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Public Facilities Location Search With Augmented Reality Technology in Android

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***Abstract*— In this research we developed an application for public facilities search with augmented reality technology so that search becomes easier and has an attractive interface. This application takes advantages of hardware that resides on the mobile device such as data connection, GPS, geomagnetic / digital compass and accelerometer. To perform a search, user directs the mobile device in the direction he wants and the application will display an icon of public facilities that are found and combined with real images coming from camera. Data residing on server and locally on mobile device so that applications can be run whether there is no internet connection. In order for local data on mobile devices are always up to date, application will synchronize with data contained on server.**

Keywords—augmented reality, public facilities search, android.

I. INTRODUCTION

Mobile devices lately grown so rapidly in the development of hardware and software. One of the advantages possessed by mobile device is the presence of some hardware on the same equipment, among which is a communication device, either in the form of voice (telephone) or data, a camera, a GPS (Global Positioning System), a geomagnetic sensor / digital compass, accelerometer and other sensors etc. [1]. Some hardware that resides on the mobile device allows augmented reality technology to be implemented. The augmented reality technology can be used to assist human life. Several studies related to augmented reality technology by utilizing the hardware in mobile devices has been done, including the establishment of a virtual three-dimensional world of photo [2], electronic compass calibration in outdoor augmented reality [3], a search of the mosque [4], indirect augmented reality [5], the identification of the mountain [6], the visualization of objects that lie outside of the camera [7]. There is also research the use of augmented reality in education [8].

In this research, the application is developed by using hardware in mobile devices, especially data communication devices, cameras, GPS, accelerometer and geomagnetic sensor to perform a search of public facilities by implementing augmented reality. User can choose public facilities such as gas stations, restaurants that will be searched using a mobile device by pointing the mobile device in the desired direction. The application will search for nearest public facilities on appropriate direction and display data in the form of an icon that is combined with real image from camera, where the position of the icon image that is displayed will be adjusted to the position / direction of actually of public facilities. Users will be able to see detail information such as location, distance, as well as a general statement or description of the selected facilities. Applications can also show the route from user's position toward the public facilities. This research is a further development of the research that has been conducted by Mazharudin [4] with the development of the type of data sought as well as the facilities of local data and ability to give notification while there is new data on server and also display route from current position to the location. Normally, data of public facilities located on server and requires an internet connection to query those data when the application is used. This has the drawback that application cannot be used if the internet connection is lost. So at this research, we use local data which will be synchronized with data on the server so that local data on the mobile device is always up to date with data on the server. Also we implement push notification, so that if there is additional data on the server, the application will be notified and user can update local data.

II. AUGMENTED REALITY

Augmented reality is a variation of virtual environment, or more commonly referred to as virtual reality. Virtual environment technology will insert user into the synthetic environment, and for entry into the synthetic environment, user can not see the real world around him. But augmented reality allows users to see real world with virtual objects ride or join real world. So that augmented reality will complement real world, do not replace real world. Users will be able to see real object simultaneously with virtual objects [9].

Modern augmented reality was first introduced in 1993 by Feiner et al [10] to create a system called KARMA that serves to project the wireframe and repair instruction schematic above equipment is being repaired. And research on augmented reality technology continues to evolve to this day along with advances in hardware and software technology. Augmented reality system must have three conditions in order to function properly [11]. The first is a tracker that is used must be accurate. Second, latency between tracker and graphics engine should be very low and the last, tracker must be able to work on far-reaching.

III. ON-DEMAND DATA VS LOCAL DATA MECHANISM

There are two types of data placement mechanism could be used for the search, namely on-demand data and local data

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mechanism. On-demand data mechanism has advantage of requiring a small memory allocation on devices that are used. Data is only downloaded when needed, is stored in temporary variables to be displayed on device screen and then could be destroyed when not in use. But on-demand data mechanism has disadvantage of always requiring an internet connection to server where data resides. It will take time to establish communication and to download data, and if at that time there is no internet connection available, then application will stop and cannot be functioned properly.

Local data mechanism has advantage of very fast query data because data are located in the device's memory. The disadvantage is that data available on local is not always up-to-date, so it is necessary to synchronize local data with data available on the server. In addition, the size of local storage relatively small compared to the available storage on the server and thus it requires further local storage management.

Taking into account the advantages and disadvantages of each data placement mechanism, in this research we used local data mechanism. The consideration is the need for real-time processing when doing a search with augmented reality, could be fulfilled by using local data mechanism. It is also meet one condition of augmented reality in order to function properly, latency between tracker and graphics engine should be very low. Using on-demand data mechanism could take time for download process so that the search process with augmented reality could be delayed.

