT) and cloud connectivity to detect vehicle accidents and alert nearby emergency services. The system includes a microcontroller, as well as various sensors [8]. The model integrates an Arduino microcontroller, GPS receiver, and GSM module to detect vehicle accidents and send SMS notifications with location data. An ADXL335 sensor captures vehicle coordinates and a 16x2 LCDs messages and accident location [9]. IoT can enable automatic notification and response to vehicle accidents by sending accelerometer and GPS sensor signals to the cloud, which triggers an alert message to subscribed individuals. The message includes accident severity and GPS location data. The ambulance can use GPS coordinates for quick response to the scene [10].

III. PROPOSED MODEL

Fig 1: Block Diagram of the Accident Detection System

ARDUINO - Arduino is based on the ATmega328P microcontroller. The Arduino UNO is a widely used microcontroller board that can detect accidents through a vibration sensor and alert emergency services or designated contacts via the GSM module. It is efficient, flexible, and easy to use, making it a popular choice for embedded applications.

GSM MODULE - Communication between GPS, and a designated mobile number, can be possible through the SIM900A GSM module. It operates on a tri-band network, with a frequency range of 900MHz to 1900MHz, including EGSM900 MHz, PCS 1900 MHz, and DSC 100 MHz It is facilitated through the receiving pin of the GSM module and the transmitting pin of the GPS module.

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GPS MODULE - The SIM28ML GPS module is used to capture the location of a vehicle on Earth, and the data is sent to the Arduino board through coordinates. The GPS module operates at 1575.42 MHz and outputs real-time location data in NMEA format. The data is then transmitted to a designated contact using the GSM module.

ACCELEROMETER - An accelerometer is a sensor used in accident detection systems to measure acceleration and detect changes in motion. When an accident occurs, the sudden impact causes a significant change in acceleration, which can be detected by the accelerometer. This data can then be used to trigger an alert or activate safety systems.

LCD MODULE – A 16x2 LCD is utilized to show numbers, alphabets, and special characters. The module is interfaced with the Arduino board using the higher bit data lines of LCD pins, such as pins 11, 12, 13, and 14, which are connected to digital pins of the Arduino, such as pins 8,9, and10, in 4-bit mode. The RS and E pins of the LCD module are connected to pins 12 and 13, respectively. The read or write pin is connected to the ground to write in the LCD module.
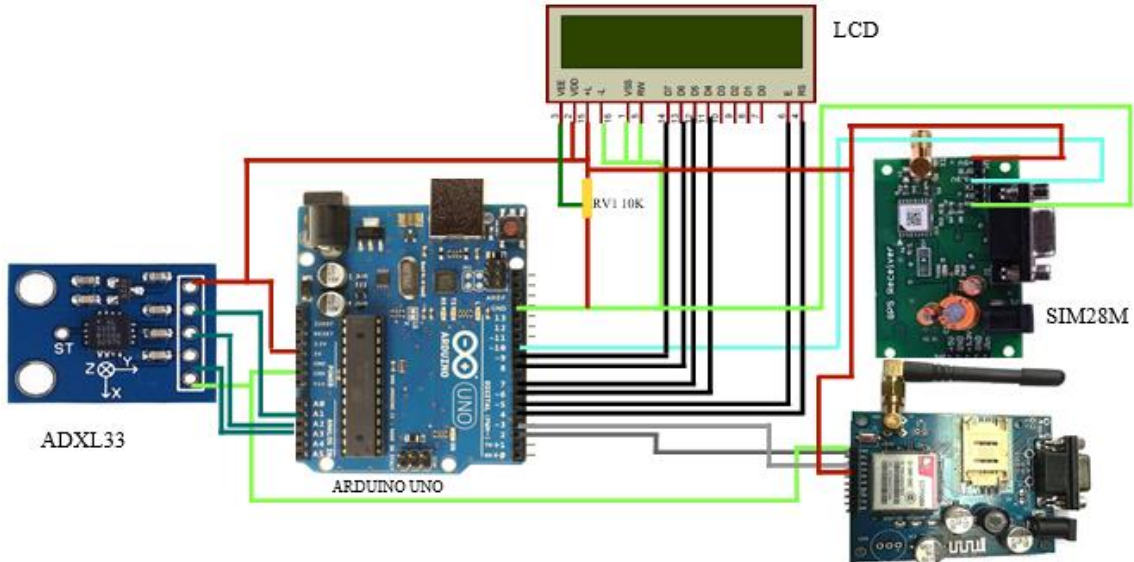

Fig 2: Proposed Model of Accident Detection System
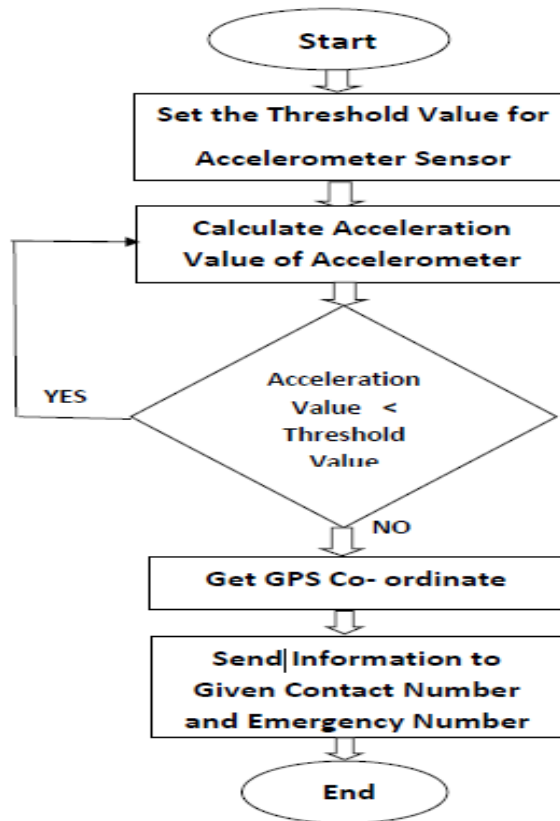
IV. WORKING MODEL

