Abstract – Tracking and monitoring vehicles are coming vastly utilized based on Global Positioning System (GPS). In this paper a real time tracking system is proposed. The proposed framework would make great utilization of new innovation that basis on embedded board denotation Arduino Intel Galileo. This system acts on Global System for Mobile Communication (GSM), Global Positioning System (GPS) and General Packet Radio System (GPRS) which are utilized for vehicle tracking and monitoring. The SIM908 Module is applied which incorporates three technics to be specific GPS, GPRS and GSM. GPS gives the vehicle location coordinates, GPRS transmits these data to the server and finally the GSM transmits warning message to the vehicle owner phone. This paper exhibit the evolution of the vehicle tracking system prototype which is used in the vehicle. In particular, the framework will use GPS to acquire a vehicle location coordinates and send it utilizing GSM modem to the owner phone and to the web server. After that, the browser can load the PHP webpage which uses Google maps to show the location in a real-time. To define the location accuracy of the suggested system, we compared the system proposed results with the different commercial GPS devices.

Keywords-Embedded System; Arduino Intel Galileo; Tracking System; Global Positioning System (GPS)

I. INTRODUCTION

Vehicle tracking and monitoring system in actual time is quite modern upcoming advanced innovation [1]. This innovation utilizes numerous sensors and Global Positioning System (GPS) for its working. The present vehicles data can be recovered from the vehicle and can be utilized in appropriate correspondence innovation. These data can be exchanged to the remote client or to the controller. In addition, the client or controller in the remote area has the capacity to reach to the vehicle and can control it [2, 3]. However, the selection of vehicle tracking framework is yet extremely inadequate. Such a framework can be utilized for some applications including security of individual vehicle, general transportation frameworks, vehicle administration and other applications. The tracking vehicle system have been accessible in the stock market for quite a while however they are application particular, district particular and are expensive. In this manner a system intended for vehicle security won’t be appropriate for vehicle administration [4, 5]. This work presents a vehicle tracking framework utilizing Global Positioning System (GPS) for situating, General Packet Radio System (GPRS) for information transmission, and Google Earth programming for place showing.

The GPS satellite navigation system is a real-time system with three-dimensional position decision. It was produced by various United State government associations, such as Department of Defense (DOD), National Aeronautic and Space Administration (NASA) and the Department of Transportation (DOT). There are three segments in the GPS: constellation of the satellite, ground system for control and monitoring, and client receiving hardware. The constellation of the satellite is a group satellite in orbit that gives the ranging signs and information messages to the client hardware. The control section regulates and keeps up the space portion which is the satellite heavenly body in space. The client portion or the client receiving hardware gets the sign from the space section and processes the route, timing and other different services [6].

The upgrade of the GSM system is a General Packet Radio Service (GPRS) to assist data exchanged information services, for example, web interface browser and email. Also existing GSM information services, like Short Message Service (SMS) and fax service using Circuit Switched Data (CSD). GPRS works on a current GSM system framework by uses accessible time opening amid every frame transmission. Therefore, it doesn't overload the current GSM system traffic and can productively support information services. The GPRS can exchange information at the most extreme rate of 115.2 kbps (with the eight accessible spaces of every frame). Due to a large coverage region of GSM systems around the world, GPRS turns into the biggest information administration system. It is the most appropriate for tracking vehicle system in a real-time [7].

The proposed system displays a real-time vehicle tracking system utilizing a client/server pattern. The customer or client contains an embedded equipment integrate with GPS/GPRS device to determine the module position information that is periodically sent to the server. The server side consists of a personal computer together with web server software.
This position data modified into the style that can be shown by utilizing Google Map innovation. The proposed real-time tracking system architecture is shown in figure 1.

The rest of the paper has been organized as follow: after introduction at section 1, the proposed system architecture has been provided in section 2. Section 3, displays the results and discussions with some screen shots of proposed system. Finally, section 4 shows the conclusions of the paper and the future work.

II. PROPOSED SYSTEM ARCHITECTURE

The development of the vehicle tracking system will be described in details in this section. The prototype components of the vehicle tracking system are as shown in figure 2.

The two main parts of the system are the hardware components and the software. The hardware components consist of the geo-location tracker (GPS+GPRS) Quad-Band module with SIM908, Arduino Intel Galileo board, 2300mA/h rechargeable battery, external GPRS-GSM antenna, external GPS antenna and 9V alkaline battery. The explanation of each components of the proposed system as follow:

A. GPS-GPRS Quad-Band Module

This shield integrates the SIM 908 module, and counts with GPRS and GPS technologies that allow to easily performing real-time tracking applications as shown in figure 3. This product is compatible with Arduino and Intel Galileo boards. The idea of this module is: read the GPS coordinates (longitude and latitude) and send them by using a HTTP request to a web server. Then use a browser to load the PHP webpage which uses Google maps to show the location in real-time.

