Tracking and Accident Detection in Automobiles Using GPS and GSM Technology

Zainab Mohammed Khamis Al-Balushi[a], Safaa Saeed Khalfan Al-Taalei[a], A. Jamaludeen[a]

This paper describes the design and development of an automatic tracking and accident detection (ATAD) system in automobiles. Oman rated as the highest causality in road accidents among GCC, according to figures released by the World Health Organization (WHO). Lack of proper reporting about the exact location add delay in paramedic unit to reach, results the loss of precious human life. The proposed single-board in-vehicle embedded system equipped with the SIM28M GPS to get geographic coordinates, SIM800 GSM modem to send the Google map link as text message, SW-420 vibration sensor to sense the collision, and the ATmega328P microcontroller as core processing unit. The vibration beyond the threshold level, say during collision is detected by the vibration sensor and this information is transferred to the microcontroller. The microcontroller gets the latitude and longitude from the GPS receiver. This coordinates send as Google map link through the GSM modem to the concern persons whose mobile numbers are stored in the memory. This text message directly loads the exact location in Google map instead of searching the location using the coordinates. This saves a precious time and victim may receive the immediate medical attention. This ATAD system serves as a complete portal to exchange information such as, real-time navigation of vehicle location, monitoring of collision, update of geographic coordinates on-demand or at regular interval and fuel shutdown using servomotor on command in case of theft.

Keywords: ATmega328P microcontroller, GPS, GSM, latitude and longitude, and accident detection Smart System

I. Introduction

The aquarium gives stunning look to the area, gives a sense of Ever increasing demand of safety and security leads to usage of latest technology and intended to develop application-specific stand-alone embedded devices. Vehicle trackaing system is one of such type of electronics devices that tracks and accident detection used in automobiles. This electronics device not only tracks the vehicle's location but also send the google link to the concern authority to exactly locate the position of the vehicle if in case of accident. GPS module to locate the vehicle's position and it will inform where position of the vehicle is and where it has been, how long it has been [1]. The system uses geographic position and time information from the Global Positioning Satellites.GSM technology used to send the SMS. Vehicle tracking systems have brought this technology to the day-to-day life of the common person. Today GPS used in cars, ambulances, fleets and police vehicles are common sights on the roads of developed countries. Integrate both GSM and GPS technologies will provide effective, real time vehicle location, and reporting. A GPS-based vehicle tracking system will inform where your vehicle is and where it has been, how long it has been. The system uses geographic position and time information from the Global Positioning Satellites. The SMS technolgoy through GSM network and GSM modem provide a user with vehicle locaiton information [2]. Effective usage of SMS has become more convenient and accessible way of transferring and receiving data with high speed. This paper describe the usege of GPS and GSM based in-vehicle tracking device based on ATmega328P microcontroller. The Vehilce locaiton is automatically send as Google maps link in SMS which make easier to track vehicle. In case of accident it also enable the paramedical team can reach place as soon as possible and this intern save the valuable human life.

II. Hardware Design

The block diagram of Vehicle tracking and locking system based on GSM and GPS technology is shown in the Fig 1. It consists the power supply section, GSM, GPS, ATmega328P microcontroller and overall system reside into a vehicle. The basic function of in-vehicle tracking system is to acquire, Monitor and transmit the position latitude, longitude, time to management center either at fixed interval or on demand [3]. Microcontroller unit form the heart of tracking unit, which acquires and process the position data from the GPS module. The GPS receiver of vehicle terminal receives and resolves the navigation message broadcasted by GPS position satellites, computes the longitude and latitude of vehicle coordinates, transforms it into the GSM message form by GSM communication controller, and sends the message to monitoring center via the GSM network. Microcontroller have a CPU in addition to the fixed amount of RAM, ROM and I/O ports, which are embedded on a chip with support functions such as a crystal oscillator, timers and serial or analog input output (I/O). The MCUs are designed for embedded

a. Department. of Engineering, Ibra College of Technology, Ibra, Oman. Correspondence: jamaludeen@ict.edu.om,

applications and can be used in remote controls, power tools, toys and other appliances. Invention of MCUs has reduced the size and cost of designs. MCUs are suitable where cost and space are critical [4].

