Vehicle Accident Emergency Alert System

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Abstract. Today’s world is moving in such a speed that no person can spare a minute to stop and look what is happening. The rapid increase in population has inevitably increased the number of vehicles on road and more road accidents with life-loss. The report from World Health Organization (WHO) revealed that approximately 1.35 million people are losing their life each year, because of road accidents. The major reason for accidents is due to drunken driving, distracted driving, over speeding etc. Also, nearly 55% of the life-loss in the highways occurs due to the negligence of accident report of the passer-by vehicles especially during the night or in deserted places remain unnoticed till dawn. A person surviving from the accident, tends to lose their life due to lack of immediate medical response. A Vehicle Accident Emergency Alert system is proposed for immediate attention which could save their life. As soon an accident occurs the vibration sensor or the accelerometer present in the system, transmits the signals to Arduino controller. Latitudes and longitudes data are collected from the GPS system, passed using the GSM module to the emergency centre, and sends a text message to all the people listed in the emergency List. Getting the exact location would help the ambulance to reach the spot with shortest route and time. The proposed alert system could be implemented with less cost and incorporated in all vehicles in near future so that the rate of life-loss could be minimized.

Keywords: Emergency alert, accelerometer, GSM module, Arduino, Embedded C

1. Introduction
Accidents are quite common on Indian roads. The major reasons behind these accidents are poor roads, rash driving, drunken drive, distracted driving, and lack of implementation of traffic rules. As the population in cities increases and urbanization expands, the number of people using automobile are increasing at a rapid rate, this is directly connected to the increasing incidence of road accidents [1]. In 2008, it was found that road accidents were the fourth major reason causing deaths in the world. About 1-1.3 million people die in road accidents and about 20 to million people suffer from injuries that are not fatal, with many people sustaining life with abnormalities which is consequence of accident. Road accidents are the major causes of death among youth aged 15-29 years and there is 1-3% drop in
gross domestic products (GDP) [6]. During the years from 1970 to 2011, the road accidents increased about 4.4 times. Among which the death toll has increased by 9.8 times and injury cases has increased by 7.3 times, even after the backdrop of greater than 100 times increase in the number of registered automobile and to a four-fold increase in the road way.

India has second largest road network in the world which is about 3.3 million km. Since 65% of freight and 87% of passengers traffic as India is supported by the road network and may grow over 14% every year, supporting the automotive telematics. About two-thirds of road traffic injury (RTI) deaths are reported in the age-group 15-44 years. In 2017, [14] officially reported road accidents were 464,910, claiming 147,913 deaths and 470,975 injured persons that is 405 life losses and 1,290 injuries per day from 1,274 road accidents. If no action is taken, death caused due to road crashes is around 19 million annually by 2020. A survey taken by Alcohol and Drug Information Centre (AIDC)India, revealed that around 40% of the road accidents is caused by drunk and drive. Accidents are a major sight in big cities, about 52% of accidents occur in the highways which are about 5% of the total road network [13]. Major causes of accidents on highways are due to high vehicle speeds or higher volume of traffic on the roads. The fatality can be reduced to a greater extent by giving immediate medical assistance to the victims in the accident spot. This can be done by the automatic alert system.

The main objective of this is to reduce the accidents by sending a message to the registered mobile using wireless communication techniques. GPS system helps in finding the location of the accident spot. Once the intensity of accident is known, the system will check for the nearest health centre and notify them about the accident. The medical team can rush to the spot immediately without any delay as the location is shared. This system is considered useful as it immediately intimates to the person related to the victim, the nearest health centre, police station and ambulance. As soon as accident occurs, the vibration sensor or the accelerator present in the system transmits signals to the Arduino. The latitudes and longitudes are collected from the GPS system, passed using the GSM module to the emergency centre [4] [7]. This sends the text message to all the people listed in the emergency list. The microcontroller AT89S52 is code in embedded C using Arduino support. A person surviving an accident may lose his/her life due to vulnerability of immediate primary health care; this can be avoided by this system.

