IOT-BASED SMART SYSTEM FOR ACCIDENT DETECTION AND PREVENTION

Amit*
Ayush Verma*
Nipun*
Rohit Anand*

*G.B.Pant Engineering College, Okhla, New Delhi, India

Corresponding Author: Rohit Anand, G.B.Pant Engineering College, Okhla, New Delhi, India

ABSTRACT

Nowadays, various factors are responsible for motor vehicle accident fatalities on roads. They may happen due to the human errors or due to the adverse weather. Most of the accidents occur when the visibility conditions are poor or when driver is unable to apply the brakes on time and in many cases the family member and authorities are not informed on time that results in delaying of help reaching the victim suffering due to an accident. The time difference between an accident occurrence and the action taken in response at the accident location is a crucial factor in the survival of the victim after an accident. By reducing the time between an accident occurrence and the action taken in response, the mortality rates may be decreased so that lives can be saved. This paper focuses first to prevent the accidents by means of indication-based techniques and collision prevention techniques, secondly by detecting the accidents by means of the various sensors and thirdly by providing secure and reliable notification methods to notify the relative of the victim and authority so that the necessary action may be taken.

KEYWORDS: Internet of Things (IOT), Arduino, Sensors, GPS and GSM.

INTRODUCTION

Nowadays, countless accidents occur due to the increase in traffic, rash driving, and carelessness of the driver and in most instances, acquaintances or the ambulance and police authority are not informed on time that results in delaying of help reaching the person suffering due to an accident. The expected solution to this problem is a smart system that can be designed to avoid such situations where response time becomes very much critical so as to save lives. So there is a

need of a system that can find a solution to these problems and can effectively function to overcome the delay caused by medical vehicles. This can be realized by the system of smart sensors along with a micro-controller placed inside the vehicle that gets activated at the time of an accident. GPS and GSM are also integrated with the system so as to obtain the exact location coordinates of the accident and to send the message to the registered mobile number, alerting them about the accident to obtain the instant help at the location and send the database of the person to the server through IOT **[1].**

This system comprises of GSM module (SIM900A) and GPS(NEO-6M) that is used to send the message to the registered mobile number and to obtain the location coordinates respectively. This system is also equipped with accident detection sensors like accelerometer, smoke sensor & vibration sensor. Accelerometer (ADXL335) is used for head movement monitoring system for drowsiness detection by measuring the change in axis **[2, 3]**. Smoke sensor (MQ-2) is used for detecting the combustible gases and vibration sensor (SW420) is used to detect the collision due to vehicle and engine malfunction. This system also consists of a motor driver (L293D) which is used to control the speed of the motor as soon as the distance become critical as measured by the ultrasonic sensor. The exact location of the vehicle is then sent to the mobile phone using the GSM module that is making timely rescue of the victim possible and the database of the person is sent to the server through IOT for further information **[4]**.

The objectives of proposed work are summarized below:

1. To design an indication and alert system for the driver in case of any mishappening
2. To establish the head movement monitoring sensor for drowsiness detection
3. To warn the driver through a collision prevention system.
4. To implement the various sensors to detect the accident
5. To locate the accident spot using GPS technology.
6. To display the various activities of the system on LCD display
7. To alert & notify the accidents immediately using GSM and send the database to the server

LITERATURE SURVEY

The authors in **[1]** developed an Automatic Vehicle Accident Detection and Messaging System using GSM and GPS Modem. The paper presented here gives the details of accident detection with the help of vibration sensors in which the GPS stores the location of the vehicle in form of

latitude and longitude in a database server. If suppose the accident is occurred but the condition of driver is not critical, then he/she can stop the sending of the message via a reset button in the system. However, if the reset button is not pressed within a predefined interval of time, then automatically a message will be sent to the registered mobile number through GSM.

In **[2]**, there has been proposed a Smart Braking System for Automobiles to avoid the accidents which considers the head movement monitoring and eye blink in the case of drowsiness as the two major criteria for the increase in number of accidents. In this paper, a GSM module is integrated within the system that is used to send the message in case of accident to the family member of the victim so that the location of the vehicle can be tracked in a quick interval of time.

The authors in **[4]** introduced a Sensor Based Accident Detection and Prevention Technology where the various sensors used are ultrasonic and smoke sensors interfaced with a microcontroller. These sensors are used to detect and control the speed of the vehicle and when it goes beyond the threshold level that is programmed for the sensors, then automatically the speed of the vehicle gets reduced making accident prevention possible in such case.

