

Vehicle Tracking and Accident Alert System

Mrutyunjay Rout¹, Kilaru Sai Venkata Raaman² and Cheerla Ganesh³

Department of Electronics and Communication Engineering

National Institute of Technology, Jamshedpur, India

E mail: - mrutyunjay.ece@nitjsr.ac.in¹, kilaru.raaman@gmail.com², ganicheerla@gmail.com³

DOI: - <https://doi.org/10.47531/MANTECH/ECC.2021.03>

Abstract

The Vehicle Tracking and Accident Alert system uses GPS and GSM electronic modules to track and send the location information to the vehicle over a mobile phone. It also sends alerts via messages to emergency contacts, Ambulance and police with a detailed location of the accident that occurred on Google map. This system can detect three types of accidents. They are accidents due to external impact on the vehicle, accidents due to the toppling of the vehicle and accidents due to unexpected fires. This project provides real time updates of the vehicle location by sending an SMS of the coordinates through the GSM module. This SMS contains the latitude and longitude of the vehicle coordinates. We are using the Vibration sensor, Accelerometer and Fire sensor is for Accident detection. If an accident occurs, the latitude and longitude of the vehicle are retrieved by Arduino with the help of a GPS module, and then it sends this information to the user in Text SMS using the GSM module. The pre-programmed contacts will receive a text SMS.

Keywords: - Vehicle Tracking; Accident Alerts; GPS module; GSM SIM900A module; Vibration sensor (SW-420); Fire Sensor; Accelerometer(ADXL335).

INTRODUCTION

Vehicle accidents contribute to a significant percentage of injuries and loss of life. The time between the arrival of emergency medical help and the time of accident occurred is an essential factor in the probability of survival of a victim after the incident. By removing that delay factor between the happening of the accident and the arrival of medical response to the scene, we can decrease the loss of life and save victims efficiently. A way to get rid of that delay between the incident and the arrival of emergency medical help is to use a system that detects when a traffic accident is most likely to happen and immediately inform the nearest essential medical help and some family contacts.

On the bright side, Vehicle Tracking has many applications in the everyday life of a typical human. The proposed system provides live information such as location, expected time of arrival, speed of the transport vehicle or service. The vehicle tracking service ensures the safety of the passengers using a transport service. It is a system that ensures theft prevention. The main application of this project is tracking the vehicle being used, and early detection of an accident that occurred. In this system, initially, the latitude and

longitude values of the vehicle are continuously collected by the GPS module. Sending a message to the GSM module activates the system and then transmits the location data, which will be used to track the vehicle.

LITERATURE REVIEW

In various projects relating to Vehicle Tracking and Accident alert systems, the systems are designed using very complicated and expensive microcontrollers like ARM, 8051, etc. In this project, we are developing the system using Arduino UNO. Arduino is an affordable, programmable and reprogrammable open-source microcontroller board. It is platform-independent, i.e. it works fine on operating systems like Windows, Mac, Linux. Hence, Arduino is a better, cheaper alternative for microcontrollers like 8051 and ARM. In combination projects, accident detection is always perceived using a single type of process or sensor. We studied these different sensors and designed a system that can detect accidents using three sensors. They are a Vibration sensor (SW - 420), Flame sensor and Accelerometer (ADXL335). This means our model can detect three kinds of accidents and also a combination of these three kinds of accidents, which makes this system much more reliable.

LCD is used to collect details about the system's proper working and check whether the system is working correctly or not.

For Accident detection in various projects and published papers, the accident is detected either by impact using a vibration sensor or by checking the vehicle's orientation using an accelerometer or by detecting fire/heat using a fire sensor [1] – [3]. In this proposed model, we will be using all three modes of detection of an accident, thereby increasing the probability of accident detection.

EXPERIMENTAL STUDY

A. System Block Diagram

In the proposed System, Arduino is used for running the whole task using GPS and GSM SIM900A modules. The above-shown Figure 1 shows the Block Diagram of the proposed model.

A GPS module determines the vehicle's location, and the vehicle's coordinates are notified to the owner via a text message with the use of a GSM module. We are using a GSM SIM900A module and a GPS module for vehicle tracking in this design. And Vibration sensor, Accelerometer (ADXL335) and Fire sensor for accident detection. We can install the system in our vehicle and power it up. By sending a text message, "Track Vehicle," to the system that fits the vehicle, the SIM900A module sends serial information to the Arduino.

