

Design and Implementation of a Cost Effective Real Time Vehicle Tracking System Using Telit GM862

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Abstract— This paper gives the description of the design and implementation of a Real Time Cost Effective Vehicle Tracking System making use of Telit GM862 Module. The Module was installed in a vehicle as the Vehicle Unit while a mobile hand set was used as the Remote Tracking Device. The Module was configured using hyper-terminal on a computer system where the necessary properties and parameters were set. SMSATRUN service was also activated on the module. The SMS information to query the location was sent from the Remote Tracking Device using GSM/GPRS modem on any chosen GSM network to the Vehicle Unit (Module). The Vehicle Unit responds with an SMS message of the location information to the Tracking Device with an authorized mobile number on the GSM Network. The coordinates of the location received are then displayed on Google Map.

Keywords— GPRS, GPS, GSM, Modem, Module, Speed, Tracking

1. INTRODUCTION

Tracking Systems started from the shipping industry wherein a large number of vehicles and assets were spread out in different ocean vessels and the respective owners were unable to keep track of what was going on. They needed a way to determine the location of each vehicle at any given time as well as the speed and distance covered. The use of tracking information to locate a vehicle anywhere in the world increased the importance of Vehicle tracking systems. (Rose India, 2016; Hofmann-Wellenhof et al, 2001)

In the past, vehicle tracking was passive, this meant that a hardware that would keep track of the Global Positioning System (GPS) location, speed and other required data was fixed into the vehicle. There was no way of getting the tracking information until the vehicle was physically present in a particular location and the hardware removed to access the data either manually or wirelessly. This type of tracking was not real time (Rose India, 2016; University of Wisconsin Milwaukee, 2016)

Passive tracking devices have a number of limitations. They could neither be used to prevent vehicle theft nor to recover stolen vehicles, In this situation a real time tracking system was required which could send the tracking data of the vehicle at preset time intervals or at any specific time of request by the user. Active tracking systems are used for real time transmission of vehicle's data through any mobile network of choice to an authorized user. (Rose India, 2016; University of Wisconsin Milwaukee, 2016)

In recent times, vehicles make use of some form of Automatic Vehicle Location (AVL). This tracks the geographical location of a vehicle using GPS and sends this information to the required destination in real time through satellite, terrestrial radio, General Packet Radio Services (GPRS) or Global System for Mobile communication (GSM) network.

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2. LITERATURE REVIEW

Hasan *et al* (2009) implemented a low cost object tracking system using GPS and GPRS. The user is able to view the previous and current locations of an object on Google Map. Dinkar and Shaikh (2011) made use of GPS for tracking. It has an in-vehicle unit as well as a tracking server. The information can be accessed by authorized users through the website.

Sudharsan and (2012) implemented a vehicle-based GPS system which is made up of several sensors responsible for vehicle speed, altitude and locations. This system senses the data automatically at preset intervals. Musa and Wang (2012) designed and implemented an easy to use vehicle tracking and anti-theft system. This comprised of a single module of GPS and GSM modem which gives the real time location of a vehicle through Short Message Service (SMS). Lee *et al.* (2014) implemented a system that combines a Smartphone application with a microcontroller. The designed in-vehicle device works using GPS and GSM/GPRS technology for vehicle tracking. The Smartphone application enables users to monitor a vehicle continuously.

This current research begins with the configuration of Telit GM862 Module so that it can respond to SMS messages sent to verify location and speed information of a remote vehicle unit. The module was thereafter used to implement the Vehicle Unit. Finally a Tracking Device (mobile phone) with an authorized mobile number recognized by the Vehicle Unit was used to query the speed and location. This is cost effective and compact since the module is a GSM/GPS unit, hence performs dual functions.

3. BACKGROUND

Tracking systems first came into usage due to the need for the shipping industry to find the exact location of each vehicle at any specific time. Passive systems were used so that the above requirements could be catered for as at that time but these passive systems however could not be used for the applications which require real time

location information of the vehicles. This was primarily because the location information was saved in internal storage which made it accessible only when the vehicle becomes available.

