Intelligent Vehicle Monitoring System using Wireless Communication

Nilesh Ananthanarayanan
Department of Electronics and Communication Engineering
Sri Venkateswara College of Engineering
Sriperumbudur - 602105, India
a.nilesh@yahoo.com

Abstract—**The use of mobile phones while driving is one of the most dangerous and widely seen causes of fatal road accidents. The objective of the paper is to develop a device to find people who use mobile phones while driving and evade from stringent laws enforced by the government easily. This novel and ingenious technique facilitates the government to take adequate action against those who are violating these laws. To meet the requirements of an intelligent vehicle monitoring system, this architecture integrates Global Position System (GPS), Global System for Mobile communications (GSM) and a Microcontroller in the whole. This device is used to prevent texting and calling of mobile phones while driving vehicles. If the driver is using the phone while the vehicle is in motion, it triggers a signal which notifies the cops with the vehicle's number plate and the location with the help of GPS system. It receives the mobile signal and detects the presence of mobile. This signal eventually triggers the microcontroller with a glowing LED. Due to the voltage fluctuation, the message is sent to the cops using GSM communication.**

Keywords- Call detection; Wireless/Mobile Communication; Mobile bug; Speed sensors; Vehicle Monitoring; GSM Modem; GPS based vehicle tracking system; Call Notification

I. INTRODUCTION

An Accident is a disaster which is specific, identifiable, unexpected, unusual and unintended external event which occurs in a particular time and place, without apparent or deliberate cause but with marked effects. It implies generally negative probabilistic outcome which may have been avoided or prevented had circumstances leading up to the accident been recognized, and acted upon, prior to its occurrence. The first one hour is the golden hour and that can make all the difference. The aim is to reach out quickly to the law breakers, upping the chances of their survival from an accident. Serious injuries can result in disability, fatalities and life-long psychological, emotional and economic damage to loved ones. The working of our project is divided into following sections:

A. GSM Communication

GSM Modem receives trigger pulse from Mobile Bug Module. It transmits messages to police control room for call detecting. It is controlled by microcontroller by interfacing with RS-232.

B. Speed Sensors

Speed Sensors keeps track of the speed of the vehicle and activates the GSM Modem when the speed of the vehicle goes beyond 40km/hr. The GSM Modem is programmed such that it transmits message only when the speed limit exceeds 40km/hr.

C. Call sensing

The sensor used to sense the call and messages and sends as pulse to the microcontroller. The pulse is transmitted as data to the GSM Modem.

D. Call notification

If the person, who drives the car, receives a call or a message while driving, then LED glows and their unique ID will be sent to cops using the GSM Modem and at the cops control center they will be having a GSM receiver, the output of which is given to another LED.

E. GPS Tracking

The GPS module calculates the geographical position of the vehicle. This helps in detecting the location/position, velocity of our system. The module output data like global positioning system fixed data, geographic position-latitude are passed to GSM Modem.

II. GENERAL TERMINOLOGIES

A. Control center

A control center is a center which monitors the traffic, SMS from GSM Modems and other activities which takes place in road.

B. Microcontroller

Microcontroller (also MCU or μC) is a functional computer system-on-a-chip. It contains a processor core, memory, and programmable input/output peripherals.

C. SMS

Short Message Service (SMS) is a communications protocol allowing the interchange of short text messages between mobile telephone devices.

D. GSM

(Global System for Mobile Communications: originally from Group Special Mobile) is the most popular standard for mobile phones in the world.

E. AT Commands

AT commands are instructions used to control a modem. AT is the abbreviation of Attention.

F. Speed sensor

It is a type of device which can be activated if the speed of a vehicle goes above a Threshold Value.

G. GPS

Global Positioning System: a navigational system involving satellites and computers that can determine the latitude and longitude of a receiver.

