THE IMPROVEMENT OF THE POINT OF INTEREST FEEDER ALGORITHM FOR MOBILE AUGMENTED REALITY

Thera Siricharoen, Sathaporn Promwong and Monchai Chamchoy

Faculty of Engineering
King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand
Emails: therasir@gmail.com, kpsathap@kmitl.ac.th and kcmoncha@kmitl.ac.th

ABSTRACT

In the present day of augmented reality, researchers have been using different algorithms such as image processing or GPS to display electronic information that reflects the reality. This paper will present the study and development of algorithms that aims to reduce the limitations of previous researches and to more effectively display information in almost real time to the user through certain types of mobile devices. This algorithm will use GPS and digital compass technology on supported mobile devices to access the user's location as well as their direction, and through a client send this information via wireless interface to the server. The server will then process the location parameters and match it with the information stored in the database, and then return suitable points of interests back to the mobile device with the algorithm called "Point of Interest feeder" or PIF. At the end of this paper the response time of PIF algorithm will be presented, where it will be shown that it can be improved to respond in nearly real time and can support mobile augment reality applications.

Index Terms—*Mobile Augmented Reality; GPS*

1. INTRODUCTION

This is the age of communication, where mobile devices are an essential part of everybody's lifestyle. Although the price of mobile devices is cheaper than in the past, there's constantly a competition in the development of new technologies on both the hardware and software side. These can range from technologies such as location tracking, high-definition photography and high-speed information transferring systems. Many of these can be developed to more efficiently display information about our world, which can be very useful for everyday life such

The method for location tracking is the GPS, which previously had been limited by the hardware size and not intended for everyday use. But technology has minimized the hardware-part, and mobile GPS devices have since boomed in certain areas. Nowadays, this GPS system has been integrated in mobile phones, making the technology and its features accessible for all and at any time. But the technology can still be further improved upon, and one such technique is by using the Point of Interest Feeder algorithm (PIF).

This paper intends to present an evaluation of the PIF while being used to display electronic information that reflects the users reality through a client on their mobile device. A target area will be evaluated based on the latitude and longitude variables in the location data. The system will then analyze and send the appropriate information back to the client, where it will be displayed to the user. The goal is to show that the PIF will improve this tasks performance to almost real-time with high-speed response time. By developing an augmented reality client in a mobile device that uses the PIF, users should be able to use and access relevant data whenever they carry their mobile devices with them, with a minimum of problems and loading times, and thus it can become a part of their everyday lifestyle.

2. RELATED WORK

Previous research in the field of mobile augmented reality in the past years has typically focused on navigation of large spaces, or in gaming applications. Feiner et. al., designed a campus navigation system using a see-through head mounted display (HMD) with built-in orientation tracker, differential GPS, and handheld computer [1]. Their system weighed 40 pounds. Azuma [2] discusses tracking technology available in mobile outdoor augmented reality, including GPS, inertial, and passive optical systems borrowing from computer vision techniques, and suggests that any augmented reality application would require more than one form of tracking. From these results it can be concluded that by combining Feiner and Azuma's research and PIF by adding an algorithm, the response time of the Point of Interest selection process can be shortened to nearly real time.

3. SCOPE

The concept of this paper is to focus on the improvement of PIF, which is the key element for all information feeding from the server to the client where the goal is to display augmented reality data on the screen of the client device. The objective of PIF is to give the client device enough information to display the digital information results in live modes. Live mode is the unique thing about PIF algorithm. This mode is a step closer to bridging the gap between two-dimensional maps and the surrounding

three-dimensional reality. Instead of a purely virtual environment, all of your content is now placed into the surrounding reality caught by the mobile device's camera. This introduces a whole new, intuitive concept of navigation.

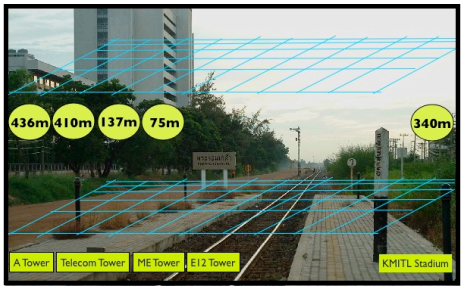

Figure 1: Live mode with building information

The purpose of the research is to develop a PIF by using an algorithm that supports real-time information feeding. It will be done in such a way that any mobile device with the necessary client can display the information. Building information will display building names that are already stored in the database. The distance value between the user's current position and buildings will be calculated and displayed as shown in Fig. 1. But how the information is displayed on the screen is the work of the mobile client software, which is not in the scope of this paper.