There is a need for a Real Time Cost Effective Vehicle Tracking System which can transmit the location information of vehicles in real time and at the same time keeping the cost of the overall unit as low as possible. For this reason Active systems have to be used while taking into consideration the simplicity and availability of the other component units. A real time cost effective vehicle tracking system makes use of a hardware device which can be fixed in the vehicle. The location data is transmitted by SMS to the tracking device through the use of GSM/GPRS modem on any chosen GSM network. This information is displayed and can be accessed by the authorized users of the system as text message sent to a hand held Tracking Device on the GSM Network.

4. SYSTEM DESIGN AND IMPLEMENTATION

The Vehicle Unit is the main hardware which is fixed into the vehicle. It captures the current location as well as the speed of the vehicle. The vehicle unit transmits the captured data to the remote Tracking Device which could be located anywhere in the world. The Vehicle unit was implemented using Telit GM862-GPS GSM/GPRS module which has the following interfaces: GPS Antenna Connector, GSM Antenna Connector and SIM Card Reader.

The GPS antenna receives signals from GPS satellites which must be directed at sky for accurate calculation of the current location by GPS receiver. The data received is processed and transmitted using GSM/GPRS modem which requires an external GSM antenna for reliable transmission and reception of data. The modem receives commands sent by tracking device and performs the action accordingly by transmitting the current location and speed of vehicle.

The Vehicle unit captures its data with the use of GPS receiver but the data provided by GPS is not in an easy to understand format. It is therefore processed and converted into useful information by SiRF Star III single-chip GPS receiver which comes together with GM862 - GPS. Information provided by GPS receiver includes the following among others; altitude, time of GPS fix, status of GPS fix, and number of satellites used to compute current location as well as speed. For the purpose of tracking a vehicle, only location and speed data is required to be transmitted. The remaining data provided by GPS receiver is only to validate the location data.

The Remote Tracking Device queries the location and speed of the Vehicle Unit by requesting it to perform certain AT commands and send back the response (Telit wireless solutions, 2016a; 2016c). A GSM Phone was used as the Remote Tracking Device for cost effectiveness and availability. The Remote Tracking Device (GSM Phone) is used to send SMS containing the AT command to be performed by the Vehicle Unit. This requires a proper understanding and use of the correct AT commands as well as making the required settings

and activation on the Telit GM862-GPS in order to respond to the SMS sent to it accordingly.

The design using Telit GM862 is cost effective because both the GPS and GSM are integrated into one single unit which eliminates the need to get the individual units at a higher cost. It is also cost effective because there is no need to write software codes to control its operations, what is needed is simply setting it up to respond to AT commands. The cost effectiveness is also due to the fact that the remote tracking device is not specially designed; it is a handset which most users have already.

4.1 Transmission and Reception of Data

Reliable data transmission from the vehicle unit and reception by the remote tracking device after the required data have been extracted and processed is very important. A wireless network is required to transmit the vehicle information to the remote device therefore an existing GSM network is selected for this purpose. This is due to its wide coverage as well as cost effectiveness instead of deploying a dedicated network. Data transmission over GSM network requires a GSM modem which can send and also receive SMS text messages and GPRS data over GSM network as shown in Fig. 1. GM862-GPS GSM/GPRS modem is selected for this purpose because of its features and capabilities. It provides AT command interface which makes all its functions accessible by the use of AT commands which perform the functions required (Telit wireless solutions, 2016a; 2016b; 2016d).



Fig.1: Tracking the Telit Module with a MobilePhone

4.2 Setting up the Telit GM862 GPS

The Telit GM862-GPS has the following: GSM Antenna Connector, SIM Card Reader and GPS Antenna Connector as shown in Fig. 2. The GSM antenna was connected to the connector as shown in Fig. 3, likewise the GPS antenna was connected to its connector (Telit wireless solutions, 2016b). A valid SIM card of an operational GSM network (in this case, a MTN network) was inserted into the SIM card reader. The Module was then inserted in the motherboard with the jumpers set appropriately, thereafter the power supply was connected to the board and a serial cable was used to connect the RS232 on the board to a PC for the purpose of monitoring the settings and commands to be issued. The Module was then turned on by pressing the ON/OFF button for at least 2 seconds until the status LED was on, at this point the PC was powered on too. If the Module is set with the Network registered, it should blink once in three seconds (Telit wireless solutions, 2016b; 2016d).

