Design of GPS and GSM Based
Vehicle Location and Tracking System

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Abstract*: A vehicle tracking system combines the installation of an electronic device in a vehicle, or fleet of vehicles, with purpose-designed computer software to enable the owner or a third party to track the vehicles location, collecting data in the process. Modern vehicle tracking systems commonly use Global Positioning System (GPS) technology for locating the Vehicle. To achieve automatic Vehicle Location system that can transmit the location information in real time. 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.*

Keywords: Global Positioning System (GPS), GPRS, GSM

1. 1. Introduction

GSM and GPS based vehicle location and tracking system will provide effective, real time vehicle location, mapping and reporting this information value and add by improving the level of service provided. 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 system has an "On- Board Module" which resides in the vehicle to be tracked and a "Base Station" that monitors data from the various vehicles. The On-Board module consists of GPS receiver, a GSM modem.

2. Background Work

2.1 Vehicle tracking system

Vehicle tracking system is the technology used to determine the location of a vehicle using different methods like GPS and other radio navigation systems operating through satellites and ground based stations. By following triangulation or tri lateration methods the tracking system enables to calculate easy and accurate location of the vehicle. Vehicle information like location details, speed, distance traveled etc. can be viewed on a digital mapping with the help of a software via Internet. Even data can be stored and downloaded to a computer from the GPS unit at a base station and that can later be used for analysis. This system is an important tool for tracking each vehicle at a given period of time and now it is becoming increasingly popular for people having expensive cars and hence as a theft prevention and retrieval device.

2.2 GPS Technology

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver. The GPS project was developed in 1973 to overcome the limitations of previous navigation systems, integrating ideas from several predecessors, including a number of classified engineering design studies from the 1960s. GPS was created and realized by the U.S. Department of Defense (DOD) and was originally run with 24 satellites. It became fully operational in 1994. A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth. Each satellite continually transmits messages that include

1. The time the message was transmitted
2. Satellite position at time of message transmission

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite using the speed of light. Each of these distances and satellites locations define a sphere. The receiver is on the surface of each of these spheres when the distances and the satellites locations are correct. These distances and satellites locations are used to compute the location of the receiver using the navigation equations. This location is then displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units show derived information such as direction and speed, calculated from position changes.

In a typical GPS operation, four or more satellites must be visible to obtain an accurate result. Four sphere surfaces typically do not intersect. Because of this we can say with confidence that when we solve the navigation equations to find an intersection, this solution gives us the position of the receiver along with accurate time thereby eliminating the need for a very large, expensive, and power hungry clock. The very accurately computed time is used only for display or not at all in many GPS applications, which use only the location. A number of applications for GPS do make use of this cheap and highly accurate timing. These include time transfer, traffic signal timing, and synchronization of cell phone base stations.

Although four satellites are required for normal operation, fewer apply in special cases. If one variable is already known, a receiver can determine its position using only three satellites. For example, a ship or aircraft may have known elevation. Some GPS receivers may use additional clues or assumptions such as reusing the last known altitude, dead reckoning, inertial navigation, or including information from the vehicle computer, to give a (possibly degraded) position when fewer than four satellites are visible.

2.3 GSM Technology

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. GSM (Global system for mobile) uses a process called circuit switching. This method of communication allows a path to be established between two devices. Once the two devices are connected, a constant stream of digital data is relayed. GSM networks consist of thee major systems the Switching System (SS), The Base Station (BSS) and the Mobile station (MS).

i. The Switching System
The Switching system is very operative system in which many crucial operations are conducted, SS systems holds five databases with in it which performs different functions. If we talk about major tasks of SS system it performs call processing and subscriber related functions. These databases from SS systems are HLR, MSC, VLR, AUC and EIR. The MSC in cooperation with Home Location register (HLR) and Visitor location register (VLR), take care of mobile calls and routing of phone calls. Authentication centre (AUC) is small unit which handles the security end of the system and Equipment identity register (EIR) is another important database which holds crucial information regarding mobile equipments.

ii. The Base Station System (BSS)
The base station system have very important role in mobile communication. BSS are basically outdoor units which consist of iron rods and are usually of high length. BSS are responsible for connecting subscribers (MS) to mobile networks. All the communication is made in Radio transmission. The Base station System is further divided in two systems. These two systems, they are BTS and BSC. BTS (Base Transceiver station) handles communication using radio transmission with mobile station and BSC (Base station controller) creates physical link between subscriber (MS) and BTS, then manage and controls functions of it.

iii. Mobile Station (Subscriber)
MS consist of a mobile unit and a smart card which is also referred as a subscriber Identity Module (SIM) card. This card fitted with the GSM Modem and gives the user more personal mobility. The equipment itself is identified by a unique number known as the International Mobile Equipment Identity (IMEI).

GSM Hardware

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. It supports instructions of AT commands. SIM300 can be integrated with a wide range of applications. SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz. SIM300 provides GPRS multi-slot class 10 capabilities and support the GPRS coding schemes CS-1, CS-2, CS-3 and CS- 4. With a tiny configuration of 40mm x 33mm x 2.85 mm, SIM300 can fit almost all the space requirement in our application. Therefore, the MCU can connect with GSM modules very expediently through serial interfaces. GSM modem as shown in Fig. 1.