4. SYSTEM DESIGN

PIF is an algorithm used for evaluation by calculating the distance between the user's current position which is acquired by accessing their location through a client on their mobile device and the building position which is stored in the database, Geographic Coordinate System [4], which specifies the position of the building with latitude and longitude, then sort out the distance value from highest to lowest. As a result, we can get the position of the closest building to the user current position. For the number of point of interests that will be return to the mobile client, PIF assigns to return 10 closest buildings or the radius of searching area less than 10 kilometers, which is only the starting number for this paper.

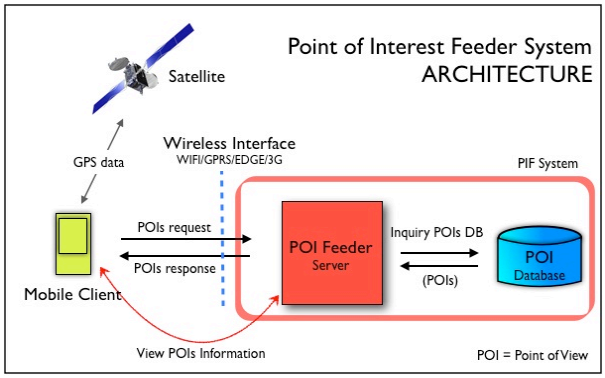

Figure 2: The architecture of PIF system

As shown in Fig. 2, PIF is a Client-Server kind of system and aims to collect data in the server, which is called Centralize Database. The overall image of system is separated in to two parts.

1. Mobile Client, which has GPS, compass and camera because they are all essential basic functions to get user current position through wireless interface.

2. POI Feeder System is the center of data processing of mobile client. It's also responsible for providing POIs with algorithm of PIF system.

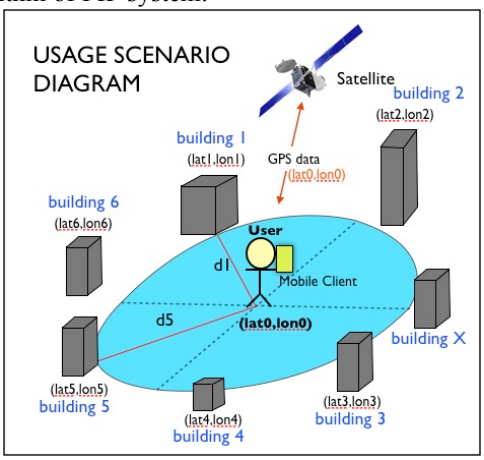

Figure 3: Usage scenario diagram

From Fig. 3, show the user's usage scenario that PIF working system is about sending POIs which consist with information of all together 10 buildings. POIs can be any position around the user but they have to be the first 10 buildings that have least distance value or d in the list or the radius of searching area less than 10 kilometers.

The procedure to define the location of user area

PIF algorithm selects the method to finding great-circle distances between two points on a sphere from their latitudes and longitudes with the equation of Haversine Formula [5] and uses MySQL database to stored building information. The database table format is as follows:

building_name, building_description, lat, lon, dist

i.e. *A Tower, KMITL office, 13.72693, 100.77648, dist1*

The Haversine Formula for MySQL are

d = distance between the user and the building

R = earth's radius (mean radius = 6,371km)

lat = latitude

lon = longitude

$\Delta lat = lat2 - lat1$

$\Delta lon = lon2 - lon1$

$$a = \sin 2\left(\frac{\Delta lat}{2}\right) + \cos(lat1) * \cos(lat2) * \sin 2\left(\frac{\Delta long}{2}\right) \quad (1)$$

$$c = 2 * a \tan 2\left(\sqrt{a}, \sqrt{(1-a)}\right) \quad (2)$$

$$d = R * c \quad (3)$$

Expanding (3) and using (1) and (2) will get d in mySQL:

d =6371*2*ASIN(SQRT(POWER(SIN((orig.lat-dest.lat)* pi(angles need to be in radians)/180/2),2)+COS(orig.lat* pi()/180)*COS(dest.lat*pi()/180)*POWER(SIN((orig.lon-dest.lon)*pi()/180 / 2), 2))) (4)

State Machine of PIF System
The PIF algorithm will be started when get an incoming POIs request message from mobile client device.

(1) GET Incoming Message
All mandatory parameters in incoming message are normalized at the process of mobile client software to be the standard format. The incoming message is defined to developing in HTTP/1.1 protocol and using HTTP GET method for requesting the point of interest from server.

