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Accident Alert System of Vehicle and Life Security using IoT Devices and Image Processing

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Abstract: In today's world, higher security deployments are needed, as the expansion of the transportation system has accelerated with time. Road traffic disasters have become a widespread problem in recent years. With the tremendous increase in traffic accidents, the fatality rate among people is quickly expanding. Whenever a mishap occurs on the roadways, it becomes a devastating situation for the victims. As an output result of the proposed model in this article, critical notification regarding the scene of an accident and car number was successfully sent to the pre-programmed number after determining the accident scene. The relevant contacts that were configured and added to the system successfully received an emergency message, providing the exact geographic coordinates of the accident scene. Following the receipt of the message, an audio call with a recorded voice was made to the pre-defined number. Moreover, Global Positioning System (GPS) was used to get the coordinates from the satellite. For this purpose, Global System for Mobile Communications (GSM) was utilized to attain the (GPS) coordinates in the event of an accident. Following on, the current location of an automobile through (GPS) was transmitted to certain contact details that were pre-programmed within the application. The system also reported the severity of the accident, as well as whether a vehicle collided with another vehicle or a disaster occurred to the vehicle itself.

Keywords: Location Tracking; GPS; GSM; Arduino; Road Traffic Accident; Vehicle.

1. Introduction

Pakistani citizens live in an area that lacks human security. When an accident occurs, the primary goal is to save a human life. To do so, one of the ways is to use a modified vehicle security system. The basic goal of a vehicle tracking system is to provide safety for the automobile. To be safe on the roads is the right of every Pakistani individual. The provinces of South Asia have been facing major security challenges. These regional and global forces constitute a threat and a major impediment to the region's development and prosperity. To resolve this issue, our work focuses on Pakistan's specific human security issues while also placing them in the context of broader South Asian human security concerns and solutions.

Accidents come in a variety of forms and causes. On the other hand, most accidents are caused by a lack of concentration, which could have been avoided [1]. To make this effort more appealing, a large amount of literature has been evaluated. Besides, working with the families, who lost people in car accidents, was also part of our research.

According to the Pakistan Bureau of Statistics Survey 2008–18, Punjab, Pakistan, leads all provinces in terms of road accidents. A total of 93,121 accidents have occurred, as shown in Figure 1, of which 39,823 were fatal accidents, 111,615 people were injured, and 48,680 died after the accidents. Currently, road accidents are rapidly increasing. Hence, there is a strong need to take a step regarding human security, especially in Punjab. Many times, an airbag saves a person's life in accidents, but sometimes it fails to do so in a severe accident.

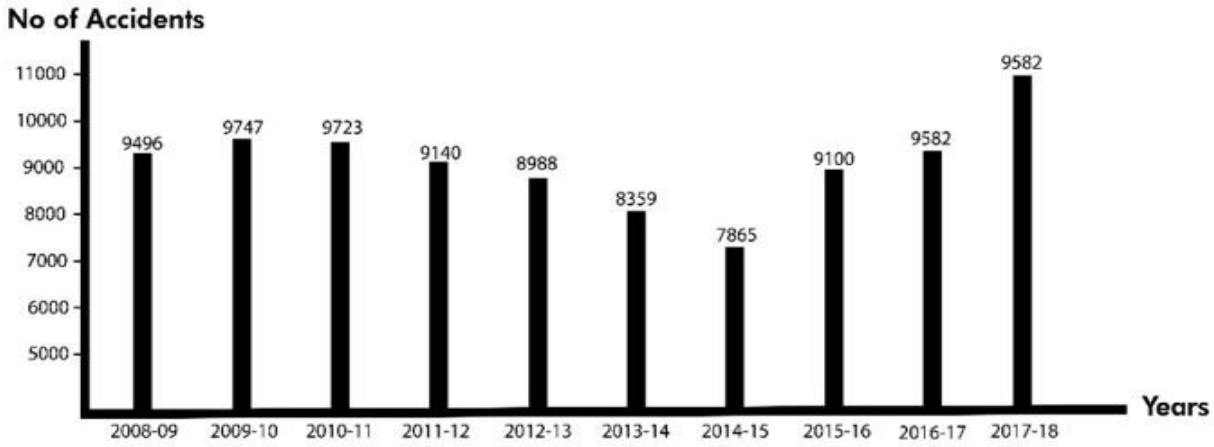

Figure 1. Accidents Ratio between 2008-2018 By Pakistan Bureau of Statistics Survey Road.

