A NEW SYSTEM DESIGN TO ENHANCE LOCATION-BASED SERVICES AND POSITIONING ACCURACY

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Abstract: Location Based Services (LBS) provide resources and information depending on the user's location. In This paper three issues related to LBS as a pedestrian navigation system have been identified: the accuracy of positioning, the volume size of data, and data presentation to the end user. Addressing these issues will enhance the performance of the system. The proposed system allows the end users to access vital, accurate and updated information based on their location. Since this location is not fully accurate, particularly in the urban environments where users are most likely use this system, a new algorithm combines correction data available from SISNeT can be utilised on the information received from Global Positioning System (GPS) receiver to enhance the positioning accuracy. Moreover, to overcome the volume of data problem, a new mechanism can be used to allow the users to load only the data of the town they are travelling to (Zone based), and not the entire GIS database, depending on their user-profile (e.g. businessman, tourist, etc.). And to overcome the problem that most of the users are facing (dealing with maps), an alternative technique can be used which allows providing information in a form of photos, voice and short videos.

1 INTRODUCTION

During the last few years, the mobile communication technology has been developed rapidly, and the speed of data transferring became high. This made it possible to work on special mobile information services such as Location-Based services (LBS) in which the location of a user plays a role in the information system (Kubber 2005).

The LBS systems combine the location information of the user with intelligent application in order to provide services (Brimicombe and Li, 2006). As shown in Figure 1, typical LBS system consists of Global Positioning System (GPS) and Geographical Information System (GIS) connected via wireless connection. The GIS is a computer system for capturing, managing, integrating, manipulating, analyzing, and displaying data which is spatially referenced to Earth (Renault et al. 2005).

LBS systems suffer from several drawbacks, firstly the obtained position from the GPS system is not fully accurate particularly or reflection, in urban, due to the blocking of satellite signals by buildings (Monteiro et al. 2005). Secondly the size of information (GIS maps, images, videos, etc.) integrated in the database is huge comparing to the users device memory (Brimicombe and Li, 2006). And thirdly, the way data presented on the map is not user-friendly, i.e. most of people cannot use it (Ordnance Survey, 2006).

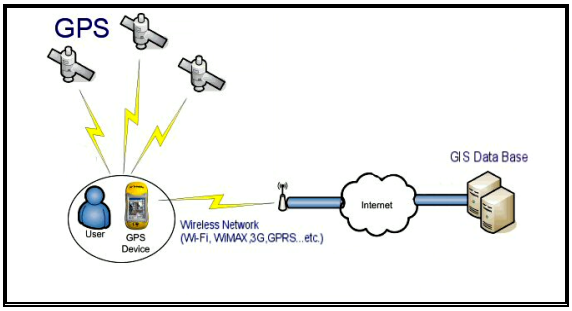

Figure 1: Location Based Services System.

This paper discusses new mechanisms and possible solutions to tackle the early mentioned problems. Also the paper incorporate a proposal for new LBS system design, which is expected to bring additive value to LBS application for pedestrians navigation and mobile information systems.

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2 LOCATION BASED SERVICES (LBS)

LBS systems provide many services, such as relevant maps, directions, points of interests (POI) e.g. filling stations, cash machines, hospitals, shops, clubs ...etc. The LBS systems are greatly useful in case of emergency calls for police, fire-fighters or ambulances (Kubber, 2005).

In order to use the LBS system the end user needs a smart mobile device such as pocket PC or Personal Digital Assistant (PDA) connected to the Internet via wireless connection such as Wireless Local Area Network (WLAN), or Universal Mobile Telecommunication System (UMTS), in addition to the GPS receiver itself which can be embedded with the mobile device or the PDA. These integrated systems combine good localization with pocket PC features such as the wireless connectivity which made it possible to keep the user of the LBS up to date with any changes on the maps or the POIs (Gartner, 2004).