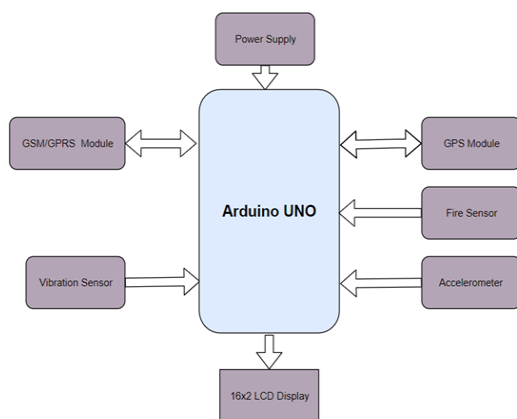


Figure 1: System Block Diagram

The main message is separated by the Arduino from the serial message and then compared with the pre-programmed message. The Arduino reads location data by extracting \$GPGGA String from the NMEA data and sends it to the end-user using the GSM SIM900A module. This message shows the vehicle location. Because of the easy usage and versatility of the system, its popularity is on the rise among owners of costly vehicles and service providers related to transport.

System Flowchart

The working procedure of our system is presented in a Flowchart shown below in Figure 2. The system Flowchart has the following steps:

- In this system, when the vehicle is powered on, the working unit gets turned on and stays like that until the vehicle is shut down.
- The system also stores the vehicle's location coordinates from time to time in its EEPROM storage using a delay.
- Whenever the owner wants to be informed about the vehicle's whereabouts, he can send an SMS through his mobile to the system. Then the GSM module gets the message. The Arduino processes the message and receives the location of the vehicle from the GPS module. The GSM module now sends a text SMS to the mobile number that requested the vehicle's location.
- If the vehicle location is not requested, the system checks whether an accident is detected by the sensors (Vibration sensor, Accelerometer and Fire sensor) attached to the system. If an accident is detected, the GSM module sends a text SMS or Accident alert to the nearest emergency medical help provider or an ambulance, pre-programmed emergency contacts and the vehicle owner. Through this system, a total of three kinds of accidents and a combination of these three kinds of accidents can be detected. They are Accidents caused by heavy external impact on the vehicle, Accidents caused by toppling or misorientation of the vehicle, Accidents caused by internal or external fires in and around the vehicle.
- This above loops of conditioned actions by the system continue until the vehicle is powered off or shut down, in turn powering off the system.

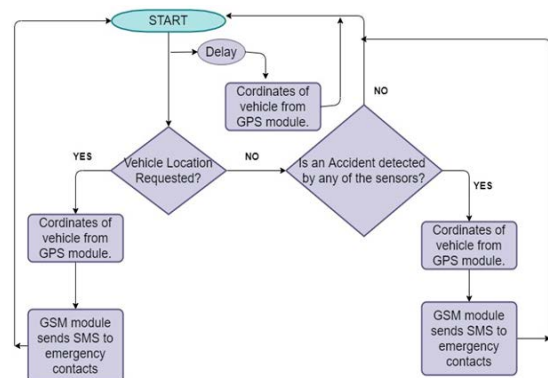


Figure 2: System Flowchart

B. Component Requirements

The component requirements for the proposed system were chosen carefully considering the actions that are to be performed by the designed system and based on the advantages these specific components have over their alternatives. The price of the parts and the assembly charges are also taken into consideration while choosing the components. The components used for this project are listed below modularly separated based on the part of the system its action belongs to:

The component(s) used for controlling the whole system:

- **Arduino Uno.**

The component(s) used for the Vehicle Tracking part of the system:

- GSM/GPRS module SIM900A
- GPS module

The component(s) used for the Accident Detection part of the System:

- Vibration Sensor
- Accelerometer ADXL335
- Fire Sensor

The component(s) used for the confirmation of the proper working of the system:

- 16X2 LCD Display

a) Arduino

Arduino Uno is a microcontroller board based on the ATmega328 microprocessor, and it is shown in Figure 3. It has 14 digital I/O pins, 6 Analog inputs, a 16 Mega Hz crystal oscillator, a USB connector, a power jack, and a reset button. It has all the components required for the microcontroller's working.



Figure 3: Arduino Uno [6]

b) Arduino is an affordable, easily programmable, reprogrammable open-source microcontroller board. It is platform-independent, i.e. it works fine on operating systems like Windows, Mac, Linux. Hence, Arduino is a better, cheaper alternative for microcontrollers like 8051 and ARM.

c) GPS Module

Global Positioning System is the abbreviated form of GPS, and it is shown in Figure 4. Global Positioning System (GPS) is a satellite-based framework that uses satellites and stations on the ground to gauge and compute the location on Earth [7]. GPS Accuracy relies upon a few factors like climate and impediments like structures and mountains. These variables can account for errors in the obtained location. A GPS must be able to get a lock on four satellites to solve for a position. The first lock enables the GPS to get the almanac information and thus what other satellites it ought to tune in for [8] – [10].



