11-14-2021

GSM Sensor Based Accident Information System by Using GPS: Case of Ethiopia

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Abstract.

Traffic accidents are increasing periodically at an alarming rate and it is a serious problem throughout the globe particularly in developing countries like Ethiopia. There are a number of factors that contribute to the risk of traffic accidents. Some include vehicle design, road design, road environment, driving skills, impairment due to alcohol or drugs, notably distracted driving and speeding. And due to the lack of emergency facilities in our country the person involved in the car accident usually dies at the scene. The aim of this paper is to deploy and develop a system which will provide an optimum solution to the above stated draw back Once the accident has been dedicated (significantly within less time) a message will be sent through the GSM module with the basic information to first aid center within a few seconds covering geographical coordinates, the time and angle in which a vehicle accident had occurred with the help of the GPS module. This alert message is sent to the rescue team in a short time, which will help in saving valuable lives.

Keywords: Car accident, GPS module, GSM module

1.Introduction.

In today‟s world there is a severe increase in the use of vehicles. Even though the Rapid growth of technology and infrastructure has made our lives easier, such heavy automobile usage has also increased traffic and thus resulting in a rise in road accidents. This takes a toll on the property and due to unavailability of immediate safety facilities it causes human life loss as well. Accident isn‟t something that can be avoided as its unexpected event but at least repercussions can be reduced (Amin et al., 2013). The proposed system of this study makes an effort to provide emergency facilities to the victims in the shortest time possible. The system has the capability to detect accidents in significantly less time and send the basic information to the first aid center within a few seconds covering geographical coordinates, the time and angle in which a vehicle accident had occurred, which will help in saving the valuable lives. The system incorporates GPS and GSM connected with a microcontroller. The entire set-up is installed in the car. Flame sensor and vibration sensor are used as means of detecting an accident. The vibration sensor measures the vibration at the location it is placed. The signal is then compared with the standard values which further confer the accident of the car, unnecessary shock or vibration produced by machines, tilt of the car with respect to the earth‟s axis can be identified with the level of acceleration. Global Positioning System (GPS) is used to identify the location of the vehicle at the time of the incident. GSM is used to inform the exact vehicular location to the pre- coded numbers (i.e. number of the emergency facility). Messages will give longitude and latitude values. From these values the location of the accident can be determined. GSM modem provides a two way communication by using a SIM card. The proposed system also works to reduce the road accidents in the near future due to drunken driving and over speeding. The Alcohol sensor detects the presence of alcohol in the vehicle and immediately locks the engine of the vehicle. At the same time an SMS along with the location of the vehicle is sent to three pre-selected contacts. Ultrasonic sensor is used as a means to calculate speed; if and when the vehicles exceed the speed limit the speed of the motor will be automatically limited. The final step is to add the data acquired through the sensors into the database designed for this purpose. The database is useful for future reference in finding which causes the most vehicle accidents and which location has the most incidents so the proper measure can be taken from there.

2. Background of research

In Ethiopia road traffic accidents are a common health problem according to the world health organization (WHO) report, Ethiopia is considered one of the worst countries in the world where road traffic accidents kill and injure a large number of road users every year (Annual report of road traffic accident in Ethiopia, 2010). The most obvious reason of persons death during an accident is the unavailability of the first aid provision, due to the delay in the information of the accident being reached to the ambulance or to the hospital. This research analyzed before designing the Accident Alert System. It helped us to understand the interfacing of various components used in the project, such as GSM and GPS modems, and also the practical implementation of such projects in real life.

3.Problem Statement.

Life of the people is under high risk. This is because of the lack of best emergency facilities available in our country. And also there is no research based database mechanism to know the real reason for the accident. The researchers undertaken intensive search from IEEE, and other research data bases to investigate whether there are similar projects or research conducted so far in this area. Important key words related with this study were inserted in major research data bases including that of Googlescholar. This research project come up with a solution to detect and prevent the accident before and after the accident has been detect or occurred. There are some reasons that the accident has occurred such as alcohol drinking, speed controlling, fire accidents and so on. An automatic alarm device for vehicles is introduced in this paper which sends the basic information to the medical rescue team within a few seconds of an accident. This device can detect accidents and sends an alert message to rescue teams in significantly less time which will help in saving the lives of the people. The alert message contains the geographical coordinates, time and angle in which the accident has occurred. In cases where there is no casualty the message can be terminated with the help of a switch in order to avoid wasting the valuable time of the rescue team.

