

Accident Detection and Automatic Emergency Alert System using GPS and GSM Technology

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Abstract—The rapid growth of technology and infrastructure has made our lives easier. The advent of technology has also increased the traffic hazards and the road accidents take place frequently, which causes huge loss of life and property because of the poor emergency facilities. Even with so many modern devices present in the field of vehicle design, road lane design and heavy traffic control accidents do occur at a large scale. Accident threatens human lives more and mainly road accident is common today. During accident many people lose their life because medical services and family member not getting accidental information on time. Any kind of accident detected is automatically sent as an alert to the required destination. Accident detection device installed in a vehicle when meets with an accident will send SMS messages to the pre-install numbers of the driver's family members, police station, ambulance and nearest hospital. This embedded system is useful for tracking and retrieving the exact position of any vehicle, which has met with an accident by using Global Positioning System (GPS), Global System for Mobile Communication (GSM) and Accelerometer (MEMS) sensors.

Index Terms—Accident Detection, Vehicle Tracking, MEMS, Short Message Service SMS, Global Positioning System (GPS), Global System for Mobile Communication (GSM), Sensors, Micro controller.

INTRODUCTION

Road traffic accidents are a cause of death all over the world and India has one of the worst records. Things like driving fast not getting enough sleep and drinking and driving are some of the reasons for these accidents. Automatic accident detection systems are very important because they help find out where accidents happen so emergency teams can get there quickly. When someone is hurt in an accident every minute counts and any delay can be very bad. The

main goal of accident detection systems is to find out when an accident happens and tell emergency contacts like family members, doctors and police right away. These systems also send the location of the accident so help can get there quickly. Not getting help right away is another reason why people die after traffic accidents. We know that every minute, without help increases the chance of death. This shows how important it is to get help quickly after an accident. The system we are talking about uses sensors to keep track of where vehicles are all the time. This information can be looked at from a distance so we can get help to people who are hurt in accidents. The system can even track vehicles when the weather is bad because it uses GPS and GSM technology to send information to a computer. This information helps get aid to people who need it during emergencies. If an accident occurs this tracking system helps to retrieve the exact position of the vehicles. This system sends an automated message to all the pre-install numbers in the device such as the driver's family members, police station, ambulances and the nearest hospitals. Exact position of the vehicles can be acquired by the help of the GPS (Global Positioning System).



Fig. 1. Overview of Accident Detection system

The GSM (Global System for Mobile Communication) module is used to send and receive the message to the various people of the accident that has happened. All the entire working of the hardware is executed with the help of the Micro controller. This micro controller coordinates with all the modules and helps sending the message. When an accident happens, the shock triggers the sensors resulting into sending signals to the micro controller. Once the signal is received the micro controller then sends the result according to its programming.

II. LITERATURE SURVEY

Every year, many people die in car accidents because medical help does not arrive quickly enough. The main problem is that when an accident happens in a lonely area or at night, there may be no witnesses to call for help. To solve this, researchers are developing systems that can detect a crash automatically. The most important part of this system is the accelerometer sensor, which measures the sudden change in a vehicle's speed and movement. If the car stops abruptly or flips over, the accelerometer detects the high impact and tells the system that an accident has occurred. Scientists have found that combining an accelerometer with GPS and GSM technology is the most effective way to save lives. Once the accelerometer detects a crash, the GPS finds the exact coordinates of the car, and the GSM module sends an emergency text message with that location. Using an Arduino to connect these parts is a great choice because it is affordable and can process the sensor data very fast. A key feature of this design is the use of EEPROM memory, which keeps emergency contact numbers safely stored even if the car's power is cut off during the impact. While expensive luxury cars have these features, most regular cars do not. This project creates a low-cost, reliable device that can be installed in any vehicle. By using the accelerometer to trigger an instant alert, the system ensures that rescue teams get the exact location immediately, significantly increasing the chances of survival for the victims.

III. METHODOLOGY

A. The main control module (Arduino Uno):

Arduino Uno is a microcontroller board. It has 14 digital input/output pins (of which 6 can be used as PWM

outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards. Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. The Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the microcontroller into a more accessible package.