1.1 APPS Developed to Prevent Accident [15]:

[1] Kruzr: The purpose of this app is to make emergency calls by declining other calls and initializing an alert message.
[2] Safely Home: This app is used for location tracking, monitor speed and to detect road crashes to help the victims.
[3] Party hard drivers: This prevents drunk and drive.
[4] One touch response: This app is used in an accident spot, to dispatch their own team and connect with the police and emergency services.
[5] Ham Safar road safety: The app collects the details of hospitals, police stations and other emergency services and sends out precise map locations.

2. Materials and Methods

Few citizens are misusing the technology development which causes more adverse impact in the society. For example, using the mobile phones while driving, rash driving, drunk and drinking etc. have increased. Most of the accident happens because of the carelessness of people. Major cause is either drunken drive or due to over speed. To detect the accidents in highways, isolated areas and to give quick information, the Accident alert system is introduced. The sensors are placed in the vehicles to detect the abnormal changes in vehicles [1]. Sensor outputs are collected, processed, and transferred as control signal to different devices like to generate the alert message through tracking system by GSM module. The controller used is the Arduino controller and vibration sensor i used for accident detection at the spot area. In [2], the authors proposed a system that helps to alert the nearest medical centre, where accident happened and status of the victim, to enable for give proper first aid/
emergency treatments. The system is implemented by using accelerometer to get details about accident nature and the heartbeat sensor output that gives the condition of the victim. If the heartbeat is abnormal the sensor immediately sends the message containing the pulse rate details to the victim’s mobile. An App developed, will alert the nearest hospital and people of close contact, and shares the exact location for further action. Also, they claimed that it is a low-cost device.

The proposed system [3] is designed for an autonomous detection, effective report system and gives emergency help for the road accident victims. Also, the system uses a low-cost SMS/message alerting system to safeguard the life of victim for immediate medical assistance. The components used are heartbeat sensor, accelerometer for motion detection and Raspberry Pi board as controller. The system [4], aimed to give emergency alert and services to automotive systems. The unit comprises of GPS system, GSM Module, CAN transceiver (Controller Area Network), Alcohol sensor. In case of emergency, the people of close contact would get the alert call for the occurrence of accident and condition of victims. The CAN transceiver is a device which can stop the vehicles through the Bus pins. Also, Arduino uses the GSM modem and checks whether the vehicle has crossed the geo fence, and the system is a self-programming and a low voltage detector. The work [5], explored the Automatic Doppler Shift Adaptation (ADSA) and refined the same for Vehicle ad-hoc networks. The authors claimed that the system proposed is robust with minimum time. Thus, the authors achieved a standard for vehicular communication. In [6], the authors devised a system which detects the nature of the driver, namely drunken by using an alcohol sensor. Accident occurrence is monitored by the accelerometer and depends on the signal received, air bag opens to avoid head injury and controlling part done by the AVR controller.

In paper [7], the authors proposed a system to determine the nature of the accident occurred and decision can be taken upon it. For this vibration sensor are integrated with ARM processor to send the alert information through GSM module. Victor in [8], developed a system called “Vehicle Accident Alert and Locator”, shortly called as VAAL is helpful in emergency rescue during accidents of auto crash. The system is installed with machine to machine (M2M) device namely GSM modem, mobile operator along with emergency operating devices to find the exact location. Supriya and Ashutosh [9] has discussed about the Automated Accident Intimation and Rescue System (AAIRS) which uses the vibration sensor and GSM modem to rescue the victim. When the sensor senses the vibration, it checks whether the sensor value is above the threshold or below it and sends the alert message accordingly. In [10], the authors explained a Geographical Information System-Transport system instead of traditional Geographic Information Systems. Also, they included the traffic models based on the time to time variation and not on the fixed slots. They made a study with environmental compatibilities to enable to avoid weather related accidents also. In [11], the authors achieved the Smart Summoning of Ambulance during a vehicle Accident, by the integrated unit which comprises of Arduino, communication module along with crash sensor. The same is combined in a single box structure to increase the reliability and exact location is send to the people of close contact and emergency nodes.

