Advanced Vehicle Tracking System on Google Earth Using GPS and GSM

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Abstract
Vehicle navigation is one of the most important applications in the era of navigation which is mostly used by drivers. Therefore the efficiency of the maps given to the drivers has a great importance in the navigation system. In this paper we proposed a very efficient system which uses the GPS and earth maps to help the driver in navigation by robust display of the current position of the vehicle on a displayed map. The main aim of this project is designing a system which is capable of continuous monitoring of path of the vehicle on PC with Google Earth Application. Here the important issue is displaying the map on several various scales which are adopted by the users. The heart elements in the implementation of this project are GPS, GSM and MCU. The GPS-GSM integrated structure is designed to track the vehicles by using Google earth application. The micro controller is used to receive data from GPS and to transfer the latitude and longitude to the PC to map by using the VB.Net language and this map is generated using Google Earth information.

Keywords
GPS, Microcontroller, Vehicle, PC and Map and Google Earth

I. Introduction
The primary roots of vehicle navigation are lying in the field of shipping. Whenever the ships are spread over the ocean, it is difficult to owners to find out or to track their ships. Therefore definitely it is important to determine where the vehicle is situated at any time. And this need of vehicle tracking rose to avoid the any kind of vehicle thefts because the police can use these tracking reports to find out the stolen vehicles. In today’s advanced technological world many systems require automatic identification of vehicle location i.e. effectively determine the geographic location of the vehicle and transforms the location information to remotely located server. In this project the efficient detection of vehicle location is the major goal and this system is implemented using so many advanced technologies: GPS, GSM and Google Earth information etc. GPS and GSM based vehicle location system provides very efficient results besides mapping information will give improving level of service quality [10-11].

A. Overview of GPS
Among all the advanced communication technologies GPS is the utmost technology and which provides very robust information of location and time in all weather conditions and at all times. Simply GPS is a Global Navigation System (GNSS) which is purely space based. The US government is maintaining the GPS and it is free to all with a GPS receiver. GPS project was initiated in the year of 1973 by overcoming all the limitations of early navigation systems. GPS system contains totally 24 satellites and it became fully available in the year of 1994.

B. Over View of GSM
In the era of mobile communications GSM (Global system for Mobile Communications) is the top most standard. 80% of the global mobile market uses the GSM standard [1]. In more than 212 countries over than 2 billion people uses the GSM [2-3]. Therefore the subscribers are able to use mobile communication throughout the world by arranging the international roaming arrangements among mobile network operators of different countries. In the GSM signaling and as well as speech channels are digital in nature, where preceding technologies are not digital. Therefore GSM is considered as second generation mobile phone system. The greatest feasibility of GSM is it provides advantage to both the parties i.e. to consumer and network operator. The consumers may get benefit from the roaming and network operators may select many GSM equipment vendors.

C. Objective
1. Implementing GPS based navigation/tracking system.
2. Implementing vehicle location system by using the information from GPS and GSM/GPRS by transforming information with following features:
   • Obtaining the information of the vehicle after every specified time interval.
   • Transmission of location information to monitoring or tracking server.
   • Implementing a display unit by using Google earth to display vehicle location in the maps.

II. System Model
The two major design units in the implementation of this navigation system is
• In-Vehicle unit
• Tracking Server/Monitoring Station.

A. In-Vehicle-Unit
In vehicle unit is the core part of this navigation system and it will be installed in the vehicle. The responsibilities of in vehicle unit are to gathering the information about current location of the vehicle and transmitting location data information to the tracking server. To achieve all these functionalities In-Vehicle unit uses following modules.

B. GPS Receiver
In-Vehicle unit uses GPS receiver to capture the current location and vehicle speed. Location and speed data provided by GPS is not in human understandable format. This raw data needs to be processed to convert it into useful information that can be displayed by a beacon on the map. CPU is required to process this raw data. SIRF Star III single-chip GPS receiver is used which comes integrated with GM862- GPS which is GSM/GPRS modem used for data transmission. GPS receiver can also provide information of altitude, time of GPS fix, status of GPS fix, and number of satellite used to compute current location information along with location and speed. GPS fix means last reported location. For tracking purpose only location and speed data is required for transmission. Other data provided by GPS receiver is used to determine the validity of location information.
C. Central Processing Unit
The raw data provided by the GPS receiver is captured by the CPU and processed to extract the required location and speed information. CPU is also responsible for monitoring the door/open close status of vehicle and controlling the ignition on/off status of the vehicle. CPU holds all the required information that is to be transmitted to remote server. It also controls data transmission module to exchange information with remote server. It actually acts as a bridge between GPS receiver, vehicle and remote server. It receives commands sent by server through data transmission/receiving module and performs corresponding action required by server. As the processing required in the In-vehicle unit is not computationally intensive therefore any low end microcontroller can be used as a CPU. The microcontroller selected to serve as CPU for In-vehicle unit is Microchip’s PIC18F248. This is 8-bit microcontroller and runs at speed of 20 MHz which is enough speed for the system.

