

# Wireless System for Vehicle Accident Detection and Reporting using Accelerometer and GPS

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**Abstract**— 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. In this paper, an efficient vehicle wireless system is designed and implemented for vehicle accident detection and reporting using accelerometer and GPS. Accelerometer sensor is used to detect crash and GPS give location of vehicle. In case of any accident, the system send automated message to the preprogrammed number such as family member or emergency medical services via GSM.

**Index Terms**— Accident detection, Wireless system, MEMS Accelerometer, ARM7 micro-controller, GPS device, GSM modem

## 1 INTRODUCTION

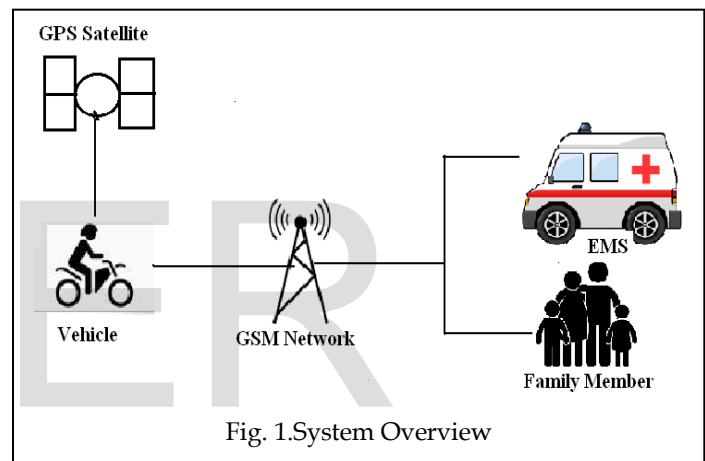
IN today's world as the population increases day by day the numbers of vehicle also increases on the road and highways.

This result in more accident that leads to the traffic jams and public not get help instantaneously [2]. This problem is due to rider's poor behaviors such as speed driving, drunk driving, riding with no helmet protection, riding without sufficient sleep etc [1]. So road safety is one issue that needs special attention. In most of the accident cases, the victims lose their lives because of unavailability of medical facilities on the right time. The crucial time between the accident and getting victim medical attention can often be the difference between life and death. It is very difficult to know that an accident has occurred and to locate the position where it is happened. To solve problem like these, this accident detection and reporting system is used to save the lives by making the medical facilities arriving on time.

In this paper we are developed a wireless system using MEMS accelerometer and GPS/GSM for accident detection and reporting. IF any accident occurs, this wireless device will send automated message to Emergency medical services (EMS) and family member giving the exact position of the spot where the crash had occurred. So they can provide proper medical treatment to patients. This system is used to record information related to accident like temperature data, position data etc. So that it can be used to analyze the accident easily and to settle many disputes related to accident such as insurance settlements. This system is also used to detect whether the driver was in drunken state and the vehicle would not start thereafter. The whole system is based on arm controller. This controller is used to co-ordinate all the activities in the system.

## 2 SYSTEM OVERVIEW

The main objective of this work is to reduce the human death rate in road accident. The paper proposed a system to give quick assistance to the people who got the accident. The fall detection and reporting system for the vehicle can gain the attention because the system will save the life and give medical treatment on time.



The system consists of ARM7 micro-controller unit, MEMS accelerometer, GPS device, GSM module, Temperature sensor, gas sensor and Alcohol sensor. An Accelerometer is used to detect the acceleration. It is the main sensor used to detect the accident. Once the accident is detected GPS collect the current position values which include latitude (N or S), longitude (E or W), date and time. The location values are given to microcontroller. Controller gives this information to GSM module. By using GSM module we can send the message to family members or EMS. Here the serial communication interface UART is used for the communication between the microcontroller, GSM and GPS module [5]. The RS232 communication standard is used for the electrical signal characteristics such as voltage levels. This communication enables point to point data transfer. A high performance 16/32 bit microcontroller unit is used to process and store real time signal from the accelerometer and various sensor [1]. Through Temperature sensor we can measure temperature in vehicle and which is display on LCD continuously. Motor stop automatically when alcohol is detected through alcohol sensor. Gas sensor is used for gas leakage detection and red LED blink when gas is detected. All the data of these sensor and GPS data are stored in memory card for analysis of accident cause. The total system is placed inside a vehicle which is not visible to others. We can imple-

ment robust package design so that system is safe from water and dust.

### 3 HARDWARE DESIGN

Hardware framework for accident detection and reporting is shown in fig. 2. Hardware consists of ARM, MEMS accelerometer, GSM modem, GPS device, temperature sensor, gas sensor and alcohol sensor.