3. Proposed Methodology

The block diagram of Vehicle Accident Emergency Alert System proposed is shown in Figure 1 and the corresponding circuit diagram is shown in Figure 2. The block diagram gives the overall working of the system. The system consists of an Arduino UNO where the commands to be passed are coded using embedded C using Arduino IDE. The Arduino is connected to an LCD in which each process undergoing is displayed on it. The accelerometer ADXL335 MEMS gives the XYZ coordinates of the vehicle and is converted to digital using ADC via SPI protocol and it is sent to the Arduino. GPRS system is used to enable the internet connection and the latitudes and longitudes are obtained from the nearest mobile tower. This data obtained is sent to the members listed while registering in the Arduino. The Arduino is also connected to the driver’s IC which is used to handle the current through the engine and the alarm. When the car meets with an accident, the Arduino processes the commands and the GPRS system immediately obtains the latitude and the longitude from the cell-phone towers as well as the GPS and sends the text message instantaneously. LCD is used to view the coordinates of
the vehicle and when the vehicle crosses the threshold value of the co-ordinates the entire process is activated.

**Figure 1.** Block Diagram of the Accident Emergency Alert System.

The circuit diagram is shown below.

**Figure 2.** Circuit Diagram of the Proposed System
The ADXL 335 MEMS is a triple co-ordinate accelerometer. The accelerometer obtains the values of the plane in which the car is travelling and feeds it to the MCP3208 12-bit Analog-to-Digital Converter (ADC) where the signals obtained are converted digital format (Figure 3). If the plane values obtained crosses the value beyond which the safety of the car is on the danger line (i.e. threshold value), and the emergency protocol is summoned immediately.

![Accelerometer Signal Flow Diagram](image)

**Figure 3.** Accelerometer Signal Flow Diagram

The GPRS modem is used to gather information on the location of the car obtained from the GPS and push it as a text message. It makes use of the local mobile network towers (Figure 4). The coordinates obtained from the accelerometer fed to the micro-controller have collaborated with the location obtained from the GPRS modem. This action takes place within a few seconds after a crash has been detected. The MAX232 IC acts as an intermediate link between the Arduino and the GPRS modem by converting and maintaining voltage signals. MAX232 IC makes sure that the data is transmitted properly without any fluctuations as it is the main voltage stabilizer of the system.

![Location information to Arduino](image)

**Figure 4.** Location information to Arduino

The data obtained and combined is next sent to the driver’s IC, an NPN transistor (BC547). This transistor is mainly used for switching and amplification (Figure 5). Here it amplifies the signal obtained from the Arduino and sends it to the alarm so that it is ringing sound makes sure that an accident has been confirmed. If no serious accident has occurred and the person is stable enough to help themselves, then, the device can be turned off manually.
4. Hardware and Software Details
The following part explains about the hardware and software details. The major components are Arduino, accelerometer, voltage level controller, GSM module etc.

4.1. ARDUINO UNO
Arduino is a hardware platform or a development board, which has a microcontroller based on it. It can be used to communicate between Arduino boards or between a computer and an Arduino or between microcontrollers and Arduino etc. It consists of ATmega328p microcontroller along with components like crystal oscillators, voltage regulators, and serial communicators to support the microcontroller. The voltage range is 3.3V to 5V with 6 analog pins and 14 input/output pins.

4.2. ADXL 335 MEMS
Figure 6. shows the ADXL 335 MEMS, which is a high range, low frequency accelerometer that is used in shock and blast detection applications. It is used to measure the static acceleration of gravity in the tilt-sensing applications as well as dynamical acceleration from motion shock or vibration. It has triple axes coordinating system i.e. all the three planes (XYZ) are considered. The device measures the acceleration due to gravity and the range is ±3 g. The device has a small ball enclosed within and the walls enclosing the ball are made up of piezo-electric elements. So, whenever the ball touches the wall due to acceleration, the co-ordinates along all the 3 axes are recorded and sent to the Arduino via MCP3208 (Figure 7).

