Real Time Fleet Monitoring and Security System using GSM Network

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Abstract: - Automobile tracking in the private and defense sector has required a vast amount of research and development. This paper presents the two-way multiple vehicles tracking system using GSM network and satellite communication. The multi-vehicle tracking system uses an extensive combination of global positioning system (GPS), GSM network and Digital mapping with cost effective hardware solution. The tracking system works on the synchronization of the vehicle client unit and the base station. Multi-layered digitized maps results real-time and precise location tracking and provides the various detail information of environment. The system is exploited for vehicle security providing opportunity to remote server to secure the vehicle in case of theft with indispensable anti theft device. Moreover the system provides text guidance to the client through embedded LCD and KEYPAD interfacing.

Key-Words: - LCD, GPS, GSM, GUI

1 Introduction

Over the past decade, real-time tracking and management of vehicles has been a field of mounting interest. Now it has developed into a powerful and marketable package due to its low-cost and varying facilities such as Anti-theft modules and Client identification. Although the system may be described in a fairly simple flow statement, the system elements are rather complexed and polished to the perfect practical application.

The GPS device is responsible for determination of vehicle position co-ordinates based on which the vehicles status is identified [1, 2, 7, 11]. The GPS module also provides us with the tracked-object speed based on location times and distance as opposed to the speeds displayed by the speedometer of the vehicle.

Following this comes the microcontroller which processes these co-ordinates from GPS and produces a location point on the digital maps [8, 9].

These are regional world maps geo-referenced to identify location. Due to unavailability of these pre-digitized maps the team was required to create them on their own. Giving the Fleet monitoring system a rather customized touch [5]. GSM is our core communication engine owing to which the position of the vehicle is notified to the client as well as our base station [10]. The information sent and received is done so using short messaging which makes this system further cost-efficient [10].

The fleet monitoring system is the fruit reaped from all previous and ongoing research in all applied technologies, making it the perfect application of these technologies combined.
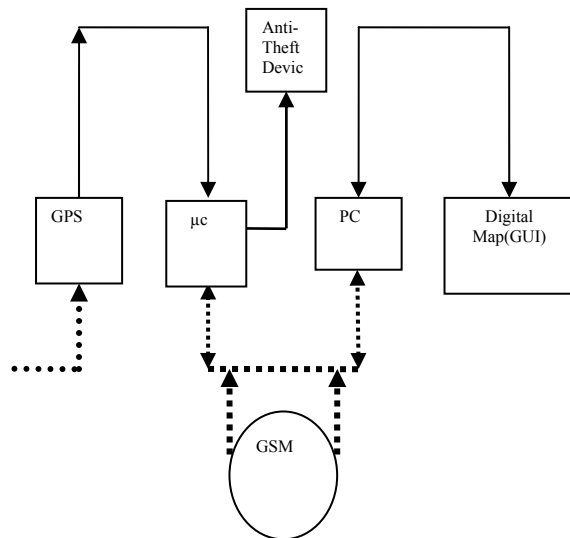
Fig.1 System Flow Statement

2 System Construction
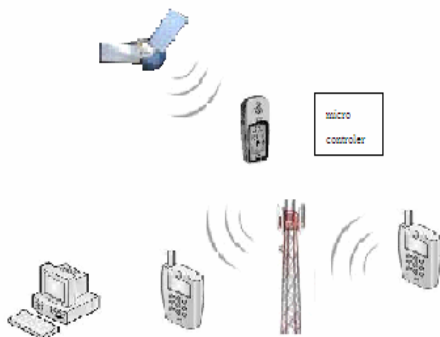
Entire system construction is shown in Fig.2.

Fig.2 System Construction

2.1 Client Unit
The client unit is a combinational structure of a GPS device, a microcontroller and a GSM engine also featuring a Keypad and an LCD for user interface.

2.1.1 GPS Device
The GPS device, as the name suggests is used primarily for location and geographical position of the object vehicle [1, 6, 7]. Powered by the car's dynamo, the GPS device accumulates Latitude and longitude co-ordinates along with details such as height and or depth.

2.1.2 Microcontroller
The microcontroller is the most important element of this unit since it acts as the transmitter as well as the receiver at the same time, interpreting information to and fro [9]. The microcontroller used is the Atmel 89C52 which has a serial RS232 port which we utilize for both the GSM engine and the GPS device as both are serial communication components.

2.1.3 GSM Engine
The GSM engine is our core communication medium which receives the data from the GPS device via microcontroller and transmits it to the base station and also puts through data received from the base station to the microcontroller [11]. The mode of transfer is short messaging which is an attractive and cost efficient service offered by GSM.

2.1.4 LCD AND KEYPAD
The LCD (liquid crystal display) and the KEYPAD are the only user interface units on the client and can be used to create messages and communication statements to be sent to the base station or other fellow clients. The LCD and Keypad are configured for the microcontroller using software KEIL®, which provides efficient control over the modules.