To overcome the limitations of a small space on local storage, we use a search range value specified by user as a limitation to synchronize. So at the time of synchronization, not all data are downloaded from the server, but only data that is met criteria in the search range will be synchronized. If at any time the local storage is full, data deletion process will be done. Data location that is farthest from the current search range will be removed first. To address the possibility of local data will be out-of-date when user move, the application is designed to always synchronize periodically every several minutes.

In addition to using local data mechanism, we also use on-demand data mechanism only to get secondary information including description and picture. The data will be downloaded only when user requires detailed information of a selected location.

IV. Distance Calculation

To calculate the distance between two location points based on latitude and longitude value obtained from sensor, haversine formula can be used. The haversine formula can be seen as follows [12].

$$\Delta lon = lon2 - lon1 \quad (1)$$

$$\Delta lat = lat2 - lat1 \quad (2)$$

$$a = \sin^2\left(\frac{\Delta lat}{2}\right) + \cos(lat1) * \cos(lat2) * \sin^2\left(\frac{\Delta lon}{2}\right) \quad (3)$$

$$c = 2 * \text{atan2}(\sqrt{a}, \sqrt{1-a}) \quad (4)$$

$$d = \text{earthRadius} * c \quad (5)$$

Fig. 1. Synchronization process

V. Synchronization Process

Before synchronizing, user should enter search range or radius value. This search range value is used to restrict data to be synchronized. Synchronization is done by reading data that resides on server according to search range value and compare with data contained in local database based on specified ID. If there is no ID in local database, then data insertion will be done. From data read from server, only public location data located within search range will be used in synchronization process. The overall synchronization process could be seen in Figure 1.

VI. System Design and Implementation

An outline of the application developed can be seen in Figure 2. Data attribute used in this application includes place ID, ID of place category, name of place, description, image, latitude and longitude. Search data is done by comparing the distance between current location of user in accordance with the direction and all of place location in database. Searching is limited by using radius parameter and 60-degree viewing angle. All of place located in the range will be shown in display.

Besides application running on android system, there is also application on the web server which is used to maintain database. If there is additional data on the server, then the application server will perform a push notification to android application so user knows there are new data and be able to sync to get the latest data.

VII. Experimental Result

When first run, the application will ask user to enter the desired search radius along with the desired category of public facilities. After that, the application will synchronize with the server so that it will get the latest data. The radius is used to limit the search so that the results are not too many that can cause search results overlapped each other on the mobile device screen. The search category is used to limit the search result according to the category desired by user. The initial view of the application can be seen in Figure 3.

