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A Review of Low Cost Object Tracking System

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***Abstract*— This paper proposes and implements a low cost object tracking system using GPS and GPRS and GIS. The system allows a user to view the present and the past positions recorded of a target object on Google Map through the internet. The key features of the system are an open-source GIS platform, HTTP protocol, A web application is developed using PHP, JavaScript, Ajax and My SQL with the Google Map embedded and a communications server, a web-server, a database server, and a map server. The Monitoring Centre displays the above information on Google Map by means of Internet and sends commands to all the subsystems. The real time availability of all exact locations and speeds of the vehicles enables the system to encompass very clear traffic information.**

Keywords—**GPRS, GPS, GIS, HTTP**

I. Introduction

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 higher which prevents from widespread use. On the other hand, the rate of car theft, asset theft, child kidnapping in many countries are increasing at a higher rate. GPRS (General Packet Radio Service) is chosen as the main method of communication between the tracking unit and the server. GPRS, being mobile technology, is ubiquitously available in the country. It is also ideally suitable for data transfer over an always on-line connection between a central location and mobile devices. The cost is per 1(KB)of data transferred, in comparison to SMS where the cost is per message. The paper illustrates the integration of multiple technologies to achieve a common goal. Global Positioning System (GPS) is a system composed of a network of 24 satellites of the United States, The satellites periodically emit radio signal of short pulses to GPS receivers .A GPS receiver receives the signal from at least three satellites to calculate distance and uses a triangulation technique to compute its two-dimension(latitude and longitude) position or at least four satellites to compute its three-dimension (latitude, longitude, and altitude) position. Once a location is computed, it can calculate an average speed and direction of travelling. Therefore, GPS is a technology for giving device its position.

II. System Overview

The system has two parts – the tracking device, the database server, a map server and platform is selected for the map server. The system uses GPRS as the main method of communication between the units need a system to track and server. The device is attached with the moving object and gets the position from GPS satellite in real-time. It then sends the position information with the International Mobile Equipment Identity (IMEI) number as its own identity to the server. The data is checked for validity and the valid data is saved into the database. When a user wants to track the device ,she/he logs into the service provider's website and gets the live position of the device on Google Map.

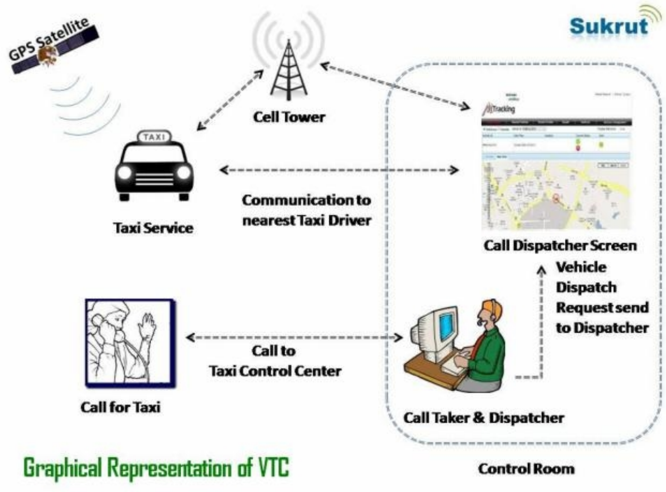

Fig. 1 The N-tier tracking system diagram

III. System Design

3.1. Hardware Specification:

Figure 1 shows the work flow of the hardware.

The tracking unit collects the location information via the GPS, formats this information into a system-specific packet format and sends it to the server via GPRS. If GPRS is unavailable at any time, time-stamped data packets are stored in a temporary storage unit to be uploaded when GPRS becomes available again. Thus, the movement information of a vehicle is not lost even in the event of a communications failure.

50MHZ/900MHz/1800MHz/190OMhz frequencies of cellular networks. Tel it GM862-GPS GPS/GPRS is the module we have selected for this system shown in Fig 2. This device is capable of working in any GSM network around the world. It has a python interpreter with 3MB Non-volatile memory and a 1.5 MB volatile memory integrated inside the module [9]. No external controller is required. It has a 20channel high sensitive GPS receiver and built-in SIM cardholder. This makes the system compact and power efficient. To build a complete working system using this module, only the power source and the antenna is required. It also supports complete standard AT command set plus custom AT command set for GPS. Figure 3 shows the work flow of the hardware. After turning on the device, it automatically initializes the network. Then It gets the GPS data in NMEA 0183 format and adds it with its own unique IMEI number [10], [11]. It then tries to connect to GPRS. If it fails due to GPRS unavailability then it logs the data in the non-volatile memory and waits for a certain fixed time period.

