Renesas Based Online Tracking System using TCP/IP Stack By GPRS

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***Abstract*—Renesas Based Online Tracking System (OTS) provides a way to keep track of devices in real time. The system makes use of GPS (Global Positioning System) in the tracking unit to find location information of the device being tracked. This information is then sent to tracking server. GSM (Global System for Mobile)/ GPRS (General Packet Radio Service) is used in tracking unit in order to send location information to tracking server. Prior to sending location information to tracking server a TCP/IP connection is established between tracking server and tracking unit. To display the location of the device the tracking server uses Google Earth application. The benefits of implementing such system include robust data transmission, wide area network coverage, cost-effective and reliable. The system can also provide security to vehicle theft. The system can find its use in speed monitoring, traffic control etc.**

Keywords— Online Tracking System, GSM/SPRS, GPS, Tracking Server, Tracking Unit, Google Earth application

I. INTRODUCTION

Shipping industry were the first to make use of tracking systems because they wanted to determine where each vehicle was at any given time. Initially passive systems were developed to fulfill these requirements. These passive systems cannot be employed in applications requiring real time location information of the vehicle because the location information is saved in the internal storage and this information is accessible only when vehicle is available. Therefore there was a need to develop a system which provided the automatic vehicle location information in real time. Hence active systems are developed. Vehicular tracking system based on real time incorporates a hardware device installed in the vehicle and a remote tracking server. The location information of the device being tracked is then transmitted to tracking server using GSM/GPRS (Global System for Mobile Communications/ General Packet Radio Services) on GSM network by using SMS or using direct TCP/IP (Transmission Control Protocol/ Internet Protocol) connection with the tracking server through GPRS. Wired or wireless modem is used in tracking server in order for the tracking server to receive vehicle location information via GSM network. The location information is then displayed on Google Earth application.

The Renesas microcontroller acts as Central Processing Unit for tracking unit of the system. All operations of the tracking unit are to be controlled by the microcontroller. Microcontroller uses instructions to operate on the tracking unit. These instructions are provided to microcontroller by writing the software into microcontroller's PROM (Programmable Read-Only Memory). The microcontroller performs necessary task based on these instructions written into its PROM.

GPS (Global Positioning System) and GSM provide a way to keep track of the vehicles, ships etc., by providing their coordinates. Tracking unit uses GPS to obtain the co-ordinate of the device being racked and GSM is used to send data to tracking server.

GSM is a standard set developed by the ETSI (European Telecommunications Standards Institute) to describe protocols for 2G (second generation) digital cellular networks used by mobile phones. As a replacement for first generation (1G) analog cellular networks GSM standard was developed. This was expanded over time to include data communications, first by including circuit switched transport and then packet data transport via GPRS and EDGE (Enhanced Data rates for GSM Evolution or Enhanced GPRS). One of the key features of GSM is the Subscriber Identity Module (SIM). SIM is a detachable smart card containing the user's phone book and subscription information. This allows the user to retain his/her information after switching handsets also the user can change operators while retaining the handset simply by changing the SIM.

Global Positioning Satellites network is known to have offered users with many applications especially in the area of tracking. If a fishermen who have lost their way in the sea could locate their position by using GPS receiver installed on their boat and call for a rescue can be made. Therefore GPS finds its application in navigation and provides continuous and timing information position of things anywhere in the world under any weather condition. GPS consist nominally of 24 operational satellites orbiting the earth at very high altitude. Satellites send signals to the GPS receiver to locate the exact

position and these satellites are constantly monitored to make sure that they are working properly.

The GPS parts consist of

- User
- Space
- Control

The project focuses on the ground segment. The ground segment is further divided into two parts

- The control and command of the satellite and
- Receiving and exploiting some set of data

The current location can be by the GPS receiver and data provided by the GPS includes information such as time, status, altitude, number of satellite in view to get the current latitude and longitude for a particular location.

LCD (Liquid Crystal Display) is used to display messages to the user using tracking device. The messages involve the status of tracking unit. The working of LCD is controlled by microcontroller. Microcontroller makes use of commands to control the LCD.