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, 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 a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega328 programmed as a USB-to-serial converter.

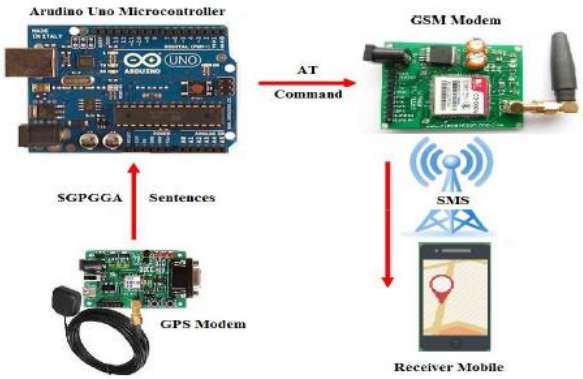

Figure 1. Block diagram of tracking and accident detection system based on GSM and GPS technology

Arduino UNO is the latest version of the Arduino UNO board using the ATmega828 instead of the FTDI chip for faster transfer rate. It is a small form microcontroller board based on ATmega328. It is equipped with a USB connection, 32kBytes flash memory, 1 reset button, 14 digital input/output pins, 6 analog input pins and 1 power jack. The recommended input voltage for this board is between 7 to 12 volts. Thus, an external power supply is needed. Power can supply to this board through the power jack. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started [5]. Besides that, Arduino UNO can communicate with a host PC by using a USB Type B cable. The user can write the program on the host PC and upload it to the board. After uploading the program, the USB Type B cable can be removed. The program will be stored in the Arduino board and it will still run each time the reset button is pushed. It also features the Atmega328 programmed as a USB-to-serial converter.

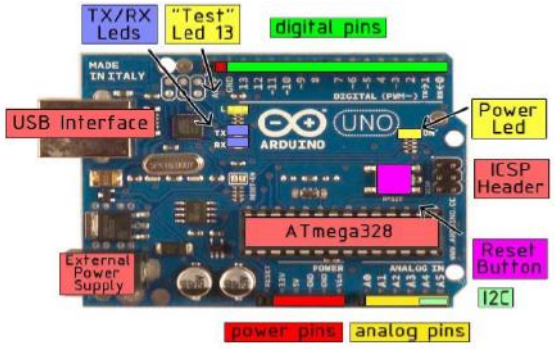

Figure 2. Arduino Uno Atmega328 microcontroller board

Navigation System with Timing and Ranging Global Positioning System, NAVSTAR is the full description of GPS. GPS is a space based navigation system which being developed, operated and maintained by the Defense Department of US. Although it is being controlled by the US government, it is freely accessible by anyone with a GPS receiver. The GPS is comprised of three important segments. The segments of GPS are: i) Space segment. The space segment consists of satellites that orbit the earth on six different orbital planes. Each of these planes has four satellites which will transmit the one way signals to the receiver equipment on earth. ii) Control segment. The control segment is the earth equipment that carrying out the task of monitoring and controlling the space segment, satellite tracking, telemetry and maintain the satellite orbit configuration. iii) User segment. The user segment is the satellite receiver equipments which are used to receive the signal from the satellites and determine the current location of the user based on the received signals.

The Global Positioning System (GPS) is a satellite based navigation system consists of a network of 24 satellites located into orbit. The system provides essential information to military, civil and commercial users around the world and which is freely accessible to anyone with a GPS receiver[6]. The GPS is suitable to be used in the people tracking embedded system because the GPS can work in any weather condition, anywhere in the world, 24 hours a day with no subscription fees or setup charges. Besides that, the GPS also can provide 3 dimensional positioning. Thus, it can be used to detect the location of the user with high accuracy. The GPS Shield based on the SIM28 GPS module. It is a cost-efficient and field-programmable gadget. It features 22 tracking / 66 acquisition channel GPS receiver. The sensitivity of tracking and acquisition both reach up to -160dBm, making it a excellent for well-suited for vehicle navigation and tracking system design. This receiver provides complete signal processing from antenna input to host port output in NMEA messages.

