VEHICLE ACCIDENT MANAGEMENT

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Abstract

The use of vehicles in today's world has been increasing day by day. It has greatly helped people to travel distant places but on the other side, road accidents remain leading cause of death and injury globally. Such sudden demises are also due to delays in medical assistance or people being unaware of the occurrence of it. This paper presents the development of Vehicle Accident Management System to promptly detect collisions, accurately locate the incident and efficiently notify emergency responders including nearby hospitals and police stations. Modern technologies such as Arduino UNO, Sensors, GPS, GSM and SD card modules are integrated which enables the development of a comprehensive and cost-efficient accident management system. The paper also highlights the challenges and limitations of the current Vehicle Accident Management System, and it explores the future of this technology.

Keywords: Vehicle Accident Management System, Arduino UNO, Collision Sensor, GSM Module, GPS Module, SD-Card Module.

Authors

Joya Borah
Department of Electronics & Communication Engineering
School of Technology
North-Eastern Hill University
Shillong, Meghalaya, India.

Nayan Jyoti Gogoi
Department of Electronics & Communication Engineering
School of Technology
North-Eastern Hill University
Shillong, Meghalaya, India.

Mrinmoy Saikia
Department of Electronics & Communication Engineering
School of Technology
North-Eastern Hill University
Shillong, Meghalaya, India.

1 INTRODUCTION

In our everyday lives, we often hear many cases of road accidents and in many cases people lose their lives due to delayed treatment or not reaching hospital in time. According to a report on " Road Accidents in India 2022" published by Ministry of Road Transport and Highways, a total of 4,61,312 road accidents have been reported by the States and Union Territories. Hence we have made an effort to design an Vehicle Accident Management System which is specifically made to send alert notifications to the nearest hospital and police station in case of any accidents. The system is an integration of Collision Sensors, GPS, GSM and SD Card modules, all connected to an Arduino UNO making it an affordable circuit which can be easily implemented in vehicles and as the location of the car will be shared to the police authorities, it will also be beneficial in cases like hit and run etc.

2 LITERATURE REVIEW

2.1 Past Research Work

In this subsection, an attempt has been made to review some of the past work done in this area of systems. Prabha et al. [1] details vehicle accident detection and alert system with SMS to the user defined mobile numbers. It explains how the GPS tracking and GSM alert based algorithm is designed and implemented with LPC2148 MCU in embedded system domain. The proposed Vehicle accident detection system can track geographical information automatically and sends an alert SMS regarding accident. Al Mamun Mizan et al. [2] In this paper, a few common reasons for road accidents were discussed in a populated as well as developing countries like ours. It highlights the smart vehicle management system as the solution for road accidents. It details how integrating features for this system, the causalities caused by road accidents can be reduced . Hari et al. [3] this paper address the problem of delay minimization, right from the detection of an accident till the victim is safely handed over to the casualty. It explains how the dedicated in–vehicle accident detection module automatically informs the server whenever an accident happens. The design of the main server tracks the ambulances and dispatches the nearest ambulance to the accident spot. It also consist of a andriod application app which helps or guide the driver to reach the accident spot. Elie et al. [4] develops a new smart IoT solution which automatically transmits the basic medical information needed by the rescue teams to the PSO(Police support officer)headquarter. It automatically transmits the basic medical information needed by the rescue teams to the PSO headquarter. It collects the geographical data which can be fed to a data mining engine to extract roads conditions, and to generate descriptive statistics reports about vehicle accidents, it also discussed the implementation of a navigation system to find the closest rescue team to the crash. Racheal et al. [5] discussed the detection of accident using GPS and GSM technology and describe how it links the database with the hardware, and store the location in the database using GPRS technology, which provides security to vehicles by tracking them over a database. Wan-Jung Chang et al. [6] Proposed A deep learning-based IoV(Internet of Vehicles) system named Deep Crash was proposed in this paper. The proposed Deep Crash system consists of an IVI telematics platform with vehicle collision detection sensors, a cloud-based deep learning server, and a cloud-based management platform. The deep learning model is trained to detect traf-