Figure 4: GPS Module [11]

d) GSM/GPRS Module

Global System for Mobile Communication is the abbreviated form of GSM.

General Packet Radio Services is the abbreviated form of GPRS.

In this project, the GSM module is used for communicating with the end devices in the proposed system. GSM SIM900A module is a distinct modem that accepts a SIM card and works using the subscriber's mobile number over a network, just like a mobile phone.

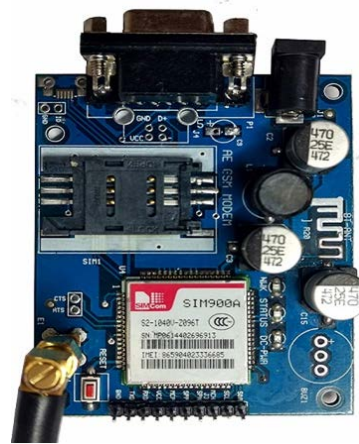


Figure 5: GSM Module (SIM900A) [12]

SIM900A is the GSM modem used in this project. It is shown in Figure 5. SIM900A works on frequencies 900/1800 MHz. The baud rate is configurable from 9600-115200 with the use of

AT command. The GSM/GPRS Modem has an internal TCP/IP stack that enables it to connect to the internet via GPRS. It is well suited for SMS, Voice as well as DATA transfer applications. Using this module, we can make audio calls, send and read SMS, use the internet and attend incoming calls etc., with AT commands.

d) Vibration Sensor (SW - 420)

In this project, we use Vibration Sensor to detect accidents caused by external impacts on the vehicle. The sensor used is called SW- 420. It is shown in Figure 6. SW stands for a switch.

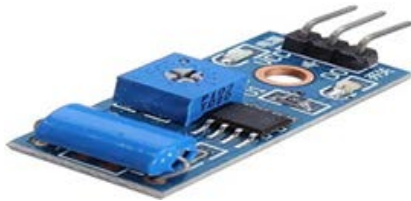


Figure 6: Vibration Sensor (SW - 420) [13]

It has three pins VCC, Ground and a Digital output pin. While interfacing this sensor to Arduino, we need to connect the digital output pin of the sensor to a digital input pin of the Arduino. It requires a 3.3V voltage to operate [14].

e) Accelerometer (ADXL335)

Accelerometer is the sensor that is used in this project to detect accidents caused due to the toppling of the vehicle. It can sense the changes in the orientation of the vehicle along x, y, z axes. It is shown in Figure 7 below. The outputs of the x_out, y_out and z_out are connected to the A1, A2 and A3 Analog pins of the Arduino. The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs.

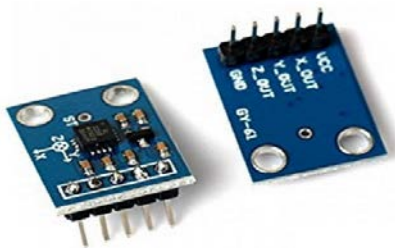


Figure 7: Accelerometer (ADXL335) [15]

f) Fire/Flame Sensor

Detection of accidents caused due to internal or external fires in and around the vehicle is done by Fire/Flame sensor. It is shown in Fig. 8. This sensor has three pins. They are VCC, Ground and a Digital Output pin. The threshold for fire detection of this sensor is adjustable.

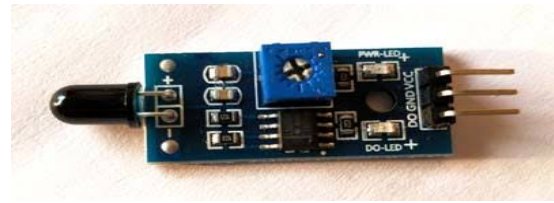


Figure 8: Fire/Flame Sensor [16]

g) 16x2 LCD Display

LCD stands for Liquid Crystal Display. Figure 9 shows a 16 X 2 LCD Display. In this project, the LCD display is used to confirm the proper working of the system and get feedback from the system.



Figure 9: 16x2 LCD Display [17]

An LCD is an electronic display module that uses liquid crystals to produce a visible image. The 16x2 represents that the display prints 16 characters per line in two such lines.

