# Providing Accident Detection in Vehicular Networks through OBD-II Devices and Android-based Smart Phones

**Narsing Rao, M[1]; Suresh Kumar, V[2]**

[1]ME Student, ECE, M.V.S.R. Engineering College, Nadergul, Andhra Pradeh, India

[2]Department of ECE, M.V.S.R. Engineering College, Nadergul, Andhra Pradeh, India

**Abstract**: ***Traffic accidents are one of the leading causes of fatalities in the world. An important indicator of survival rates after an accident is the time between the accident and when emergency medical personnel are dispatched to the scene. Eliminating the time between when an accident occurs and when first responders are dispatched to the scene decreases mortality rates by 6%.. By combining smart phones with existing vehicles through an appropriate interface we are able to move closer to the smart vehicle paradigm, offering the user new functionalities and services when driving. In this application we propose an Android based application that monitors the vehicle through an On Board Diagnostics (OBD-II) interface, being able to detect accidents. The application reacts to positive detection by sending details about the accident through SMS to pre-defined destinations, immediately followed by an automatic phone call to the emergency services.***

**Keywords:** OBD-II; Android smart phone; Bluetooth SPP; GPS information.

## 1. Introduction

In India, an increasing number of vehicles on the roads, in recent past, have led to an increase in the number of road accidents. There have been alarming statistics regarding the number of accidents per day in India. At least 1,42,000 people died due to road accidents in India in the year 2011.Bad driving, lax traffic control, and poor road conditions are the main reason for this. The ability to detect traffic accidents using smart phones has only recently become possible because of the advances in the processing power and sensors deployed on smart phones. For example, the iPhone 4 includes a GPS system for determining the geographic position of the phone, an accelerometer for measuring the forces applied to the phone, two separate microphones, and a 3-axis gyroscope for detecting phone orientation.

In this paper we propose combining existing vehicles with smart phones to achieve a solution able to improve security on the road. In our solution, smart phones are used as an alternative On-Board-Unit (OBU) within the vehicle, accessing the information in the vehicle's internal bus wirelessly. The only requirement to achieve this goal is that the vehicle supports the OBD-II standard. Since this standard is mandatory since 2001, the solution is applicable to all vehicles aged 10 years or less (as of 2011). In this work, a specialized smart phone application was developed to provide support for emergency services based on the information available in the communications bus of the vehicle. In particular, the proposed application monitors the vehicle's speed and airbag triggers to detect when an accident has occurred. Positive accident detection is followed by any sequence of actions defined by the user, such as sending accident details via SMS making an automated phone call to the emergency services.

## 2. Literature Review

In the literature we can find some works that adopt Android based smart phones to support all sorts of in-vehicle services. By combining this data with measurements from the mobile device's sensors, a high detection rate of serious accidents could be reached. In [1], the authors describe a system that gathers vehicle data and sends it to a centralized database in case of an accident. In [3], the authors present an automatic emergency alert system for two-wheeled vehicles that includes an accident detector inclination sensor and decision unit and a system to inform third parties about historic data of speed, acceleration and braking. Hernandez et al. [4] developed a prototype of an on-board unit that allows the driver to communicate with his vehicle, as well as with other available devices (PDAs, cellular, sensor networks, and so on and with the road infrastructure) in order to consume intelligent transport services.

The work done by Hampton C. Gabler [5] reports on a research effort which seeks to dramatically reduce Emergency Medical Services response time by developing and testing an Automated Crash Notification System which automatically transmits the location and severity of a crash to EMS personnel. Chen et al. proposed a vehicular Android/OSGi platform that allows diagnosing or managing the system status of a vehicular platform remotely and also to use visual intelligence to continually update their application services based on context awareness without user intervention.