Serial communication is established using RS232 between

- Microcontroller and the GSM/GPRS modem
- Microcontroller and GPS modem

Tracking server keeps track of the device (E.g., vehicle) that is being tracked. Tracking server receives location information from the tracking unit. Tracking server can make use of wired or wireless modem to establish internet connection. The IP address obtained by tracking server through internet connection is used by sent to tracking unit. The IP address sent to tracking unit is used by it to send location information to the tracking server.

The TCP/IP stack typically consists of IP, UDP (User Datagram Protocol) and TCP (Transmission Control Protocol) protocols. The TCP/IP stacks those are implemented for embedded processors use a simplified model of the traditional TCP/IP stack to reduce the code size as well as the memory utilization. For embedded applications, a single global buffer is used in which the device driver puts an incoming packet. The buffer can hold a packet of maximum size that is defined for it.

Power supply unit is used to supply the low power required by the microcontroller and the GSM modem.

II. BLOCK DIAGRAM

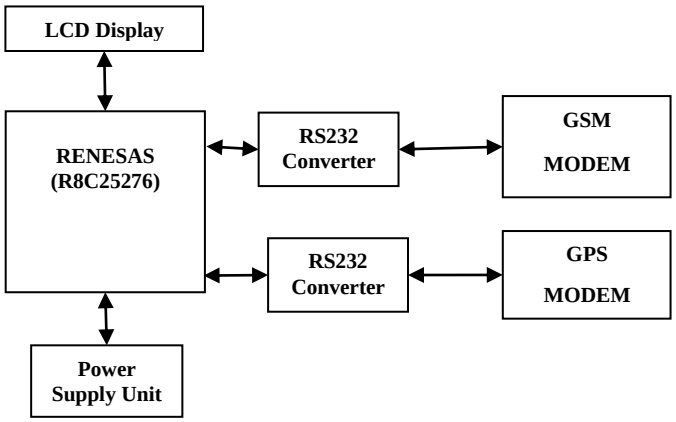

Fig. 1. Block Diagram of tracking unit

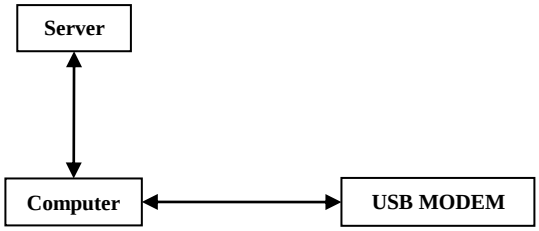

Fig. 2. Block Diagram of tracking server

Fig. 1 shows the block diagram of tracking unit and Fig. 2 shows the block diagram of tracking server.

A. Renesas Microcontroller

The microcontroller (also called the microcontroller unit/MCU/µC) is a small computer on a single integrated circuit consisting of a relatively simple CPU (Central Processing Unit) combined with support functions such as a crystal oscillator, timers etc. Microcontrollers are used in automatically controlled products and devices such as remote controls, automobile engine control systems, appliances, office machines, toys and power tools. The microcontroller is used to read data from the GPS and then provide the data to the monitoring unit. Microcontroller is used to initialize the GSM modem so that data can be sent and received between tracking unit and tracking sever. LCD connected to the controller will be used to display the status of the tracking unit. LCD function is controlled through microcontroller. The microcontroller used is Renesas microcontroller. Therefore the Renesas microcontroller acts as the CPU of tracking unit.

B. GPS

Fastrax-IT520 GPS will be used in the tracking unit to obtain location information of the device being tracked. The information so obtained is then sent to the tracking server using GSM modem.

C. GSM

SIM300 GSM will be used in tracking unit. In order to exchange the data between tracking unit and tracking server a TCP connection must established between them. Then the data

is exchanged between tracking server and tracking unit using the IP (Internet Protocol) address of each other. Prior to establishing connection between the tracking server and tracking unit the IP address of tracking server must be sent to tracking unit via SMS and then the connection is established between tracking server and tracking unit using the IP address of each other. Thus GPS and GSM provide a way to keep track of the vehicles, ships etc., by providing the coordinates details of the device.