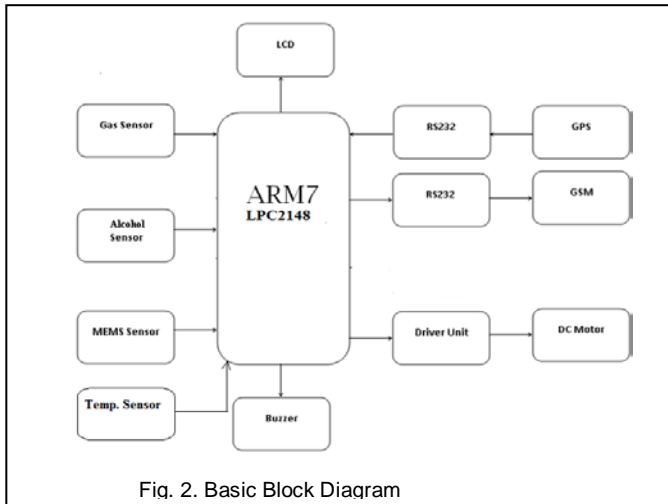


Fig. 2. Basic Block Diagram

#### 3.1 ARM7TDMI-S

Firstly ARM stands for Acorn RISC Machine from Acorn Computers Ltd. of Cambridge, UK. In 1990, ARM Ltd. was established and ARM was renamed as Advanced RISC Machines. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles. ARM7 is a series of ARM processor designs. This series has the Thumb 16-bit instruction set providing improved code density as compared previous designs. The commonly used ARM7 designs implement the ARMv4T architecture. All these designs are based on Von Neumann architecture. The microcontroller is the heart of the embedded system. The LPC2148 microcontrollers are based on a 32/16 bit ARM7 TDMI-S CPU with real/ time emulation and embedded trace support that combines the microcontroller with embedded high speed flash memory ranging from 32kb 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 application, the alternative 16-bit Thumb mode reduces code by more than 30% with minimal performance penalty. Due to their tiny size and low power consumption, LPC2148 are ideal for application where miniaturization is a key requirement, such as access control and point-of-sale. A blend of serial communication interfaces ranging from a USB 2.0 full speed device, multiple UARTs, SPI, SSP to I2Cs and on-chip SRAM of 8 kb up to 40 kb, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers particularly suitable for industrial

control and medical system.

#### 3.2 MEMS Accelerometer

An accelerometer is electromechanical device that measure acceleration forces. These forces may be static, like the constant force of gravity pulling at our feet, or they could be dynamic-caused by moving or vibrating the accelerometer. Accelerometers are sensor or transducers that generally measures acceleration forces applied to body by being mounted directly on to a surface of the accelerated body. Accelerometer in terms of 'g' ('g' is acceleration measurement for gravity which is equal to 9.81 m/s<sup>2</sup>). It is useful in detecting motion of the object. The MMA7361L is 3-axis accelerometer. It is low profile capacitive MEMS sensor featuring low pass filter, temperature compensation and g-Select which allows for the selection among two sensitivities (1.5g / 6g). MMA7361L mostly used for free fall detection, car crashes detection, tilt and motion sensing, text scroll, image stability etc.

#### 3.3 GSM MODEM

GSM is global system for mobile communication and used to send message to pre-programmed number. A GSM modem is a specialized type of modem which accepts a SIM card and operates over a subscription to a mobile operator just like a mobile phone. From the mobile operator perspective a GSM modem looks just like a mobile phone. A wireless modem behaves like a dial modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. Advantages of using this modem will be that you can use its RS232 port to communicate and develop embedded applications. Application like SMS control, data transfer, remote control and logging can be developed easily. The SIM 900 is complete Quad- band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Featuring an industry standard interface, the SIM 900 delivers GSM/GPRS 850/900/1800/1900 MHz performance for voice, SMS, data and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm\*24mm\*3mm, SIM 900 can fit almost all the space requirement in your M2M application, especially for slim and compact demand of design. SIM900 features GPRS multi slot class 10/ class8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. GSM modems support an extended set of AT commands.