## 3. Project Overview

It consists of two main sections in the system. The first section android smart phone which consists of Bluetooth SPP application and ARM7 controller based On Board Diagnostic device, where the communication between them is done based on the Bluetooth device. The Block diagrammatic representation of the circuit is shown in the Fig.1.In this work we develop an application that communicates with the vehicle's internal bus using the OBD-II interface and Bluetooth communication to determine whether accidents have occurred, and to estimate the severity of such accidents. The information retrieved is then submitted to emergency services, and an emergency phone call is automatically established by the android smart phone which is shown in the Fig.2.

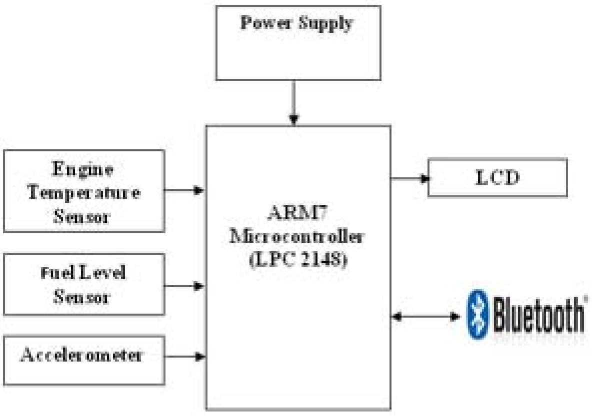


**Figure 1:** Block diagram in Vehicular Unit.

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**Figure 2:** Mobile Unit.

Initially the smart phone connects to an OBD-II device via Bluetooth to retrieve data from the vehicle's bus. The information gained, together with data from other sources (e.g. GPS system) is packed and sent to an emergency services database or to other third parties defined by the user if an accident is detected. This procedure is followed by an automatic call to an operator, which will send an ambulance or other rescue services to the accident location. This is illustrated in the following Fig 3.

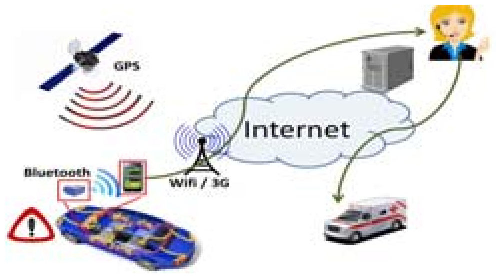


**Figure 3:** Different interacting elements in application.

The application also offers general purpose information to the driver, including gas levels, detection of failures in mechanical elements, extensive engine feedback data, etc. To understand why the proposed solution is feasible, it is worth noticing that, despite initial OBD-II connectors relied on RS-232 (serial port) or USB connections, now a days we can already find in the market OBD-II connectors that provide an application called Bluetooth SPP enabling seamless connectivity with smart phones and all sorts of mobile devices. Thus, it is an effective approach for reducing traffic fatalities, therefore, is to reduce the time between when an accident occurs and when first responders, such as medical personnel, are dispatched to the scene of the accident. Automatic collision notification systems use sensors embedded in a car to determine when an accident has occurred. These systems immediately dispatch emergency medical personnel to serious accidents. Eliminating the time between accident occurrence and first responder dispatch reduces fatalities.

### 3.1 The OBD-II Standard

Several operating modes are defined by the OBD-II standard to allow for an easier interaction with the system, and defining the desired functionality. Most automobile manufacturers have introduced additional operation modes that are specific to their vehicles, thus offering a full control of the available functionality. The European version of the OBD-II standard, known as EOBD, is mandatory for all gasoline and diesel vehicles since 2001 and 2003, respectively. Despite it introduces small improvements EOBD strongly resembles OBD-II, sharing the same connectors and interfaces. Since today's smart phones and tablet PCs are equipped with a range of modern and highly accurate sensors, they can also be used for analyzing driving related scenarios. Mednis et al. developed a system that allows the detection of potholes using a mobile device's built-in accelerometer (Mednis et al. 2011).