The authors in **[5]** provided the solution through a system called as Car Accident Detection and Notification System using a Smartphone. The process consists of two parts; the accident detection part in which the car accidents are detected and the notification part where immediately the message will be sent to the smart phone of the concerned individual in the form of location for quick response so that lives can be saved in appropriate interval of time.

PROPOSED WORK

From *figure 1*, the working of the project is explained by taking four different cases that are indication based alert system, collision prevention system, accident detection system and notification based tracking system and when all are put together, it forms an intelligent accident detection and notification system.

Indication-based Alert System

It consists of different LED's, a (16X2) LCD Display and a piezoelectric buzzer for both audio and visual indications. All these components are first interfaced with Arduino mega. We take three different conditions for vehicle indication. We measure the distance continuously by using

an ultrasonic sensor that warns the driver of the critical distance (i.e. the distance predefined in the program that warns the driver to drive safely) under poor visibility or fog conditions.

1. If the obstacle is out of range of ultrasonic sensor, then there is no indication in the buzzer and initially the 'DRIVE SAFE' is indicated on the LCD.

2. If an obstacle is in the range of an ultrasonic sensor, then distance of impact is being displayed in meters on LCD and we use a sound pattern of the buzzer for indication.

3. The third case is the case when the distance between car and obstacle is critical and the vehicle must be stopped to prevent an accident from happening. The buzzer will beep continuously and red LEDs indicate to stop.

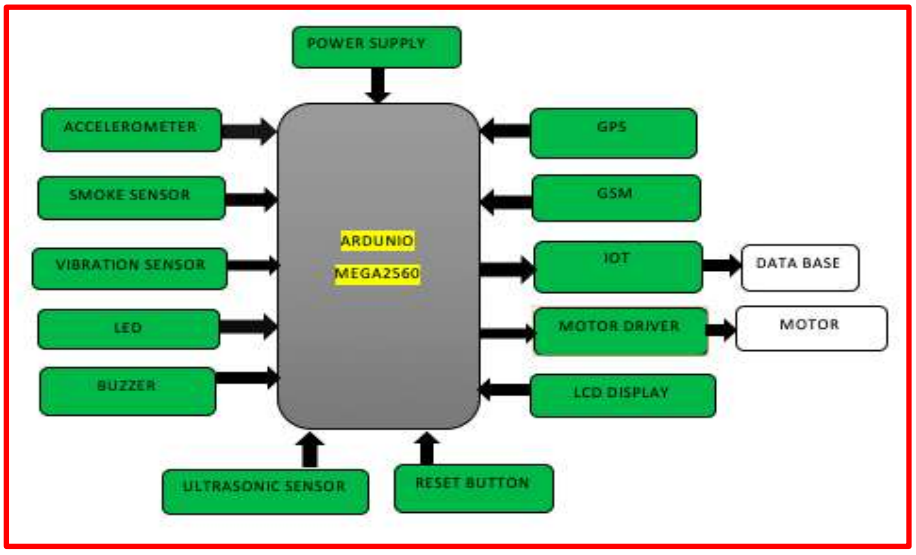

Figure 1. Block Diagram of Intelligent Accident Detection and Notification System

Collision Prevention System

It works along with an indication system and is used to prevent the collision before it happens. It consists of a motor driver IC L293D which is interfaced with Arduino. It is used to bring the variation in car speed if any obstacle appears. A DC motor works on the principle that when a current carrying conductor is placed in a magnetic field, it undergoes torque and has a tendency to move. The motor driver is used to control the speed of the motor. The distance is being continuously measured by an ultrasonic sensor as the distance of impact changes; the speed of the motor varies gradually as the car approaches the obstacle and it immediately stops the car when the distance is critical.

Accident Detection System

In this system, three sensors are interfaced with Arduino; those are ADXL335 accelerometer, Smoke sensor and a vibration sensor. An accelerometer gives the change in the position on the Cartesian coordinate. An accelerometer is an electromechanical device that measures the acceleration force. It shows the acceleration only due to the cause of gravity. It measures the acceleration in the gravity unit. ADXL335 accelerometer provides the analog voltage at the output X, Y, Z pins; which is proportional to the acceleration in the respective directions i.e. X, Y, Z. It is used to establish a head movement monitoring sensor system for drowsiness detection that is very useful for the night drivers.