4.Objective of the Research

4.1 Main Objective

The main objective of this work is to develop and design automatic accident detection and notification systems to minimize the accidents response time when an accident occurs and the time emergency responders reach the accident scene in reducing deaths due to car accidents. Total work can be summarized as: Vibration sensors are used to detect the accident precisely with the rapid change of vibration of the vehicle. An ultrasonic sensor is used in a car alarm application to calculate the speed of the vehicle. Flame sensor is used to detect the presence of extremely high temperatures that are present with fire and other light sources. Alcohol sensor (MQ3) is used to detect the presence of alcohol and the system generates an alarm once the level of the alcohol is measured above a set threshold value. When a vehicle meets with an accident immediately the sensors will detect the signal and send it to the microcontroller. Microcontroller sends the alert message through the GSM Modem including the location retrieved from the GPS Module to the emergency facility.

5.Methodology and System Design

5.1 Overview of the system

The first components of the system is that the Detection part is used to detect an accident on the road, first we need to know all the possible events that we can assume in case of accident. Here are four major events that can help in accident detection are discussed.
Collision: - a vehicle could collide with another vehicle or solid object this could result in the injury of the diver or the passenger.
Drunk Driving:- driving under the influence of alcohol impairs the ability to drive and increases the risks of causing an accident
Fire: - a fire can start in any part of the car due to collision and so on.
Speed: - speed limiter limits the driver from exceeding the speed limit.
The second part is the Notification part: this section works to notify the police or the designated contact by sending a message that an accident has occurred through GSM with exact location acquired from GPS modem.
The third part is the Database part: once an accident is detected through sensors the data is sent and saved into the database.

5.2 Description of the components

5.2.1 Software Specifications

Proteus simulation, MS SQL Server 2014, Arduino IDE, Virtual Serial Port Emulator MS Virtual Studio.

5.2.2 Hardware Specification

Alcohol Sensor(MQ3 Sensor), Arduino Mega Microcontroller, Dc motor (Small), Flame Sensor, Global System For Mobile CommunicationGSM Module (SIM800L), Global Positioning System (GPS) Module, L298N Motor Driver Module, Liquid-Crystal Display (16x2 LCD Module), Ultrasonic Sensor, Vibration Sensor, Buzzer Light Emitting Diode (LED), Jump wires and Resistors.
Alcohol sensor:- is technically referred to as MQ3 sensor which detects ethanol in the air. Alcohol detection is performed in real time by the alcohol sensor and the microcontroller. There 4 leads are +5V, AOUT, DOUT and GND. The +5 and GND leads establish power for the alcohol sensor. The other two leads are AOUT (analog output) and DOUT (digital output). How the sensor works is that the terminal AOUT gives an analog voltage output in proportion to the amount of alcohol the sensor detects. The more the alcohol it detects, the less analog voltage it will output. Conversely, the less alcohol it detects the less analog voltage will output. If analog voltage reaches a certain threshold it will send the digital pin DOUT high. Once this DOUT pin goes high, the arduino will detect this and will trigger the LED to turn on, signalling that alcohol threshold has been reached and is now over the limit
Arduino Mega Microcontroller:- The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs) 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. Power: - The Arduino Mega can be powered via the USB connection or with an external power supply. The power source is selected automatically. Memory:-The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the boot loader), 8

KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library). Input and Output:-Each of the 54 digital pins on the Mega can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms.
Dc Motor(Small):-

Numbers	Pin names	Description
1 and 2	Terminals	A normal DC motor would have only two terminals. Since these terminals are connected together only through a coil they don't have polarity. Revering the connection will only reverse the direction of the motor

