Vehicle Tracking and Anti-theft System using GPS-GSM

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Abstract

This paper proposes the design and implementation of a cheap and easy to use vehicle tracking and anti-theft system using an embedded system coupled with a single module of GPS and GSM modem. It can provide the real-time location of a vehicle and also report theft via Short Message Service (SMS) text to the client and alternatively the tracking server. The GPS reads the current coordinates of the vehicle and the data is sent to client via GSM network using the GSM modem. The client's mobile or tracking server can be used to stop vehicle theft by simply sending SMS text to the in-vehicle tracking device to switch off the vehicle ignition system. A desktop application is developed using Visual Basic (VB) and Microsoft (MS) Access with Google Maps embedded to view the current location of vehicle, set location update timing interval and prevent theft if client's mobile is lost. SMS was used due to its wide usage by mobile phone subscribers across the globe. The system is useful for vehicle location information, theft prevention, public transport driver tracking and monitoring.

Keywords: *Embedded System, GPS, GSM, SMS, VB, MS Access, Google Maps.*

1. Introduction

Over the past decade, real time tracking and management of vehicles has been a field of mounting interest. It has now developed into a powerful and marketable package due to its low-cost and varying facilities such as anti-theft modules and client identification [1]. A good number of tracking systems had so far been developed with a wide range of tracking facilities. But the operation cost of most of these systems is high which prevents it from widespread use. The goal of this research is to reduce the cost of anti-theft and tracking system using a very simple technology and making it available to the common people [2].

Cost Effective GPS-GPRS Based Object Tracking System was discussed by Khondker et al [2], which works using GPRS. However, a complete embedded system implementation of GPS-GSM Based Tracking System using SMS was reported by Abid and Ravi [3]. Baburao et al discussed GSM and GPS Based Vehicle Location and Tracking System, which makes use of existing GSM networks and GPS technology [4]. Hsiao and Chang developed analytical model to analyze the optimal location update strategy with the objective of minimum total cost [5]. Montaser et al [6] did similar works compared with ours using PIC microcontroller but used separate GPS and GSM modules and also did not provide alternate number to report theft.

We focused our research on reducing the total cost of tracking and theft prevention and in doing that, we shall use the Telit GM862 GSM/GPRS Module. The module contains a GSM modem and GPS together and therefore has all that is required to develop GSM-GPRS and GPS based systems. Global Positioning System (GPS) is a 24-hour worldwide service. It provides accurate, three-dimensional information of the location as well as precision velocities and timing services. It is accessible to an unlimited number of global military, civilian and commercial users [7]. Visual Basic (VB) is used to develop the application used in communication between the tracking server and the in-vehicle tracking device. Google map is used for mapping the location. SMS technology is utilized for exchange of messages between the tracking server and in-vehicle device. SMS has become popular because it is inexpensive,

convenient and accessible way of transferring and receiving data with high reliability [6].

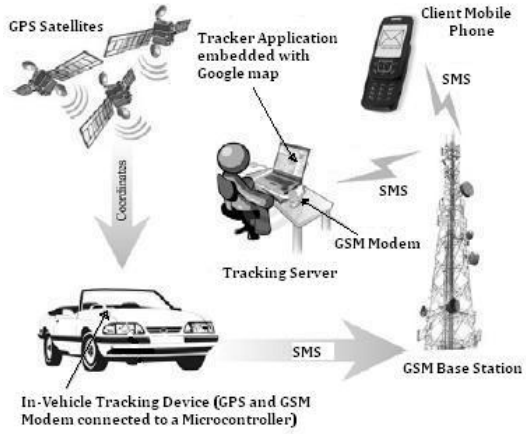

Figure 1. System block diagram

As shown in Fig. 1, when the car ignition is turned on, both the tracking server and alternate client mobile number receive SMS text that the car engine is running now. If the operation is illegal or any intruders tried to run the car, the owner can send SMS to switch off the car or in cases where the car is often snatched at gun point by armed robbers and the owner's mobile collected, the tracking server can be used to send such SMS for switching off the car. Afterwards, the in-vehicle tracking device receives the SMS and checks the number for received message, for verification that the number can access the security system; if the number is valid the device switches off the car. The car owner can track the vehicle using the desktop application embedded with Google maps installed on a PC and having a GSM modem connected to it.

2. System Overview

The system is sub-divided into two main units; the in-vehicle tracking device and the tracking server as shown in Fig. 1. The in-vehicle unit is well embedded into the vehicle and mainly consist of; a GPS-GSM module connected to a Microcontroller module with the vehicle ignition system connected to this unit as shown in Fig. 3. When the car ignition relay coil is on, the microcontroller will send SMS to the owner's mobile as well as the tracking application on the PC to confirm that the car is running. When such action is illegal, the owner can send SMS instructing the microcontroller to switch off the ignition relay coil which therefore shuts down the car engine. However, in the case where the vehicle is snatched from the owner by armed robbers, the mobile phone of the owner is often taken away by such hoodlums to avoid immediate report to the police. In such cases, the tracking server application can be used to turn off the engine. The GPS receiver retrieves the location information from satellites in the form of latitude and longitude readings in real-time [6].

The Microcontroller processes the GPS information and transmits it to the desktop application and or the user using the GSM modem part of the module by SMS after a preset time that can be set on the desktop application.

