Real-Time Vehicle Tracking System Using Arduino, GPS, GSM and Web-Based Technologies

June Myint Mo Khin
Department of Computer Engineering and Information Technology
Yangon Technological University
Myanmar

Dr. Nyein Nyein Oo
Department of Computer Engineering and Information Technology
Yangon Technological University
Myanmar

Abstract: Vehicle tracking system is a well-established technology in this era which is used by fleet system and owner of vehicle all over the world. It is a very safe and reliable technology. In this paper a real time tracking system is proposed. It is going to design a system which is used for tracking and positioning of any vehicle by using Global Positioning System (GPS) and Global System for Mobile Communication (GSM). The design is an embedded application, which will continuously monitor a moving vehicle and report the status of vehicle on demand. Tracking device used in real time vehicle location tracking is made up with Arduino Uno R3, SIM800A module and NEO 6M GPS module. For doing so the Arduino Uno R3 is interfaced serially to a GSM module and GPS module. The GSM module is used to continuously send the position of the vehicle from remote place. The GPS module that uses satellite technology for its navigation system will continuously give data like longitude, latitude, speed, distance travelled etc. Google map is used to view the position of vehicle on a digital mapping. For this work the software XAMPP and Google Map API are used. XAMPP is a free and open source cross-platform web server solution stack package consisting mainly of the Apache HTTP Server, MySQL database and interpreters for scripts is written in PHP and Perl programming languages. The Google Maps API allow for the embedding of Google Maps onto web pages using a JavaScript interface which is designed to work on desktop browser application. The MySQL database is used to store all the data of the GPS and Google Map API is used to display the location information through a Google Map.

Keywords: Vehicle Tracking System, GPS, GSM/GPRS Technologies, HTTP Service, Google Map

1. INTRODUCTION

The vehicle tracking system is a total security and fleet management solution. It is the technology used to determine the location of a vehicle using different methods like GPS and other navigation system operating via satellite and ground based stations. Modern vehicle tracking system use GPS technology to monitor and locate the vehicle anywhere on earth, but sometimes different types of automatic vehicle location technology are also used. The vehicle tracking system is fitted inside the vehicle that provides effective real time location and the data can even be stored and downloaded to a computer which can be used for analysis in future. This system is an essential device for tracking car any time the owner wants to monitor it and today it is extremely popular among people having expensive cars, used as theft prevention and recovery of the stolen car. The data collected can be viewed on electronic maps through internet and webpage.

2. OVERVIEW OF PROPOSED SYSTEM

The following block diagram of vehicle tracking system shows how the proposed system actually works. For the implementation of the proposed real time vehicle tracking system, navigational technologies such as GPS, GPRS and database technologies are used. The system is installed in a vehicle to allow the owner to track the vehicle's location, this system will use GPS and GPRS module. Global Positioning System can determine the precise location of a vehicle. The GPS antenna attaches with the GPS receiver module receives the information from the GPS satellite in NMEA (National Marine Electronics Association) format and this information is transmitted to a server using GPRS module. GPRS provide HTTP connection with tracking server. Tracking server has

received vehicle location information through the network and stores this information in database. This information is available to users of the system over the internet on map. GPS is a satellite based navigation system; it is made up of 24 satellites, these satellites placed into the orbit. These satellites transmit coded information towards GPS receiver, this information use to identify vehicle locations on earth by measuring the distance from the satellites. GPRS network is an "always on", private network for data. It uses the existing GSM network to transmit and receive HTTP based data to and from GPRS device/module. It supports packet switched data services such as email and web browser. The GPRS can transfer data at the maximum rate of 115.2 kbps. It is most suitable for a real-time tracking management system [4].
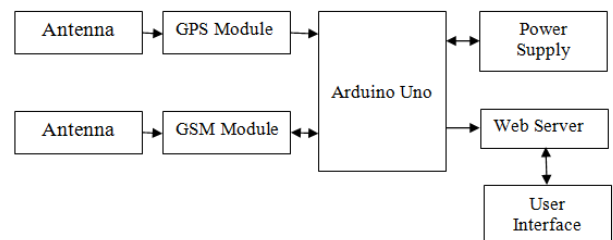