Fig. 2 GPS-GPRS module with EVK and antennas

After that it tries to connect to the GPRS again. After establishing the GPRS connection it tries to connect to the service provider's server using the HTTP protocol. After successful connection, the GPS data with IMEI number Is sent to the server as a string. Then after a certain time period it checks the availability of GPRS and connects to the HTTP server. The current location of the device is sent. In this waythe device communicates with the server and sends thelocation.

3.2. Software Specification:

To view the current position of the device a web-based application has been developed. Using this Web application an end user will be able to view the live position of the device and also the past position by selecting a specific date and time Interval. To develop this software PHP5, JavaScript and Ajax scripting language was used. My SQL database server is used for storing data because of its high-performance query engine, tremendously fast data insert capability, and strong support for specialized web functions like fast full text searches [12]. A case study shows that it could process an average of 3000 queries per second [13].A PHP file named dgl.php is responsible for accepting data which is sent by the device via GPRS using POST method of the HTTP protocol. This data consists of IMEI number of the device, Latitude, Longitude, UTC, Date, Speed and number of satellite. IMEI number is used to authenticate the device. Fig. 4 shows the server side flow diagram.

The main software components of the system are the socket communication server, the web server work and the GIS map server. It will then listen to any incoming connections when a client (a remote tracking device) connects, the server will authenticate and acknowledge the client .The web application will retrieve the data from the database server and do preprocessing for further operations as requested by the user. To develop this software PHP5,JavaScript and Ajax scripting language was used. A PHP file named dgl.php is responsible for accepting data which is sent by the device via GPRS using POST method of the HTTP protocol. This data consists of IMEI number of the device, Latitude, Longitude. IMEI number is used to authenticate the device. The Spherical law of cosines is used to find out the name of the device's location. Spherical law of cosines

d = R*acos(cos(lat1).cos(lat2).cos(lng2−lng1)+sin(lat1).sin (lat2))

d is the distance between two coordinates (lat1,lng2) and (lat2, lng2)

Four attributes as given in Table 1

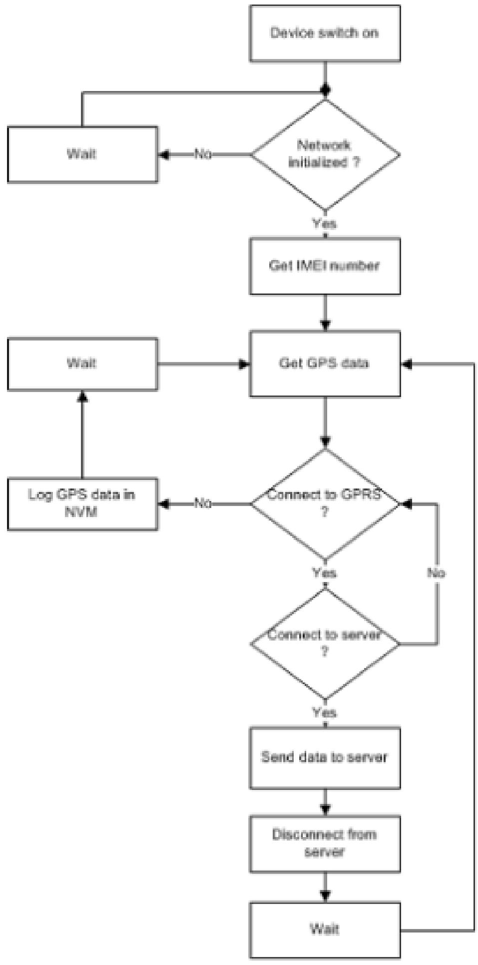

Fig. 3 Hardware flowchart of the system

Table1

ID	Name	Latitude	Longitude
1	Banani	23.3456554	90.9825973
2	Gulshan-1	23.3456546	90.9825934
3	Gulshan-2	23.3456590	90.9825926
4	Mohakhali	23.3456525	90.9825979

After receiving a new position, dgl.php the nearest location name of the newly received position is found."**SELECT** name, (3959 * acos(cos(radians('lat1)) *cos(radians(lat2)) * cos(radians(lng2)– radians('lng1')) + sin(radians('lat1')) * sin(radians(lat2)))) AS distance **FROM** geo code **HAVING** distance < 5**ORDER BY** distance LIMIT 0, 1"This query returns the name of the location which has the shortest distance with the new position.