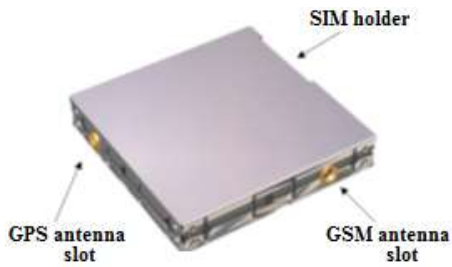


Fig. 2: Telit Module showing the SIM holder, GPS and GSM Antenna connector



Fig. 3: Telit Module showing connection of GSM Antenna

The Hyper terminal was opened on the PC, the name "Telit" was used for it and an icon was also set for the connection. Then, in the connect dialog box, the COM3 port was chosen, which is the port through which communication will be done to and from the module (Telit wireless solutions, 2016b).

The following were also set in the properties dialog box:

Bits per second field = 9600
 Data bits = 8
 Parity = None
 Stop bit = 1
 Flow control = Hardware

In the main window of the Hyper terminal file, under the properties menu, the ASCII setup was set as Echo typed locally which enables commands to be issued locally on the module through the COM port chosen above (Telit wireless solutions, 2016b).

4.3 Activation of the SMSATRUN Service

The activation of the SMSATRUN is essential for the remote SMS commands to function appropriately (Telit wireless solutions, 2016a; Telit wireless solutions, 2016c). There are two SMS that are valid for the SMSATRUN service. The first is the Simple ATRUN SMS and the second is the Digest ATRUN SMS. However, the Simple ATRUN SMS was used to keep up with the simplicity of the design. The following should be noted about the Simple ATRUN SMS:

- (i) The SMS must originate from a number that has been defined in a white list in the module.
- (ii) The string "AT" or "HAT" should precede the text.
- (iii) Default GSM 7 bit or 8 bit must be used as the SMS coding alphabet.

If the string "AT" starts the text, then an SMS is sent to the sender but if the text starts with the "HAT" string, then no SMS is sent back to the sender.

The commands come after the "AT" or "HAT" string. The received SMS does not have to be concatenated, but the response SMS can be concatenated.

The SMS ATRUN is activated with the following AT commands on the module in sequence (Telit wireless solutions, 2016a), (Telit wireless solutions, 2016c):

First of all, the SMS ATRUN service is locally configured and enabled in the vehicle module by the command #SMSATRUNCFG.

```
AT#SMSATRUNCFG=3,1,5
```

With the above command, "the service is configured to run on the third instance, the unsolicited is enabled and the timeout for the response to the AT commands is set to 5 minutes" (Telit wireless solutions, 2016a; 2016c).

```
AT#SMSATRUN=1
```

The above command, enables the service. Thereafter the command "#SMSATWL" was used to add a mobile number to the white list.

```
AT#SMSATWL=0,1,0,"+2348036968130"
```

The above command adds the number +2348036968130 in the first position of the white list. At this point the SMS ATRUN service is enabled and AT commands can be issued to the module through SMS from another device containing the SIM with the number added in the white list.

5. MONITORING AND TESTING

The vehicle unit and the Tracking device were monitored and tested to observe their performance in accordance with the settings and activations made. The results from this are then presented and where necessary pictures were included for clarifications. GM862-GPS which was implemented as the Vehicle Unit was connected to a PC's COM port through a serial cable in order to observe and ascertain the output of certain AT commands necessary for the proper operation of the Vehicle unit on Hyper Terminal.