SIM908 module is a complete Quad-Band GSM/GPRS module which combines GPS technology for satellite navigation. The compact design which integrated GPRS and GPS in a SMT package will significantly save both time and costs for customers to develop GPS enabled applications. Featuring an industry-standard interface and GPS function, it allows variable assets to be tracked seamlessly at any location and anytime with signal coverage [8].

The shield has general specifications like: Quad-Band 850/900/1800/1900MHz, GPRS multi-slot class 10, GPRS mobile station class B, Compliant to GSM phase 2/2+-Class 4 (2 W @ 850/900 MHz)-Class 1 (1 W @ 1800/1900MHz), Control via AT commands (GSM 07.07, 07.05 and SIMCom enhanced AT Commands), Supply voltage range: GPRS: 3.2 ~ 4.8 V GPS: 3.0 ~ 4.5V and the Dimensions: 30*30*3.2mm [8].
B. Arduino Intel Galileo board

In this work we utilized the new version of Arduino that called Galileo from Intel. The principal part of this project is the Arduino. It gives the decisions to control the system by processing the data comes from GPS/GPRS shield. The Arduino Galileo used in this work have features like the microcontroller board based on the Intel Quark SoC X1000 Processor, a 32-bit Intel Pentium-class system on a chip. Digital pins 0 to 13 (and the adjacent AREF and GND pins), Analog inputs 0 to 5, the power header, ICSP header, and the UART port pins (0 and 1). Small in size (highly integrated), a Real Time Clock (RTC), low power. Galileo has an I2C-controlled I/O expander that runs at 200Hz. The Arduino Galileo software is accessible for download with no license agreement against the open source licenses [9].

C. External GPRS-GSM Antenna

External 3G-GPRS-GSM-UMTS antenna was used with tracking system. It includes a RPSMA-Female to UFL pigtail. Table I shows the antenna specifications [10].

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>850 MHz-900 MHz-2.1 GHz-1800 MHz-1900 MHz</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 Ohms</td>
</tr>
<tr>
<td>Mounting</td>
<td>on glass</td>
</tr>
<tr>
<td>Polarization</td>
<td>horizontal</td>
</tr>
<tr>
<td>Gain</td>
<td>2.14dBi</td>
</tr>
<tr>
<td>VSWR</td>
<td>&lt; 2:1</td>
</tr>
<tr>
<td>Power handling</td>
<td>25W</td>
</tr>
<tr>
<td>Connector</td>
<td>RPSMA Male</td>
</tr>
<tr>
<td>Size</td>
<td>117mm x12.5mm x 4mm</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40°C to +85°C</td>
</tr>
</tbody>
</table>

D. External GPS Antenna

The external GPS antenna used with proposed system includes a SMA-Female to UFL pigtail. The antenna specifications were shown in Table II [11].

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>GPS 1575.42 MHz</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 Ohms</td>
</tr>
<tr>
<td>Polarization</td>
<td>RHCP</td>
</tr>
<tr>
<td>Gain</td>
<td>26dB at 3V, 28dB at 5V</td>
</tr>
<tr>
<td>VSWR</td>
<td>&lt; 1.2:1</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>2.7V - 5.5V</td>
</tr>
<tr>
<td>Current</td>
<td>15mA - 25mA</td>
</tr>
<tr>
<td>Power (max.)</td>
<td>125mW</td>
</tr>
<tr>
<td>Connector</td>
<td>SMA Male</td>
</tr>
<tr>
<td>Size</td>
<td>41 mm x 34 mm x 13.7 mm</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40°C to +85°C</td>
</tr>
</tbody>
</table>

The software components consist of Arduino Integrated Development Environment (IDE) and FileZilla client software. In order to program the Arduino Intel Galileo board, the Integrated Development Environment (IDE) a cross platform application is written in self-installable java. The C/C++ languages used to programs 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. The proposed system program initializes and checks the GPS coordinate receiver then send to GPRS module to display through HTTP on the web site. The coordinate send to the user mobile phone through the SMS.

The FileZilla client software used in this project will connect to an FTP or SFTP server and then download or upload files. The software used for site manager enters the hostname into the quick connect bar’s Host, the username into the Username field and the password into the Password field. The authors used the nazuka.net as an unlimited free hosting and create an account for web site. Also the PHP with MySQL has been integrated together with Apache web server 2.5.9 to design the website for the proposed tracking system.

The proposed system program contain five parts: scan and fix GPS module, detect incoming call and check phone number module, check the GPRS module, send position to the HTTP module and send SMS to the vehicle owner phone number module.