2.2 Client-Unit Software
The client unit microcontroller was programmed using C++ language.

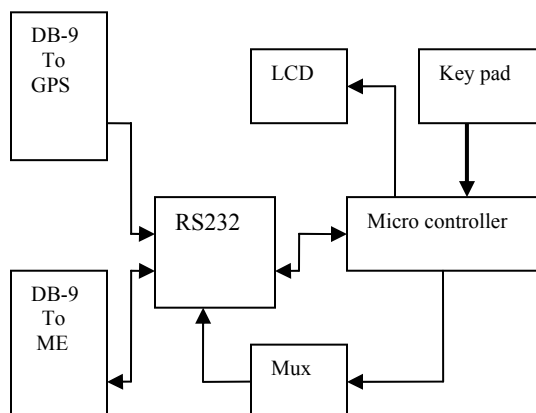**2.2.1 Client-unit hardware:**

Fig.3 Client Unit Block Diagram

3 Communication

As mentioned above, the GSM engine is our core communication device and medium. An advantage of which is the Tracking made possible everywhere the service is available. The Fleet Monitoring system can be customized even further by the purchase of bandwidth on a corporate level and make this system ever further reaching [4, 12].

3.1 Interfacing

The Client unit and base station communicate over SMS or short messaging service. The interfacing is covered using standard "AT commands for wireless modems" which are a specified communication testing standard in the Multi-Tech systems® message exchange software. The communication between car through GSM engine and Base station i.e. computer is shown in Fig.4.

3.2 AT: Used for initialization of Modem

AT+cmgf=1:   To set the Text Mode
AT+cmgr=1,2,3:   To Read the Short Messages
AT+cmgd=1,2,3:   To Delete the Short Messages
AT+cmgs="cell no"←

text ctrl Z←:   To Send the Short Messages

Fig.4 System Communication

3.3 Full-Duplex Communication

The new, never before, introduction in this project is that it offers the client unit a full-duplex communication or "two-way communication" skills. The clients can communicate with the main base station as well as with each other provided they are familiar with the client-IDs, and since they are fitted with a gsm engine, an LCD and a keypad, this is no great task for them. In Fig.5 the communication between different clients and base station (server unit) is shown.
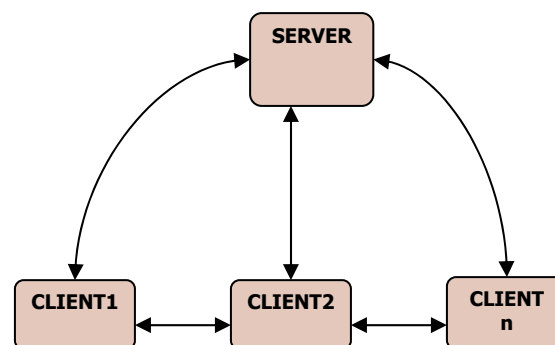

Fig.5 Full Duplex Communication

This feature can lead to a great deal of marketing potential with possibilities of "Friends and Family" style packages.
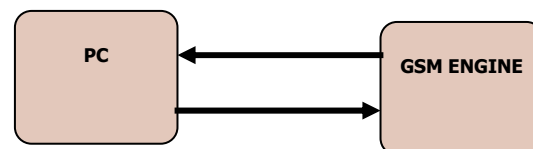
4 Base Station

Fig.6 Server Unit

4.1 Hardware

The operator or base station is based on a laptop computer which is the core of the operator unit. Attached to this is the GSM Engine which is serially connected to our operator unit.

4.2 Software

The software used in this tracking System is a module designed in Visual basic and has been designed to respond and depict real-time movements and changes. As mentioned below the GUI offers Panning and Zooming abilities and supports dynamic tracking for standard geometric shapes like rectangles or lines.

The base station is the main operation and tracking command center where tracking is performed on the basis of client-ID monitoring and Authentication codes along with any marketed features such as city bounds or restrictions. The base station can also monitor client-to-client communication making the system extremely secure and practical.

5 MAPS

The Real-time Tracking this Fleet monitoring system offers is based entirely on maps which make these maps a very crucial part of the design. The digitized-maps used in this project required the most work since these were not available and had to be created from the ground up.

5.1 Digitizing

The scanned maps were custom digitized .This required quite a bit of GPS data for our Reference points which are further used for complete geo-referencing of our maps. These maps are regional geographical pieces which are scanned and setup to be digitized and geo-referenced. Once the Latitude and longitude details have been processes, it requires quite a bit of expertise to produce a fully digitized map.

5.1.1 Layers

Layers are used for geographical differentiation between various objects or ones such as highways, residencies or just buildings. The Amount of layers that are added is a choice that is made by the design team based on how specific and precise the requirements are.

