

A Black Box with SMS Alert for Road Vehicles

Ranjitha S L, Ristha A S, Shilpashree M P, Aravind R
Department of Electronics & Communication Engineering
GSSS Institute Of Engineering & Technology For Women,
Mysuru, Karnataka

Abstract— The Black Box concept is derived from the aviation industry, a flight recorder, colloquially known as a black box; although it is now orange-colored for easy search, is an electronic recording device placed in an aircraft for the purpose of facilitating the investigation of aviation accidents and incidents. With the advancement in technology and cost coming down, in our project we attempt to build similar device for our cars, not only this device will help us in post-crash analysis but also it will help us in quicker emergency rescue operation. Our research has been targeted towards building an integrated system for emergency rescue services in the event of a road accident. The purpose of the project is to find the accident location using GPS module and to send this location by means of sending a message using GSM module to the pre-coded number. This system is usually placed inside the vehicle. It reduces the time it takes for emergency rescue to arrive at the crash location.

Keywords—Black box, flight recorder, GPS, GSM

I. INTRODUCTION

In today's world as the population increases day by day the numbers of vehicle also increases on the road and highways. This results in accident that leads to the traffic jams and people do not get the help instantaneously. Road accidents constitute the major part of the accident deaths all over the world [3]. This takes a toll on the property as well as causes human life loss because of unavailability of immediate safety facilities. [12].

During 2008, Road Traffic Injuries ranked fourth among the leading causes of death in the world. Nearly 1.3 million people die every year on the world's roads and 20 to 50 million people suffer non-fatal injuries, with many sustaining a disability as a result of their injury. Road traffic injuries are the leading cause of death among young people aged 15-29 years. If no action is taken, road traffic crashes are predicted to result in the deaths of around 1.9 million People annually by 2020. Those who live, has a high chance of incurring a disability as a result of the impact. 91% of the fatalities on the roads occur in middle and low income countries [12].

Many campaigns have been conducted by the people for the awareness, but this problem is still increasing due to rider's poor behaviors such as speed driving, drunk driving, riding without sufficient sleep, etc. The numbers of death and disability are very high because of late assistance to people who got the accident. These cause huge social and economic burdens to people involved [4][7][10].

Therefore, several research group and major motorcycle manufacturers have developed safety devices to protect riders from accidental injuries. However, good safety

device for vehicles is difficult to implement and very expensive [7].

Complete accident prevention is unavoidable but at least repercussions can be reduced [9]. In highly populated Countries like India, everyday people lose their lives because of accidents and poor emergency facilities. These lives could have been saved if medical facilities are provided at the right time [12]. In many situations the family members or the ambulance and police authority is not informed in time. This result in delaying the help reached to the person suffered due to accident. In order to give treatment for injured people, first we need to know where the accident happened through location tracking and then send a message to your related one or to the emergency services [3].

Many cases remain pending due to unknown reason of an accident. In order to react to this situation, the black box system draws the first step to solve problem. It is referred as Electronic data recorder. It records main driving data such as Engine Temperature, Distance from obstacle, Speed of vehicle, Brake status, CO2 Content, Alcohol content, Accident Direction, trip Time and Date. The recorded data will be analyzed to find out reason for the accident easily and to settle many disputes related to accident such as crash litigation, insurance settlements. It can be used to not only reconstruct what happened before an accident by Insurance agents and police but improve vehicle design, roadway design and emergency medical service by automakers, government and hospital [7].

Whenever the vehicle meet with an accident an alert message will be sent to pre-coded contact number and nearby hospitals along with the current GPS location of vehicle. Global Positioning System (GPS) is used to identify the location of the vehicle. GSM is used to inform the exact vehicular location to the pre-coded numbers. Message will give longitude and latitude values. From these values location of accident can be determined. Our project aims at intelligent security system providing situational awareness and agile safety [9]. This system will help to save life of people. Technically black box is used as a safe to store system safely. At any Environmental condition it will remain as it is [7].

1.1 Problem Statement

Whenever an accident is being met, the people nearby call the ambulance. The problem associated with this is that the victims depend on the mercy of nearby people. There are chances where no people nearby the accident spot or people who are around neglects the accident. This is the flaw in the manual system.

1.2 Existing System

There are many solutions proposed for the concerned problem and each one have some advantage over others. Presently tracking system is introduced in vehicles to avoid accidents and save people's life. They have used microcontroller for this purpose. But the existing systems are available only in high-end vehicles, because the monitoring system is expensive.