Figure 1. Block Diagram for Overall Proposed System

3. CONFIGURATION OF REAL TIME VEHICLE TRACKING SYSTEM

The development of the real time vehicle tracking system will be described in details in this section. The two main parts of the system are the hardware and the software components. The hardware component consists of tracking unit. Tracking

device used in real time vehicle location tracking is made up with Arduino Uno R3, SIM800A module and NEO 6M GPS module. The core part of vehicle tracking is microcontroller Arduino Uno. The geo location of vehicle can be captured through GPS module and that data is transmitted to the web server by using GSM technology. The implementation of the tracking unit is shown in Fig.2
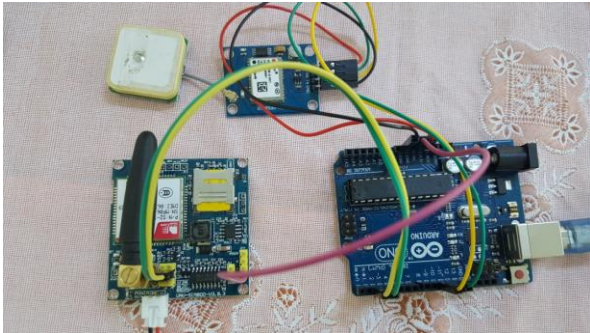

Figure 2. Tracking Unit For real Time Vehicle Tracking System

SIM800A module requires 2A peak current. So, external power supply like 12V-2A battery is used to provide the power. GPS module and GSM module are connected to the microcontroller. Firstly, the GPS module is connected easy to digital input/output pins in Arduino Uno. One thing to note was that the TX pin of the Ublox GPS module was connected to the RX pin of the Arduino Uno. The main reason for this was, TX stands for Transmit where data is send out and RX stands for Receive where data is received. Therefore, the GPS-TX sends data to the Uno RX and the GPS RX receives data from the Uno TX. GPS RX (receive) is connected to the Uno TX (transmit) and GPS TX (transmit) is connected to the Uno RX (receive).

Secondly, the GSM module is connected with digital input/output pins of Arduino Uno. The TX pin of the GSM module was connected to the RX pin of the Arduino Uno. This is because the Uno (TX) D3 transmits data to the GSM (RX) and conversely the Uno (Rx) D2 receives from the GSM (TX) shown in Fig.2. The modules and Arduino have a common ground. The tracking unit collects the location information via the GPS, formats this information into a system-specific packet format and sends it to the server via GPRS. After establishing the GPRS connection it tries to connect to the service provider's server using the HTTP protocol. After successful connection, the GPS data is sent to the server as a string. Then after a certain time period it checks the availability of GPRS and connects to the HTTP server. The current location of the device is sent to the HTTP server. In this way the device communicates with the server and sends the location.

The software components consist of Arduino IDE and web server software. Arduino Integrated Development Environment (IDE) is a cross platform application written in self-installable java. The C/C++ languages are used to program Arduino. The Arduino IDE provides a powerful yet user-friendly programming environment. It is used for compilation and uploading codes to the Arduino board through a USB connection. In this system, the coding which consist of two libraries SoftwareSerial.h and TinyGPS++.h is written C programming Language. TinyGPS++ is a new Arduino library for parsing NMEA data streams provided by GPS modules. Like its predecessor, TinyGPS, this library provides compact and easy-to-use methods for extracting position, date, time, altitude, speed, and course from

consumer GPS devices [5]. In Fig.3, arduino IDE sketch of coding for the proposed real time tracking system is described.
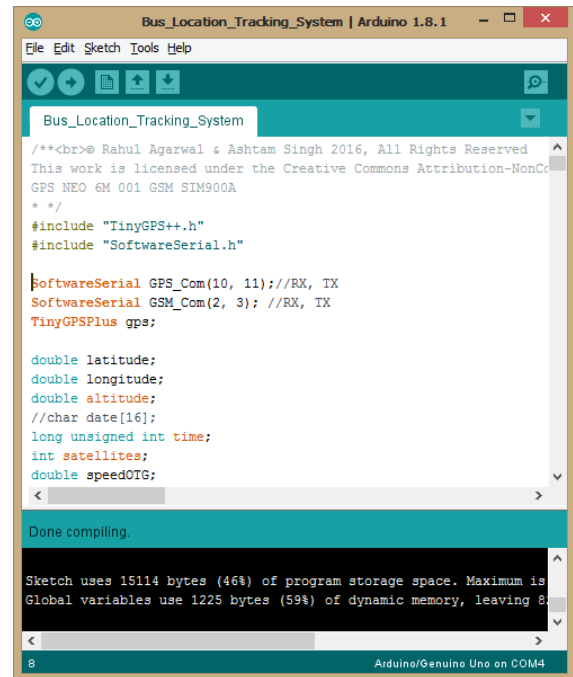

Figure 3. Arduino IDE Sketch of Coding for the Proposed System

For sending Vehicle location GPS data and other information received from GPS module through GSM network, SIM800A module connected with Arduino Uno microcontroller is used. AT command has been used in programming for communication with connected server and SIM800A module. AT commands 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 [6].

