A Location-Aware Smart Bus Guide Application for Seoul*

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Abstract

The goal of our research is to develop a smart context-aware guide system that provides a smart and personalized guide services based on implicit awareness of context. As a context-aware guide application, we have been developing a location-aware smart bus guide system for Seoul. It will guide users to the nearby bus stops and provides users with information about the bus lines at the bus stops.

1. Introduction

In the recent years, Seoul's transportation system has been drastically changed and settled into shape. The Seoul city sets up the bus management system on each bus, which connects the buses and the bus controller by satellite and gives information about the location and the speed of the bus to the bus controller. Now, the Seoul bus system provides the information about the current positions of running buses and the expected arrival time of the buses with on-line and ARS services. However this kind of services can not be regarded as a context-aware service because it doesn't use contexts like the current location of users.

The goal of our research is to develop a smart context-aware guide system that provides a smart and personalized guide services based on implicit awareness of context. As a context-aware guide application, we have been developing a location-aware smart bus guide system for Seoul. It will guide users to the nearby bus stops and provides users with information about the bus lines at the bus stops.

In this paper we describe the processes involved in designing the application and in particular we focus on the location-aware features of the system. The hand held computing device used in the project is HP pocket PC integrating GPS system.

While there have been a number of GPS enhanced tourist guide applications [1,2,8,9], this project focuses on a location-aware smart bus guide system targeting on Seoul city. Main features of the system can be summarized as follows:

1) Location-aware bus guide service based on PDA and GPS.

2) Simple and easy user interface.

3) Display bus stops on the map near by the user's current position.

4) Show bus line information at the chosen bus stop.

2. Overview of the System

The main features of our Bus Guide System are as follows:

1) Bus stop guide service by using GPS.

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It indicates the current position of the user and the nearby bus stops on the map based on the current position received from GPS.

2) Searching bus lines and bus stops.

Users can get the information about the Seoul bus system by searching the name or ARS-ID of the bus stop, or the bus line. Users can get the specific information about last stop, time of the first and the last bus, intervals between the buses, and each bus stop that the bus pass through. They can use this service at anytime and at anywhere.

3) Simple and easy user interface.

We provide a simple and easy-to-use interface for the users. The map is updated as the user moves. The user can also drag the map to see other places around the current position.

4) Map service for each bus stop.

It shows the map of the places around the bus stop, which makes users more easier to find out the location of the bus stop.

5) Scrap

Users can get the information of scrapped bus stops or bus lines fast and easily by clicking "my list" button on the toolbar.

3. Design

In this section, we describe the overall architecture of the system and the program.

1) Architecture of the system

As it is shown in Figure 1, this bus guide application has to be distributed into the PDA from the PC first. Then users must synchronize the database from the server by clicking "DBSync" button on the toolbar. It keeps getting the position values from the GPS receiver, once the user clicks "my position" button. After all of these are done, it's ready to perform the services for users.

Figure 1. Architecture of the system

2) Architecture of the program

As in Figure 2, the GPS module decides the current position of the user with the longitude and latitude values received from the GPS receiver. This program uses this position values and the information from the database downloaded from the server to operate its function. In My Position Page, it points out the bus stops nearby the user on the map after comparing the current position values from the GPS module and the location values of the bus stop in database. For other pages related to searching or scrapping, it mainly uses the information from the database.

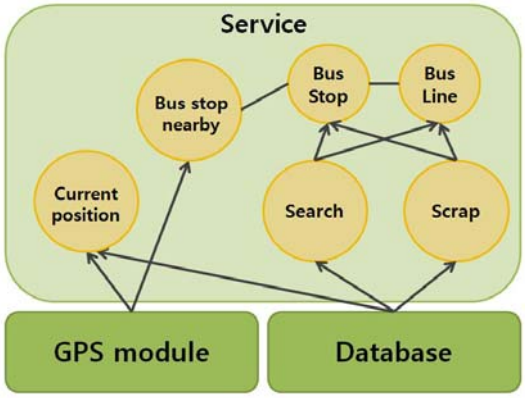

Figure 2. Architecture of the program

4. Operation of the Smart Bus Guide

This system consists of the following main functions as shown in Figure 3.

