Development of a Cheap Mobile-Object Tracking System using GPS/GPRS System

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Abstract
This article proposes a Cheap Mobile-Object Tracking System (CMOTS) which can be easily operated through GPS/GPRS systems. This system allows users to view current and former recorded positions of a target object via online Google Map service. Briefly, the positional data of the object was first read from GPS system (located in tracking device attached to the mobile object) using special designed software and sent to a web server via commercial GPRS service (GSM network) under POST method of HTTP protocol. The data is then processed, displayed, and stored in a database by using an application (developed from PHP, Java Script, Ajax, and MySQL) embedded with Google Map feature. This CMOTS is relatively cheaper than any existing live tracking systems due to its data transferring facilitates via GPRS service instead of formerly expensive communication channel, SMS. The CMOTS is very useful for polices or corresponding people in engaging with stolen cars (it can set to alarm, alert, act by starting an engine, or restrict some thief's actions), in following up one's driving, and even tracking for persons or animals.

1. Introduction

Several tracking systems with widely range of tracking facilities have been developed so far (Al-Bayari and Sadoun, 2005, Hapsari et al., 2005, Tamil et al., 2007 and Pati, 2007). However, their operation costs are still high that make them not to be prevalence for practical applications as they should be on the other hand, the reported crimes in term of car or asset stealing and kidnapping (especially children) are continuously increasing in many countries (Insurance Issue Institute, 2010) where the tracking systems could be a potential solution for resolving these problems. For this reason, the operation cost may be a turn point for tracking system usages among present time people. The objective of this study is to reduce the cost of tracking system and make it possible for general people to use in any applications. Al-Bayari and Sadoun discussed about Automatic Vehicle Location system worked under GIS environment. Moreover, Hapsari reported a complete FPGA implementation of the vehicle position tracking via Short Message Services (SMS) (Hapsari et al., 2005). Next, Xiaobo Fan et al., described about the design and implementation of a mobile-object management system that could be operated via that time existing GSM network. This system performed its extended data communication via GPRS (Fan et al., 2006). Beside this, Hsiao and Chang developed an analytical model used to determine the optimal location update strategy in order to minimize total cost (Hsiao and Chang, 2006). Interestingly, Tamil et al. also did a work similar to ours but used SMS in communication instead (Tamil et al., 2006). A more recently work taken by Nishikanta Pati involved video surveillance and tracking of moving civilian vehicle. This provided a new dimension for tracking system development (Pati, 2007). By combination of these all modern technologies, our research focused on reduction of overall tracking cost so that the NAVSTAR-GPS (a satellite based service developed and provided by US defense) was used. One outstanding benefit of global positioning system or GPS is a 24-hours worldwide service. Furthermore, it can provide accuracy, three-dimensional information about location as well as precision velocities, and timing services. Next, it can be accessed by unlimited number of global military, civilian and commercial users (US Air Force, 2010). Finally, this service is free for cost and for everybody. The Google Map was selected because it was the most flavor location mapping service well known for everybody and quite easy to use. The general packet radio service or GPRS was selected to be communication channel between the server and the tracking device because it was very cheaper service (amount of content per price unit) compared to SMS. In the other point, GPRS is now available in all mobile phone which is booming and

can reach to almost all parts of the world overcoming developed and developing boundary. For these reasons, GPRS (in this case, GSM network) is one of the best communication media for the present and future applications.

2. Methodology

2.1 The Overall System

The system composts of two parts: the tracking device and the server containing the database as shown in Figure 1. The device is attached to the moving-object and it continuously gets its (or the object attached to it) positions from satellite GPS in real-time manner. Then the positional data is sent with its own identification number (International Mobile Equipment Identity or IMEI) to the server where the data is checked for validity and saved in to the database. When the users need to track the object (or device attached to it), they can log into the website under certain service providers and retrieve the live position of the object which now appears on the Google Map. A custom report can also be generated with detailed description of the vehicle status included. By this well designed application, all previous recorded positions of the object can also possibly be revealed by the users.