III. RELATED WORK

The following are the approaches followed today, regarding call detection while driving and preventing the accidents. They are, initially [1] the cops will be setting cameras in each junction and the law breakers would be penalized if they were caught using mobile phone while driving. Teenagers are precluded from using mobile while they are driving by installing software [4] which can be manually overridden.

IV. PROPOSED SYSTEM

The architecture of the proposed system is shown in Fig.1.

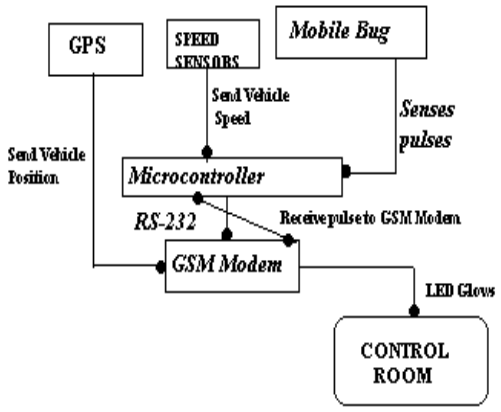

Figure 1. The proposed architecture.

It monitors the driver whether he/she is receiving/making a call and prevents them from diverting their concentration from the road, thus avoiding many accidents which take place due to the usage of mobiles while driving. A part of our system, called mobile bug which detects the call/messages within a radius of 1.5m with the help of the voltage variation in the signal. Thus, if a person drives a car above 40km/hr then this device turns on the GSM Modem and it will send a message to the cops.

The main board of the system must be installed in the driver's door in a secure location. It provides us with the following advantages:

- It enables us to identify only when the driver uses his mobile while driving.
- It makes the Driver to stop using his mobile as he also would be indicated by a glowing LED in his cabin too.
- It has a facility of allowing only certain emergency calls like calling the Ambulance, Fire Service, and Cops.
- It allows the driver to make/attend calls by slowing down his vehicle below the speed limit of 40km/hr.

We have our system designed with five modules and the following components.

Module 1: GSM Communication

Module 2: GPS Tracking

Module 3: Call sensing

Module 4: Speed Sensing

Module 5: Call Notification

A. Microcontroller

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4 Kbytes of Flash Erasable and Programmable Read Only (EPROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-510 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications. The AT89C51 provides the following standard features: 4 Kbytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, five vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator and clock circuitry.

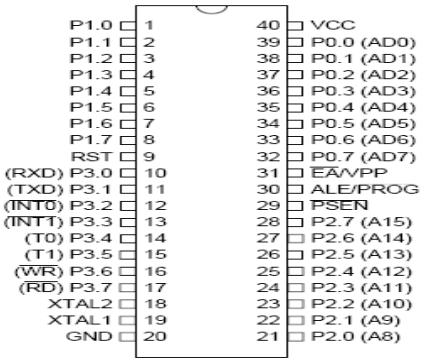

Figure 2. Pin diagram of Atmel AT89C51

B. GSM Modem

A GSM Modem [3] is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while wireless modem sends and receives data through radio waves. A GSM modem can be an external device or a PC Card/PCMCIA Card. Typically, an external GSM Modem is connected to a computer through a serial cable or a USB Cable. A GSM Modem in the form of a PC Card/PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card/PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM Modem requires a SIM Card from a wireless carrier in order to operate. Both GSM Modems and dial-up Modems support a common set of standard AT commands. You can use a GSM Modem just like a dial-up Modem. In addition to the standard AT commands, GSM Modems support an extended AT commands are defined in the GSM standards.

C. AT Commands

AT commands [2] are instructions used to control a modem. AT is the abbreviation of Attention. Every command line starts with "AT" or "at". That's why modem commands are called AT commands. Many of the commands that are used to control wired dial-up modems, such as ATD (Dial), ATA (Answer). ATH (Hook Control) and ATO (Return to online data state), are also supported by GSM/GPRS Modems and mobile phones. Besides this common AT command set, GSM/GPRS Modems and mobile phones support an AT command set that is specific to the GSM technology, which includes SMS-related commands like AT+CMGS (Send SMS message), AT+CMSS (Send SMS message from storage), AT+CMGL (List SMS messages) and AT+CMGR (Read SMS messages). Note that the starting "AT" is the prefix that informs the modem about the start of a command line. It is not part of the AT command name.