D. Tracking server

The tracking server later uses this data to establish online tracking. The location information is displayed on Google Earth application in order to view the location of the device.

E. RS232

Serial communication is established using RS232 between

- Microcontroller and the GSM modem.
- Microcontroller and GPS modem.

F. Power supply

Power supply unit is used to supply the low power required by the tracking unit.

G. USB MODEM

USB MODEM is used in the tracking server in order to establish internet connection. After internet connection is established an IP address is assigned to serer which is then used by tracking unit to establish TCP/IP connection with the tracking server. USB MODEM will be a data-card; even wired MODEM can be used for this purpose.

III. WORKING PRINCIPLE

Tracking server keeps track of the device (e.g., vehicle) that is being tracked. It receives location information from the tracking unit. Tracking server has a wired or wireless modem attached to it in order to establish an internet connection. When internet connection is established an IP address is assigned to the tracking server. This IP address is sent to the tracking unit through a SMS. Tracking unit then uses this IP address first to establish a TCP connection with tracking server and then sends data (the location information of the device being tracked) to tracking server on this connection. The tracking server then uses this data to display the data on Google earth application. The main functions of the tracking server will be as follows:

- Establishing internet connection
- Read location details sent by the tracking unit
- Online display of the location details to the user

Tracking unit is placed in the device that is to be tracked. It accesses the location information of the device through GPS and then sends the locations inform to the tracking server through GSM network via GPRS. The tracking unit mainly consists of:

- Microcontroller
- GPS Modem
- GSM Modem

Microcontroller acts as Central Processing Unit for tracking unit. All operations of the tracking unit are to be controlled by the microcontroller. Microcontroller uses instructions to operate the tracking unit. These instructions are provided to microcontroller by writing the software into microcontroller's PROM. The main functions of microcontroller will be:

- To read location details of the device being tracked i.e., the microcontroller has to read data from GPS.
- Configure GSM such that GSM can be used to establish TCP connection with the tracking server and then send the location information of the device being tracked to the tracking server on the connection established.

The embedded software that is to be designed must provide communication interface to the GPS and GSM modem attached to microcontroller's serial port through RS232. GPS has to be configured in such a way that the information arriving at GPS must be read by the microcontroller through serial port using RS232. Initialization of the GSM must also be done through embedded software.

GSM modem communicates with the microcontroller through serial port using RS232. GSM modem is used in tracking unit to send the location information of the device being tracked to the tracking server.

IV. TCP/IP STACK

The TCP/IP stack typically consists of IP; UDP and TCP protocols .The TCP/IP stacks those implemented for embedded processors use a simplified model of the traditional TCP/IP stack to reduce the code size as well as the memory utilization. For embedded applications, a single global buffer is used in which the device driver puts an incoming packet. The buffer can hold a packet of maximum size that is defined for it. When a packet enters from the server the device driver puts it in the buffer and calls the TCP/IP stack. In case of receiving, if the packet contains data, the TCP/IP stack will notify the corresponding application. For sending case when the application sends data to the server, first it goes into the buffer. Then TCP/IP stack calculates the checksums and fills in the necessary header fields on that data and send the packet to the server.

V. FLOWCHART

Fig. 3 shows the flowchart of the system to be implemented.