According to statistics, the sooner a disaster is reported, the faster paramedics can respond, and hence the survival rate of crash victims will improve. Moreover, the majority of those who are injured in road crashes obtain the required aid from other motorists, passengers, or bystanders. The life expectancy rate becomes low when nobody is present to alert the relevant parties during the "majestic time" for nursing facilities, such as when a hazard happens in an unknown area or when the motorist is the only occupant in the automobile and the crash impact leads to a loss of senses. Considering these problems, a system is required for fatal crash recognition, simulation, and warning.

Human security is every human right. It does not refer to the security of any state. It is for every individual. Our proposal lies in the human security area. Personal security is the sensation or state that happens when sufficient precautions have been taken to delay, warn, or dissuade possible events, which is the key goal to capture in human security. The goal is often to protect against the possibility of physical or material abuse that puts a person in danger. It refers to people's safety - whether they are men, women, girls, or boys - and the manner in which they are enabled to pursue a sustainable lifestyle without having fear either in danger. Personal security is a common concept that takes many real and tangible experiences of families and individuals. To be safe on roads is the right of every Pakistani individual. Our system will make sure personal security as we will try to save every individual's life through emergency calls.

This gear is fitted in the car in a somewhat manner that no one inside or outside the vehicle can see it. Emergency alert detects the position and broadcast's exact location to the preselected cell phone number in the system. The sensor gadget detects any obstacle beside an automobile, indicating that an accident has happened. We set the ultrasonic sensor in Microcontroller if any hurdle or an animal comes, this set value, then the alarm has active to alert the vehicle driver and send the message on a mobile phone when an accident has occurred including GPS latitude and longitude current value of the vehicle. A technology has created that might be used to locate a vehicle's exact location and track it on a Satellite view.

Figure 2. Emergency Call Module

2. Literature Review

Various researchers and scientists developed different tracking systems using Global Positioning System (GPS) and Global System for Mobile Communications (GSM) modules, creating a security alert and an inbuilt pre-detection control system. In the event of an emergency, the system provides alert information in the form of alarms, and a message is sent to a GSM-authorized person. The designed system attempted to track the movement of a moving vehicle and provided on-demand reports on its status [2]. Furthermore, a GSM-based remote monitoring system was introduced. The GSM network is a technique for transmitting signals over long distances. As a result, the model simulated and operated the surveillance stations and the control center's wireless connection [3]. An automobile-detecting mechanism was developed based on the available technology for demanding scenarios such as increased traffic congestion on highways [4]. From the studies mentioned above, it can be concluded that the challenges with the designed devices are feature-based tracking, system performance on a huge data collection, and the use of a prototype system in real time.

In another study, only certain aspects were observed to make the system stronger in partial closure [5]. The developed technology was safe, dependable, and cost-effective. The proposed System-on-Chip(SOC) incorporated into the planning gateway Field Programmable Gate Array(FPGA) promised more integrated construction, operating time reduction, as well as improved framework communication. The tool helped monitor car fuel levels and speeds using cloud computing infrastructure. The proposed method greatly reduced the number of car accidents on the road. A bus-fighting program with the main bus tracking feature was developed for Search Engine [6]. The student's entrance to the coach was predicted by the tracking system. The system used a variety of detectors that supply the bus with extra safety alerts. The satellite mapping approach was utilized to figure out the bus location.