1.3 Proposed System

The proposed system is designed such that, the device itself sends a message to the concerned person when an accident is met. Proposed system uses Arduino board that provides an easy access to input/output and analog pins and easy burning/uploading of a program. The system uses GPS to find the location of the accident and uses GSM to send that location in the form of SMS to the previously coded number. It also includes the feature to detect the presence of alcohol.

1.4 Objectives

- To find the exact location of an accident.
- To send an alert message to the pre-coded number.
- To sense the presence of alcohol.

II. LITERATURE SURVEY

Sri Krishna Chaitanya Varma, Poornesh, TarunVarma and Harsha in [3] have designed a working model of automatic vehicle accident detection and messaging system using a GPS and GSM modems successfully. In this work they have used a basic AT89C52 microcontroller for cost effective and easy understanding. The microcontroller is interfaced to GPS and GSM module via a multiplexer, where these devices are activated using select lines internally built in the multiplexer. When the IR sensors sense any obstacle, they send an interrupt to microcontroller. The GPS receives the location of the vehicle that met with an accident and gives the information back. This information will be sent to a mobile number through a message. This message will be received using GSM modem present in the circuit. The message will give the information of longitude and latitude values. Using these values the position of the vehicle can be estimated. They have used assembly programming for better accuracy.

Rajashri R, Lokhande and Sachin P. Gawate in [5] have developed a Wireless black box using MEMS accelerometer and GPS tracking system to monitor the accident. The system consists of conjunctive components of an accelerometer, microcontroller unit, GPS device and GSM module. At the time of project installation, the registration number of vehicle, relative's phone number and emergency services number are fed into the source code of the system. When a car meets with an accident the sensor will be activated automatically and start its surveillance mode. If user is not in critical condition and can help himself then he will stop surveillance mode within given time period else system will consider user need assistance and start auto contacting with call center and specified person. Immediately, the system gathers the car location using GPS device and records the car details like car owner details, car number, car model,

car speed and sends it to call center and person's relative. Once the call center gets the car status it finds the nearest emergency service and contact then to reach at accident location to help the person.

Ramchandra Patil and Shivaraj Hublikar in [7] have presented a new vision for the vehicles industry, which is the Black Box system and Collision Avoidance System used for vehicles. The system consists of ARM7LPC2148, GSM Module, Vehicle to Vehicle Collision Avoidance Unit (VVCAU) to avoid crashing between vehicles and Black Box to record the relevant details about a vehicle. This system also contains Alcohol Sensor, Brake Sensor, CO₂sensor, Temperature sensor and Ultrasonic sensor for pre-accident detection system. GSM module is used to send the SMS to relative person to indicate accident has been occurred. As soon as the driver runs the motor, this system collects the data from all the sensors and stores in EEPROM along with date and time. The data saved can be retrieved after the accident for privacy purposes.

Mr.Dinesh Kumar HSDK, Shreya Gupta, Sumeet Kumar and Sonali Srivastava in [9] have designed an accident detection and reporting system using GPS and GSM module. The system incorporates a single-board embedded system that contains GPS and GSM modems connected with a microcontroller89S52, alcohol sensor and vibration sensor. GPS is used to identify the exact location of the vehicle and GSM is used to inform the exact vehicular location to the pre-coded number. In accidents, when the drivers lose control and fail to stop the vehicle, the vibration sensor will be triggered because of the vibrations. The processor locks the brakes when triggered and thus the impact of the accident can be weakened.

Shailesh Bhavthankar and Prof. H. G. Sayyed in [10] have designed and implemented an efficient vehicle wireless system for vehicle accident detection and reporting using accelerometer and GPS. The system consists of ARM7 micro-controller unit, MEMS accelerometer, GPS device, GSM module, Temperature sensor, gas sensor and Alcohol sensor. When a vehicle meets with an accident, a Micro electro mechanical system (MEMS) sensor will detects the signal and sends it to ARM controller. Immediately microcontroller sends the signal to GPS module to collect the current position, time and date and then it sends the alert message to family member or emergency medical service (EMS) through GSM modem which contains GPS parameter values. If the vehicle meets with a small accident or no serious injuries to people then we can send a message that we are safe by pressing switch manually in order to save the valuable time of emergency medical service.

III. METHODOLOGY

The proposed system consists of the Arduino UNO as the main processing unit for the entire system and all the sensor and devices are connected with the microcontroller. The components are connected to the Arduino through serial communication. The GPS module repeatedly sends the data to the Arduino and at the second the limit switch is applied with pressure, the Arduino picks the data sent by the GPS module at that particular time and send that data to GSM

module which sends those received latitude and longitude to the pre-coded number. Similarly when the alcohol sensor senses the alcohol, it send a signal to the Arduino and the Arduino signals the GSM module with the data sent by GPS module and GSM module sends the latitude and longitude to the pre-coded number. The implemented design consists of Arduino UNO, GPS module, GSM module, limit switch, relay and alcohol sensor.