fic collision events by the cloud-based deep learning server based using a popular open deep learning framework. Moreover, alert messages and notifications are issued via the cloud-based information platform according to the collision prediction result, and the GPS position of the traffic accident is provided. Mounika et al. [7] Here the accident detection and providing medical aid to accident victim is being discussed. Piezo electric sensor, Transducer sensor, Fire sensor and MEMS(Micro Electronic Mechanical System) are used to determine whether an accident had occurred also gives the owner with the feature of tracking his vehicle in case of theft. GSM is responsible for the communication between system and the responder. Vikas J.Desai et al. [8] proposed an innovative wireless black box using MEMS accelerometer and GPS tracking system has been developed for motorcycle accidental monitoring. The system can identify type of accident (linear and nonlinear fall) from accelerometer signal using threshold algorithm, posture after deafening of motorcycle and GPS ground speed. After accident is detected, short alarm massage data (alarm massage and position of accident) will be sent via GSM network. The scheme has been tested in real world applications using bicycles. The test results illustrate that it can identify linear fall, non-linear fall and normal ride with no false alarm. From this project we get the idea of extending our system in case of motorcycles also in future. Nimisha.C et al. [9] proposed a system that provides the optimum solution to poor emergency facilities provided to victims in road accidents in the most feasible way. With the help of this technology immediate action can be taken when an accident occurs by alerting the respective people by sending a message. The drawback with this system is that it does not work without network. So in areas where no network is available the system will not be able to send the alert message. The proposed method is highly beneficial to the automotive industry.

Sampoornam et al. [10] - [14] have mainly focused in the area of using IoT(internet of things) in application for vehicle safety purpose , accident prevention purpose or post accident management purpose . In [10] the combination of sensors and real-time data processing techniques are detailed to detect accidents and inform the authorities through the integration of GPS and GSM technology. Gunjan et al. [11] ,have discussed a method of vehicle tracking and locking systems that is used to track the theft vehicle by using GPS and GSM technology. This system puts into the sleeping mode while the vehicle is handled by the owner or authorized persons; otherwise goes to active mode. The mode of operations changed by persons or remotely. When the theft identified, the responsible people send SMS to the micro controller, then issue the control signals to stop the engine motor. and hence can easily catch the thief or get back the vehicle. Rani et al. [12] have proposed a IOT device that keeps sending continuous notification of crash occurrence until it makes sure its reception by the headquarter. Accident detection device installed in a vehicles when meets with an accident will send SMS/ messages to the pre-install numbers of the drivers family members, police station, ambulance and nearest hospital. This embedded system is useful for tracking and retrieving the exact position of any vehicle which has met with an accident by using GPS and sensors. Raffik et al. [13] In this article, the prototype of an automatic accident detection system is proposed. It details about integrating GSM,GPS,and gyroscopic sensor to send alert after the vehicle is theft or met an accident. Because of the high accuracy tracking technology, this prototype might be used to trace down those responsible for the horrible crimes. Gadekar et al. [14] In this paper, an idea is prposed to detect accident and report it to emergency service,

hospital and police with internet message. The proposed system will help a victim to get emergency services (i.e. ambulance) quickly after a accident is reported. Here the user detect accident and capture the image then the system send alert to the nearest hospital and police station.

2.2 RESEARCH GAP AND ANALYSIS:

In today's world many sensors are there which are used for protection for eg ultrasonic sensors are used for the purpose of parking , radar sensors are used to detect object and their speed and many more sensors are there.Our project is specified on collision detection sensor which will detect all kind of collision as the sensors will be on all 4 sides of the car and with the help of GPS and GSM module it will immediately notify nearby hospital and police station.The system is designed with cost-effectiveness,flexibility to be implemented in all kinds of cars and and accuracy in mind.

3 METHODOLOGY

After analysis of the above papers, we have designed a system which will detect accidents with the help of collision sensors, and track its coordinates using GPS module and send the notification to the nearest hospital and police using GSM module.

Hardware Connections: Power source is connected to the Arduino and from Arduino all the components are supplied power to operate.

Arduino codes: The code is designed to function such that after the vehicle being hit or collision occurred, the notificaton is being sent but at first it should find the nearest hospital and police station and for that it uses haversine formula to calculate the shortest distance between the accident site and these emergency responder locations.