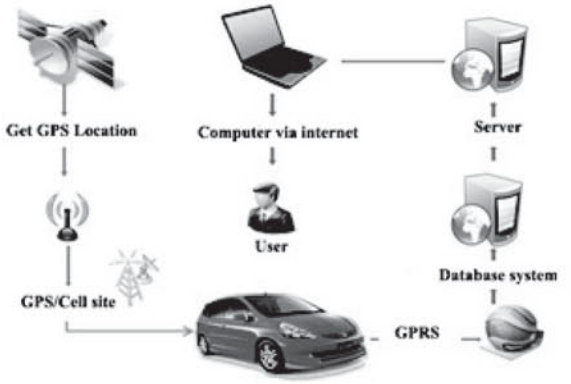

Figure 1: The CMOTS tracking system

2.2 Hardware Requirement

This system requires PCM-36E06 module (Figure 2) because it is compatible with 900MHz/1800MHz-/1900MHz frequencies of cellular networks and work in any GSM network around the world. The interpreter core used in this system is Python script (script means the small programs made in such language) run under 3MB non-volatile memory [Flash Rom] and only 1.5 RAM is used by the interpreter without external controller. The selected mobile phone contains 51 channels of high sensitive GPS receiver and built-in SIM card holder inside that make the system more compact and efficient.

Additional accessories require for this system building are a power source and an antenna that support complete standard AT command set plus custom AT command set for GPS.

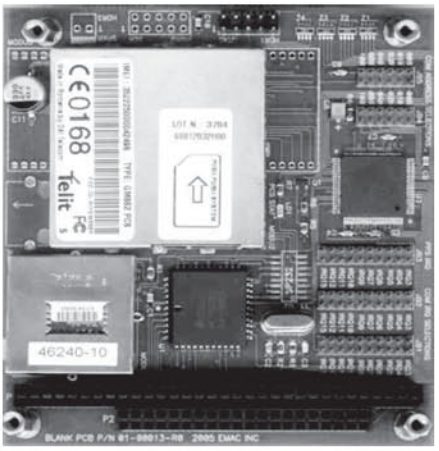

Figure 2: GPS-GPRS module

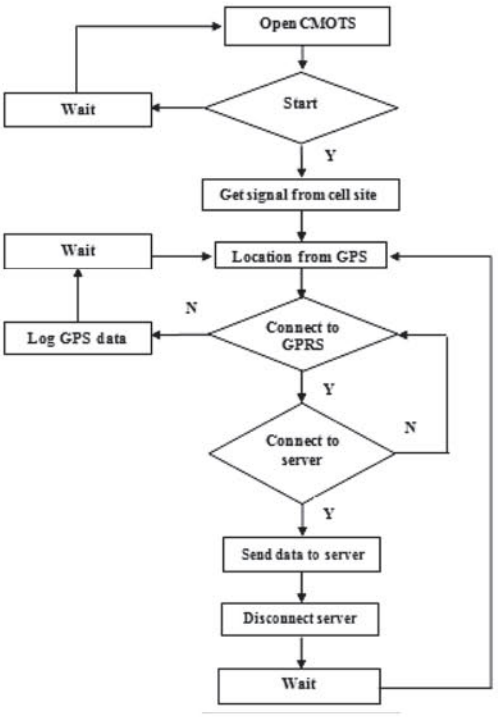

Figure 3: Flowchart of the system

The flowchart of the hardware was shown in Figure 3. After turning on the device, it automatically initializes the network and gets GPS data in NMEA 0183 standard. Then its own IMEI number is added into the data. After a connection to GPRS is established (in case of failure present, the data will be logged in the volatile memory and the system will try to connect again, until stop in certain time

failures), the system tries to connect to the service provider's server using HTTP protocol. In case of success, the GPS data with IMEI number is sent to the server in form of string. The GPRS availability is also perpetually checked after a certain time period. The data is finally interpreted and present to the users using designed software described in next section. Thus, current location of the object (also the device) is known by the user in this way.