3.1 Hardware Requirements

Arduino UNO Board:

It is an open-source platform that is used to design and manufacture single-board microcontroller and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. 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 our computer, used to write and upload computer code to the physical board. The Arduino platform has become quite popular with people just starting out with electronics and for good reason.

The Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller. The Uno board is the first in a series of USB Arduino boards and the reference model for the Arduino platform. The ATmega328 on the Arduino UNO comes pre programmed with a boot loader that allows to upload new code to it without the use of an external hardware programmer. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (shields) and other circuits. 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. The Arduino UNO is generally considered the most user-friendly and popular board with boards being sold worldwide for less than 5\$.

GPS (Global Positioning System):

The GPS is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3D

position (latitude, longitude and altitude). GPS transmission occur on a frequency of 1575.42 MHz.

Function of GPS: The Global Positioning System satellites transmit signals to equipment on the ground. GPS receivers passively receive satellite signals; they do not transmit. GPS receivers require an unobstructed view of the sky, so they are used only outdoors and they often do not perform well within forested areas or near tall buildings. GPS operations depend on a very accurate time reference, which is provided by atomic clocks on board. Each GPS satellite transmits data that indicates its location and the current time. All GPS satellites synchronize operations so that these repeating signals are transmitted at the same instant. The signals, moving at the speed of light, arrive at a GPS receiver at slightly different times because some satellites are further away than others. The distance to the GPS satellites can be determined by estimating the amount of time it takes for their signals to reach the receiver. When the receiver estimates the distance to at least four GPS satellites, it can calculate its position in three dimensions. There are at least 24 operational GPS satellites at all times plus a number of spares. The satellites, operated by the U.S. Department of Defence, orbit with a period of 12 hours (two orbits per day) at a height of about 11,500 miles travelling at near 2,000mph. Ground stations are used to precisely track each satellite's orbit.

GSM (Global System for Mobile communication):

GSM is an open, digital cellular technology used for transmitting mobile voice and data services. GSM is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM and CDMA). It operates at either 900 MHz or 1800 MHz frequency band. It supports voice calls and data transfer speeds of up to 9.6 Kbits/s, together with the transmission of SMS. Here we have used SIM800A. It is a quad band GSM module that works on frequencies GSM 850 MHz, EGSM 900 MHz, DCS 1800 MHz and 1900 MHz. The power supply range of SIM800 is from 3.4v to 4.4v. The operating temperature range is $-40^{\circ}\text{C} \sim +85^{\circ}\text{C}$.

Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. GSM modem can be used just like a dialup modem. In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, various things can be done such as - Sending SMS messages, Monitoring the signal strength etc.

Limit switch:

A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break an electrical connection. Limit switches are used in a variety of applications and environments because of their ruggedness, ease of installation, and reliability of operation. They can

determine the presence or absence, passing, positioning, and end of travel of an object. They were first used to define the limit of travel of an object; hence the name "Limit Switch".

Alcohol sensor:

Alcohol sensor typically used as a part of the breathalyzers or breath tester for the detection of ethanol in the human breath. MQ-6 gas sensor has high sensitivity to alcohol and has good resistance to disturb of gasoline, smoke and vapor. Sensitive material of MQ-3 is SnO₂, which with lower conductivity in clean air. Mainly used for vehicle alcohol detector.

3.2 Software Requirements

ARDUINO Software (IDE):

The Arduino integrated development environment (IDE) is a cross - platform application (for Windows, macOS, Linux) that is written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It works in conjunction with an Arduino controller in order to write, compile and upload code to the board. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching and syntax highlighting and provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. Designs can be verified and compiled, with an error log displayed in the lower part of the UI that allows to review the code. The Arduino IDE supports the languages C and C++ using special rules of code structuring.

ARDUINO Software 1.8 is used to implement the proposed system.

Embedded C:

Embedded C Programming is the soul of the processor functioning inside each and every embedded system we come across in our daily life, such as mobile phone, washing machine, and digital camera. Each processor is associated with an embedded software. Embedded C language is most frequently used to program the microcontroller and it is used in the proposed system.

Embedded C is a generic term given to a programming language written in C, which is associated with a particular hardware architecture. Embedded C is an extension to the C language with some additional header files. These header files may change from controller to controller. The embedded system designers must know about the hardware architecture to write programs. These programs play prominent role in monitoring and controlling external devices.

