# Design and Implementation of Black Box in Car using GSM and GPS Tracker

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*Abstract*— **our research has been targeted towards building an integrated system for emergency rescue services in the event of a road accident. The project focuses on building an infrastructure which vehicle safety authorities can implement to enhance the reporting of vehicle crashes, provide post-crash analysis using motion sensors, record of the event in images and reduce the time it takes for emergency rescue to arrive at the crash location. We have achieved this using existing cellular network infrastructure already in place and also using GPS to pinpoint the exact location of the crash and send that data to an emergency rescue authority (such as Hospital, Fire Department, Police) using GSM text service. Our target was to build a low cost device that everyone can afford and use in their vehicles.**

*Index Terms*—**road and safety, GSM, GPS, emergency instant notification, crash data, accident, car, accelerometer, tilt, camera, black box, sensors.**

## I. INTRODUCTION

The focus of our research is to reduce the time it takes for an ambulance to arrive at the crash location in the event of an accident and build a rescue infrastructure for emergency services. To create a model of this system our objectives include Build a device (Black Box) that can collect GPS Data and Send them via GSM instantly on the event of a crash. Allow trigger for several types of crash such as vehicle getting plunged in to water, high cabin, engine temperature and different road collision types such as rear-end collision, angle or side impacts. Log data such as GPS, temperature, frame by frame image of the event, Motion Data for preliminary post-crash analysis. Design a prototype desktop application for the emergency rescue department to track multiple crashes and locate the nearest medical facilities from the spot of the crash for quicker ambulance dispatch.

The risk of accident or crash on road has become an unavoidable issue globally and of everyone's concern.

According to WHO Road Traffic Injuries Fact Sheet about 1.24 million people die each year as a result of road traffic crashes. They have predicted the figure would reach 1.9 million casualties by the year 2020 if no action is taken. 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. The issue is of such concern that vehicle safety has been improved from the factory to a reasonable amount with airbags becoming standard vehicles and improved crumple zone. With vehicle productions ranging in wide variety of make and model several assessment programs have been initiated such as Euro NCAP to crash test vehicles and provide a standard rating system for safety. Along with protection by ensuring safer vehicles other initiatives such as The International Road Assessment Programme is making roads safer by design. Bangladesh and India now has a minimum target of three stars rating to be implemented on all road builds.

Even with so many initiatives in place accidents are still a major factor. Especially in places where road and traffic law enforcement is very low. Only 7 percent of the world's population is under comprehensive road safety laws. According to Road Safety Cell (RSC) of Bangladesh 70% of drivers in Bangladesh have no legal driving license.

Cause of accidents also includes weak condition of vehicles, poor traffic management and also lack of awareness for road safety by the drivers. As a result the annual fatality rate is very high as presented in the table below.

Overall the annual fatality rate for Bangladesh is 85.6 per 10,000 compared to below 3 per 10,000 for most developed countries. Addressing such issue our system falls in to this exact place where we have targeted to reduce the mortality rate for road accidents using a combination of GPS, GSM technology to instantly notify an emergency authority in the event of a crash. Not only that, our device (Black Box) sends the exact GPS coordinates of the crash along with vehicle information in the form of a text notification to the rescue authority, family member and police so that instant dispatch of ambulance can be made, because basic life support may be needed soon after the crash. We have developed an entire system to be deployed around our device which will facilitate quick rescue times. Our target is to reduce the time it takes for a crash report to appear to the authority (usually by the locals in that area) and an ambulance to arrive at the location. Such systems deployed in the wider scale will result in much accurate and more accurate accident reports recorded effectively saving more lives. Even if a vehicle crashes and the driver is dead or unconscious in an isolated location where no one is around to notify of the incident, such system may become a critical factor in life safety.

| TABLE I. | FATALITY RATE COMPARISON BY COUNTRY | | |
|---|---|---|---|
| Country | Road fatalities per 100,000 motor vehicles [7] | Estimated GDP lost due to road traffic crashes [27] | Number of Registered Vehicles [27] |
| USA | 15 | 2.3% | 258,957,503 |
| Malaysia | 36.5 | 1.6% | 20,188,565 |
| India | 100 | 3.0% | 114,952,000 |
| Bangladesh | 6300 | 1.6% | 1,624,862 |

## II. RELATED WORKS

### A. Accident detection and reporting system using GPS, GPRS and GSM technology

This related work has conceptualized to monitor the GPS Speed data from the vehicle satellite navigation system to trigger an accident event if the speed is below a specified speed and send that data using GSM network. The concept only depends on Speed.

### B. Vehicle Factory Safety Systems

Many production vehicles on the road such as Porsche Car Connect System utilizes built in systems to monitor the airbag as a trigger to send a crash notification to an emergency service. Such system is usually available only as an optional extra and is not available on more general road cars.

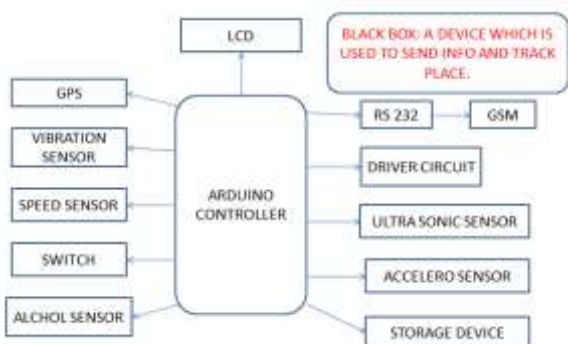## III. BLOCK DIAGRAM OF THE BLACK BOX IMPLEMENTATION



## IV. MAJOR DEVICE SPECIFICATIONS & COST

### A. Two Arduino Uno R3

Arduino Uno is a small single board microcontroller utilizing the ATmega328P. Our device utilizes it to collect data from the GPS Sensor, Temperature, Moisture Sensor, Gyro and Accelerometer and passes it to the Raspberry Pi using USB ports. It also gets power from this port.