Mane and Shinde devised a mechanism that automatically tracks and monitor school buses [7]. The software used Ide, Ubuntu, GSM, Ground station, and Wireless system. In another study, a proposed GPS-based car tracking system was devised [8]. A GPS receiver, microcontroller, and GSM sim card modem were included. As a part of the transmission, the gadget was applied to track the vehicle for communicating essential information to the other end. Besides, a graphical user interface (GUI) from MATLAB was included in the Recipient section [9].

Another research recommended using a GPS tracking system. Unit tracking, the cloud, and an Android system were the three primary components of the application. The tracking units were installed in the car and communicated the essential data to the cloud, such as the temperature and control of the vehicle, which was now done by recognizing the vehicle's length and length. Following on, the position was plotted on a landmass, facilitating legitimate monitoring. In comparison to other similar systems, this system used a small power quantity [10]. Automobile detection and radar mechanisms were built using the Firebase infrastructure, functioning as processing elements and detention centers [11]. The section identified operator elements, based on brain activity and booze consumption, along with vehicle factors such as volumetric efficiency and automotive velocity. The driver's state was monitored using an optical sensor and an alcohol sensor. A notification was sent if the driver's status was deemed to be abnormal [11].

A large and diverse network-based interstate disaster alert mechanism was presented [12]. The scheme's foundation was an approach to understanding thruway car crashes, informing exchange amongst diverse data centers. Radio Frequency Identification(RFID) pedestrian cones with modern grids were used [13]. The intelligent road cones were equipped with a charge-coupled device (CCD) camera, an RFID tag, and a handheld device, offering route and crosswalk advanced innovations for car wrecks and automobile recognition. To perform an accurate vehicle collision assessment, [14] suggested a multimodal evaluation integration system, utilizing detector information gathered by a motion sensor mounted on a vehicle powerplant and several interior airbag enlistment detectors. [15] looked at potential prospects for the early identification of left-curve, crosswalk, and exact reverse collisions.

For collision caution functionalities, [16, 17] suggested a blockchain network connection centered on V2X interactions. The kernel unit was utilized in the suggested technique to evaluate the assertion details linked to other units. For a forward-moving smart automobile disaster alerting mechanism, [18] created a Feature-based convolutional algorithm using depth perception automobile recognition and both deep-learning and machine-learning approaches. [19] used 348 experimental datasets from actual incidents at

crossings to predict motorist motion behavior. The findings revealed that motorists seemed to pick up speed more quickly in ultimately ensures situations than in typical situations. [20] suggested a vehicle collision model and an automated collision identification model, that use cell phones. The suggested approach used the integrated equipment within contemporary handsets, such as a Navigation system, a gyroscope, a motion sensor, and a magnetometer, to collect the information. The model tracked the radial momentum of moving objects and promptly sounded an alert if anything was out of order.

According to [21], the vehicle crash methodology limits the three-dimensional accelerometer information. Handsets are typically mounted in vehicles thus they are in intimate interaction with the automobile. The automobiles frequently accelerate by about 60 g whenever a significant incident occurs. According to the authors, if a cellphone is thrown from a height of one meter or greater, it can adequately gather data outside the scope of the accelerometer's identification. Hence, gyroscopic statistics were incorporated into the crash mechanism to lower the erroneous alert ratio of cell phones. One of the researchers used a 100 Hz accelerometer and cellphone mouthpiece to capture large acoustic ripples, with high amplitude for damage diagnosis [22].

An accident prevention and detection system utilizing an eye blink sensor and camera to monitor the driver's eye and head movements while also detecting the driver's behavior was proposed in Ref. [23]. It used a GPS receiver and an ARM LPC2148 microcontroller to determine the precise position of the accident. The bump sensor module was used to identify the collision. A model was proposed in Ref. [24] to identify accidents or abrupt changes, Arduino was utilized along with a GPS receiver, GSM module, and accelerometer ADXL335, displaying coordinates or status messages on a 16x2 LCD. In the proposed model [25], GSM module SIM 800L and GPS GY6MV2 were integrated with Arduino UNO R3. The vehicle's X- and Y-axe coordinates were acquired by a MEMS accelerometer, and a GSM SIM 800L, delivering a notification message to the designated contact number. A GPS module continually recorded the vehicle's latitude and longitude.