D. GPS

The global positioning system (GPS) was developed by the U.S government for the department of Defense. It is essentially a U.S military system, it offers navigation services to civilians; however, at present, there is no law which mandates the service to be made available for commercial application. Position fix is obtained through passive receivers by the triangulation method; where in estimated ranges from four satellites are used to derive the position of a point. Ranges from three satellites can provide the latitude and longitude of a point on the earth; the addition of a fourth satellite can provide a user's altitude and correct receiver clock error. It is possible to derive the velocity of the user and precise time information originating from onboard atomic clocks which have a drift rate of 1sec per 70,000 years. There are cesium atomic clocks abroad each satellite.

E. GPS Services

GPS [5] provides two levels of services: standard positioning service (SPS) and precise positioning service (PPS). The standard positioning service is a positioning and timing service that is available to all GPS users (military, private and commercial) on a continuous, worldwide basis with no direct charge. SPS will provide a predictable positioning accuracy that 95% of the time is to with in 100m horizontally, 156m vertically and 185m 3-D, with a time transfer accuracy to UTC (universal Transverse Mercado Grid) with in 340 nanoseconds. Precise Positioning Service (PPS) is a highly accurate military positioning, velocity and timing service on a continuous word wide basis to authorized users only. PPS user equipment provides a predictable positioning accuracy 95% of the time of at least 22m horizontally, 27.7m vertically and 35.4m 3-D and a time transfer accuracy to UTC within 200 nanoseconds. Only authorized users with cryptographic equipment and keys and specially equipped receivers can use the precise positioning service. PPS was designed primarily to be used by the U.S government agencies, and selected civil users specifically approved by U.S government. In our project we are using Standard Positioning and timing.

F. GPS Receivers

In 1980, only one commercial GPS receiver was available on the market, at a price of several hundred thousand U.S. dollars. This, however, has changed considerably as more than 500 different GPS receivers are available in today's market. Commercial GPS receivers may be divided into four types, according to their receiving capabilities. These are: single-frequency code receivers, single-frequency carrier-smoothed code receivers, single- frequency code and carrier receivers, and dual-frequency receivers. Single-frequency receivers access the L1 frequency only, while dual-frequency receivers access both L1 and the L2 frequencies. GPS receivers can also be categorized according to their number of tracking channels, which varies from 1 to 12 channels. A good GPS receiver would be multi channel, with each channel dedicated to continuously tracking a particular satellite. Presently, most GPS receivers have 9 to 12 independent (or parallel) channels.

V. WORKING OF THE SYSTEM

A. GSM Communication

GSM Modem [7] sends the message as "THE DRIVER IS USING HIS MOBILE WHILE DRIVING" along with the "VEHICLE NUMBER PLATE" to the control room of the cops using AT commands as AT commands +CMGS can be used to send SMS messages from a computer / PC AT+CMGS="91234567"<CR> Sending text messages is easy. <Ctrl+z>.GSM Modem is controlled by using Microcontroller which is interfaced with RS-232. RS-232 and Microcontroller is interfaced using MAX-232.