D. Data Transceiver
When all required information is extracted and processed, it needs to be transmitted to a remote Tracking Server which will be able to display this information to the end user. For real time tracking of vehicle, reliable data transmission to remote server is very important. Wireless network is required to transmit vehicle information to remote server. Existing GSM network is selected to transmit vehicle information to remote server because of broad coverage of GSM network. It is also cost effective rather than to deploy own network for transmission of vehicle information. For data transmission over GSM network GSM modem is required. GSM modem can send and receive data SMS text messages and GPRS data over GSM network. GM862-GPS GSM/GPRS modem is selected to transmit data over GSM network because of its features and capabilities. GM862-GPS provides AT commands interface i.e. all functions can be accessed by use of AT commands. AT commands can be sent to it using serial Interface. It has built in UART that accepts the AT commands and modem performs the function as required by AT command received.

III. Design of In-Vehicle Unit
In-Vehicle unit is designed using OEM module Telit GM862-GPS GSM/GPRS modem and microcontroller PIC18F248 manufactured by Microchip. Fig. 1 shows the block diagram of In-Vehicle unit.

![In-Vehicle Unit Block Diagram](image)

GPS antenna receives signals from GPS satellites and it must face towards sky for correct computation of the current location by GPS receiver. Location data is transferred to microcontroller through serial interface. After processing of the data provided by GPS receiver, microcontroller transmits this information to remote location using GSM/GPRS modem. Microcontroller controls the operation of GSM/GPRS modem through serial interface using AT commands. External GSM antenna is required by the GSM/GPRS modem for reliable transmission and receiving of data. When modem receives any command sent by tracking server, it passes this information to microcontroller which analyses received information and performs action accordingly (i.e. turns on/off ignition of vehicle, transmits current location, restarts GPS receiver, restarts whole system etc). Some of microcontroller I/O ports are connected to vehicle ignition on/off circuitry and door status output of vehicle. Information packet sent to server also contains status information of these I/O ports.

A. GM862-GPS Interface Board Design
First step in circuit design of In-Vehicle unit is to design interfacing circuit for Telit GM862-GPS so that it can be interfaced with microcontroller. Telit GM862-GPS is provided of the following interfaces:
1. GSM Antenna Connector
2. Board to Board Interface Connector
3. SIM Card Reader
4. GPS Antenna Connector

GSM, GPS antennas and SIM card are not important from design point of view as they can be just installed into connectors. Only important is board to board interface connector which provides interface for external devices to the modem.

IV. Tracking Server
Tracking server maintains all information received from all In-Vehicle units installed in different vehicles into a central database. This database is accessible from internet to authorized users through a web interface. Authorized users can track their vehicle and view all previous information stored in database. Tracking server has a GSM/GPRS modem attached to it that receives SMS from In-Vehicle units and sends those messages to the server through serial port. Tracking server saves this information into database.

Design of Tracking Server is partitioned into four major parts.
- Hardware design for GSM/GPRS Modem GM862-GPS
- Communication Software for GM862-GPS
- Database
- Web Interface

A. Web Interface Design
As described in previous section Tracking Server maintains all information in a database. To display this information to end users front end software is required that can display all information to the end user. End user is the user of system who has installed the In-Vehicle unit in his vehicle and also the administrator of the system who is managing Vehicle Tracking System. There may be a number of vehicles installed with In-Vehicle units therefore server must be able to manage and distinguish information sent by all In-Vehicle units. For this purpose information must be available to server about all vehicles that are installed with In-Vehicle units.