The suggested system used a microcontroller board built on the Microchip ATmega328P microcontroller and developed by Arduino, to determine whether an accident has happened and its severity level [26]. The ATmega328P microcontroller is a high-performance 8-bit Pico power, AVR, RISC-based microcontroller that combines to give accident victims rapid medical treatment by alerting them to their position near the scene of the accident through message and tracks a vehicle's location in the event of a theft.

2.1. Problem Statement

By reviewing the cause of most accidents, it happens mostly due to over-speeding and sometimes, due to animals, such as a cat or dog, crossing the road. These animals may or may not die on the spot by heavy vehicles. At night, these animals cause a massive problem when dying on the road as the speedy vehicles sometimes cannot be able to see their dead bodies on the road, thus causing a devastating crash. Sometimes in the worst cases, peoples die during an accident, and their relatives stay unaware of the accident and the person's death. So, a system is highly needed to make sure that the relatives stay aware of the person's accident. Reviewing these problems, a crash identification, assessment, and reporting system is required so that the relatives of a related person will get a call, message, and location of an accident when a vehicle gets hit.

3. Proposed Model

The proposed model schematic is depicted in Figure 2. A GPS receiver, GSM module, ultrasonic sensor, camera, and microcontroller are included in the model. The proposed model uses an Arduino microcontroller board. The complete setup is secured to the car. The GPS receiver transmits to the Microcontroller the longitude and latitude data relating to the vehicle's position (Arduino). The Microcontroller provides these data to the GSM Module, which sends the automotive placement value through GPS coordinates to the pre-programmed mobile phone number. The camera is used to capture images of any animal that comes in front of a vehicle so that the department will also receive information if any animal died on the road.