Smoke sensor is used for detecting the carbon monoxide and other hydrocarbons (LPG CNG) for detecting fire and any leakage. The resistance of the sensor is different depending on the type of the gas. The smoke sensor has a built-in potentiometer that allows adjusting the sensor sensitivity according to how accurate we want to detect the gas. A vibration sensor is used for detecting the unusual vibration in the vehicle and is used to detect the collisions. Vibration sensors, also known as piezoelectric sensors, are the versatile tools for the measurement of various processes. These sensors use the piezoelectric effect that measures the change in pressure, acceleration, temperature, strain or force by converting them to an electrical charge.

An upper limit of threshold is set for each of the sensors. When this set threshold level is exceeded for anyone of sensors or all at the same time, the sensor will send logic '1' to the microcontroller and will alert the microcontroller that an accident has happened.
For ADXL the threshold value is (roll>100 && roll<200) and (pitch>200 && pitch<300).
For vibration the threshold value is 10700.
For smoke sensor the threshold value is 450.
(These values may vary from manufacturer to manufacturer)

Notification-based Tracking System

When there is an abnormality in the sensor value, the accident is detected and a reverse countdown starts which is displayed on the screen of the LCD. If this happens due to human error or the person is safe after the accident has occurred, then the person can press the reset button and the system automatically resets.

However, if the reset switch isn't pressed, then the microprocessor initiates the notification system and takes the current location of vehicle using GPS module in the form of latitude and longitude. GPS provides a result for most receivers within an accuracy of 10 to 100 meters.

As the accident occurs, the microcontroller takes location readings from the GPS to notify the programmed mobile number and sends the messages through GSM module **[5].** The accident notification system notifies the programmed mobile number with the help of this technology to the register mobile number and at the same time, location in form of google link and cause of accident is sent using GPRS and the database of the person is sent to the server through IOT. This technology is used in the project to send the message so that the concerned individual may be informed in appropriate time so that necessary action may be taken. That is why, this system is very much reliable in different kinds of terrains such as hilly areas, areas far from cities.

IMPLEMENTATION

Figure 2 shown gives the complete system for the IOT-based smart system for accident detection and prevention.

Figure 2. IOT-based Smart System for Accident Detection and Prevention

The algorithm of the system is explained through the flowchart shown in *figure 3.*