(2) Define User Area is the method of boundary creation to scope searching area by define. This method can reduce response time when database is getting large. The algorithm to create boundary of searching area is following:
From definition of 1° of latitude and longitude so
1° of latitude ~= 111 km. (5)
1° of longitude ~= cos(latitude)*111 km. (6)
To calculate lon and lat for the rectangle in mySQL:
set lon1 = mylon - dist/abs(cos(radians(mylat))*111) (7)
set lon2 = mylon + dist/abs(cos(radians(mylat))*111) (8)
set lat1 = mylat - (dist/111) (9)
set lat2 = mylat + (dist/111) (10)
From equation 7 – 10, we will limit scope of searching area with define user area.

(3) POIs search
PIF system will continue to query POIs from database with the beginning conditions. The procedure to create stored procedure to improve performance of DB is

```
CREATE PROCEDURE poidist(IN userid int, IN dist int)
BEGIN
        declare mylon double; declare mylat double;
        declare lon1 float; declare lon2 float;
        declare lat1 float; declare lat2 float;
-- get the original lon and lat for the userid
SELECT longitude, latitude into mylon, mylat from users
WHERE id=userid limit 1;
```

From equation (4) and equation (7)-(10) can run the query for POIs search:

```
SELECT destination.*, d
FROM building position, users origin
WHERE origin.id=userid and destination.longitude
between lon1 and lon2 and destination.latitude between
lat1 and lat2 having distance < dist ORDER BY Distance
limit 10;
END
```

(4) Return POIs Response
The POIs Response message format is JSON protocol. JSON is defined as RFC 4627 or The Application/ JSON Media Type for JavaScript Object Notation (JSON). JSON format has structure that is more concise than XML so will be reasonable to select JSON format.

5. RESULT

The results of POIs search method is the information in table 1, which is sorted in order of range from closest to farthest and this result is simulated with the condition of the user standing in front of the E12 tower (lat = 13.72700, long = 100.77272, Engineering office, KMITL, Bangkok). The objective of the experiments in this paper is to compare the two PIF. The method for doing so is through checking that the Full table and Boundary search responses are fast enough to be acceptable for Augmented Reality applications. When displaying the results as a live mode database, the results of each scenario comes from the average response time received when performing the test five times in every situation, with similar results. (The server specification is processor name Intel (R) core (TM) 2 quad cpu Q6600 @ 2.40GHz, RAM 4G, Linux Red Hat 5, mySQL V.5.0.67)

TABLE I
The results of POIs search method

Location Name	Latitude	Longitude	Distance	Description
E12 Tower	13.72764	100.77245	0.07453km	Information Eng Department
ME Tower	13.72766	100.77348	0.1369 km	ME office
KMITL Stadium	13.73003	100.77245	0.3403 km	Sport complex stadium
Telecom Tower	13.72744	100.7762	0.4106 km	Telecom Eng Department
A Tower	13.72693	100.77648	0.4375 km	KMITL office

The details of the simulator test comparing the performances between PIF system which performs by full table search and by algorithm search under the searching condition of the building information – Fig 4 shows the results from increasing the amount of location information in the database but with a fixed radius = 10 km and the amount of POIs = 5. In order to prove that in regards of the size of the database, the results of this scenario shows that the size of the database has an immediate effect on the response time of the PIF, as when performing the Boundary search the response time is radically shorter if compared to full table search (the location data in the database has details for 200 real locations in Bangkok, 500 locations in Thailand, 1500 locations in Asia and another 1400 locations on the planet).

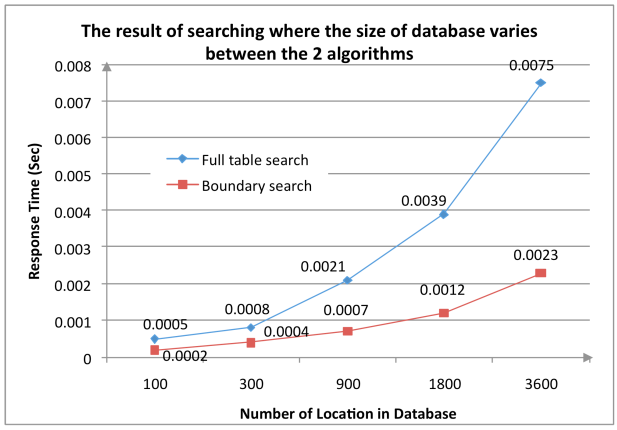

Figure 4: The response time of PIF where the size of database varies

In the second scenario which is stored in the database equally and are 3600 rows but specify the numbers of building information within 10 km. radius from the user – to be different which are 5,10,15, 20, 25, 30 and 300

POIs. This scenario presents the theory regarding the amount of POI, showing that the amount of POIs from PIF response that increases will have an effect on the response time. But the effect will be a lot less if compared with the results received from increasing the database size. After the test, the results calculated from the response time are shown in Fig. 5.