As the layers are made on the same maps they are color coded for object recognition. Each layer is exported onto a shape file which is a file extension standard recognized by all map generation software's. We have processed these shape files using the previously mentioned process. The environment of digitized map is shown below in Fig.7.
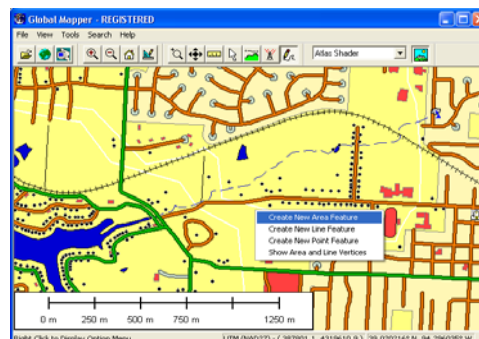

Fig.7 Digital map

5.2 GUI (Graphical User Interface)

The Graphical user interface on the base station has been designed using Visual Basic. The objective of which was to display maps with various layers, add remove layers in runtime, and to track vehicle position and path [3].

The add and remove buttons which have been included in the GUI application are used for including or deleting unrequited layers from the map. The GUI application includes features such as Pan and Zoom control along with Layer-combinations accessed directly using "combo" buttons.

The GUI has the option to display any map of the major cities of Pakistan. It has the major option of adding and removing any layer as required or clearing the whole screen. The GUI includes the availability of sending and receiving message which is

interfaced with LCD and KEYPAD. It includes one major application of fleet monitoring system and tracking of controlling cars engine which will be discussed later in applications of this product. Along the bottom the current position of the mouse cursor on the screen in latitude/longitude is displayed.

The software also supports dynamic tracking for geometric shapes such as points, lines, rectangles or ellipses. For multiple vehicles tracked at once, the application automatically assigns different colors to the tracking points. Final GUI of our tracking system is shown in fig.8.
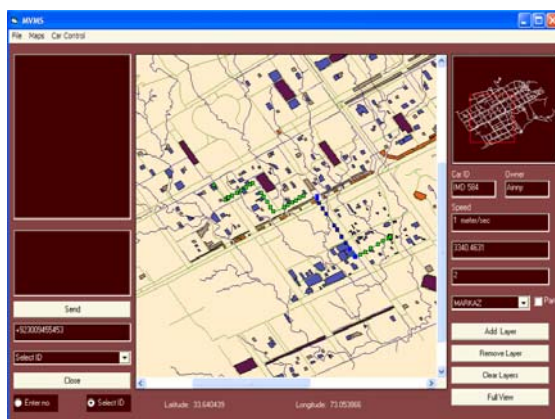

Fig.8 Graphical User Interface

6 Applications

The Application possibilities of this design are vast and rather numerous. Ranging from Defense to standard commercial business, this device makes a promising stand. Starting from a "multi-vehicle" tracking device, it transforms into a Fleet-monitoring system and further into an anti-theft car security service which can even work through cross border transport.

6.1 Anti-Theft Device

An Additional and attractive feature introduced in this system is the "cost Efficient" vehicle tracking. A standard, older and cheaper version of the Anti-theft switch, when installed in the car, can be activated and deactivated upon GSM

communication with the microcontroller. The introduction of this Anti-theft device gives the base station the perfect level of control and makes the service, that this design offers, very valuable which is not done before.

6.2 Post-Border tracking

Seeing that the system that has been developed works on available GSM Services another possibility is that of tracking beyond borders. Using international roaming features on the used cellular service provider, the client unit can be traced in any GSM-Networked country all the while being mapped in real-time.

6.3 Safety and Law enforcement

A rather usable feature of this specific design can very easily be implemented in highway and road safety enforcement since the GPS module on the client unit also provides vehicle speed details to the server unit based on which speed warnings may be delivered. The difference between the GPS tracked speed (Km/h) and the vehicle speedometer (Km/h) can be seen in the following graph-1
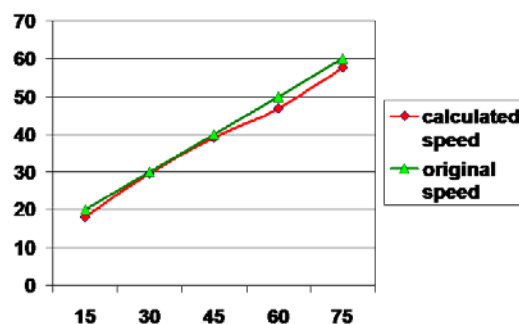
Graph: 1 Speed Differences

7 Results

The vehicle tracking system produced capital results and the vehicle can actually be tracked to a minor variation of 10m at the maximum. On a commercial foresight the system, once installed, completely secures the car with the highly efficient anti-theft

device. With Variable locations and constant communication maintenance the system proves an all-terrain tracker. GSM-based communication can also be used to maintain a client-server communicative speed control which adds to the package. On top of all this there is no limit to the number of vehicles that may be tracked as well as no map range limits, altogether making this design a rather attractive package.

8 Conclusions

The vehicle tracking and fleet monitoring system has literally countless applications due to its simple design and compatibility. Its has a grand future ahead of it with advancement possibilities in all its modules and has already become a very big industry.

This research and its future advancements promise perfect car security which is soon to become a requirement of every car owner the world over.

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