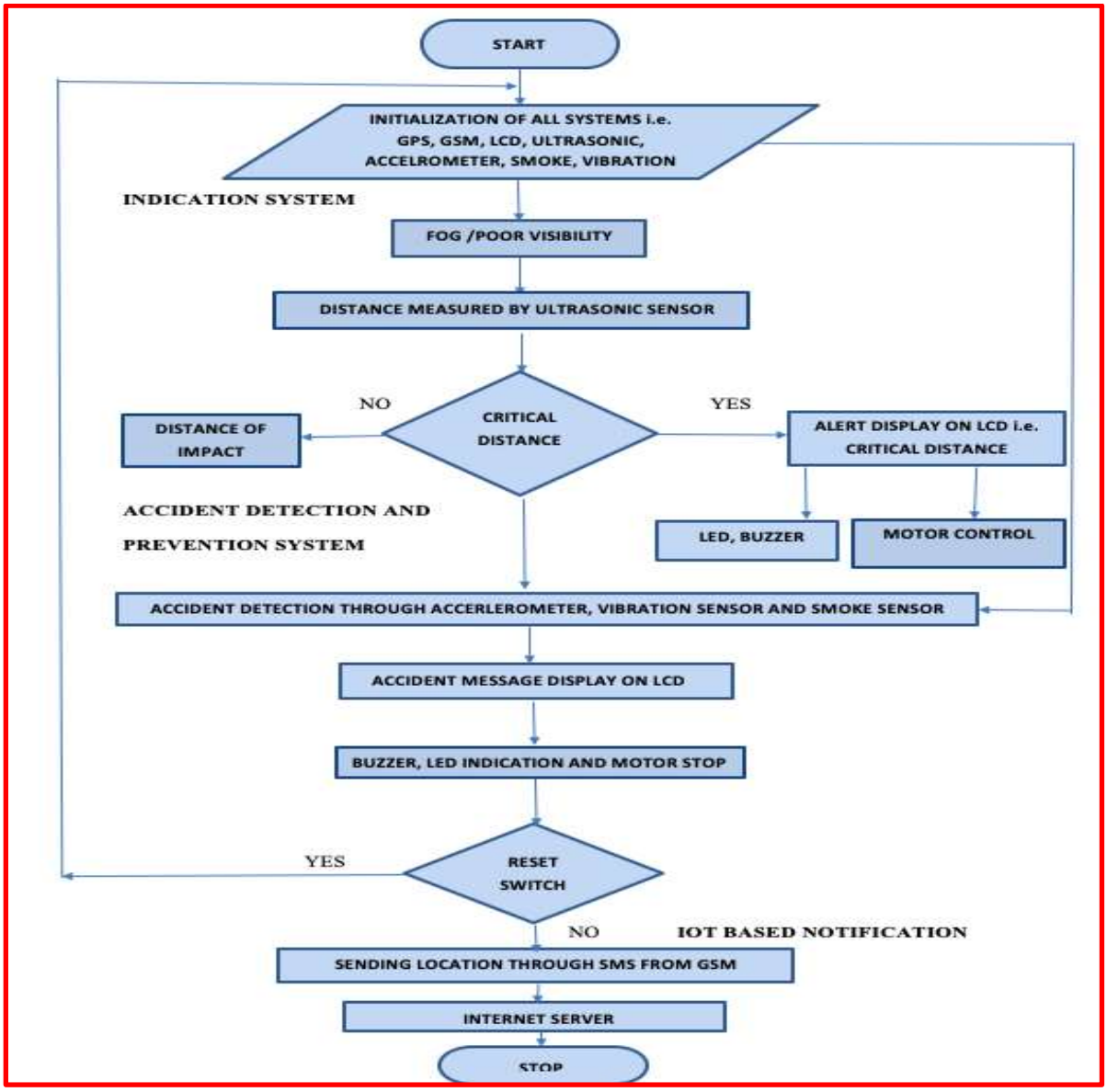

Figure 3. Flowchart of the Accident Detection & Prevention System

Step 1: Start

Step 2: Initialize all the modules i.e. LCD, GPS, GSM and all the sensors.

Step 3: Wait for the sensors to detect the accident using ultrasonic, vibration and accelerometer sensors

Step 4: Prevent collision by stopping the motor as soon as the distance becomes critical.

Step 5: Once an accident is detected, it is indicated by LED's, buzzer and the motor is stopped.

Step 6: Check whether the reset button is pressed within the given interval of time that is fixed for the various sensors.

Step 7: If the reset button is pressed, turn off the buzzer and go to step 2.

Step 8: If the reset button is not pressed, get the current location through GPS.

Step 9: Check whether the GSM modem is registered on the network.

Step 10: Send the SMS with the google link to an authorized mobile number through vehicle notification system and send the database to the server using IOT.

RESULTS

The various causes to determine the accidents, detections through the different sensors and their respective locations are shown in the table 1 by real-time illustrations through a vehicle having vehicle number DL5CA9810.

Table 1. Results showing causes of Accident and Location

SR No	Vehicle No.	Cause of accident	Detected through the sensor	Location
1.	DL5CA9810	Change in axis of the vehicle	Accelerometer	Latitude:28.565605 Longitude:77.226746
2.	DL5CA9810	Collision/engine malfunction	Vibration	Latitude:28.565632 Longitude:77.226539
3.	DL5CA9810	Fire	Smoke	Latitude:28.565719 Longitude:77.226642

Indication-based Alert System: If the obstacle is out of range of the ultrasonic sensor, then there is no indication in the buzzer and initially the 'DRIVE SAFE' is indicated on the LCD (as shown in figure 4).

Figure 4. 'Drive Safe' Indicated on LCD

The distance is being continuously measured by an ultrasonic sensor as the distance of impact changes (as shown in figure 5).

Figure 5. Distance displayed on LCD

Collision Prevention System: The motor driver is used to control the speed of the motor and it immediately stops the car when distance becomes critical (as shown in figures 6, 7 and 8).