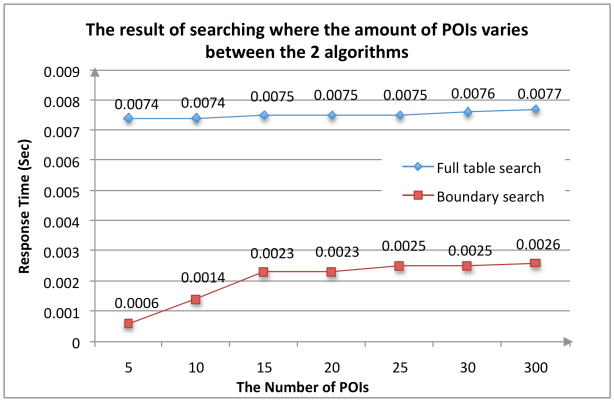

Figure 5: The response time of PIF where the amount of POIs varies

In the third scenario the radius around the user is increased and the location information are 3,600 locations and no fixed amount of POIs, which means that the amount of POIs will increase when the radius is increased as shown in Fig. 6. The results from this scenario are that an increased radius has an effect on the response time, but one that is a lot less when compared with the results of an increased database size.

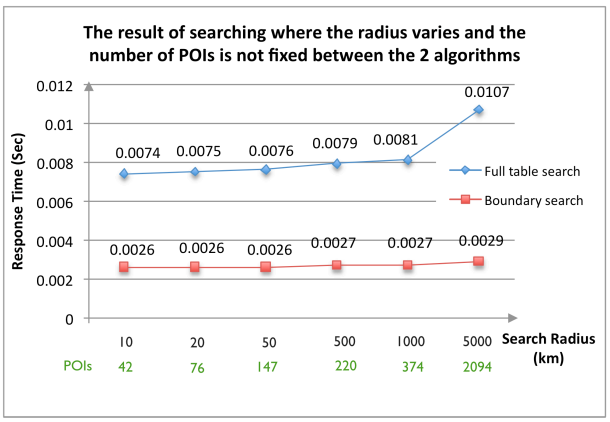

Figure 6: The response time of PIF where the radius varies and the number of POIs is not fixed

To summarize the results, the size of the database, the amount of POIs and radius around user affects the response time of the PIF, but the thing that affects response time the most is the size of the database. When we use PIF in a real situation with a lot of building information or POI within the search parameter, the response time is satisfactory and acceptable in terms of user experience. The results of full table and boundary search are the same in all environment tests. If the size of the database is big, by using PIF through boundary search the response time will be faster than through full table search.

6. CONCLUSION

This paper introduces the PIF for data feeding, which results in a better response time for mobile augmented reality and less errors in displaying the information. Boundary search has an advantage over full table search because of the following points:

1. Less response time
2. System utilization, as the system searches only the area surrounding the user.
3. User Experience, as the system return the suitable place to mobile client
4. It is better able to handle mass-usage by a lot of users at the same time.

7. FUTURE WORK

From the continues study about the amount of information that is necessary for displaying in mobile client, it should be displayed only the necessary amount which equal the user's visibility at that moment, for example, if the user's current position is near the building's position which values more than x within the distance area, the value of y will be compared that the user is in the city which has a lot of big buildings. Therefore, the user has less visual radius because of block out from the buildings, then PIF should return the amount information or point of interest = a, which is less than x in order to display only the necessary information to the user at that moment. The study of how to increase the efficiency of this evaluation will be the road map for this paper in the future.

In addition, the authors also has interest in the researches about gyroscope which are used in many mobile device nowadays such as iPhone 3G, iPhone 3Gs and iPhone 4. Gyroscope can be applied for increasing the efficiency of the evaluation process for mobile augmented reality, for example, if the user's current position is in front of a building, which has a lot of point of interests, that might be because of the building, is very high. Therefore, to display more details, PIF should respond to user interface that is the result from the mobile device that is tilted down by user in order to evaluate point of interests, which are on the higher levels of the building.

REFERENCES

[1] Feiner, S., A Touring Machine: Prototyping 3D Mobile Augmented Reality Systems for Exploring the Urban Environment. IEEE Computer Society, Washington, DC, 74.

[2] Azuma, R. T. (1999): The Challenge of Making Augmented Reality Work Outdoors. In Mixed Reality: Merging Real and Virtual Worlds, pp 379-390, Mar 1999.

[3] Geographic Coordinate System, A guide to coordinate systems in Great Britain, V1.9 Mar 2008, http://www.ordnancesurvey.co.uk

[4] W. Gellert, S. Gottwald, M. Hellwich, H. Kästner, and H. Kü stner, *The VNR Concise Encyclopedia of Mathematics*, 2nd ed., ch. 12 (Van Nostrand Reinhold: New York, 1989).