Table 3. Pin configuration of DC motor

Flame Sensor: A fire detector works by detecting smoke and heat. These devices respond to the presence of smoke or extremely high temperature that are present with fire and other light source of the wavelength in the range of 760nm-1100nm when the sensor detects flame the LED will light up and the D0 pin goes low and high feature of photosensitivity.
Global system for mobile communication (GSM): is a globally accepted standard for digital cellular communication. GSM is used to inform the exact vehicular location to emergency responders by providing the vehicle position in the form of latitude and longitude coordinates through SMS. In the project, we use the latest GSM technology, simcom SIM 808 which supports quad-band network mode. It features slim and compact design, robust in operation and easy to use, small form factor and ultra-low power consumption in sleep mode, Operation .
Global Positioning System (GPS) Module Global Positioning System (GPS): provides reliable positioning, navigation, and timing services to worldwide users on a continuous basis in all weather, day and night, anywhere on or near the earth which has an unobstructed view of at least four or more GPS satellites. We used a global positioning system, (GPS). This is a navigational system that uses a network of satellites. The satellites are positioned in orbits about an altitude of 12,000 miles from the earth surface. The satellites send microwave signals which are collected by GPS receivers. GPS helps determine the exact position of any object on earth. Hence, making GPS has become a widely-used in both the military and the civilian industry application.
L298N Motor Driver Module: The L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.
Liquid-Crystal Display (16x2 LCD Module): LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day to day life, either at PCO‟s or calculators. The appearance and the pin outs have already been visualized above now let us get a bit technical
Ultrasonic Sensor HC-SR04 Ultrasonic (US): sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school

formula that Distance = Speed × Time The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module Now, to calculate the distance using the above formulae, we should know the Speed and time. Since we are using the Ultrasonic wave we know the universal speed of the US wave at room conditions which is 330m/s. The circuitry inbuilt on the module will calculate the time taken for the US wave to come back and turn on the echo pin high for that same particular amount of time, this way we can also know the time taken. Now simply calculate the distance using a microcontroller or microprocessor.

Vibration Sensor Smart vibration Sensors detect accident occurrence and send a signal to the connected microcontroller. Vibration sensor is a device which is used to sense the collision or impact. Vibration sensor converts the mechanical energy generated due to collision into electrical impulse. When the produced electrical impulse exceeds the set threshold, the microcontroller is activated and the concerned program starts to execute. When a collision occurs, the magnet starts moving due to spring action which generates a small EMF according to Faraday's law. If this signal is greater than the threshold signal, the signal is passed on to other connected devices, else it is ignored. The sensitivity of the vibration sensor can be changed using a variable resistor

A buzzer or beeper: is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

LED (Light Emitting Diode): is basically a small light emitting device that comes under “active” semiconductor electronic components. It‟s quite comparable to the normal general purpose diode, with the only big difference being its capability to emit light in different colors. The two terminals (anode and cathode) of a LED when connected to a voltage source and the correct polarity may produce lights of a different color, as per the semiconductor substance used inside it.

A wire is a single, usually cylindrical, flexible strand. Wires are used to carry electricity and telecommunications signals. Standard sizes are determined by various wire gauges. The term wire is also used more loosely to refer to a bundle of such strands, as in 'multi-stranded wire', which is more correctly termed a wire rope in mechanics, or a cable in electricity. Although usually circular in cross-section, the wire can be made in square, hexagonal, flattened rectangular or other cross-sections, either for decorative purposes or for technical purposes such as high-efficiency voice coils in loudspeakers. Edge-wound coil springs, such as the Slinky toy, are made of special flattened wire

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law: $I = V/R$ Where I is the current through the conductor in units of amperes, V is the potential difference measured across the conductor in units of volts, and R is the resistance of the conductor in units is (ohms). The ratio of the voltage applied across a resistor's terminals to the intensity of current in the circuit is called its resistance, and this can be assumed to be a constant (independent of the voltage) for ordinary resistors working within their ratings.