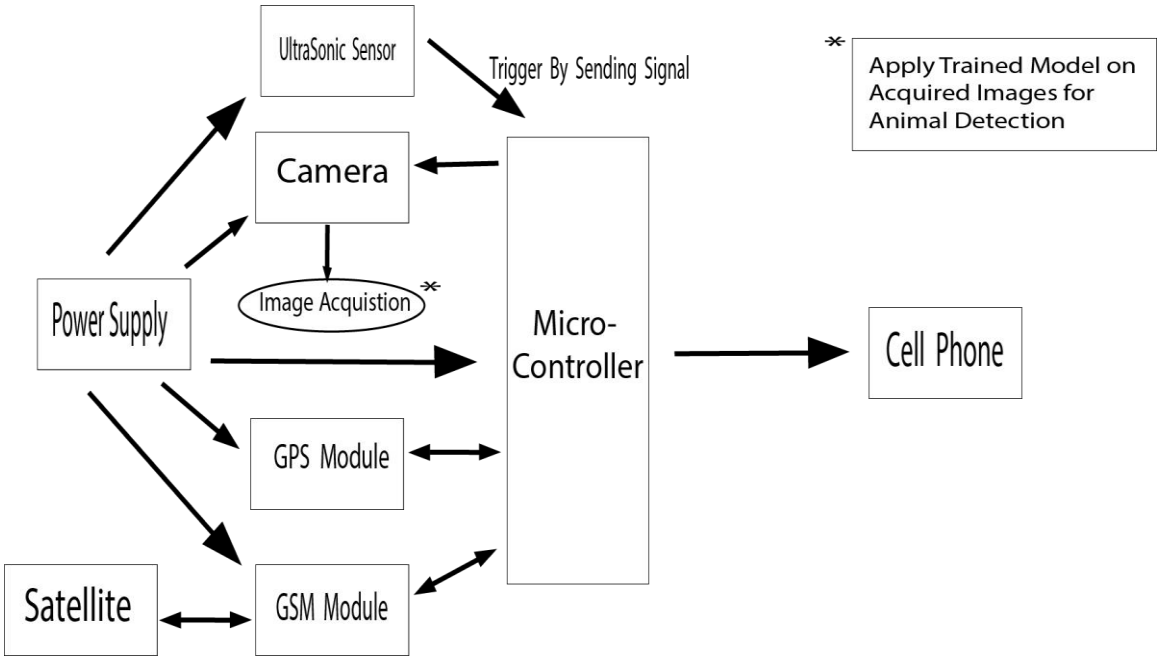

Figure 3. Block diagram of the proposed model.

3.1. Working Methodology

Initially, power will be supplied to the circuit, thus activating all the sensors and the microcontroller board. The sensor will detect and show the cell phone via the microcontroller. As a result of an accident, the motion sensor will be activated and will send a signal to the micro-controller GSM, resulting in a message to the mobile phone. Using the GSM Module, GPS will send the vehicle's position, latitude, and longitude, via message, as shown in Figure 3.

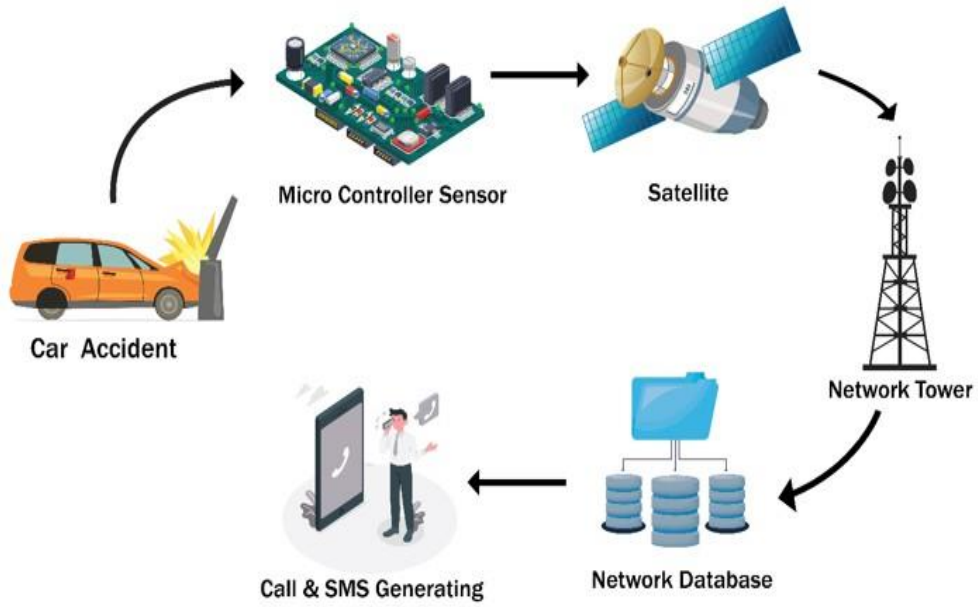

Figure 4. Working methodology of the proposed model.

3.2. Arduino Nano

Arduino Nano is an ATmega 328P-based embedded system. It has 14 basic input/output channels, six analog sources, 16 MHz quartz zirconia, Midi connectivity, also a socket, a Serial interface, as well as a tuning knob, as described in Figure 4. It also includes everything to start a microchip. This device starts working with a plug-in into the laptop via Flash drive or with an AC-to-DC connector power supply.