By referring to Figure 3, the data was taken at 12:35:19, the GPS receiver is located at Latitude 48 deg 07.038', N and Longitude 11 deg 31.000' E, 545.4 meter above mean sea level and 46.9 meter, above WGS84 ellipsoid.

Figure 3. Explanation of $GPGGA sentence

GSM is the short for global system for mobile communication. It was a communication system that originated in Finland Europe and developed by using digital technology. GSM is a 2G technology that is implemented globally and used to transmit voice and low volume digital data service. Examples of low volume digital data are SMS (short message service) and MMS (Multimedia Message Service). Besides that, GSM has four frequency ranges, which are 850MHz, 900MHz, 1800MHz and 1900MHz [7].

The core of data communication about this system lies in wireless communication control terminals that uses GSM Modules to transfer long-distance data extensively and reliably. GSM network is a public land mobile network (PLMN). Mobile station which is made up of a SIM (Subscriber Identity Module) card is the user terminal in GSM network while the mobile terminal refers to the user device such as mobile phones. A system that uses a cellular network based around broadcast stations or satellite technology that is connected to signal from orbit are part of the GSM network. The main purpose of the GSM network is to facilitate easier access to cellular and satellite platforms across international lines.

GSM modem is similar to mobile phone. It is a specialized wireless modem which needs a SIM card and works with a GSM wireless network. GSM modem utilizes the radio wave for sending and receiving the messages. Utilization of SMS technology has become popular because it is an inexpensive, convenient and accessible ways of transferring and receiving data with high reliability. Besides that, GSM modem can be used for automating business process, sending SMS from a computer and vehicle tracking with integrated GPS.

A GSM modem is controlled by using the AT commands. If the user would like to do the operation such as reading, writing, deleting and sending messages, an extended set of AT commands which are defined in the GSM standard is needed[8]. The SIM900 is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. It is very compact in size and easy to use as plug in GSM Modem. .The baud rate can be configurable from 9600-115200 through AT command. The modem needed only 3 wires (Tx, Rx, GND) except Power supply to interface with microcontroller. AT which stands for AT tension is a set of instructions that are used to control modems such as GSM/GPRS modem and GPS modem. AT command can be divided into two types, which are the basic commands and extended commands. The basic commands are commands which do not have "+" after "AT", such as ATA, ATD, ATO and ATH. For extended commands, there is a "+" after "AT" such as "AT+CMGD" and "AT+GMCF". Table 1 show some of the AT commands for GPS modem and GSM modem. Table 1shows some of the AT commands for GPS modem.

AT Command For GSM	Function
AT + CMGD	Delete SMS message
AT + CMGF	Select SMS message format
AT + CMGR	Read SMS Message
AT + CMGS	Send SMS message
AT + CMGW	Write SMS message to memory
AT + CNMI	New message indication
AT + CSCB	Select cell broadcast SMS message

Table 1. AT commands for GPS modem

Arduino IDE is an environment that consists of a message area, a simple text editor and menus. 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 your computer, used to write and upload computer code to the physical board. It allows the user to create the "sketches" in order to let the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package [9,10].

Arduino board interaction with the device which connected to it. The sketches that written by the user can be stored in sketchbook. Besides writing the program, it also allows user to compile and upload the sketches to the Arduino board. Furthermore, Arduino IDE has its own software library which called "Wiring". This library makes the common input output operation become easier. It uses the tool chain and AVR library to compile the program and uses the avrdude to upload the program to the Arduino board.