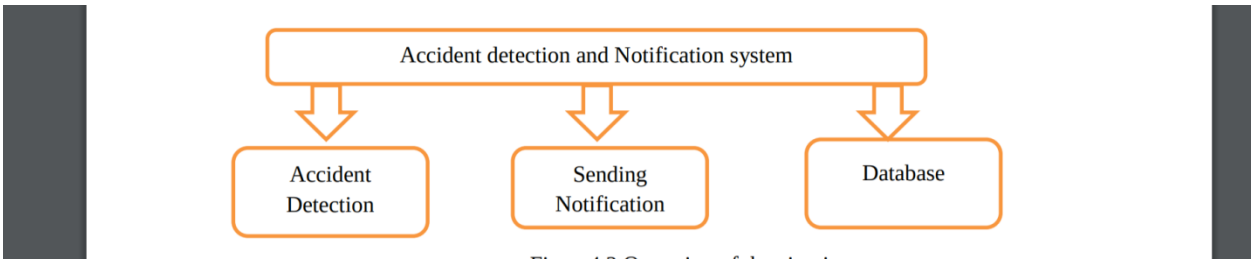

Figure 5. Overall system overview

Connect the sensors to Arduino following the appropriate interfacing mechanism and by using the specified pins. I.e. Alcohol Sensor to pin- A0, Flame Sensor to pin- 4, Ultrasonic to pin 5, 6 (echo and trigger respectively), Vibration to pin-3. Connect GPS, GSM, Buzzer and Led to the Arduino using the appropriate interfacing mechanism. The Arduino can be powered by the PC. After the circuit is constructed, upload the code to the Arduino board. This way the circuit is implemented Assembling and testing the software specifications. Installation of software‟s. MS SQL Server 2014,MS Visual Studio, Proteus, Arduino IDE and Virtual Serial Port Emulator Development of software, testing and implementation. Impact simulation and transmission of data. This involved a mechanism subjecting the impact sensors to a level of impact that would generate a signal to be transmitted to the GSM device subsequently to the database. Data review to check on the efficiency of the system. This involved checking to confirm that the impacts generated by the sensors were logged into as data in the accident database. Data review performed on the database accident instances recorded, with the objective to ensure correctness and integrity. For example to authenticate the accident date and time, site coordinates and vehicle detail.When one of the sensors designed for detecting accidents (i.e. Flame sensor and vibration sensor) detect an accident, the exact location of the vehicle obtained from the GPS is sent to the emergency facility with the help of GSM modem. In case of drunk driving and Speeding the system works to prevent accidents by locking the engine and limiting the speed of the vehicle when it exceeds the limit respectively.

6.Result and Discussion

The proposed system as presented in figure 6.1 is discussed in this section as follows:

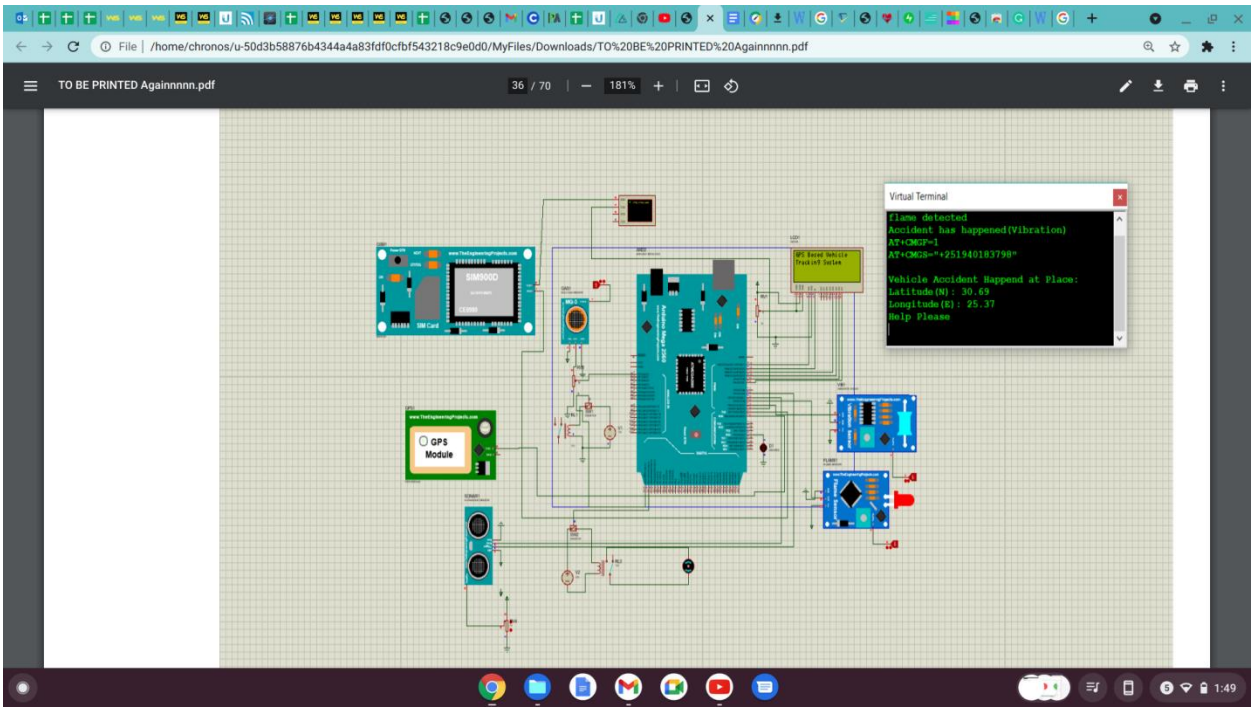

Figure 6.1 Simulation Diagram

Accident detection: When a vehicle meets with an accident immediately a vibration sensor detects the signal and the microcontroller sends the alert message through GSM modem with location with the help