B. GSM Modem (SIM900A):

A GSM modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection. The GSM modem has wide range of applications in transaction terminals, supply chain management, security applications, weather stations and GPRS mode remote data logging. The GSM modem used in the System is SIM900A which is a complete Dual-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications allowing you to benefit from small dimensions and cost-effective solutions. Featuring an industry-standard interface, the SIM900A delivers GSM/GPRS 900/1800MHz performance for voice, SMS, Data, and Fax in a small form factor and with

low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900A can fit especially for slim and compact demand of design.

C. GPS Modem (NEO-6M):

Exact location on earth can be known GPS latitude, longitude information. The Global Positioning System (GPS) [3] is a space-based radio navigation system consisting of a constellation of satellites and a network of ground stations used for monitoring and control. GPS is operated and maintained by the Department of Defense (DOD). The GPS is a constellation of satellites in orbit around the Earth which transmit their positions in space as well as the precise time. It is the receiver that collects data from the satellites and computes its location anywhere in the world based on information it gets from the satellites. The heart of the GPS modem in the system is NEO-6M GPS chip from u-blox. It can track up to 22 satellites on 50 channels a level of sensitivity i.e. -161 dB tracking, while consuming only 45mA supply current. One of the best features the chip provides is Power Save Mode (PSM). It allows a reduction in system power consumption by selectively switching parts of the receiver ON and OFF. This dramatically reduces power consumption of the module to just 11mA making it suitable for power sensitive applications like GPS wristwatch. This includes pins required for communication with a microcontroller over UART. The module supports baud rate from 4800bps to 230400bps with default baud of 9600.

D. Accelerometer (ADXL345):

An accelerometer is a Micro-Electro Mechanical System (MEMS) sensor which measures static (earth gravity) or dynamic acceleration in all three axes. It measures level of acceleration where it is mounted which enable us to measure acceleration/deceleration of object like car, or tilt of a platform with respected to earth axis, or vibration produced by machines. Accelerometers measure in terms of 'g' ('g' is acceleration measurement for gravity which is equal to 9.81m/s²). Accelerometer converts mechanical motion into electrical output.

IV. SYSTEM FEATURES AND WORKING

A. Architecture of the System:

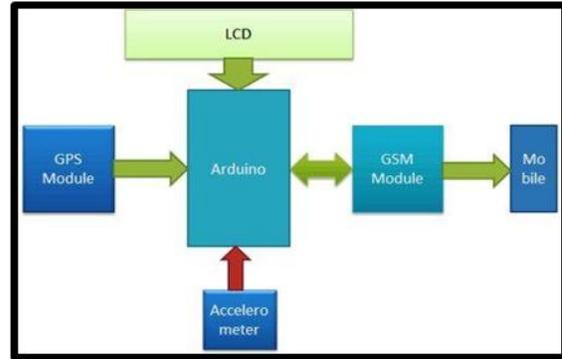


Fig. 2. Block Diagram

The proposed system consists of accident detection and alert system, vehicle tracking system. The accident detection system will constantly monitor the vehicle and detect whether the vehicle is in normal driving posture or has fallen down or any impact has taken place on the vehicle. When the vehicle accident is detected by means of different sensors interfaced the system then immediately inform the location of the accident to the contact numbers mentioned in the program which is dumped in the microcontroller by making use of the GPS module interfaced in the system.

B. Accident Detection and Alerting System:

This system consists of two main parts. The first part detects whether the vehicle has fallen down or met with any impact. This module consists of the Accelerometer (MEMS) sensor. Once the vehicle accident is detected the information is send to the second part of the system. The second part consists of an Arduino uno, GSM module, GPS module. When the sensors get activated based on the level of impact then the micro-controller in the Arduino fetches the location from the GPS receiver and sends the corresponding information to the contact number mentioned in the code which is dumbled in the Arduino i.e., to near and dear one's via SMS.