The OBD-II standard specifies the type of diagnostic connector and its pin out, the electrical signaling protocols available, and the messaging format. It also provides a candidate list of vehicle parameters to monitor along with how to encode the data for each. There is a pin in the connector that provides power for the scan tool from the vehicle battery, which eliminates the need to connect a scan tool to a power source separately. However, some technicians might still connect the scan tool to an auxiliary power source to protect data in the unusual event that a vehicle experiences a loss of electrical power due to a malfunction.

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## 4. Implementation Details

Our application was developed for the Android platform, now a day's available in most smart phones in whole world. Android-based smart phones typically include different wireless interfaces, such as Bluetooth, WiFi, GPS and 3G, making them ideal for our purposes. In particular, our solution will rely on the Bluetooth technology to establish a data between the smart phone and a Bluetooth-enabled OBD-II interface. This application basically combines two elements-vehicle and smart phone via Bluetooth technology. We have to store the phone number of the first responder in our design and a SIM should insert in the GSM module. After storing the phone number we can get the all the sensors information like fuel, temperature, accelerometer values along with GPS information in the form of longitude and latitude will be displayed on LCD and phone which is shown In the Fig 4.


**Figure 4:** Displaying sensor values on phone**.**

The accelerometer value i.e. g value depends on the orientation of the vehicle along three axes. If the g value less than 1, the vehicle is moving in safe zone. If g value is greater than 1, this indicates that vehicle met with an accident. Then suddenly the SMS will be sent by GSM to the first responder as shown in Fig 5. The responder notifies the GPS information in the form of longitude and latitude values then immediately he will inform the emergency services. This way we can reduce the interval between when an accident occurs and when emergency services such as 108, medical ambulances will be reach to that particular location.


**Figure 5:** Message to first responder phone.

After getting an accident details in the form of longitude and latitude along with g value, the automatic call from the accident location will go as shown in the Fig 6.


**Figure 6:** An automatic call to the predefined destination**.**

Our proposed application contains the applications in our daily life, like Cost efficient technique since data can be analyzed in the mobile itself, Accident prevention and Improving the driving efficiency and comfort.

## 5. System Design and Scope

As road traffic is increasing day by day, monitoring it in an effective way has been challenge to researchers. Since smart phones are penetrating into common people's lives very fast, utilizing the sensors available in them for traffic monitoring is good idea. The data processed by the mobile can be sent to a central server, which can use the information received to annotate maps accessed by the users through this application. This annotation can contain lot of information like the intensity of traffic at a junction, the bumpy nature of the road etc. All this can be done in an energy efficient manner by using low energy consuming components of the mobile like accelerometer and occasionally using GPS for localization and finding the bearing of the road. Also, applying machine learning techniques in classifying data can help the system to adapt to changing factors like nature of the road and vehicle type the users use.

The experimental setup for this project is shown in the Fig 7. It contains an Android based application called Bluetooth SPP that monitors the vehicle through an OBD interface being able to detect accidents. If a vehicle met with an accident, immediately the first responder will get the accident details and location through SMS, followed by an automatic call by using GSM,GPS technologies in order to respond quickly it help at saving lives.

The application reacts to positive detection by sending details about the accident through SMS to pre-defined destinations, immediately followed by an automatic phone call to the emergency services. Experimental results using a real vehicle show that the application is able to react to accident events in less than 3 seconds, a very low time, validating the feasibility of smart phone based solutions for improving safety on the road. Since android is an open source operating system it is easy to develop applications using java and as well as the native language and then converting it into the Android Classes. The idea what is been proposed is to have a basic 1 GHz computer system running in the car with Android operating system being the sole controller. The system is interfaced with the vehicle ECU and the sensors and it helps the user to have a better control over the vehicle.