Figure 1: GSM Modem

3. Problem Definition

3.1 Existing System
In the previous system security lock and alarm is implemented in a car. If a burglar can break open the lock, then it becomes easy for the burglar to steal the car. And in old security system if the car is stolen then it is out of the owner control. User doesn't have any awareness about the current location of the vehicle [7].

3.2 The Proposed System

The RF transmitter is attached with the vehicle which has its own identification. This data will be continuously

transmitted to the RF receiver connected to the microcontroller. This GPS will be location the position of vehicle and transmit that data to the microcontroller. Suppose the RF receiver not receiving signal from the transmitting unit, receiver unit send the signal to the microcontroller, from that we can identify the theft. If the vehicle is theft it automatically sends location of the vehicle to its owner as a SMS through GSM modem. To achieve automatic Vehicle Location system that can transmit the location information in real time. Active systems are developed. Real time vehicular tracking system incorporates a hardware device installed in the vehicle (In- Vehicle Unit) and a remote Tracking server. 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 [7].

The scope of study which is needed for the completion of this topic involves the following criteria:

i.   Architecture of ARM7TDMI knowledge
ii. ARM7 programming
iii. The study of modem functions involving AT commands.
iv. The circuitry and devices that is needed to construct the devices and establish the necessary communication between the devices.

4. Objective

Exploring GPS based tracking systems

1. Developing Automatic Vehicle Location system using GPS for positioning information and GSM/GPRS or information transmission with following features.
2. Acquisition of vehicle's location information (latitude longitude) after specified time interval.
3. Transmission of vehicle's location and other information (including ignition status, door open/close status) to the monitoring station/Tracking server after specified interval of time.
4. Developing a web based software to display all transmitted information to end user along with displaying location of vehicle on a map.
5. The objective of the project is to build an additional feature to the present security system that will warn the owner of the vehicle by sending SMS when there has been an intrusion into the vehicle.
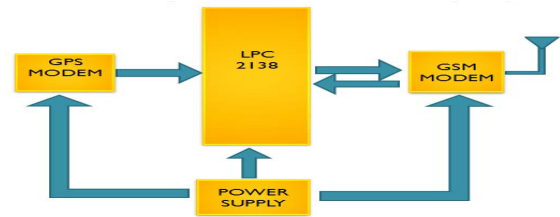6. To provide a solution to avoid car stolen in the lower cost than advance security car system [1].

Figure 2: Block Diagram of vehicle tracking system

System

The system consists of modern hardware and software components enabling one to track their vehicle online or offline. Any vehicle tracking system consists of mainly three parts mobile vehicle unit, fixed based station and, database and software system.

1. Vehicle Unit: It is the hardware component attached to the vehicle having either a GPS/GSM modem. The unit is configured around a primary modem that functions with the tracking software by receiving signals from GPS satellites or radio station points with the help of antenna. The controller modem converts the data and sends the vehicle location data to the server.

2. Fixed Based Station: Consists of a wireless network to receive and forward the data to the data center. Base stations are equipped with tracking software and geographic map useful for determining the vehicle location. Maps of every city and landmarks are available in the based station that has an in-built Web Server.

3. Database and Software: The position information or the coordinates of each visiting points are stored in a database, which later can be viewed in a display screen using digital maps. However, the users have to connect themselves to the web server with the respective vehicle ID stored in the database and only then s/he can view the location of vehicle traveled.

5. Experimental Study

Present project is designed using ARM7 microcontroller in this Project it is proposed to design an embedded system which is used for tracking and positioning of any vehicle by using Global Positioning System (GPS) and Global system for mobile communication (GSM). In this project LPC2138 microcontroller is used for interfacing to various hardware peripherals. The current design is an embedded application, which will continuously monitor a moving Vehicle and report the status of the Vehicle on demand. For doing so an ARM7 microcontroller is interfaced serially to a GSM Modem and GPS Receiver. A GSM modem is used to send the position (Latitude and Longitude) of the vehicle from a

remote place. The GPS modem will continuously give the data i.e. the latitude and longitude indicating the position of the vehicle. The GPS modem gives many parameters as the output, but only the NMEA data coming out is read and displayed on to the LCD. The same data is sent to the mobile at the other end from where the position of the vehicle is demanded. An EEPROM is used to store the mobile number. The hardware interfaces to microcontroller are LCD display, GSM modem and GPS Receiver. The design uses RS-232 protocol for serial communication between the modems and the microcontroller. A serial driver IC is used for converting TTL voltage levels to RS-232 voltage levels. In the main they are easy to steal, and the average motorist has very little knowledge of what it is all about. To avoid this kind of steal we are going to implement this project which provides more security to the vehicle. When the request by user is sent to the number at the modem, the system automatically sends a return reply to that mobile indicating the position of the vehicle in terms of latitude and longitude from this information we can track our vehicles.

6.   Applications and Advantages

6.1 Applications
1. Stolen vehicle recovery.
2. Field service management.
3. It is used for food delivery and car rental companies.

6.2 Advantages
1. It provides more security than other system.
2. From the remote place we can access the system.
3. By this we can position the vehicle in exact place.

7.   Conclusion

Tracking system is becoming increasingly important in large cities and it is more secured than other systems. It is completely integrated so that once it is implemented in all vehicles, then it is possible to track anytime from anywhere. It has real-time capability, emerges in order to strengthen the relations among people, vehicle and road by putting modern information technologies together and able to forms a real time accurate, effective comprehensive transportation system.

8.   Acknowledgement

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