Testing: Test were done using different GSM and GPS module which would work properly,in short working of hardware and arduino codes is being test if it is giving the requisite result.

3.1 COMPONENTS

ARDUINO UNO: Arduino Uno consists of 14 digital input/output pins (6 of which can be used as PWM outputs) and 6 analog inputs. This Arduino uses ATmega328P as it's microcontroller, which also features a 16 MHz crystal oscillator, 1 UART(hardware serial port), a power jack, an In-Circuit Serial Programming(ICSP) header, a USB connection, and a reset button. It is powered via a USB cable or with an external power supply.

YL99 COLLISION SENSOR: The YL99 Crash Switch Collision Sensor is an instrument used to detect physical impact or vibration upon collision. The device consists of two significant components – the Switch and the Signal Output. The Switch remains normally open and closes when a physical collision or vibration is detected. Once the

switch is activated by the impact, the Signal Output sends a digital signal to the microcontroller. This signal can be used to trigger an action or alert in response to the collision, allowing the system to react accordingly.

GPS MODULE: The GPS 7m NEO WaveShare Module is a high-performance GPS receiver module with a tracking sensitivity of -161dBm. It features a 56-channel receiver, enabling fast and accurate initial fixes even in challenging environments such as dense foliage and urban areas. The acquisition time for cold start is 27 seconds, while for hot start, it is 1 second or less. This module provides output in NMEA standards, delivering precise GPS data like latitude, longitude, speed, and time. It supports multiple satellite systems like GPS, GLONASS, and QZSS, making it ideal for a wide range of positioning applications.

GSM MODULE: Sim900A is a wireless module that supports GSM and GPRS connectivity. It has dual band GSM support, the module supports 900 MHz and 1800 MHz frequencies. It enables devices to communicate over cellular network that provides services of SMS, Voice Calls and connect to the internet through the GPRS standard.

SD CARD MODULE: The SD card allows us to store and retrieve data, log sensor readings, store images and audio files. It communicates with the microcontroller through SPI(serial Peripheral Interface). It is 3.3V and 5V compatibility.

3.2 PROCESS FLOW

The system comprises of Collision sensors, GPS module, GSM module, SD CARD module. All these sensors and modules are combined and connected to each other through Arduino. Here the red line signifies the flow of power supply and black line signifies the flow of information.

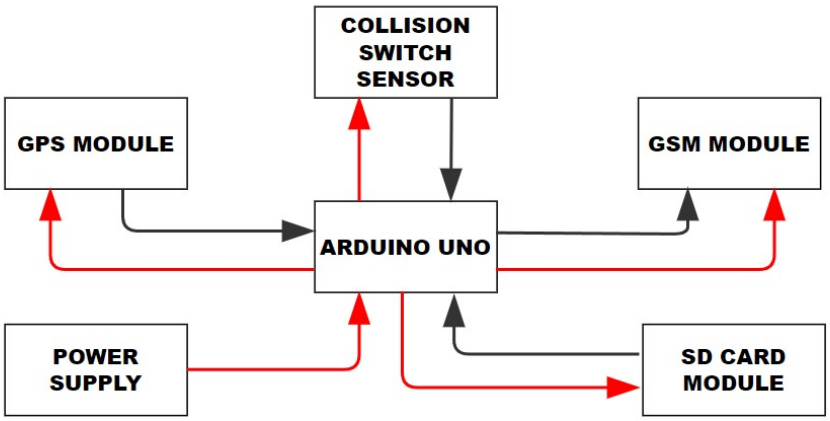

Figure 1: Block diagram of the system

3.2.1 DETECTION OF ACCIDENT

As the collision sensors are situated at all the 4 sides of the car, any heavy bump or collision will be detected as the switch state change, once it feels enough pressure against its body.

3.2.2 LOCATE THE NEARBY HOSPITAL AND POLICE STATION

Once the collision is detected, the GPS module track its coordinates. SD card contains the coordinates of all the hospitals and police stations, the microcontroller(i.e.Arduino UNO) calculates the nearest hospital and police station with the help of haversine formula.