Arduino programming language is a simplified version of C or C++ programming language. It is encompasses strong typing, imperative, declarative, functional, generic, object-oriented and component-oriented programming disciplines. This programming language does not need to include the header file at the beginning of the coding. Besides that, there are only two functions are needed in order to make a cyclic executive program. Those functions are setup () and loop (). Setup () is the function that is used to initialize the settings and only runs once at the beginning of the program. While the loop () is the function that is called continuously [11,12].

III. RESULTS

Tracking module which consists of GPS and GSM module is responsible for tracking the current location of the user, extracting the $GPGGA sentences and send out the SMS through GSM network. Complete system as shown in Fig. 4 contains complete connection of Arduino board along with GSM and GPS system. Starting from the satellite, the GPS module receives the geographic coordinates. The vehicle's location information is read in from the GPS module by the microcontroller. After initializing the driver pins, GSM mode is turned ON to register in the network and the baud rate of the GPS is set to 9600bps. GPS mode is turned ON for navigation purpose. When the serial port has been opened successfully, the GPS starts to track the coordinate of the location. Fig. 4 shows the status of the system when it is powered up.

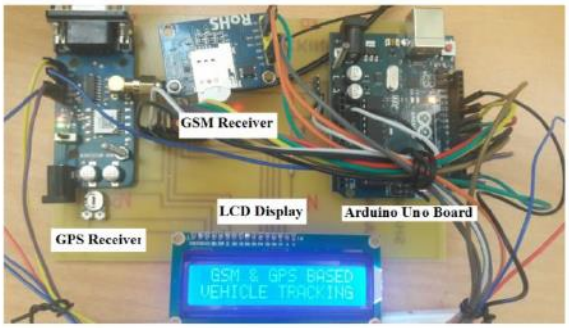

Figure 4. Status of the system when it is powered up

After turning ON the GPS, the GPS receiver will start receiving the signal from satellite. Since GPS needs time to warm up and become stable, the GPS was commanded to track the user location for 10 rounds per cycle, in order to obtain correct and stable coordinate. If the GPS is not ready, the $GPxxx sentences that we received just having the information of current time and check sum data. If the GPS is ready, the complete $GPxxx sentences with full information is received. The coordinate information that is received from GPS receiver was in various forms of $GPxxx signal, such as $GPGGA, $GPRMC, $GPGSA, $GPGSV, and $GPGLL. All of these $GPxxx sentences contain the latitude and longitude information, but in different format. Mirocontroller extracting the $GPGGA sentences from various form of $GPxxx sentences because the latitude and longitude information for $GPGGA sentence are in degree and minute, which are easier to extract and interpret. Every cycle, the GPS tracks the user location for ten seconds in order to get a stable coordinate. After that, the last coordinate information that was received by the GPS receiver is sent to the microcontroller. The microcontroller extracts part of the $GPGGA sentences from the signal received and store the signal in an array. The $GPGGA sentence has other information other than latitude and longitude such as the time GPS signal was received. to determine the exact location of the user, only the part which contain the coordinates and the ordinal that determines the position are needed. Thus, an array which can only store 41 characters was created in order to eliminate the unnecessary part of the $GPGGA signal. The information that are saved in the array were latitude, longitude and the ordinal that determines the position. Then, the signal that is stored in the array which contains the $GPGGA sentences is sent to the GSM modem.

After that, the GSM mode is turned ON. The AT and extended AT commands were sent by the microcontroller to configure the GSM modem and request GSM to send the string in the array to another GSM modem which is connected to the PC. The baud rate of GSM is set to 9600 bps. The commands required to send out the $GPGGA sentence through GSM modem are "AT+CMGF=1" and "AT+CMGS= "\9689xxxxxxx\"". First, "AT+CMGF=1" is sending to GSM modem to configure the modem to use the text mode. After set the modem to text mode, AT+CMGS command sends an SMS message to a GSM phone, "\9689xxxxxxx\". Fig. 5. shows the GSM module transmitting the latitude and longitude of the vehicle's location.