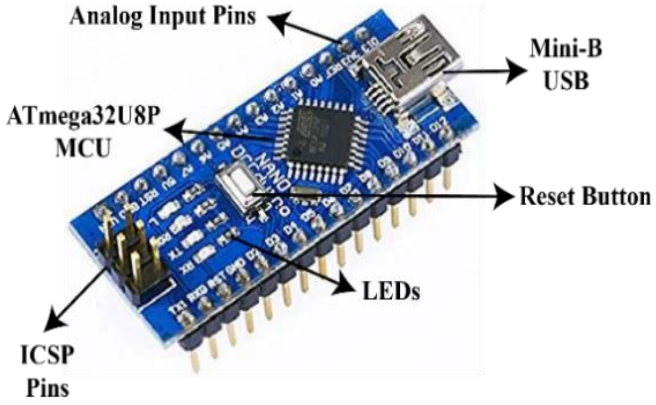

Figure 5. Arduino nano microcontroller for controlling and triggering relevant devices.

3.3. GPS Module

Geolocation is an earth observation celestial developed for the US Ministry of Defense that uses a network of 24 satellites to provide accurate positioning. GPS was originally designed for the military, but in the 1980s, the government made the technology available to the general public. GPS, shown in Figure 5, works in any situation, 24 hours a day, anywhere in the world [27].

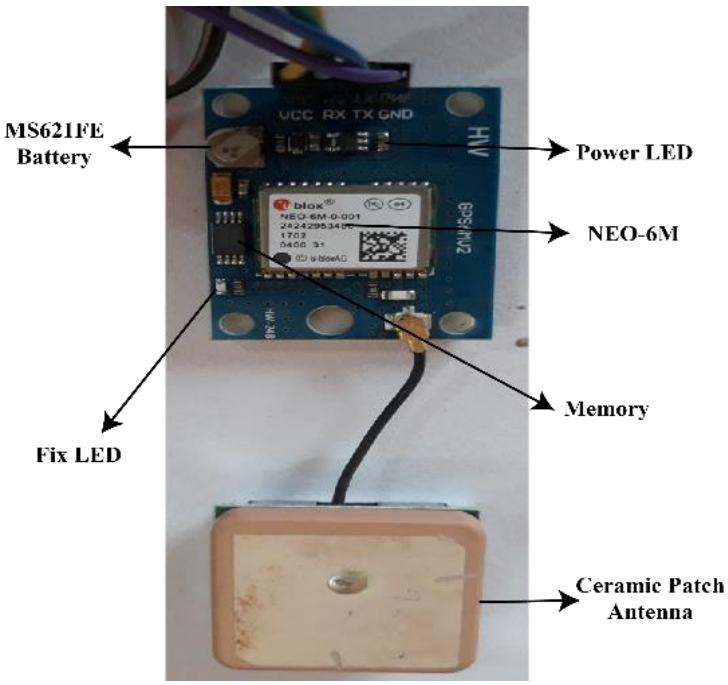

Figure 6. GPS Module for locating the coordinates of the accident location.

3.4. GSM Module

The gadget is a particular chip that accepts SIM cards and manages mobile operator subscriptions. The GSM modem resembles a cell phone from the perspective of a cell phone operator. Globally Communication computerized, a phone framework, is popular in Europe as well as several regions of the globe. It is widely utilized in three digital wireless telephony technologies and uses a wide range of time separation, including TDMA, GSM, and CDMA. GSM is a digital system that compresses data before sending it, including two distinct consumer datasets. The module, shown in Figure 6, uses the 900 or 1800-Megahertz frequency bands [28].