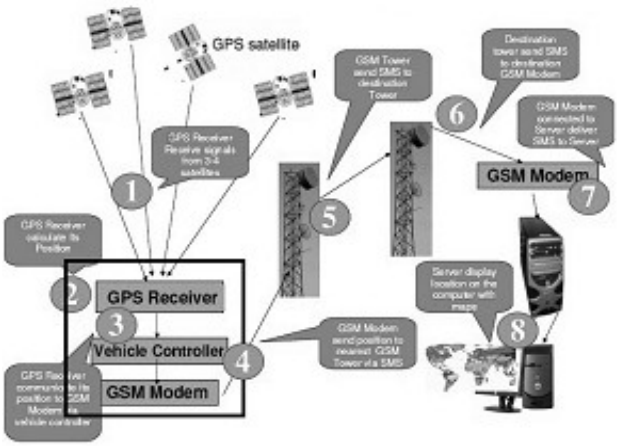

Figure 3. SMS based GPS-GSM tracking system

B. *GPS Tracking*

Each GPS satellite transmits radio signals that enable the GPS receivers to calculate where its (or your vehicles) location on the Earth and Convert the calculations into geodetic latitude, longitude and velocity. A receiver needs signals from atleast three GPS satellites to pinpoint your vehicle's position. GPS Receivers commonly used in most Vehicle tracking systems can only receive data from GPS Satellites. They cannot communicate back with GPS or any other satellite. A system based on GPS can only calculate its location but cannot send it to central control room. In order to do this they normally use GSM-GPRS Cellular networks connectivity using additional GSM modem/ module. GPS Receiver can only receive data and cannot send data to Satellite(s)**.** GPS satellites do not know the position of a GPS Receiver. GPS Receiver calculates its position using data from 3-4 satellites and no single satellites know the calculations done by PS receiver or its position. To know your location you need highly accurate map. If maps are not accurate you will have much high error in location. Normally accuracy of Maps is considered more important then accuracy of GPS Receiver. GSM-GPRS is most suitable two way communication system available to complement GPS receiver and send location information to Mobile phone, Office or Internet. GSM-GPRS Modem/Receiver can allow you to receive GPS position by SMS or Data.

C. *Call Sensing*

Call sensing is done by the circuit here called "Mobile Bug" which is used to sense both incoming as well as outgoing calls/messages within a radius of approximately 0.5-0.75m. The circuit may be shown as below. The antennae receives the RF Transmission signal from the activated mobile phone, it starts sounding a beep sound with a glowing LED. An ordinary RF detector using tuned LC circuits is not suitable for detecting signals in the range of GHz frequency band used in mobile phones. The transmission frequency of mobile phones ranges from 0.9GHz to 3GHz with a wavelength of 3.3 to 10cm. So this circuit helps in detecting the calls from/to mobile within the range. Whenever an RF signal is received with a voltage, it is given as input to the OP-AMP which acts as a current to voltage converter. We have used the OP-AMP IC CA3130 with capacitor C3 connected between its inverting and non-inverting inputs.