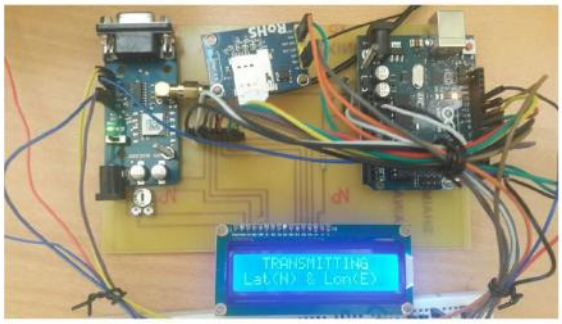

Figure 5. GSM module transmitting the latitude and Longitude of the vehicle's location.

The coordinates that are extracted from the string will be displayed in the text box of latitude and longitude. If the returned coordinate is valid, the mapping button will be enabled in order to display the point on Google Maps. Fig. 6 shows the extracted latitude and longitude send to the specific mobile number.

Figure 6. Extracted latitude and longitude send to the specific mobile number as Google maps link.

If the displaying part keeps updating by receiving the messages from the GSM and GPS modem, the latitude and longitude data will be extracted from every incoming message, displayed on the LCD display and send through the specific mobile number at regular interval of time.

Fig. 7 shows the current position of vehicle on Google Maps for regular interval of time specified in the code. In order to demonstrate operation of the vehicle tracking system successfully, a smart phone was configured with the Google maps application.

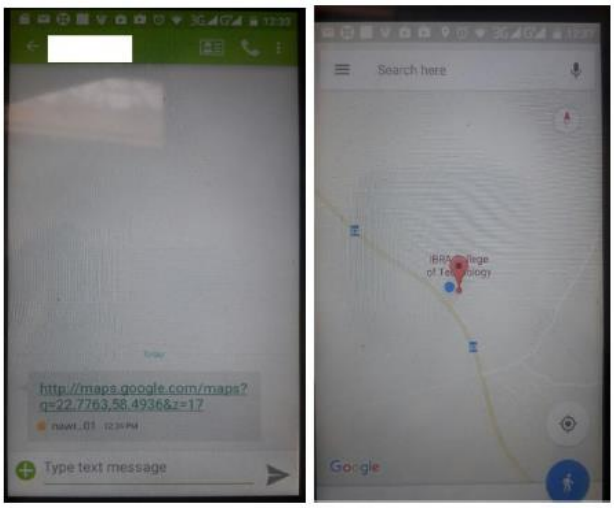

Figure. 7 Current position of vehicle on Google Maps and display of location of the vehicle

Although there are varieties of software packages, which can be used to simulate the circuit; the most commonly used are the circuit wizard and the PCB wizard. In order to test the circuit, Proteus design suite (software) is used. It is very powerful tool for the electronic circuit simulation, the schematic capture and the printed circuit board (PCB) design. By combining ISIS schematic capture and ARES PCB layout the Proteus design suite (software) provides an integrated and easy to use suite of tools for professional PCB design. The Proteus can be used to design a complex circuit for the simulation and the printed circuit board (PCB) layout.

IV. CONCLUSIONS

The vehicle tracking system presented in this paper can be used for positioning and navigating the vehicle with an accuracy of 10 m. The positioning is done in the form of latitude and longitude along with the exact location of the place, by making use of Google maps. The system tracks the location of a particular vehicle on the user's request and responds to the user via SMS. The received SMS contains longitude and latitude that is used to locate the vehicle on the Google maps. The vehicle tracking system allows a user to: remotely switch ON the vehicle's ignition system, remotely switch OFF the vehicle's ignition system, remotely lock the doors of the vehicle, remotely unlock the doors of the vehicle, and remotely track a vehicle's location. Some changes were made in which most notable change was alteration of the tracking methodology (i.e. Access to 32 channels of satellites instead of 3). The vehicle tracking system was built successfully. However, the vehicle tracking system could be made more robust by using more accurate GPS unit.

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