Whenever In-Vehicle unit is installed, information about that vehicle is stored in the database. Web interface must also support this functionality. Since web interface will be accessible over the internet therefore access must be restricted to authorized users.
only. Therefore information about all users of the system must be stored in database.

**B. Database Design**

Database is designed to store all received vehicle information, information about In-Vehicle units and users of the system. Information to be stored in the database is:
1. Information about users of the system
2. Information about vehicles
3. Information about received from vehicles

**C. GM862-GPS Interface Board for Tracking Server**

GM862-GPS is GSM/GPRS modem that was used in In-Vehicle unit. The same modem is used on server side to exchange information with In-Vehicle units through SMS. Vehicle information sent using SMS on GSM network is received by this modem. Tracking server can also send commands for In-Vehicle units using this modem. Same interface board is used on this side. GM862-GPS interface board is connected to the serial (COM) port of server. Server can communicate with modem using AT commands. To send and receive data using this modem a software is required that can send AT commands to module.

**D. Design of Communication Software for GM862-GPS**

The software that is to be designed will provide communication interface to the GM862-GPS modem attached to computer’s serial port. It will control the operations of GM862-GPS. This software must be able to support following functions:
- Configuration of GM862-GPS for sending and receiving SMS
- Processing received SMS and saving information into database
- Sending SMS to in vehicle unit as required by user
- Accepting TCP/IP connections from In-Vehicle units
- Exchanging information with In-Vehicle units through internet

GM862-GPS will be configured in such a way that whenever new SMS arrives, GM862-GPS will send the information about SMS to the serial port. Software will be listening at serial port; it will read the SMS from GM862-GPS memory and extract the information from SMS. After extracting the information SMS will be deleted from GM862-GPS by software and information will be written to the database. Design requirements suggest that following objects are part of the system:
- GM862-GPS Modem
- Serial Port
- Vehicle Info
- TCP/IP Socket
- Database

This analysis yields following classes in the system.

**V. System Testing and Results**

System design needs to be verified by testing after integration of all components of the system. PCB designed for In-Vehicle unit and server side was assembled. After integrating all the components, system was tested.

**A. Testing In-Vehicle Unit (SMS Configuration)**

GM862-GPS interface board was connected to microcontroller board through a serial cable.

![Flowchart of Communication Software for GM862-GPS](image)

Debugging serial port of In-Vehicle unit was connected to a laptop’s COM port to see the debugging messages printed by microcontroller on HyperTerminal during its operation. This laptop and debugging COM port is just for debugging purposes, in real time there is no need to connect laptop to In-Vehicle unit. After connecting the GSM antenna and GPS antenna to the In-Vehicle unit system was powered on. Following logs of microcontroller operation were captured from HyperTerminal.

![Results of Execution of Startup Routine](image)

When In-Vehicle unit is powered on it executes Startup routine. It first reads and displays the existing configuration of the system. In next step microcontroller is configuring the GM862-GPS. It first tests the communication interface by sending “AT” command. GM862-GPS responded with “OK” message which shows that interface is working. +CPIN: READY response shows that SIM card is ready and +CREG: 0, 1 response shows that module is connected to network.
B. Testing Tracking Server

In order to test server, laptop was configured to act as a server. GM862-GPS COM was connected to COM port of laptop. Apache server was run on laptop to make it act like server. MySQL DBMS was installed. After running the fig. 4 Results of execution of SMS Configure routine Communication software for GM862-GPS following results were observed.

C. Web Interface Testing

Since server is setup on the local machine. Website was opened in internet explorer. After logging to the website it displayed the page as shown in fig.

VII. Conclusion

The results presented in this paper contain execution of Startup routine, execution of SMS Configure routine, Logs of Tracking Server and Pointing out current location of vehicle. For vehicle tracking in real time, in-vehicle unit and a tracking server is used. The information is transmitted to Tracking server using GSM/GPRS modem on GSM network by using SMS or using direct TCP/IP connection with Tracking server through GPRS. Tracking server also has GSM/GPRS modem that receives vehicle location information via GSM network and stores this information in database. This information is available to authorized users of the system via website over the internet. Currently In-vehicle unit was implemented with two boards. Microcontroller board was externally connected to GM862-GPS interface board. Single board can be designed to incorporate Microcontroller circuitry on the GM862-GPS interface board. It will reduce the overall size of In-Vehicle unit and it will also reduce the number of components so will the cost.

References

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