A. NMEA Conversion

This following NMEA protocol is received using GPS device by the web server, a method is used for tokenizing

all the particular data. This is done after verifying the IMEI number of the device that the NMEA formatted data converted to the decimal format. After converting NMEA formatted data to decimal Latitude and longitude, it changes as following:
2345.3522N = 23.755895
09022.0288E = 90.367205

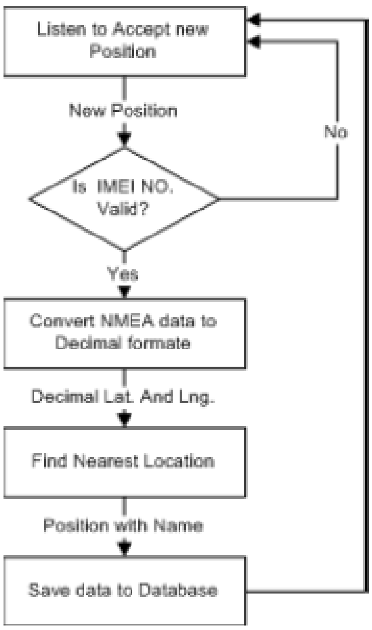

Fig. 4 Server side flow diagram

B. Finding nearest Location

The Spherical law of cosines is used to find out the name of the device's location. This formula is used generally for computing great-circle distances between two pairs of coordinates on a sphere.
Spherical law of cosines [14]:
d=R*acos (cos(lat1).cos(lat2).cos(lng2−lng1)+sin(lat1).sin(l
at2))
Here, d is the distance between two coordinates (lat1,lng2)and (lat2, lng2).
After receiving a new position, dgl.php the nearest location name of the newly received position is found. This is done by running the Spherical law of cosines in sql query as below:
"**SELECT** name, (3959 * acos(cos(radians('lat1)) * cos(radians(lat2)) * cos(radians(lng2)– radians('lng1')) + sin(radians('lat1')) * sin(radians(lat2)))) AS distance **FROM** geo code
HAVING distance < 5**ORDER BY** distance LIMIT 0, 1"This query returns the name of the location which has the shortest distance with the new position.

C. Live Tracking:

Live tracking is the major part of this web application. This enables a user to view the live position of the device on the map. Google Map Satellite version is used to locate the position .After Logging in, a user will automatically be redirected tolive_track.php page. In this page AJAX (Asynchronous JavaScript and XML) function is used to fetch the new position from the server. This is done at fixed intervals in order to update it on the map without reloading the whole page repeatedly. The Fig. 5 shows the how AJAX works between user and server side.