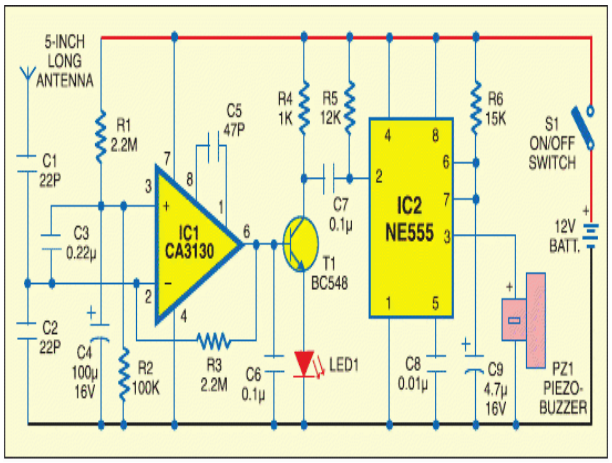

Fig. 4 Mobile Bug Circuit

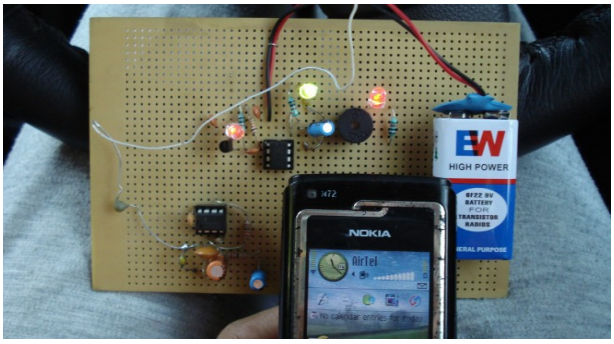

Figure 5. Image of the Mobile Bug detecting the calls of the driver

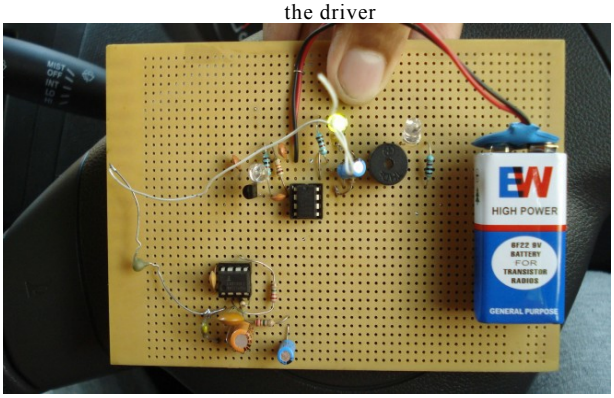

Figure 6. Image of the Mobile Bug when there is no detection of calls of the driver

It is a CMOS version using gate protected P-channel MOSFET transistors to provide very high input impedance, very low input current and very high speed of performance. The output CMOS transistor is capable of swinging the output voltage to within 10mv of either supply voltage terminal. Capacitor C3 in conjunction with the lead

inductance acts as a transmission line that intercepts the signal from the mobile phones. This capacitor creates a field, stores energy, transfers the stored energy in the form of minute current to the inputs of IC1. This will upset the balanced input of IC1 and convert the current into the corresponding output voltage. When the mobile phone is detected by C3, the output of the IC1 becomes high and low alternatively according to the frequency of the signal as indicated by LED1. This triggers monostable timer IC2 through capacitor C7.

D. Speed Sensing

The vehicle's speed sensor [6] which is mounted on the output shaft of the transmission (some later models with mechanical speedometers have the speed sensor mounted behind the speedometer) sends electrical pulses to the micro controller, pulses which are generated through a magnet that spin a sensor coil. When the vehicle's speed increases the frequency of the pulses also increases. Note that for any given speed of the vehicle, there is a corresponding pulse frequency. It is this pulse frequency which the cruise control tries to maintain as a constant. Speed sensors are usually made up of a toothed metal disk mounted on a rotating shaft and a stationary detector covering a magnetic coil. The Vehicle Speed sensors are made to transmit pulses to the micro controller when the speed of the vehicle reaches the threshold of 40km/hr which is taken as one of the input to it.

E. Call Notification

Whenever the driver uses his/her mobile phones while driving the cops would be intimated by the message saying that the driver is using his mobile phone while driving along with the position of their vehicle along with the number plate details which is already stored in the micro-controller's memory. Thus, the law breakers can be caught easily through this system.

VI. COMPONENT DETAILS

TABLE I. TABLE DEPICTING THE VARIOUS HARDWARE AND SOFTWARE REQUIREMENTS

S.NO	COMPONENTS
1	Microcontroller AT89C51
2	Vehicle Speed Sensor
3	GPS Module-ZX 41215P
4	GSM Modem
5	RS-232
6	Call Sensing Circuit

VII. CONCLUSION AND FUTURE WORK

Thus, this system would act as a benchmark rendering effective and quick response from the cops for reporting use of mobile while driving by the drivers. Also, it could be fitted onto existing vehicles, requiring to special setups.

This project could help to save precious human lives by reporting the use of mobile phones while driving, then the success of our project would have been achieved.

In future, a small jammers constrained only to drivers cabin may be designed and if the vehicle is moving at a speed more than 40km/hr then the jammer should be activated and the driver should be barred from receiving as well as making calls and messages. This may avoid many accidents on the spot as the life of human beings is more important than anything.

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