### B. Temperature Sensor

Engine temperature is important in engine control unit, if this value goes to abnormal, some unwanted gases exhaust from vehicles due to improper combustion. In this project, in order to obtain the vehicle engine temperature, we have used LM35 temperature sensor. This temperature sensor continuously reads the engine temperature and fed to the microcontroller. The output of LM35 is given to pin P0.28 of LPC2148. It converts temperature value into electrical signals. Its temperature sensing range is -55 to +150°C.

### C. Alcohol Sensor

In this project, MQ-3 gas sensor is used for alcohol detection. It is high sensitive to alcohol, simple drive circuit, stable and long life. If driver has drunk, then alcohol sensor sends signal to microcontroller. The output of MQ-3 is given to pin P0.29 of LPC2148 and message is displayed on LCD.

**TABLE: Hardware Specification of the Raspberry Pi Board (Model B)**

| Component | Specification |
|---|---|
| SoC | Broadcom BCM2835 |
| SD Card | SanDisk 16 GB |
| CPU | 700 MHz ARM1176JZF-S Core |
| Memory | 512MB SD RAM |
| USB | 2 USB 2.0 Ports |
| Low-level peripherals | 8xGPIO, UART, FC bus |
| Power ratings | 700 mA(3.5 W) |

**TABLE: HARDWARE SPECIFICATION OF THE ARDUINO UNO BOARDHARDWARE**

| Component | Specification |
|---|---|
| Microcontroller | ATmega328P |
| Operating Voltage | 5V |
| Digital I/O Pins | 14 |
| Analog I/O Pins | 6 |
| Flash Memory | 32KB |
| SRAM | 2KB |
| Clock Speed | 16 MHz |

Figure demonstrates the components used to build the Black Box. Figure shows the component connectivity of the entire device.



**Figure. Image showing our Black Box prototype & its components.**

## V. EMERGENCY CRASH RESCUE DISPATCH SYSTEM

Currently, in the event of an accident it is reported to the police or a hospital by the locals in the area if they have discovered the wreckage or the incident happened on sight. Usually the caller is uncertain of the injuries and according to a research in delay of ambulance to crash location reveals that even with emergency services in place it can take up to 5minutes or more in the developed countries for an ambulance to arrive.

Therefore, we have built the entire emergency software around the Black Box so that more accidents can be registered and the seriously injured can receive medical care as soon as possible. One text is sent to a specific family member that the vehicle is registered to and the other one goes to the Emergency Rescue department (which can be a central medical facility, fire department, police or the department of motor vehicles). When a new one arrives, it marks the crashed location on Google Maps along nearest hospitals in range of 20 kilo meter radius of the crash. Such system would allow instant dispatch of ambulance from the nearest hospital available, therefore might be crucial factor in saving lives.



**Figure. Image showing the event flow of the emergency crash rescue service**

Figure illustrates the information flow diagram of the Emergency Crash Rescue System. Figure 8 shows a prototype Desktop Microsoft Windows Application we have built using Microsoft Visual C# to handle the crash events and locate the nearest hospital.



**Figure. Image showing Emergency Crash Rescue System Desktop Application showing hospitals near the crash location along with vehicle registration number.**

## VI. ADVANTAGES OF THE SYSTEM AND THE DEVICE

### A. Quick Location fix of accident, ambulance service to save lives.

One of our key points was to reduce the time it takes for an ambulance to arrive at the location of the crash incident. So far we have identified how this happens at the moment and we have proposed a solution that can act as a rescue infrastructure for all road vehicles. Just like digital number plates were made mandatory for all vehicles in Bangladesh; such devices can be made mandatory for at least commercial vehicles such as Busses and Trucks which has a higher risk of accidents due to the higher travelling distance and more payloads.

### B. Detection and mitigation of frequent points of accidents

Over a period of time and with enough crash locations, the frequent points of incidents can be identified. With the aid of RAP, those sections of roads can be reconstructed to solve the issue.

### C. Increased and accurate reporting of road accidents

Since the device is free of human intervention, the accidents can be instantly registered providing a more accurate overview of the number of accidents happening on the road. This will also contribute to the National Road Traffic Accident Report.

### D. Image Record of accident for preliminary post-crash analysis.

The frame by frame image captured would help determine the cause of the crash. With the help of this single unit, the multi-faceted reason for accidents can be properly identified and then a solution can be proposed to mitigate the issue. Such real world crash images can also help shape cars to be safer in the future.

### E. Identification of dangerous road conditions

The vertical axis g-forces can provide an idea of the road condition the vehicle was being driven on. The bumpier the road, the higher values will be registered along with gravity. Driving behaviour can be understood with the help of gyroscope data (tilt angles, acceleration). Figure shows a plot made from 52,000 data points acquired from a test run on real roads.

## VII. CONCLUSION

Overall such devices and systems can be the changing factor in road safety. Life is priceless and we should be doing whatever possible to make roads safer. WHO has already predicted 1.9 million casualties by the year 2020. Bangladeshis especially at risk as the country is being reformed by building more bridges, roads and better transportation network sand new areas emerge to develop. Gradually with assistance from both the vehicle owners and the Government assisting in deployment of such devices in vehicles, we can reduce the impact from the ever so concerning issue of road accidents. In addition it will help save lives, aid in better data collection and build an infrastructure solution using Emergency Crash Reporting Software to support the rescue services of the country.

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