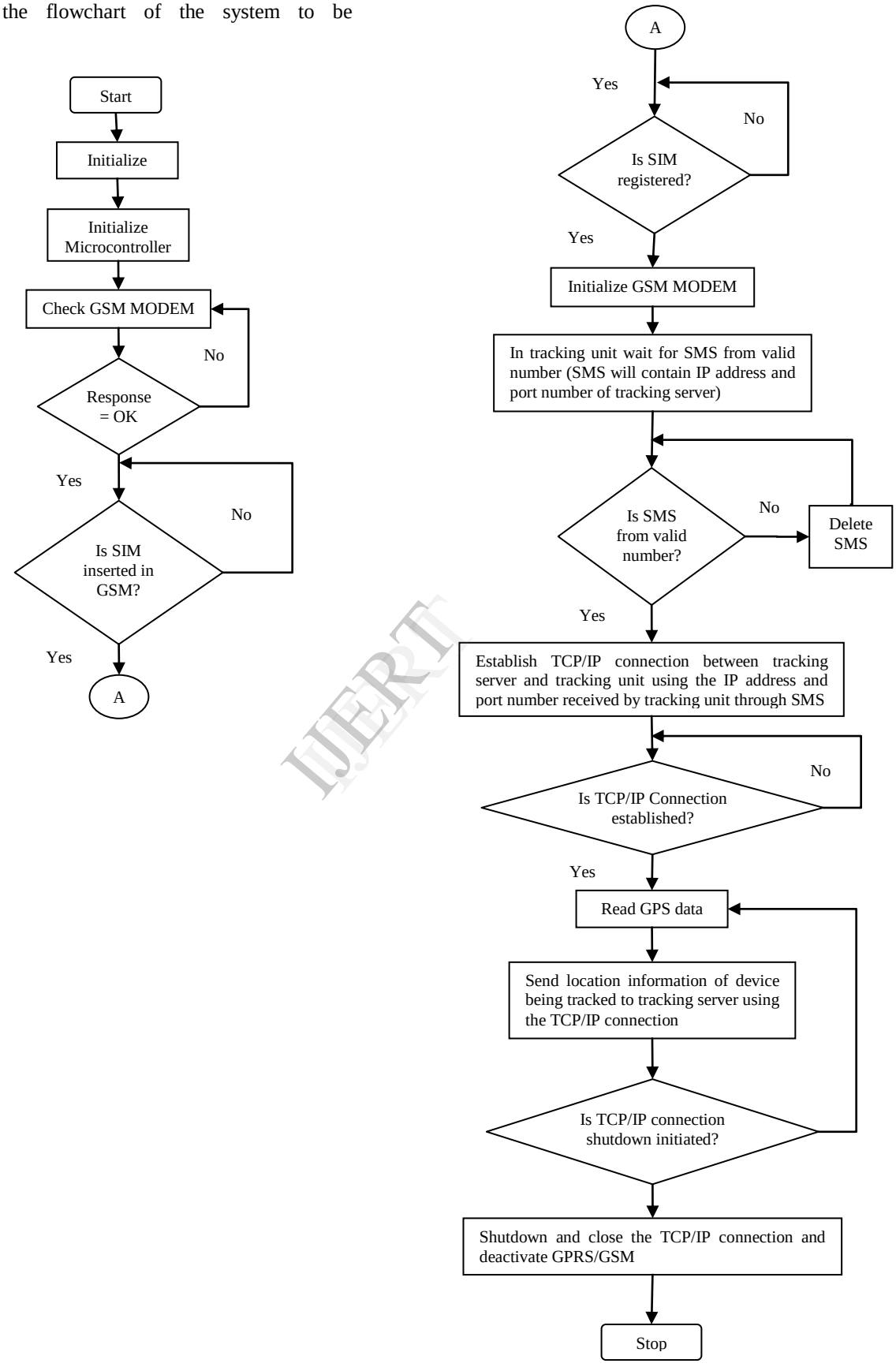

Fig. 3. Flowchart

VI. AT COMMANDS FOR GSM

Prior to using GSM modem the GSM modem must be initialized according to our requirement. This can be done with the help of AT commands. These commands are sent by the microcontroller of the tracking unit to GSM modem. For example AT+CMGS command is used to send message.

VII. AT COMMANDS FOR TCP/IP

Data can be transmitted and received on a TCP/IP connection between tracking server and tracking unit. But before transmitting and receiving data on TCP/IP connection the connection needs to be established between the tracking server and tracking unit. After successful connection establishment data can be exchanged. These operations can be performed with the help of AT commands for TCP/IP connection. These commands are sent by the microcontroller of the tracking unit to GSM modem. For example AT+CLPORT is used to specify type of connection required (TCP or UDP); AT+CIPSTART is used to start TCP or UDP connection.