HAVERSINE FORMULA: The haversine formula calculates the shortest distance between two points on a sphere of radius R using their latitude and longitude measured along the surface.

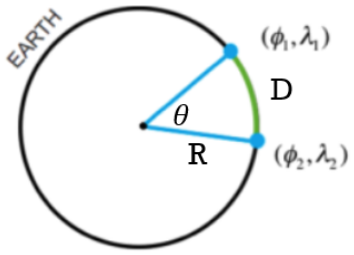

Figure 2:

Let ϕ_1 and λ_1 be the coordinates of the present state of GPS and ϕ_2 and λ_2 be the coordinates of different hospitals or police stations
The haversine of θ is given by :

$$\text{hav}(\theta) = \sin^2\left(\frac{\theta}{2}\right) = \frac{1-\cos(\theta)}{2} \tag{1}$$

The haversine formula allows us to calculate hav(ϑ) directly from the latitude (represented by ϕ) and from the longitude (represented by λ).

$$\text{hav}(\alpha) = \text{hav}(\phi_2 - \phi_1) + \cos(\phi_1)\cos(\phi_2)\text{hav}(\lambda_2 - \lambda_1)$$

To solve for the distance D we apply the archaversine (inverse haversine) to h=hav(α) or use the arcsine(inverse sine) function

$$D = R\ \text{archav}(h) = 2R\ \arcsin\left(\sqrt{h}\right)$$

or more explicitly:

$$D = 2R\ \arcsin\left(\sqrt{\text{hav}(\phi_2 - \phi_1) + (1 - \text{hav}(\phi_1 - \phi_2) - \text{hav}(\phi_1 + \phi_2)) \cdot \text{hav}(\lambda_2 - \lambda_1)}\right)$$

$$= 2R \arcsin\left(\sqrt{\sin^2\left(\frac{\phi_2-\phi_1}{2}\right)\cdot\cos^2\left(\frac{\lambda_2-\lambda_1}{2}\right)+\cos^2\left(\frac{\phi_2+\phi_1}{2}\right)\cdot\sin^2\left(\frac{\lambda_2-\lambda_1}{2}\right)}\right)$$

$$= 2R \arcsin\left(\sqrt{\sin^2\left(\frac{\phi_2-\phi_1}{2}\right)+\cos\phi_1\cdot\cos\phi_2\cdot\sin^2\left(\frac{\lambda_2-\lambda_1}{2}\right)}\right).$$

This can be further transformed to :

$$D = 2R\arcsin\left(\sqrt{\frac{1-\cos(\phi_2-\phi_1)+\cos\phi_1\cdot\cos\phi_2\cdot(1-\cos(\lambda_2-\lambda_1))}{2}}\right)$$

3.2.3 SENDING NOTIFICATION TO THE AUTHORITIES

Along with the coordinates of hospitals and police stations, SD card also contains its respective contact numbers, the GSM module will send message and it will keep calling until the call is responded and it will also send a copy of it to the nearby traffic control authority. And for the sake of immediate action to be taken it will also inform emergency services like 108 in India.