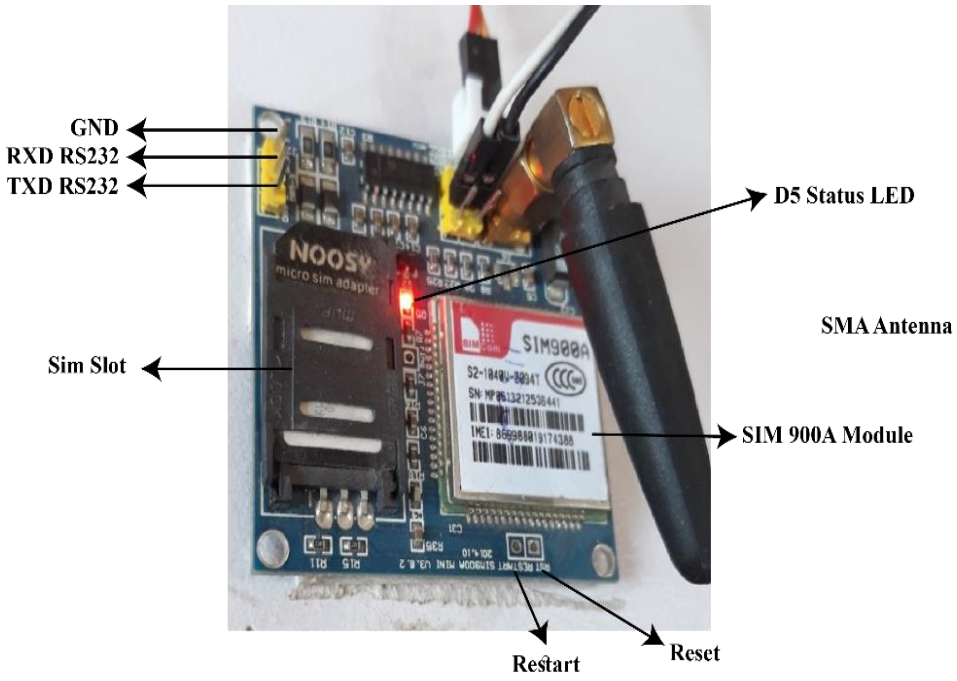

Figure 7. GSM module to transfer SMS and call.

4. Results & Limitations

4.1. Results

Due to the accident of a car, the ultrasonic sensor will activate and provide the signal to the microcontroller. As a result, the GSM MODULE machine will launch a message to the provided cell phone number, which was already saved in the microcontroller programming. A 5-volt power supply with a battery was provided to the system.

The proposal's real-time findings are displayed in Figures 7 and 8. After the car crash, the emergency phone call to the pre-programmed number was made successfully. The critical notification regarding the scene of an accident and car number were sent to the pre-programmed number. The relevant contacts that were configured and added received an emergency message, providing the exact geographic coordinates of the accident scene. After receiving the message, an audio call with a recorded voice was also generated to the pre-defined number.

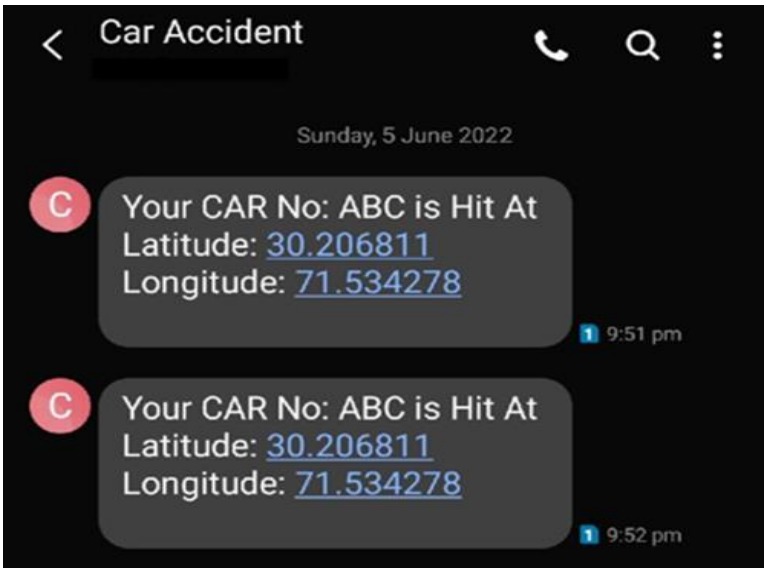

Figure 8. Message output of the proposed system containing accidental location coordinates.