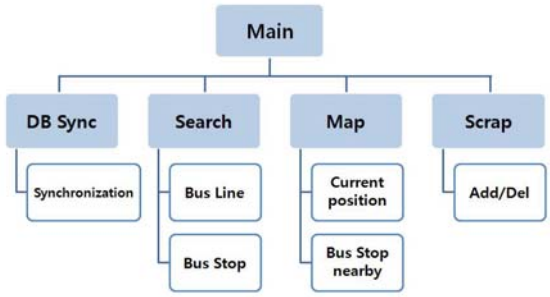

Figure 3. Function Diagram

4.1 DB Synchronization

If the user click "DBSync" button, it downloads the database which has all the information about the bus system of Seoul into the PDA from the designated server. The downloaded database is saved as a sdf file in the PDA. Users can update their databases by clicking this "DBSync" button and synchronizing the databases.

Figure 4.Example of Implemented Pages

4.2 My Position Page

If the user click "My Position" button on the toolbar, it starts to get the longitude and latitude of the current position from the GPS receiver. It indicates the current position of the user and the location of bus stops nearby on the map as shown in Figure 4. Users can choose one of the nearby bus stops listed on this page, and it will display all the information about the chosen bus stop. The map can be reduced to the scale of 1:10000 and also can be enlarged to the scale of 1:5000. It also can be dragged and moved, so users can see the map of other places, not just the map of current location.

4.3 Searching the Bus Info

1) Search Page

Users can search bus lines with the name or the ARS-ID of bus stops as a key word. With a keyword, it gets the right information from the database and displays it in Bus Line Info Page or Bus Stop Info Page.

2) Bus Line Info Page

In this page, it shows the information such as time of the first and the last bus, intervals between the buses and the route of the bus as in Figure 4. If the user chooses one of the bus stops on the route map, it gives more information about the bus stop.

3) Bus Stop Info Page

In this page, it lists all the bus lines that stop over at the bus stop. Like the way it works in Bus Line Info Page, if the user chooses one of the bus lines on the list, it gives the user detailed information about the chosen bus line in Bus Line Info Page. It also provides the map of the bus stop for the user's convenience. Users can scrap the bus lines or bus stops on their needs by clicking the "scrap" button in Bus Line Info Page or Bus Stop Info Page.

4.4 My List Page

It shows the list of the bus lines and bus stops that the user scrapped in this page. If the user clicks one of

the scrapped bus lines or bus stops, it changes to Bus Lline Info Page or Bus Stop Info Page to show the specific information. The scrapped bus lines or bus stops can be deleted from the scrap list by clicking the "delete" button.

5. Implementation

5.1 Database Synchronization

For the use of multiple smart devices, subscribers need to synchronize their databases in PDA with publisher's one on the server by using merge replication. This bus guide system uses the SqlCeReplication object which is provided by The .NET Compact Framework to perform the merge replication. After creating the object, we set the values for the attributes such as Publisher(the name of the server), InternetUrl(SQL server CE agent's URL), and SubscriberConnectionString(the address of the subscriber's database in PDA). If there is no database in the specified address in PDA, it creates a new database and then calls the synchronize() method. However if the database already exists, it just calls the synchronize() method.

5.2 Calibrating the GPS values with map

For calibrating the GPS position values and the map image, this bus guide system uses the open source code, "geoReference". As it is shown in the figure 5, the x, y pixel coordinates, and the real longitude and latitude values of those three points-top left corner, the center, and right bottom corner-on the map image are used in this code. It calculates the pixel coordinate of current position on the map image by using those coordinates of three points and the longitude and latitude values received from the GPS receiver. In the raster images, x pixel value increase in positive X axis(from left to right) and y pixel value increases in the negative Y axis(from top to bottom). However in the N/E hemisphere, longitude increases in the positive x direction(left to right) and the latitude increases in the positive y direction (bottom to top) as in Figure 5.

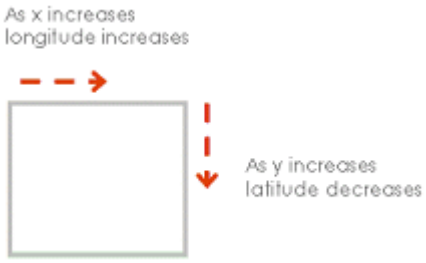

Figure 5. Lon., Lat. in raster image

With this theory, it calculates the rate of change in both latitude and longitude. In other words, it calculates both the degrees per pixel in x direction(degrees of longitude) and in y direction(degrees of latitude). It calibrates the map and longitude, latitude values received from GPS receiver by using this method.