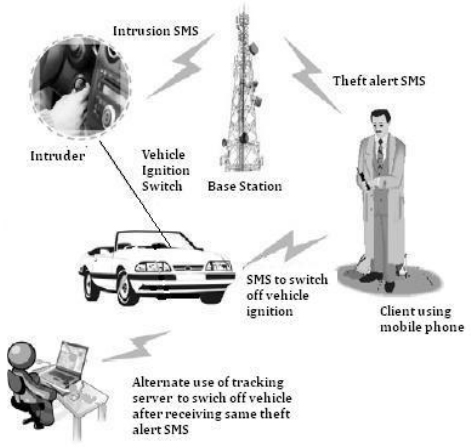

Figure 2. Theft detection and prevention

Both tracking server and user mobile phone receive SMS text that includes GPS coordinates and vehicle engine status. The tracking server has installed on it a Visual Basic application to obtain the numeric parameters, which are saved in a database and vehicle coordinates displayed on Google maps to show vehicle location. Overall system efficiency depends on the QoS [8] of the used mobile communication network.

Vehicle theft is detected when the owner receives an intruder alarm through SMS text that the vehicle ignition is on as shown in Fig. 2 above. Thereafter, the owner can send SMS to switch off the vehicle or if the vehicle is snatched together with the owner's mobile, the desktop application can be used to send SMS via GSM modem connected to the PC to switch off the engine.

3. Hardware Design

The proposed in-vehicle tracking device unit, as shown in Fig. 3, consist of two main inputs; the input from the Telit GM862-GPS module and that from the vehicle ignition relay coil. The AT89S52 microcontroller module is interfaced serially to the Telit GM862-GPS module while the ignition relay coil is connected via one of the bi-directional I/O ports. The Telit GM862-GPS module is the one selected for this design because of its compatibility with 850/900/1800/1900MHz frequencies of the cellular network hence its capability to work on any GSM network around the world. It has a 20-

channel high sensitivity GPS receiver and a built-in SIM card holder, making the system compact and power efficient. It also supports complete standard AT command set plus custom AT command set for GPS. The Telit GM862-GPS is the ideal platform for mobile application in areas such as telematics, fleet management, tracking, security and vehicle navigation [9]. AT89S52 microcontroller was selected because it can efficiently handle the requirements of this design and relatively cheaper compared to other microcontrollers.

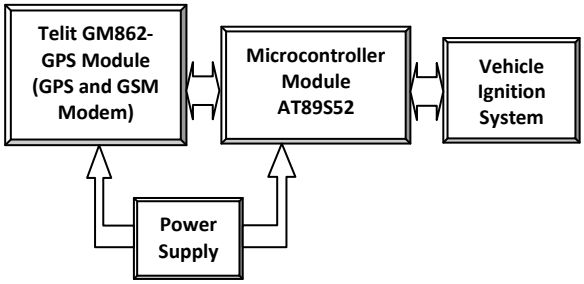

Figure 3. Hardware block diagram

After the device is turned on, it automatically initializes the network. It then gets its unique IMEI number [10], the GPS data in NMEA 0183 format [11], and ignition status which it adds together. This data is then sent to the tracking server's and client's numbers respectively via SMS to indicate current location of vehicle and ignition status. It shall then check for a newly received SMS, verify the sending number, if valid, the system performs the SMS instruction e.g. switch off vehicle engine. The system then waits for a preset time, after which it gets the GPS data again and sends data to tracking server.

4. Software Specification

To view the real-time location of the vehicle, a desktop application is developed using VB. Google map [12] is embedded into the application since it is free, very rich in map data and supports most GPS devices. MS Access [13] is used to develop the database for storing received data. It is flexible and also suitable to handle the requirements of the application. The data received from the in-vehicle device is in NMEA 0183 format, and therefore contains several sentences, starting with the character $, with a maximum of 79 characters in length [6]. The GPRMC NMEA message is used to read data and determine vehicle location by reducing SMS text.

The same Telit GM862-GPS GSM modem is used at the tracking application end. It receives the transmitted SMS and gets GPS coordinates. The received data is processed by the VB desktop application and saved in the MS Access database. The coordinates saved in the database can thereafter be displayed on the embedded Google map. However, user of the desktop application needs to have created a profile prior to all of the above. This is done by creating a username and password to access application, registering client details and saving such into the database. A time interval for updating vehicle location can be set using the desktop application.

Figure 5. Preliminary System Test Results

5. Discussion on Design Cost and Solution

The design mainly focused on providing vehicle tracking and anti theft solution at the minimal cost possible and a very robust system. Device and service cost has been reduced by using free, simple, cheap and robust tools for both hardware and software requirements, making the solution cheap and affordable by individuals as well as large corporations.

SMS was used for data transfer instead of GPRS. This is due to the fact that SMS is the most

widely used data application in the world, with 3.6 billion active users, or 78% of all mobile phone subscribers [14]. Also, GPRS services are relatively poor and sometimes unreliable especially in some developing countries. The use of SMS will avail a large number of vehicle owners the ability to use the device.

The external controller to the GPS-GSM module was interfaced to enable the provision of alternate number for reporting theft in case the user's mobile is snatched together with the vehicle as the case may be.

6. Conclusion

A low cost, easy to use tracking and anti-theft system is presented in this paper. The system was composed of a tracking module containing an embedded system with a single GPS-GSM module to report burglary and retrieve real-time vehicle location and send it to tracking server. The tracking server receives the transmitted information via SMS, processes it and display vehicle location on Google map. Theft is also reported, and vehicle can be stopped by simply sending SMS text either from the user's mobile phone or the desktop application.

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