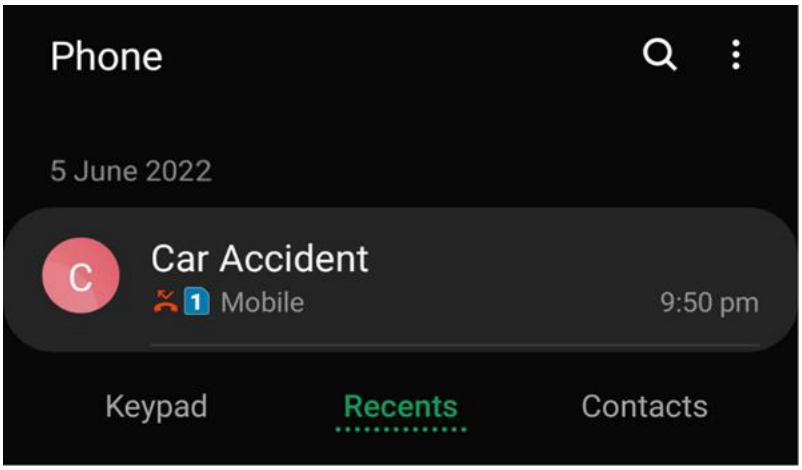

Figure 9. Call output of the proposed system.

The outcome of the suggested system showed the best location accuracy in the outdoor location, while for indoor, the accuracy of the GPS (location) was compromised. On the other hand, call accuracy was of good relevance in both cases. Table 1 compiles the details of the proposed system outcomes.

Table 1. Result of proposed model outcomes.

Module	Module Purpose	Input	Expected Output	Result
GSM	To send a message and generate a call using network SIM	12v Power Supply, Network SIM	Received message, and then Call	Pass
GPS	To get the latitude and longitude coordinates of the location	12v Power Supply	Gives exact Coordinates of GPS present location	Pass
Camera	For real-time detection of any animal	12v Power Supply	Analysis of the acquired image and detect the animal	Pass
Ultrasonic Sensor	To trigger the micro-controller when any animal interferes	12v Power Supply	Trigger the micro-controller so that camera can acquire the image of any hurdle that comes	Pass
Micro-Controller	Triggers the appropriate devices	12v Power Supply	When ultrasonic sonic triggers the micro-controller, then it triggers the camera and GPS and GSM	Pass

4.2. Limitations and Advantages

Commercial transport carriers are the most frequent users of automotive monitoring services. These systems are utilized on board for operational activities like navigation, security, and sending and collecting data. This system can also be employed in conjunction with a fire detector for large vehicles such as trains, and buses. Remote monitoring, airplanes, navigation, fleet management, remote control, security systems, teleservices, vehicle schedule, driver monitoring, route monitoring, accident detection, accident analysis, accident alert, speed monitoring, and other applications are the advantages of this model.

The model that has been discussed has a few disadvantages. To fulfill different functions, we may increase the number of sensors. The microcontroller used in this system contains built-in ADCs, which can

receive analog inputs. To improve the system's accuracy, more sensors are needed. However, overall the function of the model is crucial in preserving lives by informing alarming situations at right time.

5. Conclusions

In this study, a model has been proposed to lessen the number of deaths due to road accidents. To do so, various sensors and devices, including Arduino Nano, GPS, and GSM were linked. The model was tested and the following major conclusions were identified:

1. A notification containing the scene of an accident and car number was successfully sent to the pre-programmed number. Furthermore, the exact geographic coordinates of the accident scene were also received using GPS and GSM. Following the message, an audio call with a recorded voice was also received to the pre-defined number.
2. The location accuracy was precise for the outdoor, while accuracy was compromised for the indoor location. However, the call accuracy was of good relevance for both cases.

This system can further be explored for car thefts and emergency services by providing a precise location to the concerned authorities.

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