As an overview of some of the most common location-based services as identified by Urs Hengartner, 2006:

- Navigation. Users can capture information regarding their position directly to their POIs using this service.
- Monitoring. With this service a user can receive a warning message if a related user entered a certain boundary. A good example of this would be parents monitoring children or employers tracking delivery of their goods or services.
- Nearby information. Includes services such as places of interest, advertisements, weather and traffic alerts related to the user's current location.
- Friends finder. The users could use this service to find out the current location of their friends.
- Nearby-friends alert. The user receives an alert if a friend is nearby.
- Locate me. Informs a user of his current location. This service might be useful for third parties to know a user's current location, which can be beneficial while the user is travelling.

3 ISSUES WITH LBS

3.1 GPS Accuracy

The GPS is well-known to many people especially the In-Car navigation system users. It uses 24 satellites orbiting the earth (Theiss, David and Yuan, 2005). One of its most common problems is the inaccuracy within the urban environments (Theiss et al. 2005). Nowadays, the differential technique (DGPS) is used to make the positioning process more accurate. If the essential number of satellites available is not enough, then another source of sensing is placed, but this can be applied only up to 100 Kilometres from the station (Monteiro et al. 2005). To overcome such problems, the Wide Area DGPS was developed, the idea of this method is to calculate the error from each satellite individually and then to transmit it to mobile receivers through geostationary satellites (Chen et al. 2003). A European project called Signal in Space through the Internet (SISNET) is utilised to provide access to the European Geostationary Navigation Overlay Service (EGNOS) messages using the GSM/GPRS or any other mobile internet connectivity method (Chen et al. 2003). In the near future a new positioning system will be lunched in the world called GALILEO (Hunaiti et al. 2006), this new system will use 30 satellites instead of 24, and this will highly improve the positioning accuracy up to centimetres.

The proposal is to establish a correction algorithm inside the LBS server, which allows performing the correction process locally by comparing the GPS sentence which is received from the client side with the SISNeT sentence which is received from the internet (See figure 2), and send the corrected location to the GIS Database Management System (DBMS) to perform the user's query.

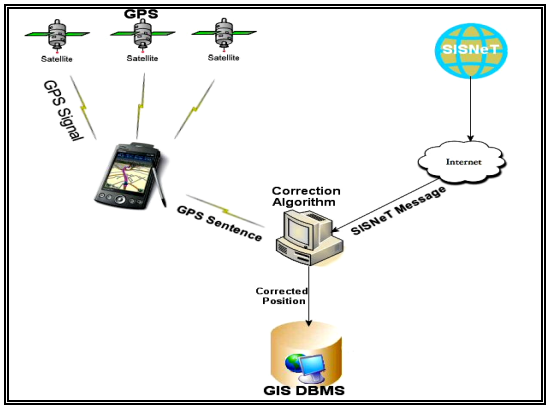

Figure 2: Correction Process.

There are number of advantages for such approach:

- It allows the users to use a nominal standalone GPS receiver.

- It contributes in saving the power of the mobile device, i.e. power required to perform the correction in each device.
- It avoids the impacted delay caused by the wireless communication link which might result invalid correction data.
- It is much cheaper to purchase a non sophisticated mobile device.

3.2 Size of GIS Database

The GIS database contains all the roads, buildings, images, videos and other points of interest. The user will be able to navigate, search, view and play so many services according to his/her position; for example when the end user pass in front of certain shop, a popup will appear automatically on his mobile, showing new prices or telling some news or it may be a short video clip as advertisement. The size of this information is so huge, and it needs a very sophisticated mobile device to deal with. That's why the data is divided in a way to load only the needed information into the user's mobile system.

In order to overcome the volume size of information which can be loaded to the user device, the users are attached to many profiles, for example: businessman, sports fan, etc (see Figure 3). This customisation is going to help in loading only the required information (Images, Videos, etc).

Figure 3: Categorising Data in GIS database.

Those profiles are organized inside the database and connected with certain services and contents. For example, the Tourist profile is connected to the Directions service and to the Hall, Parks and Stations Contents. This will save the size of memory and the limitation of power at the client side of the system.

3.3 Data Presenting

According to the recent surveys conducted by Ordinance Survey, 66% of people cannot use the map (Ordnance Survey, 2006). This paper proposes new way of presenting information to the end user. This system uses images, voice and short videos in addition to the digital maps. This is going to help people to find their way easily, quickly and with less errors (see figure 4).