D. Circuit Design of the System

Circuit Connections of Vehicle Tracking and Accident Alert System proposed in this project is shown in Figure 10. The system is simple. Here, the Transmitter and Receiver pins of the GSM module are connected to D2, D3 of Arduino and the Transmitter and Receiver pins of the GPS module are connected to D10, D13 of the Arduino. Both GPS and GSM modules can be powered using less than a 5V power supply.

The Flame sensor's Vcc pin is connected to a 3.3v power supply, and the Gnd pin is connected to the Arduino's common ground pin. The output pin Do is connected to the D11 pin of the Arduino board.

The Vibration sensor's Vcc pin is connected to a 5v power supply, and the Gnd pin is connected to the Arduino's common ground pin.

The output pin Do is connected to the D12 pin of the Arduino board. The Accelerometer ADXL335 is the sensor used to identify the accidents caused due to toppling or misorientation of the vehicle. It has five pins (Vcc, x_out, y_out, z_out and Gnd). The Vcc pin is connected to a 3.3v power supply and the Gnd pin to the common ground pin of the Arduino. The accelerometer's x_out, y_out and z_out pins are connected to the analogue pins A1, A2 and A3 pins of the Arduino board. All the accident detection sensors are capable of powering with 1.8V to 3.3V. Now, the RS, E, D4, D5, D6, D7 of the LCD display are connected to digital pins D4, D5, D6, D7, D8 and D9 of the Arduino board.

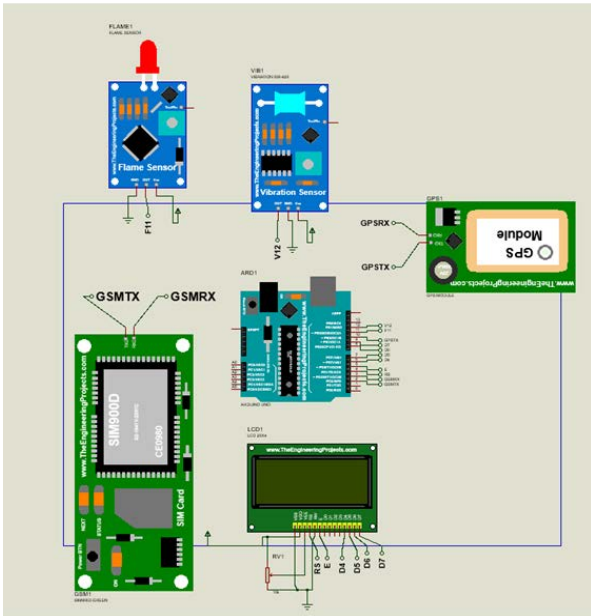


Figure 10: Circuit Design of the System

ESTIMATED RESULT AND DISCUSSION

When the vehicle is powered on in the proposed system, the working unit gets turned on and stays like that until the vehicle is shut down. Whenever the owner wants to be informed about the vehicle's whereabouts, he can send an SMS through his mobile to the GSM module. The Arduino gets the vehicle's location from the GPS module, and the GSM module now sends a text SMS to the mobile number that requested the vehicle's location. The system also checks whether an accident is detected by the sensors attached to the system. If an accident is detected, the GSM module sends a text SMS or Accident alert to an ambulance, pre-programmed emergency contacts and the vehicle owner.

As soon as we upload the code into the Arduino, the LCD display shows the words "Vehicle Tracking & Accident Alert", as shown in the Figure 11.

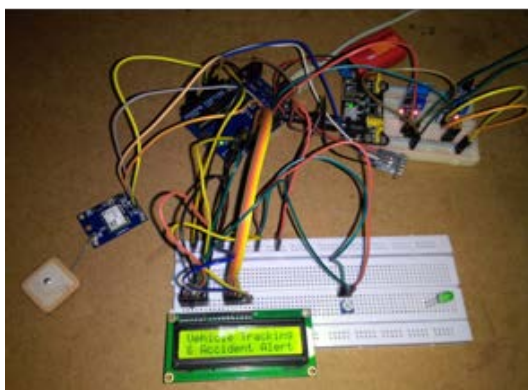


Figure 11: System Initiation

Now, the GPS module starts giving us the NMEA data that we parse to obtain the required latitude

and longitude coordinates. During this time, the system supply power to all the modules working alongside the Arduino and configures them. The LCD display shows the message "System Ready" when the system is ready, as shown in Figure 12.