Figure 5. Arduino information to Alert system

Figure 6. MEMS Accelerometer Circuit Diagram
4.3. **MPC3208 Circuit**

**Figure 8.** shows the circuit diagram of MCP3208 circuit. It is an electronic Multi-Chip Package IC which is predominately used to convert analog signals to digital signals which consists of 8I/P channels and has 12-bit input. It is used in sensor interfaces, to control the sensor and to acquire data from various sensors and co-ordinate them accordingly.

The data received is in analogous form which must be converted into digital format so that the Arduino understands the process and makes, only the right commands are passed. The operating voltage in a region between 2.7V and 5.5V and has an industrial temperature of -40°C to +85°C. The analogous inputs are programmable either to give 8 single ended inputs or 4 pseudo-differential input pairs. The maximum rate of sampling is at VDD=5V.

4.4. **MAX 232 IC Circuit**

**Figure 9.** shows the circuit diagram of MAX 232 IC, which is an Integrated circuit acting as a voltage level converter. This IC is used in RS232 communication system which is the standard protocols for series communication. This communication system is used to connect the signals between data terminal equipment’s such as modem, computers. This entire setup is utilized for voltage conversion of TTL devices such that it is made compatible with PC serial port and vice-versa. This has dual drivers and dual receivers to support two conversions in parallel. Average speed is 120kBit/s and has an operating current of 8mA. The device is a 16-pin configuration with 4 external capacitors that has a range between 8µF to 10µF and withstands a voltage of 16V.
4.5. *GPRS SIM 900L*

The most effective miniature form of the GSM modem is the SIM900L GPRS module. This can be used to do a lot of activities such as send text SMS, receive, or make calls and even connect to the internet. The operating voltage of this model is 3.4V to 4.5V, consumes less power and it is constructed with the help of LiPo battery. The dimensions of the device is 23mm*35mm*5.6mm. It can connect to any GSM even with the basic 2G network connection. Thus, it makes the device handy and persistent even in low bandwidth. The GPRS connects to the internet using “http://”. They communicate with the Arduino using a UART port. It also supports an internal GPS Module which makes use of the mobile towers to get the latitudes and longitudes of the device and hence can be used as a tracker. The device with the location data can be sent as link by accessing mobile data present in a text message.

4.6. *GPS SIM28ML*

GPS SIM28ML is a high-performance stand-alone receiver with a built in LNA (*Figure 10*). It does not require an antenna for transmission and can track signals as low as -165dBm without network assistance. The device consumes very less power and it supports various navigation applications. The mapping application used in all devices makes use of this GPS predominantly as it can track the location without the support of internet connection i.e. via A-GPS. This model is cost efficient and is reliable. The accuracy of this device is very much precise and can give the data of latitude longitude and altitude. This model is preferred as it gives the data with a more accurate timestamp also.

*Figure 10. GPS SIM28ML Diagram*
4.7. Embedded C
The most popular language used to program Arduinos is the embedded C. This code is widely used by the software industries to code many electronic gadgets as the code is easy to understand, reliable, portable, and scalable. The system proposed makes use of embedded C in Arduino IDE. The flow of the program is as follows: the maximum and the minimum limits are defined after which all the header files and the various declaration and preliminary calculations are done. Several void functions are created for example, a void function for GSM module is created to initialize the GSM module and a separate void function is created to establish communication between the hardware and software system. Using the loops, the accelerometer calibration is done along with reference values of the threshold axis. A separate void function is created for the GPS to get the exact location, extract, and convert them to decimal values and to send it to the LCD. By this way, the system is skilfully so that the entire setup runs flawlessly.

4.8. Flow chart
Figure 11. shows the flow chart of the vehicle accident alert system.

![Flow chart](image-url)

**Figure 11.** Flow chart of the Proposed System
5. Results and Discussion
The Table I, gives the range values of accelerometer, along all the possible axes at which the accident occurs. In all the three axes the voltage recorded is 3.24 volts.