2.3 Software Requirement

In order to view the current position of the object (also the device) a web based application has been developed. By this application, the users are able to view the live position of the object (also the device) including all former recorded positions by selecting a specific date and time intervals. This software was developed by using PHP5, JavaScript, and Ajax scripting languages. The MySQL with high performance query engine was used as server database in data storing because of its tremendously fast data inserting capability and having strong ability to support for specific web functions such as fast full text searching (MySQL, 2010). An evident from a case study indicated that it could process an average 3000 queries per second. In the server, a PHP file is responsible for accepting data sent by the device via GPRS under POST method of HTTP protocol. This data consists of IMEI number of the device, latitude, longitude, UTC, date, speed and number of accessed satellite.

2.3.1 NMEA alteration

The following NMEA protocol is received using GPS device. After the web server accepts the IMEI and NMEA data from the device (the NMEA format of the IMEI number is converted to decimal format and it must pass the verification process), the latitude and longitude which are also converted to the decimal degree.

2.3.2 Finding nearest location

The spherical law of cosines is used to find out the name of device's location. This formula is generally used for computing various great-circle distances between two pairs of coordinates on an ideal sphere.

2.3.3 Live tracking

This is the major part of the web application. It enables the users to see the live position of the object (also the device) on the map. The Google Map satellite version is used in this position locating. After logging in, the page will automatically be redirected to cmotslive_tracking.php page where Ajax (Asynchronous JavaScript and XML) function is used to fetch the newly position corresponding to the former position in the map under given time interval in order to update it on the map without whole page reloading. Figure 4 shows how Ajax works. Ajax is asynchronous software so that extra data is requested from the server and loaded in the background without any existed display or page interfering. The data is retrieved using the object named "XML Http Request" which is available to scripting language running in modern browsers. It can be alternatively retrieved through the use of remote scripting in browsers which do not support XML Http Request object.

2.3.4 Tracking history from the system

Tracking history can be retrieved by the users after logging into the system. The 'history.php' page allows the users to reveal the past positions of the object (also the device) by selecting a certain time intervals. Certain positional information stored in the database can be specifically retrieved in time point manner and the location of the object (also the device) corresponding to such time point will also be displayed to the users. (Figure 5)