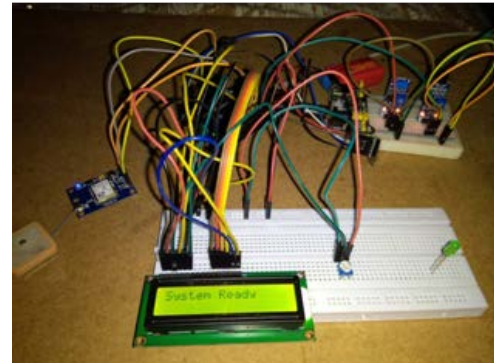


Figure 12: System Reconfiguration

The obtained coordinates are displayed on the LCD display as shown in the Figure 13.

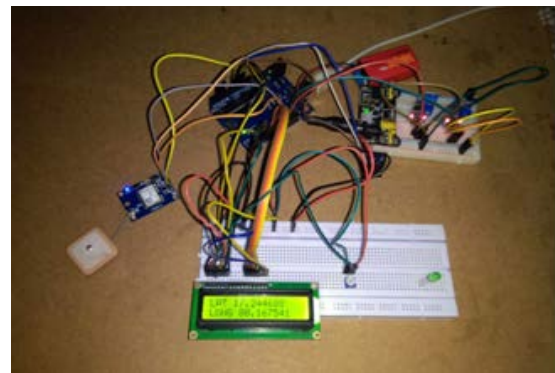


Figure 13: Displayed coordinates on LCD Display

Now, the System checks for any accidents with the use of attached sensors. When the Vibration Sensor SW – 420 or Flame Sensor or the Accelerometer ADXL335 detects an accident, it sends a pulse as output to the Arduino. As soon as the Arduino receives the pulse, it triggers the GSM module to send a text message of the vehicle's location to the owner's mobile, as shown below in Figure 14, Figure 15 and Figure 16.

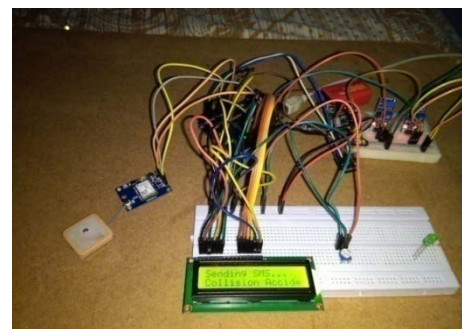


Figure 14: LCD Display as a result of Collision Accident

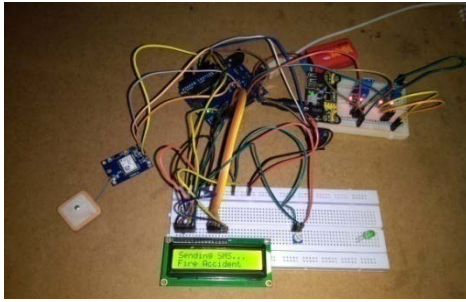


Figure 15: LCD Display as a result of Fire Accident

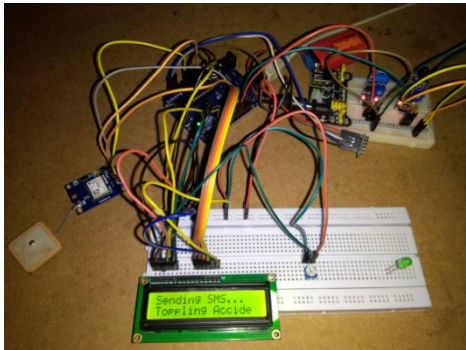


Figure 16: LCD Display as a result of Fire Accident

After sending the SMS, the system configures back to the initial state and shows a message on the LCD display saying “System Ready” as in Figure 12.

Now, the system gets ready for the new iteration of Arduino’s uploaded code. And once again, the Flow chart begins its operation from the start step. These steps in this loop continue until the system's purpose is met.

The received messages on the owner's side are shown below in Figure17 and Figure 18.