3.3 FLOWCHART

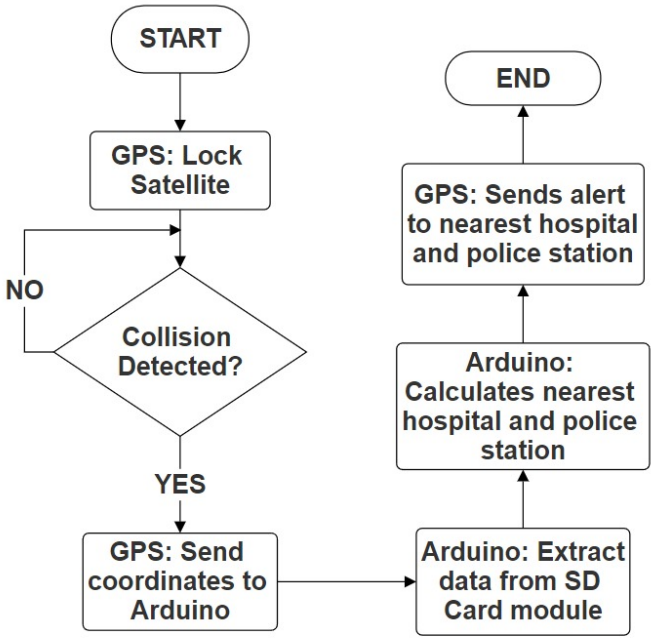

Figure 3: Process Flow Diagram

4 RESULTS AND DISCUSSIONS

4.1 RESULTS

We have followed the prototype of this paper and designed the vehicle accident management system which gave us the requisite results, after testing the system in various weather condition it showed to give results properly but in a very dense cloud area it might take a delay of around 29s to track the coordinates.

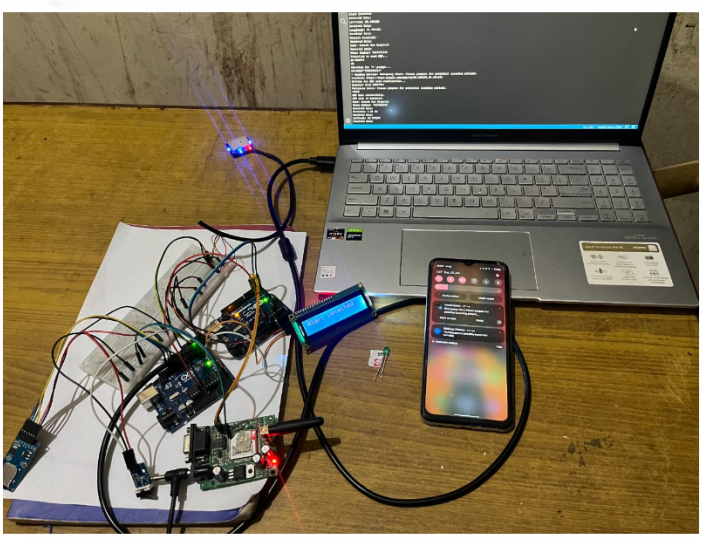

Figure 4: Hardware Implementation

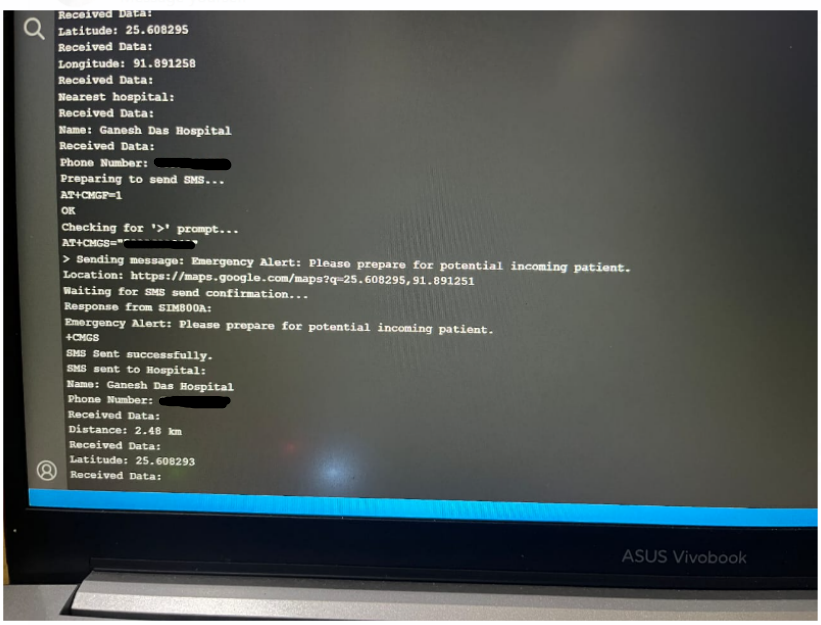

Figure 5: Output displayed in serial monitor

In the above figure the information of accident location with their coordinates and nearest hospital and police station information along with their phone number is displayed

in serial monitor. We have tried to make it more understandable by detailing it in a table below:

Parameters	**Details**
Latitude and Longitude	Coordinates of the vehicle traced by the GPS module
Nearest Hospital	Ganesh Das Hospital (during testing)
Phone Number	7099xxxxxx09
Distance	2.48 km (during testing)
Nearest Police Station	Mawlai (during testing)
Phone Number	8055xxxxxx87
Distance	1.89 km (during testing)

Table 1: Details of the output displayed

As a whole this system proved to be essential in car as its installation is also not that complicated and there is no human intervention while sending the notifications to the authorities and at the time of accidents every seconds count so it can save our lives. The best thing about it is, it can save our lives at a very low cost and it does not matter what kind of facilities are available in our car we can install it anyway and get ourselves a helping hand at the most crucial time.

4.2 CHALLENGES

Problem: Software Serial Conflicts

When connecting the Arduino UNO with both the GPS and GSM modules, we have faced issues in retrieving the data. Both the modules when connected alone to the UNO works fine. The Arduino UNO can only handle one interrupt-driven software serial stream, if we have two or more devices connected to software serial (e.g. GPS and GSM), we cannot receive data from both simultaneously. When switching between the devices i.e. GSM to GPS or vice versa, data is lost as when Arduino UNO receives the data from one device, the other device sending data is not received timely.

Solution: To overcome this issue, we have used two Arduino UNO boards. One board connected to the GPS module and the other board connected to the GSM module. One board is choosen as the main microcontroller board for controlling all other devices(i.e. Sensor, SD card module). The microcontroller board connected with the devices(i.e.GSM or GPS) sends the data to the main microcontroller board for futher calculations using wired serial communication between them.

4.3 LIMITATIONS

Effects of bad weather conditions:

GPS is a satellite based communication module that provides us with accurate location data. The GPS works by continuously receiving data from satellites and the GPS calculates the position accurately by a process called trilateration. Therefore, bad weather such as rain and cloud cover, causes signal attenuation. This weakening of signals lead to delay of generating coordinates.

Poor network connectivity:

GSM module enable devices to communicate over cellular network for voice, sms and data transmission. One most common challenge face by the GSM module is the poor network connectivity. In rural areas with limited cellular infrastructure may suffer from low signal coverage leading to connectivity issue.

4.4 FUTURE DEVELOPMENT

There are two major limitations of the current system. In future, the following work can be implemented to avoid those constraints. Using high quality external antennas for enhanced signal reception. This will help in reducing errors and improving the accuracy of GPS readings, even in challenging weather conditions. To address the issue of poor network connectivity of GSM module, an add on module i.e. LoRa(Long Range) radio module can be used. It is a wireless technology that uses spread spectrum modulation technique to send small amount of data over long distances. In rural areas where the GSM module fails in poor network, the LoRa module can be a reliable alternative. In addition with the integration of advanced IoT devices along with cameras and more variety of sensors will make the Vehicle Accident Management System more efficient.

5 CONCLUSION

This project signifies the importance for a proper accident management system which will timely assist injured people. With the use of modern technologies such as Arduino UNO, Collision sensors, GPS, GSM and SD card modules, the developement of such system has been made possible. With the use of collision switch sensor the road collisions are detected. The GPS module helps in locating the accident area by sending the current coordinates to the nearest hospital and police station. This transmission of data or alert is send through the GSM module. The microcontroller board (i.e. Aruduino UNO) plays a major role in controlling the flow of all other components. The UNO acts as a central node for receiving data from sensors, GPS and also the SD card module. The SD card module contains the dataset of all hospitals and police stations along with their coordinates and phone numbers. These data are used by the UNO board to calculate the distance of nearby hospitals and police stations and finding the nearest one and sending the alert to the same. The calculation of the shortest distances is done with the help of a formula called the Haversine Formula. Further development of the system includes the use of external antennas for the GPS module to overcome the affect of bad weather conditions. Also, by using wireless technologies such as LoRa will assist in transmitting data or alerts in poor network areas. Moreover, with the utilization of advanced IoT devices and various sensors, the efficiency of the system can be increased. Overall, the integration of these technologies and future developments will ensure reliability and efficiency of the Vehicle Accident Management System, ultimately saving lives with timely intervention and communication.

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