Table 1. Accelerometer Output

| Axis | Range                  | Voltage Recorded |
|------|------------------------|------------------|
| X    | 0-10 or 170-180 (ROLL) | 3.24V            |
| Y    | 0-10 or 170-180 (PITCH)| 3.24V            |
| Z    | 0-10 or 170-180 (YAW)  | 3.24V            |

Figure 12. Car Longitudinal Movements

The longitudinal movement on three axes is shown in the Figure 12. Consider the longitude possibilities, if the vehicle is travelling along all the axes at 90 degrees, the vehicle is safe, and no accident message is initiated. Now, if the vehicle is tilted between the range 0-10 and 170-180, if it is along the X axis, the vehicle rolls either on the right or left and accident occurs. Else if it is along the Y axis the vehicle pitches back or forth causing a front/back crash. Else the vehicle yaws along the Z axis without a proper control over the drift occurred and hence an accident takes place. The values of these co-ordinates are updated every second to the Arduino. By making use of the Piezo-electric property present in the MEMS accelerometer, any abnormalities in the system is detected easily by comparing these values with the threshold value measured by the accelerometer and fed into the board.

Figure 13. shows the flow chart for GPS working. Due to the presence of the GPS module, an abrupt change in the latitude and longitude can be used to detect an accident. For instance, if the vehicle is hit by another vehicle on any of the four sides, and if the car does not roll, yaw or pitch, but instead, moves along the direction of hit at a high speed, the sudden change is sensed and an error is immediately sent to the Arduino and it immediately starts the emergency protocol as soon as it crosses verifies the values obtained from the GPS with the pre-coded threshold value. The threshold values of the latitude and longitude are calculated with the help of mathematical formulae such as the Harsevine’s formula and Vincity’s algorithm. The geo-fencing limit of vehicles can be approximately set to 2.5 m. If the vehicle crosses this limit instantaneously, the entire system starts it action.
Figure 13. Flowchart for GPS module working

The following table (Table No. II) gives the distance output moved for change in latitude and longitude.

| Latitude Change | Distance (m) | Longitude Change | Distance (m) |
|------------------|--------------|------------------|--------------|
| 0.001’           | 1.84         | 0.001’           | 2            |
| 1’               | 1840         | 1’               | 1805         |
| 1°               | 110160       | 1°               | 108299       |
| 10°              | 1101600      | 10°              | 1082990      |

From the above table, it is inferred that a small change in the latitude makes a greater impact on the distance. GPS is used as a secondary system to recheck if the accident has occurred or not. It proves to be an excellent backup also. The same process of sending an alert SMS is followed here as soon as the information from the GPS module is passed to the Arduino. The program in the Arduino is suitably coded in embedded C such that, there is exact readings of the data. As soon as the accident alert is obtained from the Arduino, the GSM module sends the location of the incident spot obtained from the GPS as a link in a text message [Figure 14], to the registered numbers as well as the nearest EMC.
If an accident occurs, the entire process of the system is initiated, and the text message is sent as follows. Using the link provided in the text message, one can obtain the exact location of the incident spot and reach there quickly by taking the shortest route. The text message is also forwarded to the nearest EM centre, so that an ambulance is sent to the location as quickly as possible and the death rate can be reduced. This system can be installed in all types of vehicles such as two-wheelers, three-wheelers as well as four-wheelers.

6. Conclusion and Future works
The Vehicle Accident Alerting and Detecting System could be a safer system and about two third of the lives from dangerous road accidents could be saved, especially in remote areas where the human activity is less. The GPS tracker attached in the system gives the information of the exact geographical location that could specify the latitude and longitude. The SMS contains the details about the information of occurrence of accident and condition of patient by measuring the vital bio signals and the registration number of the vehicle. SMS alert is sent immediately to the nearby hospitals, ambulance, police station, also to the family members of the victim. The ambulance could be arrived at the accident spot immediately by using the location details and quick medical help could be provided to the victim. If the victim is not injured severely, then that person can switch off the alert system by pressing a button which is placed in the side of the unit. Thus, a simple way is achieved to reduce the frequency of accidents and immediate alerting system, a low-cost way to save high cost lives. As a future works, the method could be devised as a low-cost product and will be installed in all type of vehicles.

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