Fig 3: Algorithm for Accident Detection System

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This initiative aims to enhance road safety and emergency response by promptly relaying the location of a vehicular accident to the nearest police station, hospital, and ambulance, thereby potentially saving lives. The project aims to address the issue of delayed medical attention for accident victims. It utilizes an accelerometer to detect car crashes and GPS and GSM modules to promptly report the incident, potentially expediting the hospitalization of patients and improving their chances of recovery. In the event of a vehicular accident, the accelerometer is designed to detect the impact and send a signal to the processor for subsequent processing. Fig 3 shows the algorithm of how the processor process the data of the accelerometer. To ensure accuracy and reliability, a predetermined threshold value is established within the processor to continually monitor and compare the sensor or acceleration values. Once the acceleration value surpasses the established threshold, the system will recognize that an accident has occurred. Using GPS technology, the system provides real-time information regarding the accident's location, time, and date, which is then transmitted to ambulance services through GSM communication. The emergency response units receive the accident location in the form of a Google Maps link, enabling them to locate the victim swiftly and potentially save their life. Fig4 showcases a physical model of the accident detection system.
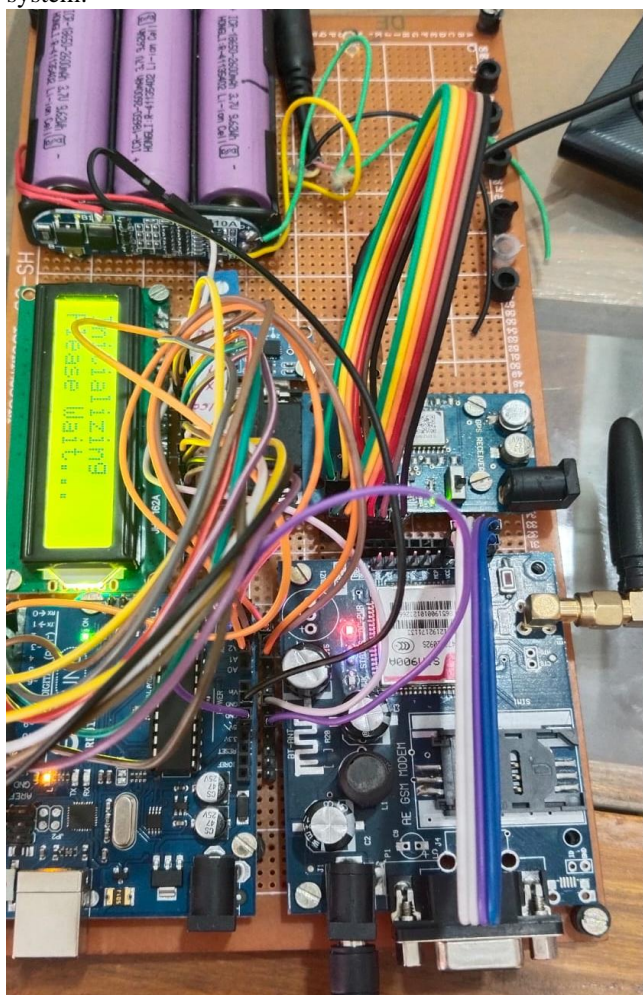

Fig 4: An image of the Working Model of the Accident Detection System

V. RESULTS AND DISCUSSION

After the occurrence of an accident with a vehicle, it is essentially required to inform the nearest hospital and ambulance. Delaying the medical hospitalization may happen loss of lives. This accident detection device solves this problem and informs the nearest healthcare. Figure 5 (a) and (b) shows the message containing the location received through SMS. The system is capable of providing both longitude and latitude information in addition to the accident location details.
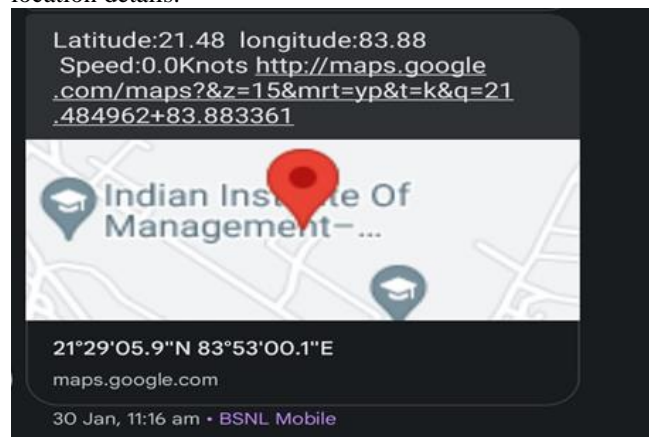
(a)

Fig 5 (a): Message received through SMS

(b)

Fig 5 (b): Google Map indicating the longitude and latitude of the accident spot

VI. CONCLUSION

The primary objective of this project is to mitigate the high rates of mortality caused by road accidents through the utilization of sensor-based technology and wireless communication modules to promptly alert emergency services of an accident's precise location. This is achieved through a mobile application that is integrated with the vehicle and can immediately send out alerts to emergency services. The system is cost-efficient and suitable for any type of vehicle, and its significance will increase as the number of vehicles on the road increases.

The system can also alert emergency services in cases of small accidents where there is no significant loss.

DECLARATION

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Authors Contributions	All authors have equal participation in this article.

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