The PC will however not be necessary in the actual Vehicle unit; it is just for monitoring purposes. The GSM antenna as well as the GPS antenna were connected to the Vehicle unit, thereafter the system was turned on and the following output were observed in the Hyper Terminal when the corresponding AT commands were issued. When the Vehicle unit is powered on and the status LED blinks once in three seconds, this signals that the Network is registered but the following AT commands were used to confirm the readiness of the Vehicle unit to receive and execute data (Telit wireless solutions, 2016a; 2016c)

The command "AT" was issued in the Hyper Terminal Window and the Vehicle unit responded with the message "OK". This indicated that the interface was working properly. Next was the issue of the command "AT+CPIN" to which a "READY" response was received. This indicated that the SIM card was ready. The command "AT+CREG" was issued also and the response was "+CREG: 0, 1" which showed that the

module was connected to network as shown in Fig. 4 below, Fig. 5 shows the AT commands used before activation of SMSATRUN service while Fig. 6 shows the AT commands used to activate SMSATRUN service as well as their corresponding responses in each case.

information requested in each case as shown in Fig. 9. The Google Map of the coordinates received is shown in Fig. 10

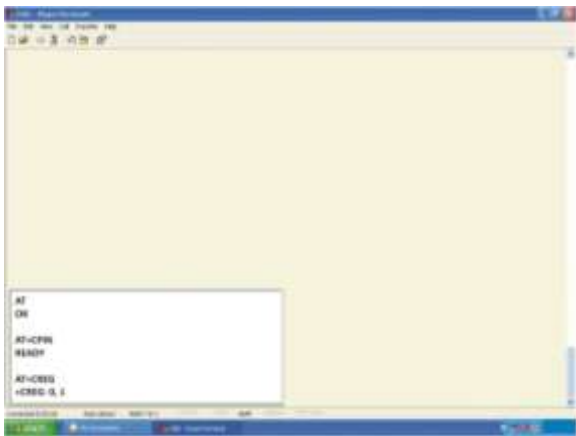


Fig. 4: AT commands to confirm readiness of Vehicle Unit

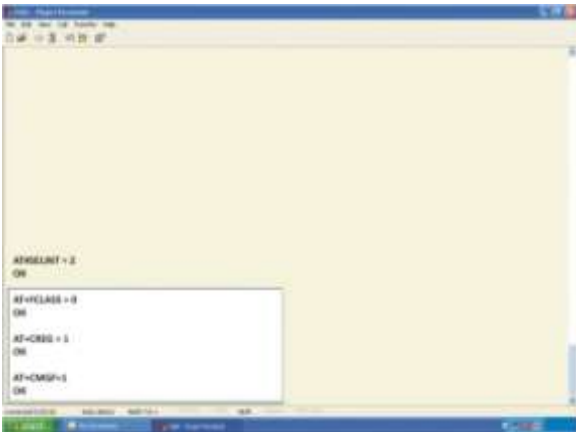


Fig. 5: AT commands used before SMSATRUN service activation

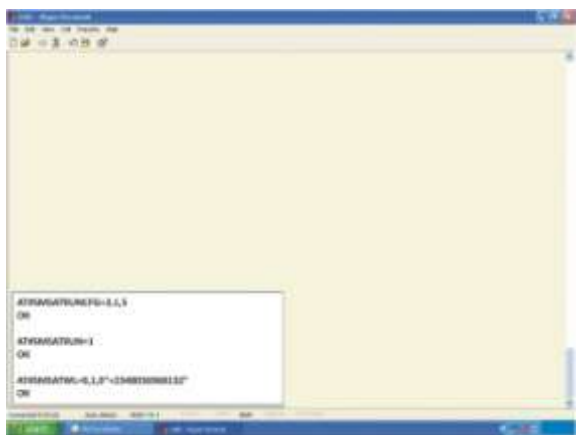


Fig. 6: AT commands used to activate SMSATRUN service

The Tracking device was tested by sending SMS containing AT commands to query the location and speed of the Vehicle unit as seen in Fig. 7, each of the SMS sent from the tracking device generated a corresponding command instance on the Vehicle Unit as shown in Fig. 8 and thereafter sent the corresponding reply back to the tracking device with the relevant