The Embedded C Programming Language uses the same syntax and semantics of the C Programming Language like main function, declaration of datatypes, defining variables, loops, functions, statements, etc. The extension in Embedded C from standard C Programming Language include I/O Hardware Addressing, fixed point arithmetic operations, accessing address spaces, etc. It has source code format that

depends upon the kind of microcontroller or microprocessor that is being used.

IV. IMPLEMENTATION

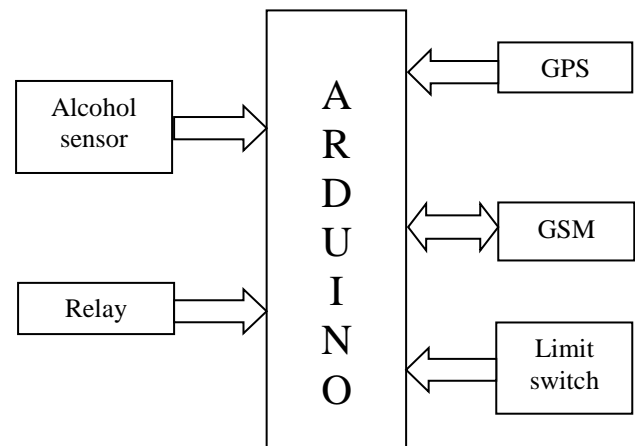


Fig.4.1: Block Diagram

The Black Box concept is derived from the aviation industry, a flight recorder, colloquially known as a black box. With the advancement in technology and cost coming down, in our project we attempt to build similar device for our car which can send the location to pre-coded number when an accident occurs.

Adaptor:

The adaptor is used to supply power to the entire model. It is connected to one of the inputs of the modules. The input to the adaptor is 90-265V, frequency of 50-60Hz and 0.6A. The output of the adaptor is 12V, 2A.

Arduino UNO:

The code for the working of our proposed work will be dumped to the Arduino board through the USB cable. The GPS module, GSM module, limit switch, relay, alcohol sensor and the temperature sensor are connected to the Arduino board.

GPS module:

The GPS antenna repeatedly collects the location of the vehicle and the GPS module continuously sends the location of the vehicle in terms of latitude and longitude to the Arduino.

GSM module:

The GSM module is programmed in such a way that when the latitude and longitude from the GPS module is sent by the Arduino to the GSM module, it will be able to send that particular latitude and longitude to the pre-coded number in the form of an SMS.

Limit switch:

When the limit switch is applied with certain pressure, at that particular time the Arduino picks the latitude and longitude sent by the GPS module and sends these coordinates to the GSM module.

Alcohol sensor:

If the driver has consumed alcohol, the alcohol sensor will sense the alcohol and signal the Arduino and the Arduino will send a signal to the GSM module and the GSM module will send the SMS to the pre-coded number.

V. RESULT AND DISCUSSION

5.1 Result:

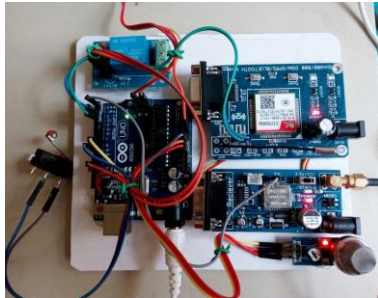


Fig. 5.1: Working Model

The proposed work is used to send an alert through an SMS to the pre-coded number, the mobile number of the user should be included in the software programming in order to receive the accident location values from the SIM card which we are using in GSM modem. The SMS includes the latitude and longitude of the place where the vehicle accident has occurred. It also sends an SMS to the pre-coded number when the alcohol sensor senses the alcohol.

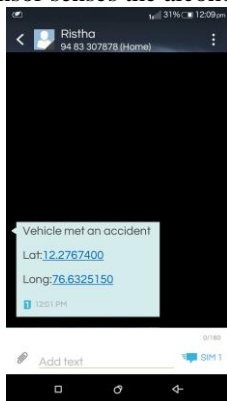


Fig. 5.2: Accident Detection Message

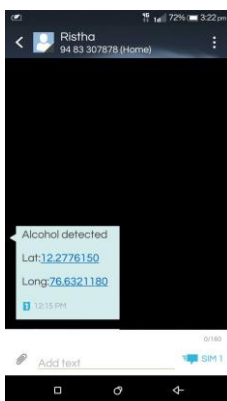


Fig. 5.3: Alcohol Detection Message

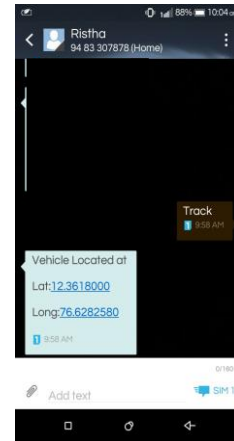


Fig. 5.4: Vehicle Tracking Message

5.2 Advantages

- It is easy to detect the exact location of the vehicle
- It provides security to the vehicle in very reasonable cost
- Simple to install and operate
- It will help to provide emergency responders with crucial information at the earliest possible time