Figure 6. Critical Stop

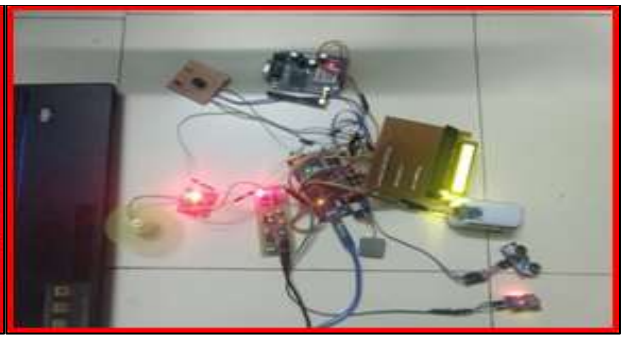

Figure 7. Motor is Running

Figure 8. Motor is Stopped

Accident Alert System: The accidents are detected for the various cases using smoke sensor, vibration sensor and accelerometer sensor (as shown in figures 9, 10 and 11).

Figure 9. Smoke Sensor Detects Fire

Figure 10. Vibration Sensor Detects Collision

Figure 11. ADXL Sensor Detects Axial Change

Notification-based Tracking System: As the accident occurs, the microcontroller takes the location readings from the GPS to notify the programmed mobile number and send messages through the GSM module. The information is further sent to the database server through IOT using node MCU. This is shown in figure 12 and figure 13.

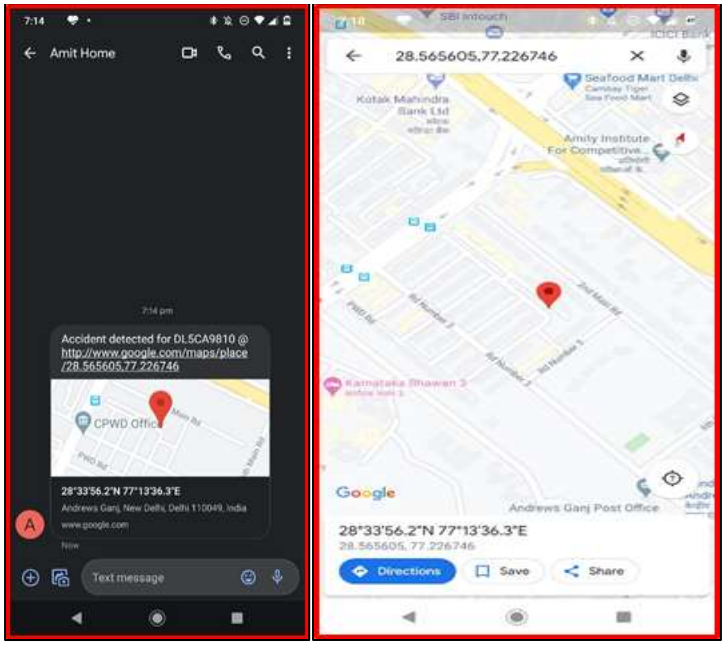

Figure 12. GSM over GPS

Figure 13. Vehicle Database Sent to the Server

APPLICATIONS, ADVANTAGES AND LIMITATIONS

Applications

1. It is used in automotive and transport vehicles like cars and motorcycles.
2. This system can be interfaced with the vehicle airbag system so that when the accident is detected, the airbags get opened.
3. It can be used for the cab or car companies.

Advantages

1. It saves precious time required to save the accident victims.
2. It can easily detect the exact location of the vehicle.
3. It provides the security to the vehicle.
4. It is simple, accurate and reliable.

Limitations

1. The system takes some time for the synchronization of all the modules.
2. The system is quite expensive to implement.
3. There are many places where GSM has less or no network, hence it cannot send SMS in those places. For example, in tunnels etc.

CONCLUSION

This paper focuses on a system that comprises of the various sensors such as accelerometer, an ultrasonic sensor, vibration sensor and smoke sensor along with GPS, GSM, and Wi-Fi modules, all interfaced to the microcontroller Arduino MEGA. The main aim of is reduce the causality by indicating driver prior to the accident occurrence by means of LED's, LCD and buzzer. It is also used to prevent the collision by decreasing the speed of motor, to detect the accident using various sensors and to provide the secure and reliable notification methods by sending the

message through GSM that consists of live coordinates from GPS to notify the relative of the victim and Wi-Fi is used to send the updates to the Central server for authorities so that necessary action can be taken. The time difference between an accident occurrence and the action taken in response at the accident location is a crucial factor in the survival of the victim after an accident. By reducing the time between an accident occurrence and action taken in response, the mortality rates may be decreased so that the different lives can be saved **[6, 7]**. This system reduces the response time and provides the accurate location of the accident site. This system is also very helpful to avoid the accident that may occur due to the fog or any other low visibility conditions **[8].**

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