Fig. 7: AT commands sent as SMS from Tracking Device to Vehicle Unit

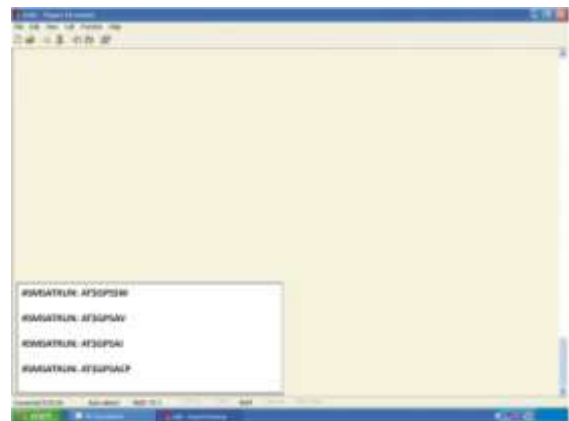


Fig. 8: AT commands instance generated on Vehicle Unit by received SMS



Fig. 9: Response SMS from the Vehicle Unit

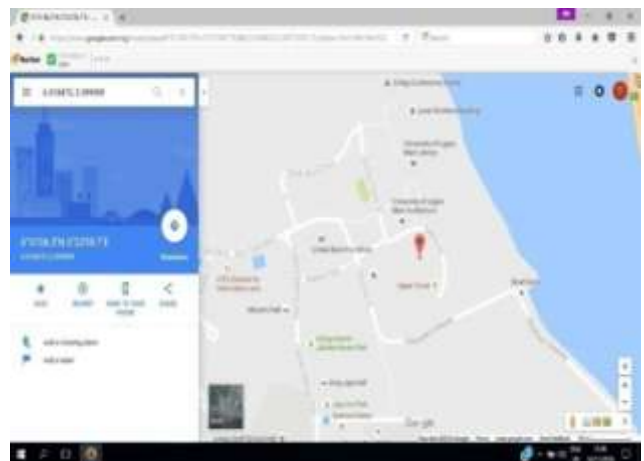


Fig. 10: Google Map of Coordinates Received

6. RESULTS ANALYSIS AND DISCUSSION

Fig. 4 confirms that the module was ready to execute AT commands. The response "OK" to the "AT" command was an indication of a proper working interface. The response "READY" to the command "AT+CPIN" shows that the SIM inserted into the SIM holder of the module was ready for data transmission and reception. The response "+CREG: 0, 1" to the command "AT+CREG" finally showed that the module registered and connected to the Network.

Fig.5 switches the AT command interface style of the product, to the new products which also supports the GPS products since the GPS is important for getting the location information with the "AT#SELINT = 2" command. The next command "AT+FCLASS=0" was used to set the wireless module in data connection mode since SMS data will be sent to and from the module. The command "AT+CREG=1" was used to enable network registration while the command "AT+CMGF=1" was used so that the format of the text messages sent and received was in text mode.

Fig. 6 was used to activate the SMSATRUN service. The command "AT#SMSATRUNCFG=3,1,5" configures the service to run on the third instance, enables the unsolicited and sets the time out for the AT commands to 5 minutes. Then next command "AT#SMSATRUN=1" enables the SMSATRUN service and the last command "AT#SMSATWL=0,1,0,+2348036968130" was used to add the number 2348036968130 to the first position of the white list.

Fig. 8 were instances generated by the SMS sent in Fig. 7 to which the module sent the individual responses back to the mobile phone as seen in Fig. 9. The Google Map view of the coordinates received on the tracking device is shown in Fig. 10.

7 CONCLUSION

The execution of basic AT commands was carried out successfully for the operations and activation of the SMSATRUN commands on the Telit Module. It was also responsible for the execution of AT commands sent via SMS from a Remote Tracking Device (mobile phone) to the Vehicle Unit (Telit GM862-GPS) requesting the actual location of vehicle as well as the speed. The information was transmitted to the Tracking Device using GSM/GPRS modem on GSM network by using SMS. Tracking device receives vehicle location information via GSM network and this information is available to the device user as viewed on Google map. The system is however limited to the geographical coverage area within which the GSM network operates but the Implementation of the Vehicle unit with Telit GM862-GPS Module which serves a dual function for GSM and GPS removes totally any software related costs and also reduces the component cost, the implementation of the Remote Tracking Device with a mobile phone brings about reduction in the number of components used as well as reduction in the overall size of the design which automatically makes the design cost effective.

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