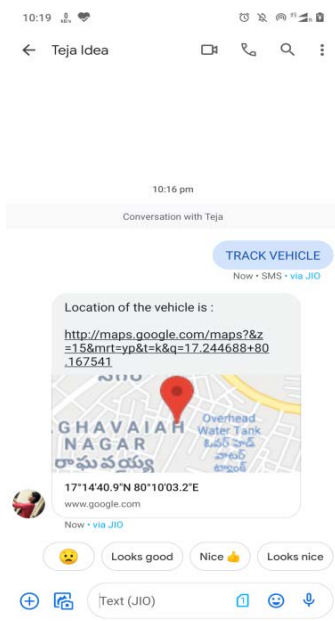


Figure 17: Received Location on Owner’s End

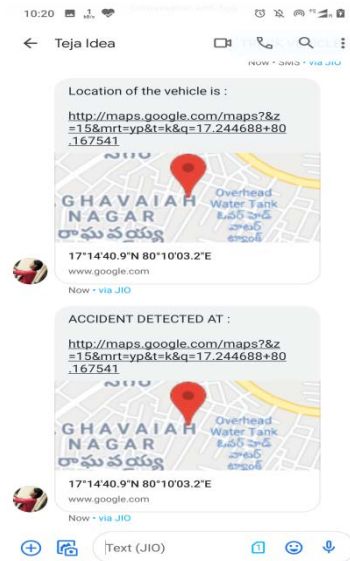


Figure 18: Accident Alert on Owner’s end

CONCLUSION

Usually, in many such projects, accident detection is always achieved using a single type of process or sensor, i.e. only a single type of Accidents is detected. We studied different sensors and designed a system that can detect accidents using three sensors: Vibration sensor, Flame sensor and accelerometer. This means our model can detect three kinds of accidents and also a combination of these three kinds of accidents, which makes this system much more reliable.

FUTURE SCOPE

This project is a very advantageous system with many features. It is very useful to various types of clients like Commercial transport service providers, who are the most significant users of Vehicle Tracking systems, Military and Defence etc. This project can be used in cabs and school buses to provide safety and security to the passengers and children. The implementations for this project are in automobiles, security systems, military, remote monitoring, navigation, aircrafts etc. It gives better security to the vehicle and a lot better medical help in case of accidents. Accuracy of location is very high, and data processing is fast, enabling emergency help communication to reach faster.

ACKNOWLEDGMENT

The authors would like to thank Dr Mrutyunjay Rout for supervising and guiding the project. The authors would also like to thank Dr S.N.Singh and Mr Jayendra Kumar for providing support by encouraging us.

REFERENCES

1. Aarya D.S, Athulya C.K, Anas.P, Basil K, Jerin SJ, Leena T, "IJAREEIE" paper Vol.7, Issue 4, April 2018.
2. T Kalyani, S Monika, B Naresh, Mahendra V, "IJITEE" paper, ISSN: 2278-3075, Volume-8 Issue-4S2 March, 2019.
3. Surekha P, Manjunath KK, C Joseph, Dayana T, Jibin PB, Jithin PB, "IJIRCCE" paper, Vol. 5, Issue 5, May 2017.
4. R. Kumar, H Kumar, "Availability and handling of data received through GPS device; in tracking a vehicle", Advanced Computing Conference (IACC) 2014, IEEE International.
5. Aarya D.S, Athulya C.K, Anas.P, Basil K, Jerin SJ, Leena T, "IJAREEIE" paper Vol.7, Issue 4, April 2018.
6. <https://learn.sparkfun.com/tutorials/what-is-an-arduino/all> (Accessed on 30/11/2019)
7. C Prabha, R Sunitha, R Anitha, "Automatic Vehicle Accident Detection and Messaging System Using GSM and GPS Modem", IJAREEIE, Vol. 3, Issue 7, pp. 1-5, 2014.
8. Amit M, Sri Krishna I, Monika N, Saket JJ, Sachin J, Mujeeb R, "Automatic Accident Detection and Reporting Framework for Two Wheelers", IEEE pp. 962-967, May 2014.
9. <https://learn.sparkfun.com/tutorials/gps-basics/all> (Accessed on 29/11/2019)
10. https://en.wikipedia.org/wiki/Satellite_navigation_device (Accessed on 30/11/2019)
11. <https://www.indiamart.com/proddetail/neo-6m-gps-module-19819679162.html> (Accessed on 30/11/2019)
12. <https://www.amazon.in/Electronics-SIM900A-module/dp/keywords=gsm+SIM900A&qid=15> (Accessed on 30/11/2019)
13. <https://www.amazon.in/OEM-Vibration-Sensor-Module-Motion/dp/B00MRVT2L8> (Accessed on 30/11/2019)
14. https://www.rhydolabz.com/miscellaneous-other-widgets-c-205_124/the-vibration-sensor-module-vibration-switch-sw420-p-2317.html
15. <https://www.dnatechindia.com/ADXL335-Accelerometer-Sensor.html> (Accessed on 30/11/2019)