C. Algorithm for Different Processes in the System:

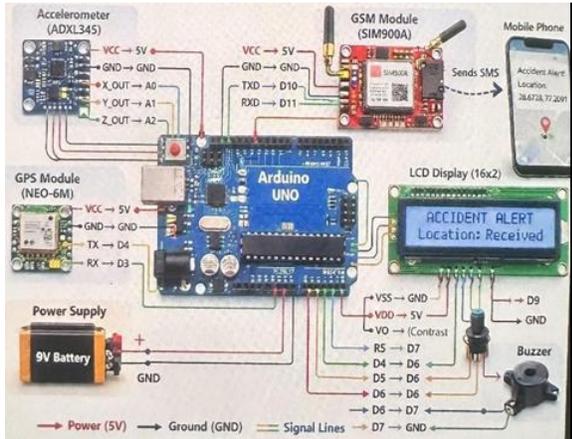


Fig. 3. Flow chart of Accident Detection System

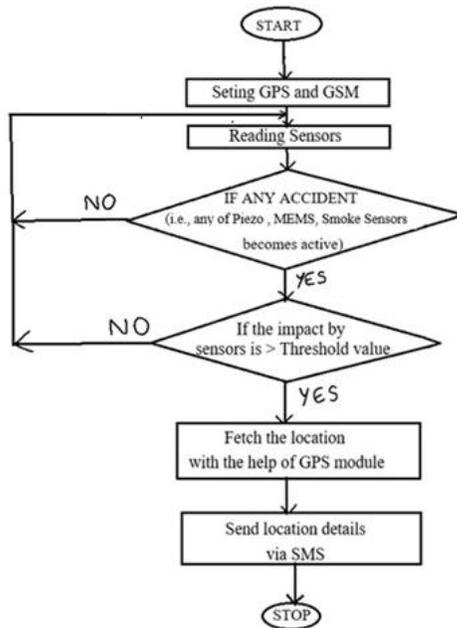


Fig. 4. Circuit Diagram

V. RESULT AND DISCUSSION

The results include the successful operation of an automatic accident detection and notification systems. This system can detect the accident and then alert the drivers family or vehicle owner to provide emergency medical aid to accident victim. The proposed accident detection system was successfully prototyped using an Arduino microcontroller interfaced with an ADXL345, a NEO-6M GPS module and GSM900A modem. The communication between the Arduino and the ADXL345 was established using the I2C

protocol, ensuring high data integrity and minimal wiring complexity.

The results demonstrate that the integration of digital MEMS sensors like the ADXL345 significantly enhances the reliability of automated accident detection. Unlike analog sensors, the ADXL345's internal interrupt registers allow the Arduino to remain in a low- power state until a "High-G" event occurs, optimizing the overall power consumption of the device. The consistent performance of the NEO-6M GPS ensures that even in semi-urban environments, the location data remains accurate enough for first responders to reach the site effectively.

A. Accelerometer Readings During Accident Detection:

Test No.	X-axis (g)	Y-axis (g)	Z-axis (g)
1	0.02	0.01	0.98
2	0.15	0.10	0.92
3	1.85	0.40	0.20
4	2.10	0.75	0.30
5	0.05	0.02	0.97

Fig. 5. Table showing Accelerometer readings

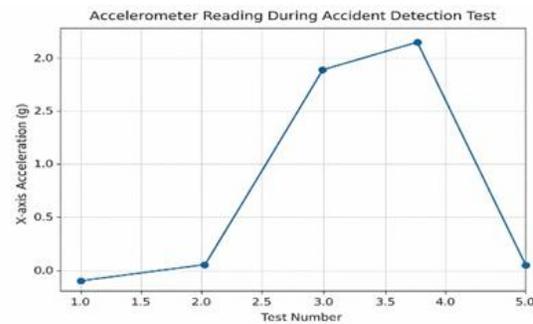


Fig. 6. Graph Showing Accident Impact

B. GPS Location Data Collected:

Test No.	Latitude	Longitude	GPS Signal
1	28.6123	77.2291	Strong
2	28.6125	77.2293	Strong
3	28.6128	77.2295	Medium
4	28.6130	77.2298	Strong

Fig. 7. Table showing GPS location

C. SMS Alert Transmission Result:

Accident Detected	SMS Sent	SMS Delivered
No	No	–
Yes	Yes	5 sec
Yes	Yes	6 sec
No	No	–