Figure 4-a: shows that the current systems use only text, maps and voice. But Figure 4-b (Proposed System) shows how the images and videos are supporting the map, so the users can see the real world on their mobile's display. This information should be always up-to-date in order not to make any confusion. That's why the user should be always connected remotely to the GIS database.

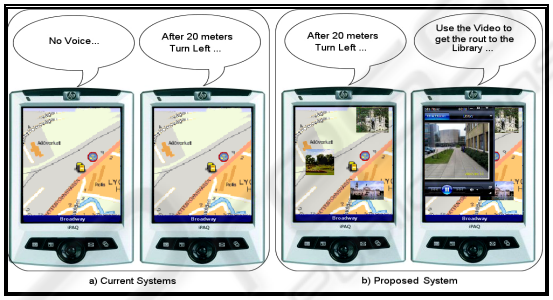

Figure 4: Current and Proposed User Interface.

4 PROPOSED SYSTEM

The proposed system architecture, as it can be shown in figure 5, is an integration of three main elements; Satellite navigation (namely GPS), GIS, and mobile networks.

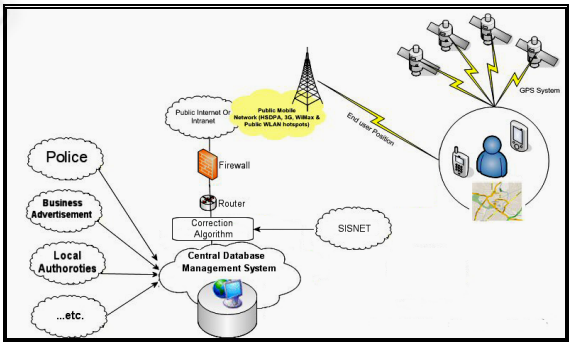

Figure 5: Proposed System Architecture.

The main functional user equipment is a mobile device which can be in a form of pocket PC, PDA, laptop…etc, with built-in GPS receiver and mobile communication interface (3G, WLAN, …etc.) (Zola and Barcelo, 2006). At the other side of system is the Centralised database management system which is acted as a central hub for all the mobile units where a comprehensive database is stored. The centralised server can be also linked with other

terminals (such as Police, Council …etc) in order to provide continuous and updated information. In addition, the centralised server will also perform a correction process on the received location data, via applying the correction data provided by other systems such as SISNeT and OSNet (Chen et al. 2003).

The system is designed to operate as follows. When the user travels with the mobile unit, the GPS receiver fixes the position, while the mobile communication link allows the transmission of the users location information and the remote access to the centralize database in the server. Based on the received location information from the mobile unit, the centralised server builds and provides the mobile user with the essential information about that specific area (Town), in such way, the mobile unit will store only the information that the user need, for example if a user is travelling from Colchester to Chelmsford, at a certain location the system will ask the user to load only the town of Chelmsford into his mobile device. That will contribute in reducing the power consumption of the mobile device by avoiding loading unnecessary information and minimizing the processing time required by any searching query. Also it will contribute in the better utilization of the mobile device memory and bandwidth utilization.

Moreover, the proposed system can be integrated with other systems in order to provide help for people with disabilities such as the remote guidance system for visually impaired pedestrians (Hunaiti et al. 2006).

5 CONCLUSIONS

This paper focus was on three main issues associated with LBS system; the GPS inaccuracy, the volume size of data and the unfriendly data presentation have been discussed along with possible solutions to tackle them. Dealing with these issues will enhance the overall performance of LBS systems, which has been used as main base on the proposed system presented in this paper. This system is to design a pedestrian navigation system to overcome early mentioned problems. This system uses SISNeT correction information which is available through the internet to overcome the first drawback and it divides the information which is stored inside the GIS database logically to overcome the second drawback. And it supports the maps with images and videos to enhance the way how to present data so as to overcome the third drawback. In the next phase of this research, a prototype of the system will be implemented and evaluation will be carried out to investigate and validate the new approach.

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