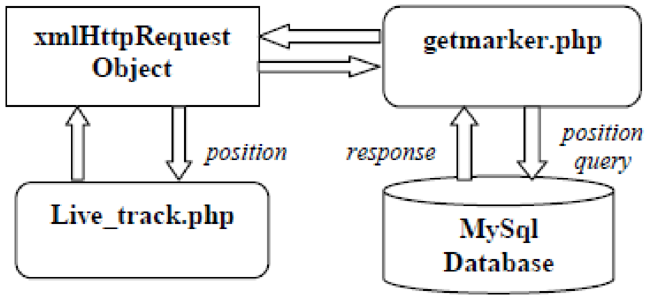

Fig. 5 Live Tracking Flow Diagram using Ajax

IV. GEOGRAPHIC SPATIAL INFORMATION

The Geographic-data module deals with all spatial information in the system and we can see the current situation device. The main information components are Locations, Geophones, Routes and Tours. Geo-fences are circular areas defined around a Location. The GPS location of the center of the circle and the radius define a Geo-fence .A Route comprises of two or more Locations described above. When a vehicle needs to be reserved for a particular trip, the system operator creates the Tour by combining parts of the pre-defined Routes. For example when the vehicle needs to travel from Colombo to Horana . A Tour may be defined by joining the Colombo-Katubedda segment from the Colombo-Galle Route, theKatubedda-Piliyandala Route and the Piliyandala-Horana segment from the Colombo Horana Route. This is done through a graphical user interface including digital maps. For example, a mouse click on a particular city can be used to retrieve its coordinates. While the vehicle is on tour, the system tracks its position in real time and is able to detect if it deviates from the defined tour. Along with the location information, the tracking device also sends other relevant data such as speed, time, and power level to the communication server. This information is also stored in the database. In the tracking module these data will be displayed along with the vehicle number which is being tracked. Vehicle which is being tracked is displayed as a point on the map. The browser refreshes the map every eight seconds, so that the vehicle's movement can be tracked .In this system user can check the history of tracking with Google map

Fig. 6 Snapshot of the webpage which shows the live position of the tracking device by using Google map

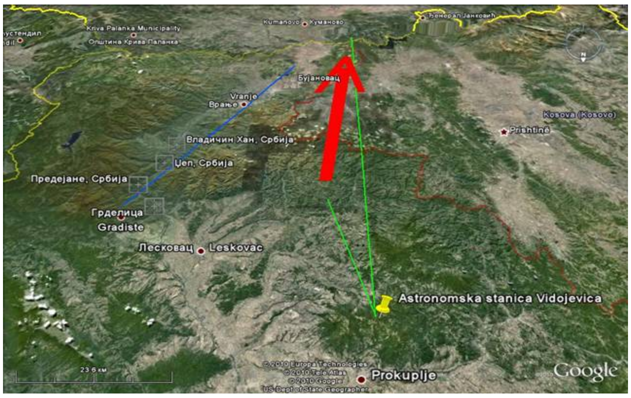

Fig. 7 Snapshot of the webpage which shows the history (previous recorded positions) of the tracking system. Bubble indicates the position and time of tracking device.

V. Discussion On Low Cost Solution

Efforts have been taken to reduce the total cost of the system including device and services. The device cost is reduced by using a single module solution. By using free Google map API and HTTP protocol the service cost has been reduced dramatically. Starting from small business to large enterprise, the device and service cost can be affordable. They can also set up their own customized web-based remote monitoring system easily. GPRS was used for data transfer instead of SMS. Several SMS based vehicle tracking systems are available in the local market which sends SMS with current position data when are quest is made by SMS. This SMS based tracking system is neither efficient nor cost effective. In most countries the cost of GPRS is cheaper than SMS by a factor of 20 to 100. (SMS costs about 0.5-1.0 Taka/SMS whereas GPRS costs about0.02 Taka/KB [16].)To reduce the total system cost, a single GSM/GPRS/GPS module was used instead of separate devices. It requires only external power and an antenna for GPS and GSM. Beside the cost, this approach saves extra PCB space of the system. On the other hand, it is integrated with high level python language interpreter. This makes it easy to program, update and optimize the system and additionally save the external controller. Moreover, it saves development time and cost compared to programming and interfacing externalcontroller.The service cost was reduced by integrating free Google map into the service provider's site using the Google map API and customizing the service. Countries where there is a lack of proper GIS based map, it would be time consuming and extremely expensive to develop a map solution. A small company can start providing such tracking service quickly in an affordable price by using Google map. Moreover, they advantage of the advanced features of the Google map by integrating their own customized services. Using the HTTP protocol also reduces cost to send data from the tracking device to the server. Most of the GPRS/GPS based tracking devices available in the market use TCP or UDP protocol to connect with the server and send data. A dedicated server with a static IP is required. This is more expensive compared to that of shared web hosting. Opening several ports for TCP or UDP incoming connection makes the server vulnerable. On the other hand, this tracking device uses HTTP protocol to communicate with the server. It uses the POST method which is safer in data communication. Since it does not require any extra port other than the HTTP port (port 80) for incoming connection, it is more secured. Small companies can easily set up and provide their own services in a shared web hosting.

VI. Conclusion

This paper presents a low cost tracking system using GPS and GPRS of GSM network, suitable for wide range of applications all over the world. The combination of the GPS and GPRS provides continuous and real time tracking. The cost is much lower compared to SMS based tracking systems. Free Google map and the use of HTTP protocol as data sending method reduces the monthly bundle cost for the individual user and also for the small business owner. It is expected that the full implementation of the proposed system would ultimately replace the traditional and costly SMS based tracking systems.

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