#### 3.4 GPS Device

The Global Positioning System (GPS) is a space based global navigation satellite system (GNSS) that provides reliable location and time formation in all weather and times anywhere on the globe. When people talk about a GPS, they usually mean a GPS receiver. GPS used a constellation of 27 earth orbiting satellites (24 in operation and three extras in case one fails). These satellites, which are equipped with atomic clocks, transmit radio signal that contain their exact location, time and other information. The GPS satellites act as a reference point from which receivers on the ground detect their position. The fundamental navigation principle is based on the measure-

ment of pseudo ranges between the user and four satellites. Ground station precisely monitor the orbit of every satellite and by measuring the travel time of the signal transmitted from the satellite four distances between receiver and satellites will yield accurate position, direction and speed. Though three-range measurements are sufficient, the fourth observation is essential for solving clock synchronization error between receiver and satellite. Whichever the modem is used it works based upon the NMEA 0183 protocol. Basically, a GPS receiver determines four variables: longitude, latitude, height and time. The data can be taken in to the controller by using UART protocol.

### 3.5 Temperature Sensor

Temperature sensor is used to sense temperature of medium. The LM35 series are precision integrated circuit temperature sensor, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 does not require any external calibration or trimming to provide typical accuracies of  $\pm 1/4$  °C at room temperature and  $\pm 3/4$  °C over a full -55 to +150 °C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output and precise inherent calibration make interfacing to read out or control circuitry especially easy. It can be used with single power supplies are with plus and minus supplies. As it draws 60  $\mu$ A from its supply, it has very low self heating, less than 0.1 °C in still air.

### 3.6 Gas Sensor

A gas sensor is a technological device that detects or senses a signal, physical condition and chemical compounds. Gas sensor is a subclass of chemical sensor. Gas sensor measures the concentration of gas in its vicinity. Here we are using MQ-6 gas sensor. It has high sensitivity to propane, butane, LPG and natural gas. The sensitive material of MQ-6 sensor is SnO<sub>2</sub>. It has lower conductivity in clean air. When the target combustible gas exist, the sensors conductivity is higher along with the gas concentration rising.

### 3.7 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-3 gas sensor has high sensitivity to alcohol and has good resistance to disturb of gasoline, smoke and vapor. Sensitive material of MQ-3 is SnO<sub>2</sub>, which with lower conductivity in clean air. Mainly used for vehicle alcohol detector.

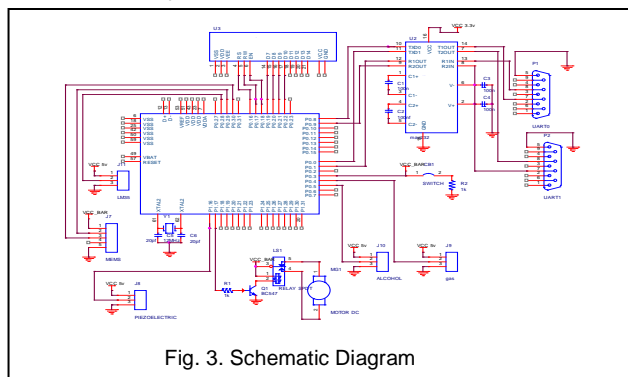


Fig. 3. Schematic Diagram

### 3.8 Data Storage

The system includes memory card to store necessary data of vehicle. The data contains longitude, latitude, date, time and all sensor value. The memory card can be expanded depending upon the use. Serial data logger is used to accept incoming serial data and then logs data to text files. The data stored in SD card can be accessed on PC with the use of external card reader.

## 4 METHODOLOGY

The system design for accident detection and reporting is based on ARM and GPS. When vehicle meets an accident, at that time the accident will be detected by accelerometer. MEMS accelerometer sensor can be used as a crash detector of vehicle during and after crash. At that time vibration sensor is used as alarm application to gain attention of people towards accident spot. According to this project 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 co-ordinates values which contains longitude (N or S), latitude (E or W), time and date. After that the microcontroller sends the alert message to family member or emergency medical service (EMS) through GSM modem which contains GPS parameter values. Due to this alert message we can provide immediate medical treatment at accident location and victim can get the treatment as fast as possible. If the vehicle meets with a small accident or no serious injuries to people then we can send a message we are safe by pressing switch manually in order to save the valuable time of emergency medical service. Through Temperature sensor we can measure temperature in vehicle and which is display on LCD continuously. Motor stops automatically when alcohol is detected through alcohol sensor.