For using GSM network the response of SIM card is checked by using AT commands firstly. Then it checks the response of network status. After the confirmation of network status is available, it checks the GPS status and acquires the GPS information of the bus. Then it checks the HTTP request for internet. Initially, the network registration is done by using AT+CGATT command and set Access Point Name (APN), user name and password. After getting the data of vehicle's location, the data are sent to the web server by using HTTP request. AT+SAPBR command has been used for setting the configuration of GPRS. To access the internet HTTP service, AT+HTTPINIT command is used to initialize HTTP service, HTTPPARA command is used to set the parameters value.

To check the GPRS parameters, the following steps are shown:

1) sending "AT+SAPBR=3,1,\"Contype\",\"GPRS\" " and the response "OK"
2) sending "AT+SAPBR=3,1,\"APN\",\"mptnet\" " and the response "OK" (where MPT SIM card APN = mptnet)
3) sending "AT+SAPBR=3,1,\"USER\",\"\" " and receiving the response "OK" (where MPT SIM card USER = blank)
4) sending "AT+SAPBR=3,1,\"PWD\",\"\" " and receiving the response "OK" (where MPT SIM card USER = blank)

5) sending "AT+SAPBR=1,1" and receiving response "OK"

6) sending "AT+HTTPINIT" and receiving response "OK"

7) sending "AT+HTTPPARA= \"URL\", \"\" " and receiving response "OK"

8) sending "AT+HTTPACTION=0" and receiving response "OK"

In Fig.4 shows serial monitor of the Arduino IDE when running the proposed tracking system.

Figure 4. Serial Monitor of the Arduino IDE during Running the Tracking System

After the activation of the GPRS service, the HTTP protocol starts work directly [2]. This is used to send the vehicle's position to a web server. A free web hosting service is used for a web server construction. In this system, the 000webhost.com is used as an unlimited free web hosting and an account is created for website of real time vehicle tracking system. The FileZilla client software is used for connecting to an FTP or SFTP server. The required files for website is uploaded or downloaded by using it. To implement the website for the proposed vehicle tracking system, PHP with MySQL has been integrated together with Apache web server is used.

4. SIMULATION AND RESULTS

For visualization of the location of vehicle into the Google map, HTML is written in web application which is developed with PHP script to show the web page into the browser [1]. In this script Google Map API is embedded. MySQL database is used for storing the data into database. By using GET and POST function in the PHP script, GPS data which is transmitted by GPS module through HTTP connection are stored in database and fetched into the Google map to show the location of bus.

The API automatically handles access to Google Maps servers and display map [7]. API calls also are used to add markers. For setting the center location of map google.maps.LatLng ( ) method is used. As Google Maps API provides different kind of maps view, ROADMAP is used for this web application. For fetching the data into the Google Map, getElementByID ( ) method is used. JQuery and Google Map API are embedded into the script which helps to show the location of the vehicle into the Google Map in real time.

The web page shown in Fig.5, user can get vehicle information such as latitude, longitude, satellites, speed and course and vehicle's current location is pointed in Google map with maker.
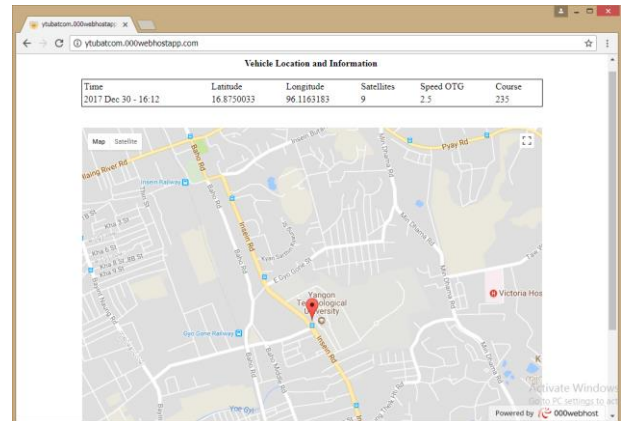

Figure 5. Web Page for the Proposed Real Time Vehicle Tracking System

5. CONCLUSION

This paper presents an efficient real time a vehicle tracking system that is flexible, customizable and accurate using GPS and GPRS of GSM network, suitable for wide range of applications all over the world. The combination of the GPS and GPRS provides continuous and real time tracking. To display the position on Google map Google map API is used. The Arduino is the brain of the system and the GSM module which is controlled by AT commands that enable data transmission over GSM network while the GPS provide the location data. Whenever the GPS receives a new data it is updated in the database and hence it is able to see the location on the Google map [3]. In the case of vehicle tracking, the proposed system gives the vehicle location information include latitude, longitude, altitude, date, satellites, speed OTG and course. The outcomes of the system are good like the results of the industrial devices. For the future work, a variety of services can be added to this system by using sensors or actuators.

6. ACKNOWLEDGMENT

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