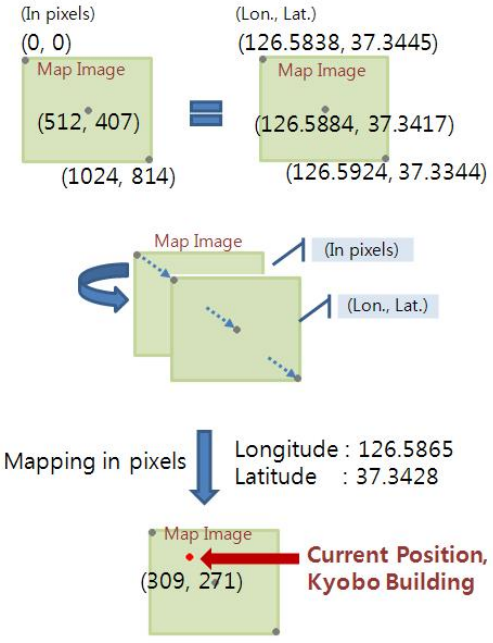

Figure 6. Map Calibration

For example in Fgure6, the longitude and latitude values are 126.5856 and 37.3428 at Kyobo Building in Seoul. These values are converted to 309 and 271 in pixel coordinate after applying calibrating method, and it points out the current position(Kyobo Building) on the map.

5.3 Implementation of Searching

It's necessary to download the database into the PDA from the server first to perform the search function. In the search page, users can search with a bus line, the name or the ARS-ID of the bus stop. If they search with the bus line or the name of the bus stop, it lists every bus lines or bus stops that include the key word received from the user. Then the user can choose one from the list.

If the user chooses a bus line, the system gets all the information about it from the database and displays it in the Bus Line Info Page. Likewise, if the user chooses a bus stop, the ARS-ID of the chosen bus stop works as the key and all the information about the bus stop from the database is displayed in the Bus stop Info Page. If the user clicks the "map" button, it gets the position coordinate of the bus stop from the database, and it indicates the location of the bus stop on the map.

If the user chooses one of the bus stops that the bus line pass through in the Bus line Info Page, its page changes to Bus Stop Info Page and list every information about the chosen bus stop. Similarly, if the user chooses one of the bus lines that stops over at the bus stop in the Bus Stop Info Page, its page changes to Bus line Info Page and list every information about the chosen bus line.

5.4 Implementation of Scrapping

If user clicks the "scrap" button in the Bus Line Info Page or Bus Stop Info Page, the value of the scrap field changes "false" into "true". In My List Page, it lists the bus lines or the bus stops that have "true" scrap field value in the database. The value of the scrap field changes "true" into "false" when the user clicks the "delete" button. Users also can get all the information about scrapped bus lines or bus stops in My List Page. Its page changes to Bus line Info Page or Bus stop Info Page.

6. Related Works

There have been a number of research efforts into GPS-based hand held tourist applications, and we provide an overview of three of these systems. Our system is unique in that it focuses on a location-based practical application targeting smart bus guide system for Seoul.

We first provide an overview of a number of areas currently being investigated by context aware computing and mobile computing.

Context-aware computing refers to a program feature that change depending on environmental conditions of the user during the operation of the application [5,6]. Context may include: the user's location, people currently interacting with the user, time of day, and current user task. A simple example is of context sensitive help that provides documentation for the particular feature that a user is in the process of using. A conceptual Framework and a toolkit for supporting rapid Prototyping of context-Aware Applications are provided by Dey et al [3].

With the advent of mobile phones and hand held computers, mobile computing is fast becoming the norm for personal information spaces [7]. The use of hand held computing devices communicating via a

wireless network has been investigated as a means to facilitate collaboration by Fagrell et al. [4]. Their architecture FieldWise is based on two application domains: first, mobile and distributed service electricians; and second, mobile news journalists.

There are several research works on location-based tourist guide applications: Simcock et al. developed a location based tourist guide application for the outdoor environment. This project focuses on software support for location based applications [8]. In [2], they have built and tested different versions of electronic tourist guides for the city of Lancaster. They use a larger device, which allows for a display to support a traditional web browser style interface, supplying a rich information service to the user. Cyberguide is also a hand held electronic tourist guide system that supplies the user with context sensitive information [1]. Initially Cyberguide was developed for indoor tours at the GVU, and then it was extended to operate outdoors with GPS. In [9], a location-aware tourist guide was developed for an old palace in Seoul.

7. Conclusion

In this paper, we have developed a smart Bus Guide System based on GPS and PDA. This system shows the current position of the user and nearby bus stops on the map using GPS information. The user can also get the information of the bus lines at the bus stop.

If this system is linked with other services of Seoul City, this system can be expanded to include other services too. We are working on improving the system to provide more convenient service with more accurate information for the user. We are also planning to implement this system on the mobile phone to maximize the portability and mobility.

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