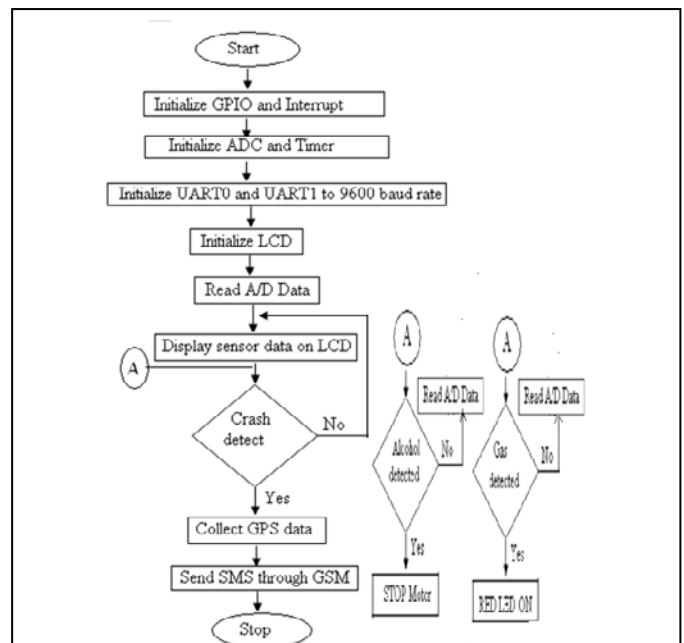


Fig. 4. Flow chart of accident notification message

This system is programmed using Embedded C in Keil soft-

ware. Keil software offers development tools for ARM and Keil  $\mu$ Vision Debugger simulates the complete ARM instruction-set. The code is burned into ARM and other chips using Flashmagic software.

## 5 WORKING MODEL

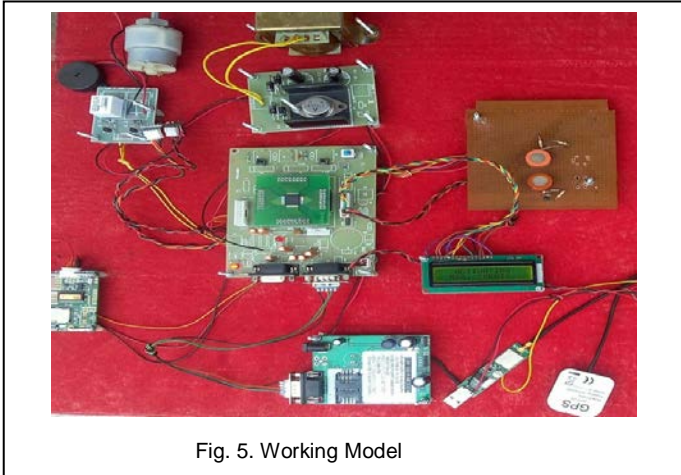


Fig. 5. Working Model

## 6 RESULT

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. Motor stops automatically when alcohol is detected. Red LED on when gas is detected through gas sensor. Here one switch is provided to send a message we are safe, when there is no serious injury happen. Due to this we can save the valuable time of emergency medical services.

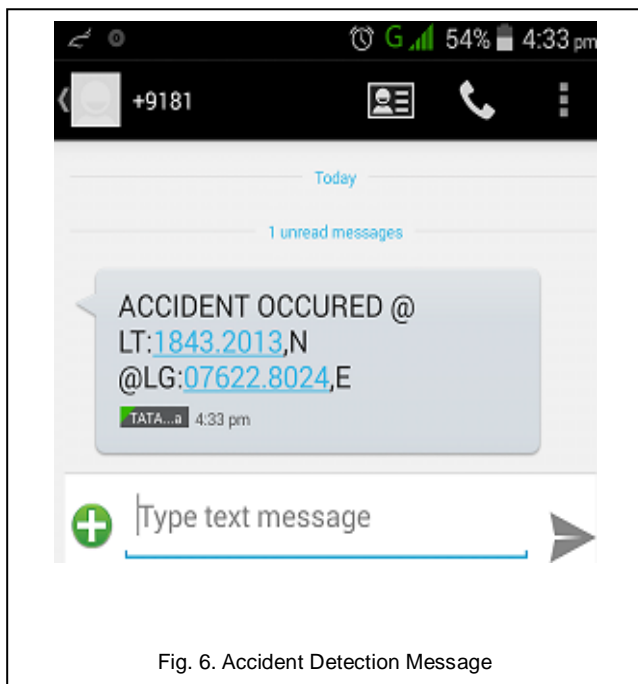


Fig. 6. Accident Detection Message

## 7 CONCLUSION AND FUTURE WORK

An innovative wireless system using Accelerometer and GPS tracking system has been developed for vehicle accident detection and reporting. This vehicle accident detection and reporting systems provide 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. In future we can interface with vehicle airbag system. This will optimize the proposed technology to the maximum extent and deliver the best accident detection system.

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