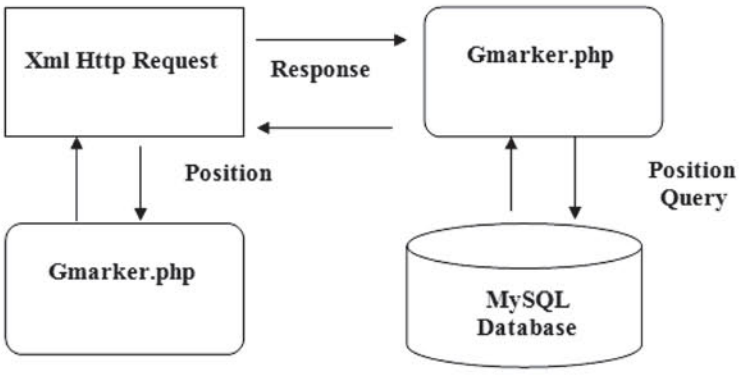

Figure 4: Live tracking diagram using Ajax

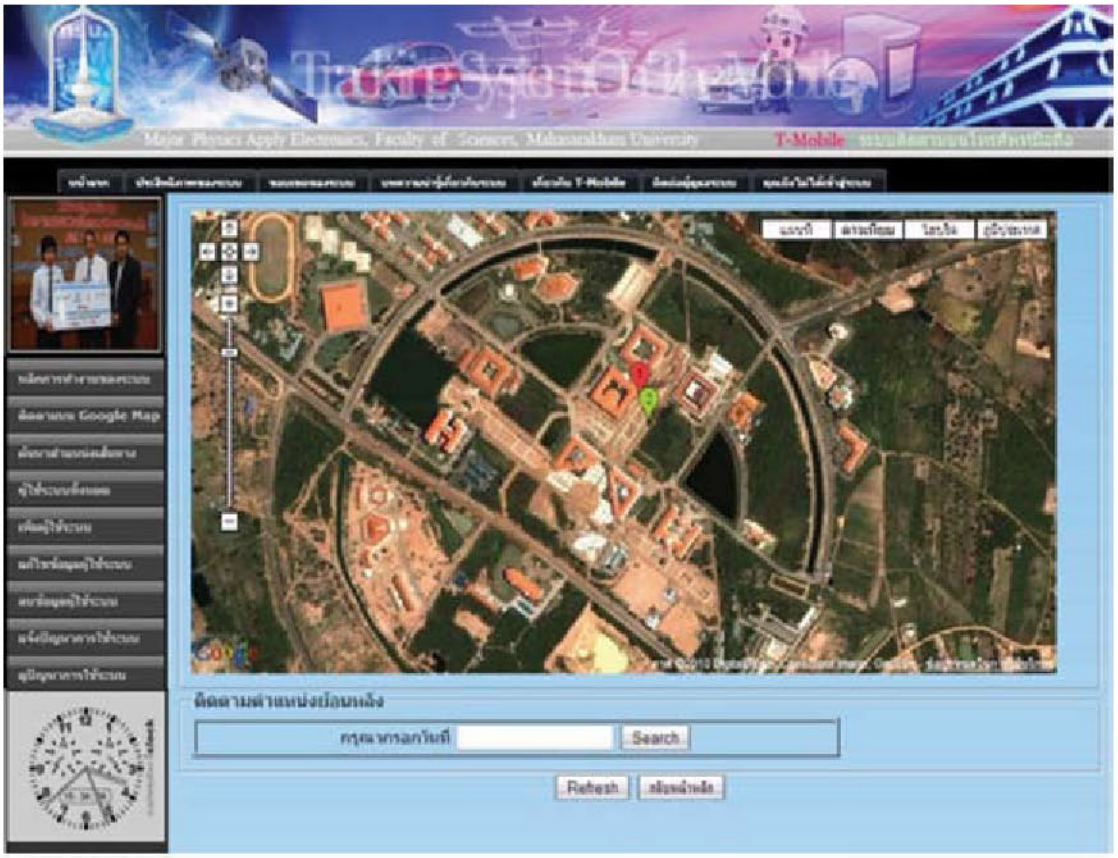

Figure 5: The webpage show the CMOTS

3. Discussion

Many efforts have been taken to reduce the overall tracking costs, both device and service. The device cost can be reduced by using only single module and using free Google Map API through HTTP protocol makes the service cost reduced dramatically. Both device and service used in this system are available commercially and affordable for any businesses, (no matter what it is small or large enterprises). The businesses can also possibly set up and customize this web based remote monitoring system by themselves easily using GPRS instead of SMS. Although several SMS based vehicle tracking systems are available in open markets, but most of them can only send the requested positional data via SMS which is both inefficient and ineffective ways. The developed COMTS requires only external power and an antenna. Thus this is not only saving much cost than other existing separate devices, but also making the system save for extra PCB space. Furthermore, the high level Python language interpreter integrated in the system makes it easy to handle (to program, update, and optimize) and need no external controller. Thus, this saves much of developing time and cost. For the service cost, it is reduced by integrating the free Google map into the application using Google Map API with a little customizing. It is waste very much of time and money to develop one's own specific GIS based map instead of using the Google Map service, especially in the countries where this service is lacked. It can be said that even small enterprises or even individuals can obtain this supreme tracking equipment in affordable price and can take advantage of any advance features of Google Map by their own customizing. Using of the HTTP protocol also reduces data sending cost from the tracking system to the server. Most of existed GPRS/GPS tracking systems use Transmission Control Protocol: TCP or User Datagram Protocol: UDP protocol in server connecting and sending data that relatively expensive because these protocol usually run in dedicated servers with static IP or non-web hosting sharable servers.

4. Conclusion

This article illustrates a Cheap Mobile-Object Tracking System (CMOTS) using GSM/GPS/GPRS module. The CMOTS is suitable for wide ranges of

applications around the world. The combination of the GPS and GPRS provides continuous and real time tracking while the cheaper cost (both for device and service) is realized by using single module (GSM/GPS/GPRS) together with free Google Map and HTTP protocol instead of SMS and TCP or UDP. The CMOTS working principle is that the vehicle location to install the device. The data are transmitted from a device installed in vehicles to a Google Map and HTTP protocol immediately made fast than in the old system. It is expected that the CMOTS would ultimately replace the traditional and more expansive SMS based tracking systems. Also, it should be continuously developed for more applications, more efficiencies, and cheaper in future.

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