of GPS modem. The GPS sensor can detect the current location of the vehicle. In our proposed system we use the GPS device to find the exact accident location. When a microcontroller receives any signal of accident it requests the current location of the accident spot to the GPS. The GPS sends the location of the accident spot to the microcontroller. Sending Notification: With accident location link GSM sends text message to the hospital and police control room. The hospital and police control room will get a message along with the map link which will contain the exact latitude and longitude details of the location. At the same time, the nearest police station receives an accident message with a link Google map. With the help of these details, the ambulance can take the shortest route to the accident location and reduce the time to save the Database: The database system is for storing and taking care of the data, a database engine can sort, change or serve the information. We detect the vehicle accident and then the location and the reason of the accident is stored in the database. This data is then used to find the location of the nearest hospital and a communication with the locality of the vehicle is sent to them thus medical help can reach the point of accident as soon as possible. Also SMS will be sent to their family members to inform them about the accident.

In this project work, we have studied and implemented programming and interfacing of microcontrollers. This project integrates GSM and GPS modules and different sensors like Alcohol sensor, Flame sensor and vibration sensors, with Arduino based microcontroller. An optional 16x2 LCD is also used for displaying status messages and process progression. The sensors will be positioned at a strategic location. There are different causes of accidents to be considered. In case an accident is due to drunk driving, the Alcohol sensor (mq3) will check if alcohol level of the driver exceeded above 500ml and if it has it sends the signal to the microcontroller and relay will be closed. In case of an accident due to the occurrence of flame, the flame sensor will detect the presence of flame and send the signal to the microcontroller. In case of an accident due to over speeding, the ultrasonic sensor detects if the vehicle has exceeded the speed limit and if the speed limit is exceeded an alert message will be shown to the driver telling it to slow down. In case an accident is due to collision, the vibration sensor (impact detector) will detect the collision and send the signal to the microcontroller. The microcontroller acknowledges the signal and starts the execution of the program. The Arduino microcontroller reads location coordinates by extracting string from GPS module data .The GSM modem will send an accident notification message to the predefined numbers (emergency facilities) in the system along with the information about location of the accident. For purposes of demonstration we used our own phone numbers as we don‟t have access to the emergency numbers. The maximum time the message should take to reach the recipient is 6 seconds of being sent, taking into consideration network lag. The SMS sent contains Minimum Set of Data (MSD) information which will include: geographical location of the accident. In addition, the MSD information sent can be used to estimate/ indicate the time of accident occurrence. Thus, 31 | P a g e enabling recreation of accident details. Medical help can be provided quickly to the victims and hence there will be a decrease in the number of deaths as timely medical assistance can be provided. Depending on the user requirements we could add the phone number of close relatives, who will get notified about the accident and reach the victims. The next step is to save the data on the database. The database used for the project is SQL database. The MS SQL server is a relational database management system used for storing and retrieving data as requested by the user. In this proposed system, software applications will be developed to interface the accident detection subsystem with the database and also to provide a front end to the database users. To start the project will use MS SQL Server relational database management system to store data automatically captured from accident sites. Details of vehicles fitted with the solution will be stored in the database prior to activating the system in the specific vehicle For example, vehicle owner details (include name, address and phone number), the vehicle plate, the sensors mentioned above and the GPS. These details will be collated with the details coming from the accident scene to give more information on the accident.

7.Conclusion

This project presents a vehicle accident detection and alert system with SMS to the user defined mobile numbers. The GPS tracking and GSM alert based algorithm is designed and implemented on proteus simulation. The proposed vehicle accident detection system can track geographical information automatically and sends an alert SMS regarding accidents. Once this happens the data is stored on the database. This research is vital in reducing the death of people from acquiring immediate at least first aid. The researchers recommends other researchers to test the proposed model to be tested in a larger scale to enhance the generalization of the study.

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