**Figure 7:** Hardware setup for the project.

The important hardware parts used in the above figure are,

1. ARM7 TDMI-S Processor (LPC 2148 micro controller)
2. Fuel level Sensor
3. Temperature Sensor
4. Accelerometer Sensor
5. GPS Module
6. GSM Module
7. Bluetooth

### 5.1 LPC 2148 Micro Controller

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. The main features are

a. 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
b. 8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash memory.
c. 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
d. In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader software.
e. Single flash sector or full chip erase in 400 ms and programming of 256 B in 1ms.

### 5.2 LM35 Temperature Sensor

LM35 converts temperature value into electrical signals. LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The LM35 requires no external calibration since it is internally calibrated. . The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range.

### 5.3 Accelerometer Sensor

The MMA7660FC is a ±1.5 g 3-Axis Accelerometer with Digital Output (I2C). It is a very low power, low profile capacitive MEMS sensor featuring a low pass filter, compensation for 0g offset and gain errors, and conversion to 6-bit digital values at user configurable samples per second. Fuel level sensor is used to measure the level or quantity of fuel in the fuel tank. This sensor works on the principle of electrical capacitance, which states that, when air surrounded electrode is immersed in the liquid it changes its capacitance.

### 5.4 GSM and GPS Technologies

Bluetooth wireless technology enables communication between Bluetooth-compatible devices. It is used for short-range connections between desktop and laptop computer. we have used HC-04/06 Bluetooth module in order to establish the connection between the vehicle and smart phone. A GPS receiver (GPS634R) acquires these signals and provides the user with information. Using GPS technology, one can determine location in the form of latitude and longitude which are used in this project, velocity and time, 24 hours a day, in any weather conditions anywhere in the world for free. Our project contains GSM module of type SIM 300 supports power supply of 3.3v-4.5v. GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services. GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world.

Latitude is defined as a measurement of distance in degrees north and south of the equator. There are 90 degrees of latitude from the equator to each of the poles, north and south. Latitude lines are parallel, that is they are the same distance apart. The equator is the longest of all lines of latitude. Longitude is defined as measurement of distance in degrees east or west of the prime meridian. Longitude lines to the left of the prime meridian give locations west, in the western hemisphere. Longitude lines to the right of the primer meridian give locations east, in the eastern hemisphere.

## 6. Conclusion

The above idea proposed is an economic alternative to the high budgeted cars in today's market. If given a proper backbone to this project it would create a revolution equivalent to the buzz what Android has created in the mobile phone sector. This idea is cost efficient and is more controlled by the user than the manufacturer which would be the one of the main reason this system would sell. To further increase the usage of automatic accident detection and notification systems, smart phones can be used to indirectly detection accidents through their onboard sensors, such as accelerometers. Many challenges must be overcome however, particularly the potential for false positives from accidentally dropped phones. Due to the large volume of "phantom" (accidental) calls to emergency services, reducing the false positive rate of smart phone accident detection is important. Using a combination of context data, such as determining when a user is inside a vehicle, sensor data, such as accelerometer and acoustic information, and intelligent sensor data filtering, accident detection systems can be created that are resistant to false positives.

## 7. Future Scope

Our future work is aimed towards using advanced machine learning techniques to find out patterns from the collected data and classify them accordingly. This can be done on a server where data can be uploaded at the end of the journey. We also want to enable crowd-sourcing, to collect mass data and analyze other subtle reasons behind rash driving, e.g., under what conditions - traffic, rush hours etc. a person drives rashly. Along with this idea proposed by us we are trying to implement this model on a small term basis and try to experiment with other hybrids in the world of Android development. We would come out with the implementation of the above idea proposed if essentials pertained. Also, applying machine learning techniques in classifying data can help the system to adapt to changing factors like nature of the road and vehicle type the users use.

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## Author Profile


**M Narsingrao** received B. Tech degree in Electronics and Communication Engineering from J.N.T.U Hyderabad in 2010. Presently he is doing M.E from M.V.S.R engineering college affiliated to Osmania University in E.C.E. He has taken Embedded Systems and VLSI Design as a specialization.