Fig. 8. State and Response Time of the System

D. LCD Display Output:

System Condition	LCD Message
System Start	“System Ready”
GPS Searching	“Getting Location”
Accident Detected	“Accident Alert!”
SMS Sent	“Message Sent”

Fig.9 G. 16x2 LCD Display Output

E. SMS sent to Mobile in case of Accident:



Fig. 10. SMS Sent to the Mobile Phone

VI. CONCLUSION AND FUTURE WORK

Every human life is precious and worth saving. Life should not end on road waiting for help in a crash. This project shouts out for help where we are unable to shout for help. The system can detect the accident and then alert the victim’s near and dear ones to provide medical aid to accident victim. Sensors are used to determine whether an accident had occurred. The communications between the system and the responder or owner is done by GSM. We have observed the performance of accident detection and alerting via SMSs using GPS, GSM and sensors helps not only in finding the location of vehicle but also it is helpful in saving the lives of victims by finding where an accident has happened. In Future we can interface

different sensors with this module, such as Alcohol Sensor, we can Make the Engine off when the Driver is Drunk. Our system can be reprogrammed to off the vehicle’s Engine in case of theft. We can use the EEPROM to store the previous Navigated positions and we can navigate up to N number of locations by increasing its memory. We can use this System to assist the traffic. By keeping the kits in the all the vehicles and by knowing the locations of all the vehicles. Accident detection and alert systems are highly relevant in these days and this project aims at developing a low-cost solution for the same for the benefit of the society.

VII. ACKNOWLEDGMENT

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REFERENCES

- [1] J.S Bhatia and Pankaj Verma: “Design and Development of GPS-GSM based tracking system with Google map-based monitoring”, International Journal of Computer Science, Engineering and Applications, Vol.3, Issue. 3, pp. 33 40, 2013.
- [2] SeokJu Lee, Girma Tewelde and Jaerock Kwon: “Design and Implementation Vehicle Tracking System using GPS/GSM/GPRS Technology and Smartphone Application”, IEEE World Forum on Internet of Things (IoT), pp. 353- 358, 2014.
- [3] Baburao Kodavati, V. K. Raju, S. Srinivasa Rao, A. V. Prabu, T. Appa Rao and Dr. Y. V. Narayana:” GPS and GSM Based Vehicle Location and Tracking System”, International Journal of Engineering Research and Applications, Vol.1, Issue 3, pp.616- 625,2013.
- [4] V. Dhana Raj, G. Vasu, S. Kanaka Durga, “Arm- 7 based semi-autonomous vehicle” IEEE 2012.
- [5] Tanushree Dalai, “Emergency Alert and Service for Automotives for India”, International Journal of Advanced Trends in Computer Science and Engineering (IJATCSE), Mysore, India, Vol.2, No.5, Pages: 08-12 (2013) Special Issue of

ICETCSE 2013.

- [6] Montaser N. Ramadan, Mohammad A. Al Khedher, and Sharaf A. Al Kheder “Intelligent anti-theft and tracking system for automobiles”, IEEE-2012 February 2012.
- [7] Akshay Agrawal, Anand Khinvasara, Mitali Bhokare, Sumit Kaulkar, Y. K. Sharma, “Accident Detection System Application”, International Journal of Emerging Technologies in Computational and Applied Sciences, pp.425-428, September-November, 2013.
- [8] Mithun Haridas. T. P, Naveen. R, Ananthanarayanan. V, Rajeswari. A, “Reliable and Affordable Embedded System Solution for Continuous Blood Glucose Maintaining System with Wireless Connectivity to Blood Glucose Measuring System”, IJCA Proceedings on Amrita International Conference of Women in Computing 2013 AICWIC (2): pp 36-43, January 2013.
- [9] M. Grewal, L. Weill and A. Andrews, Global positioning systems, inertial navigation, and integration. New York: John Wiley, 2001.
- [10] M. Hendry, Near field communications technology and applications. “Cellular networks for massive IoT,” Ericsson White Paper, Jan 2016.