VIII. NMEA-0183 PROTOCOL

The GPS data is normally received and transmitted in a standard NMEA-0183 format. This GPS continuously outputs a lot of NMEA sentences such as GGA, GLL, GSA, GSV, RMC, and VTG. For example $GPGLL data set contains latitude, longitude and time information.

IX. ADVANTAGES

- Easy to keep track of vehicles, ships etc.
- Adds to security of vehicles.
- Traffic control can be made easy.
- Speed monitoring can be integrated to the system.
- If each vehicle is equipped with RFID (Radio-frequency identification) then online fine generation can be implemented for the vehicle which violated the traffic rules.

X. APPLICATIONS

- It is easy to keep track of vehicles.
- Added advantage of security for the vehicles.
- Useful as a guidance system. Say if fishermen lose their way then they can be guided properly to the destined place.
- Online tracking may be useful for traffic control.

XI. RESULTS

Table I. gives the result obtained for mobile device that is being tracked.

TABLE I. LATITUDE AND LONGITUDE VALUES FROM TRACKING UNIT AND TRACKING SERVER FOR MOBILE DEVICE THAT IS BEING TRACKED

Theoretical value of latitude position of the device being tracked	*Theoretical value of longitude position of the device being tracked*	*Latitude value of the device being tracked from Tracking Unit*	*Longitude value of the device being tracked from Tracking Unit*	*Latitude value of the device being tracked displayed in Tracking Server*	*Longitude value of the device being tracked displayed in Tracking Server*
12° 57’ 53.45’’	77° 32’ 6.4’’	12° 57.8907’	77° 32.12106’	12.9648445°	77.535351°
12° 57’ 54.15’’	77° 32’ 6.7’’	12° 57.90195’	77° 32.1131’	12.9650325°	77.53521833°
12° 57’ 36.7’’	77° 32’ 59.2’’	12° 57.61177’	77° 31.98453’	12.96019617°	77.5330755°

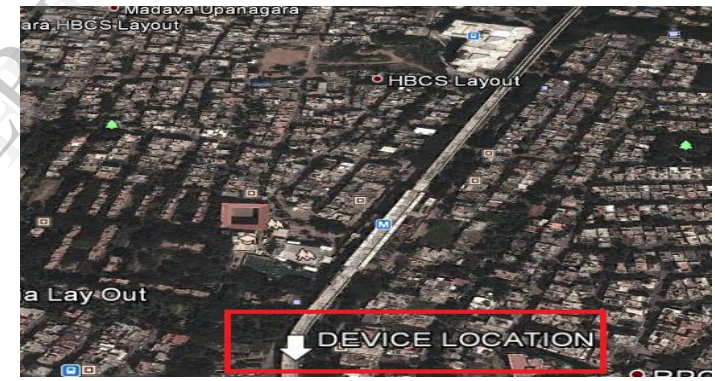

Fig. 4. Device location of the mobile device being tracked (coordinate values - 12.96019617N, 77.5330755E)

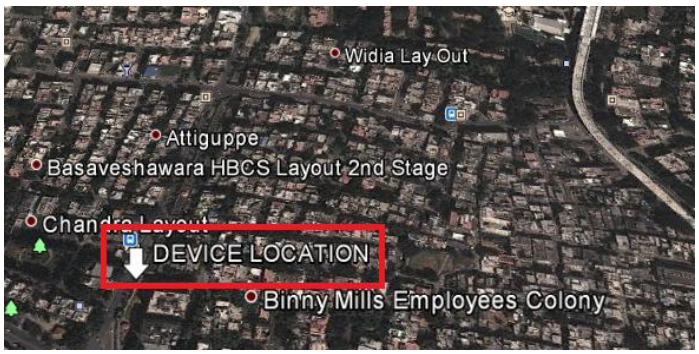

Fig. 5. Device location of the mobile device being tracked (coordinate values - 12.95808417N, 77.52879767E)

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