5.3 Applications

- Used in automobiles and transport vehicles- from lighter vehicles like cars, to heavier automobiles like ships and aero-planes.
- Security and remote monitoring of vehicles especially during military operations.
- This system is also can be interfaced with Vehicle airbag system such that when the sensors detect the accident, the air bags get opened.

CONCLUSION

A working model of a Black Box with SMS alert for road vehicles has been developed for vehicle accident detection and reporting. It is a system that uses Arduino UNO, GPS tracking system and GSM module developed for vehicle accident and reporting. It provides crucial information to emergency responders in the earliest possible time. The crucial time between the accident and getting victim medical attention can often be the difference between life and death. This system provides better safety rather than no safety. The system uses GPS module to find the location of the accident and GSM module to send an SMS notification to the pre-coded number.

FUTURE SCOPE

In future we can interface the system with vehicle airbag system. This will optimize the proposed technology to the maximum extent and deliver the best accident detection system. The proposed system can be improvised by adding other components which will be able to collect several information such as recording the voice, recording the video, to detect the part of the vehicle where it is hit.

REFERENCE

1. Abdallah Kassem, Rabih Jabr, Ghady Salamouni and Ziad Khairallah Maalouf, "Vehicle Black Box System", IEEE International Systems Conference, April 2008
2. P. Ajay Kumar Reddy, P.Dileep Kumar, K. Bhaskarreddy, E. Venkataramana and M.Chandrasekhar Reddy, "Black Box For Vehicles", International Journal of Engineering Inventions (IJEI), Volume 1, Issue 7, October 2012
3. Sri Krishna Chaitanya Varma, Poornesh, Tarun Varma and Harsha , "Automatic Vehicle Accident Detection And Messaging System Using GPS and GSM Modems", International Journal of Scientific & Engineering Research (IJSER), Volume 4, Issue 8, August 2013
4. Shaik Khadar Basha and P Sireesh Babu , "Wireless Black Box Report for Tracking of Accidental Monitoring In Vehicles", International Journal Of Professional Engineering Studies (IJPRES), Volume 1, Issue 2, Dec 2013
5. Rajashri R. Lokhande and Sachin P. Gawate, "Design & Implementation of Vehicle Black Box For Driver Assistance And Alert", IOSR Journal of Computer Science (IOSR-JCE), 2014
6. Prof. Ashish B. Dudhale, Steve Felix S, Harsha Phatak and Sayali Jathar, "Car Black Box System for Accident Prediction and Crash Recovery", International Journal of Engineering Science and Computing (IJESC), May 2014
7. Ramchandra Patil and Shivaraj Hublikar, "Design and Implementation of Car Black Box with Collision Avoidance System using ARM" ,International Journal of Innovative Technology and Exploring Engineering (IJITEE), Volume4, Issue3, August 2014
8. Vikram Singh Kushwaha , DeepaYadav , Abusayeed Topinkatti and Amrita Kumari, "Car Accident Detection System Using GPS and GSM", International Journal of Emerging Trend in Engineering and Basic Sciences (IJEEBS), Volume 2 , Issue 1, Jan- Feb 2015
9. Mr.Dinesh Kumar HSDK, Shreya Gupta, Sumeet Kumar, Sonali Srivastava, " Accident Detection and Reporting System Using GPS and GSM Module", Journal of Emerging Technologies and Innovative Research (JETIR), Volume 2, Issue 5, May 2015
10. Shailesh Bhavthankar and Prof. H. G. Sayyed, "Wireless System for Vehicle Accident Detection and Reporting using Accelerometer and GPS", International Journal of Scientific & Engineering Research (IJSER), Volume 6, Issue 8, August 2015
11. P. Kaliuga Lakshmi and C. Thangamani , "An Efficient Vehicle Accident Detection Using Sensor Technology", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Volume 5, Issue 3, March 2016
12. Namrata H. Sane, Damini S. Patil, Snehal D. Thakare and Aditi V. Rokade, "Real Time Vehicle Accident Detection and Tracking Using GPS and GSM", International Journal on Recent and Innovation Trends in Computing and Communication (IJRITCC), Volume 4, Issue 4, April 2016