As soon as the tracking system begins to work, scan and fix GPS module start as shown in the following example:

1) sending "AT" and receiving the response “OK”.
2) sending "AT+CGPSPWR=1” to check if the GPS start and receiving the response “OK” or sending “AT+CGPSPWR=0” to check if the GPS not start and the response “OK”.
3) sending “AT+CGPSSTATUS?” to check the status and the response “2D Fix” or sending “AT+CGPSSTATUS?” and the response “3D Fix”.

The second module detects incoming call and check phone number listen whether there is an incoming call and check. If the phone number is the same of the vehicle owner phone number, it will call the GPRS module as shown in figure 4.a.

The GPRS module starts when the vehicle owner phone number detected and checked the GPRS parameters as shown in the following steps:

1) sending “AT+CPIN=0000” and receiving the response “OK” (where CPIN=0000 for the Orange SIM card in this case).
2) sending “AT+CREG?”, “+CREG: 0,1” or “AT+CREG?”, “+CREG: 0,5” and receiving the response “AT+CREG?”.
3) sending “AT+CLIP=1” and receiving the response “OK”.

The proposed system program contain five parts: scan and fix GPS module, detect incoming call and check phone number module, check the GPRS module, send position to the HTTP module and send SMS to the vehicle owner phone number module.
4) sending “AT+SAPBR=3,1,"Contype","GP RS" and the response “Ok”.

5) sending “AT+SAPBR=3,1,"APN","net" and the response “Ok”. (where Orange SIM card APN = net).

6) sending “AT+SAPBR=3,1,"USER","" and receiving the response “Ok”. (where Orange SIM card USER = blank).

7) sending “AT+SAPBR=3,1,"PWD","" and the response “Ok”. (where Orange SIM card PWD = blank).

8) sending “AT+SAPBR=1,1” and the receiving response “Ok”.

The HTTP module starts work directly after the activation of the GPRS module and this module used to send the vehicle position to a web site. Figure 4.b shows the flowchart of the HTTP module.

3) Print “Connecting to the network...”.

4) sending “AT+CMGF=1” and the response “OK” (used for sets the SMS mode to text).

5) sending “AT+CMGS="%s", phone number and receiving the response “OK” (send the SMS to the vehicle owner phone number that include latitude, longitude, altitude, date, satellites, speed OTG and course ).

III. RESULTS AND DISCUSSIONS

We have implemented a prototype based on the design of the figure 2. Figure 5 shows the serial monitor of the Arduino IDE when start runs the tracking system display the results. According to the tracking system programming the “AT+SAPBR=1,1” that means the system is ready and listen to mobile phone calling.

The vehicle owner calls the system to find his vehicle position. In the case the vehicle was stolen, as shown in figure 6. The tracking system sends the location information including latitude, longitude, altitude, date, satellites, speed OTG and course to the web site. Also this information will be sends directly as SMS to the vehicle owner as shown in figure 7.

Finally, the SMS module used to send a message to the vehicle owner phone number that include the vehicle position as shown in the following steps:

1) sending “AT” every two seconds and wait for the answer , when receiving the response “OK” this module start work.

2) sending “AT+CPIN=0000” and receiving “OK”.
During a vehicle stolen, the system can track the vehicle and sends the data in a real time with a high accuracy as presents in figure 8.

In order to define the location accuracy of the suggested system, we have accomplished test and compared the system proposed results with the different commercial GPS devices. We have used Garmin Nuvi 3598 LMT HD GPS and Garmin Nuvi 255 LMT in the field test. The Field trials has been implemented in different places in Bucharest city of Romania. The recommended system was tested and registered different locations as shown in figure 9. Also figure 9 display the web interface of the server to shows the details of the GPS tracking system information such as Time, Satellites, Speed OTG and Course.

The results of this comparison between the proposed system with Garmin Nuvi 255 LMT presented in the Table III. It was recording the latitude (Lat) and longitude (Long) for each location using proposed system with industrial GPS device. There are a little difference between the results of the suggested system and industrial devices.

Table IV shows the comparison among proposed system with Garmin Nuvi 3598 LMT HD. The important point here, the negligible contrasts in the results are observed among the two industrial GPS devices. The outcomes demonstrate that the location accuracy of the suggested system is good as the industrial equipment.

### IV. CONCLUSIONS

This paper proposed an efficient real time vehicle tracking and monitoring system. The proposed system has been effectively designed and implemented of vehicle tracking based on GPS technology. The device inside the vehicle is collected of embedded board Arduino Intel Galileo and SIM908 Module that include GPS/GPRS/GSM services. The system received GPS signals and transmitted the data to the Apache web server 2.5.9. Also these data has been sent to the vehicle owner as SMS. In the case of vehicle theft, the suggested system gives the vehicle location information include latitude, longitude, altitude, date, satellites, speed OTG and course. This
information helps to track the stolen vehicle and access to it in the shortest possible time. The results of the tracking system proposed compared with the two commercial GPS devices to ensure the accuracy of this positioning system. 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 connect sensors or actuators.

REFERENCES