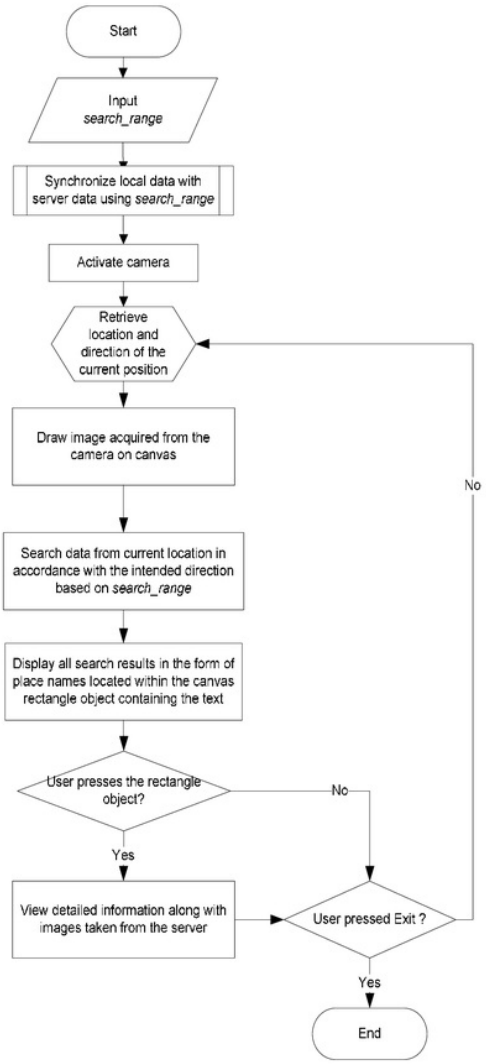

Fig. 2. System design

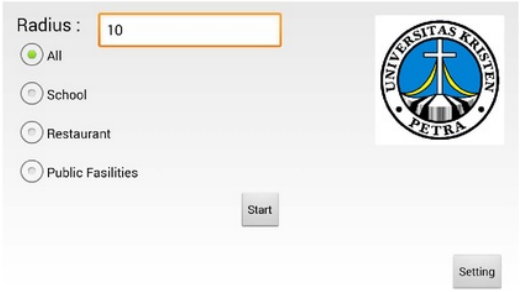

Fig. 3. Initial display applications

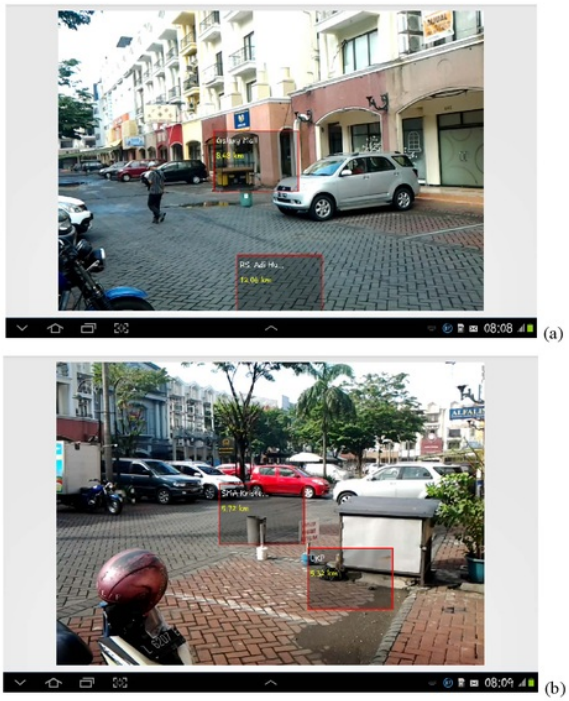

Fig. 4. Search results

After user enters a search category and its radius, then user can move the mobile device to get the search results in the desired direction. Along with the movement direction of user, the application looks for public facilities contained in that direction starting from current user position as far as of the radius that was previously entered. Search results will be obtained with the short information displayed on screen, the name of public facilities and distance from current user position. Some results can be seen in Figure 4.

In the search results in Figure 4, user is at a location on Mayjend Sungkono street, Surabaya, and radius of search is 30 km from the location for all public facilities. Based on the data of existing public facilities, the obtained results are Adi Husada Hospital, 12.06 km of the location and Galaxy Mall, 8.48 km from the location of the intended direction. This can be seen in Figure 4a. Then user change the direction of the search and get search results that SMA Kristen Petra at a distance of 5.72 km and UKP (Petra Christian University) is 5.32 km away. These results can be seen in Figure 4b. Obtained distance is straight line distance from the position of user to the location, not the distance traveled by road.

To be able to display more detailed information, user can select one of the search results. For detailed information, the application will read data from the server, either text or image. Information will be displayed on the next page. In Figure 5 can be seen information and image from one of the search results.

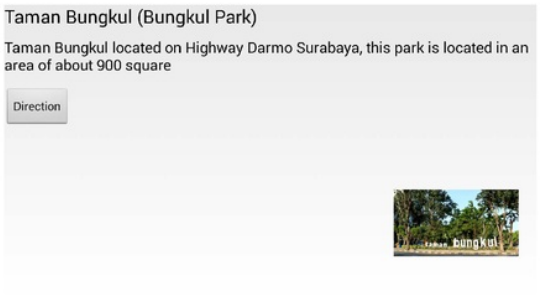

Fig. 5. Information and image from one of search results

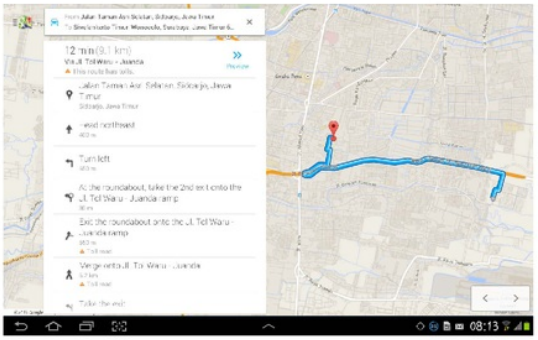

Fig. 6. Map and route to location

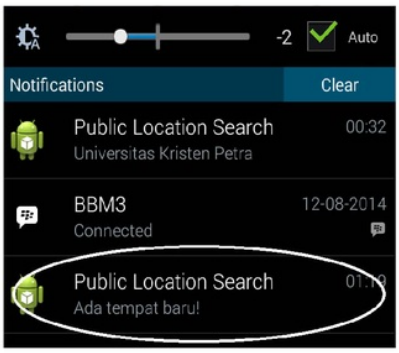

Fig. 7. Notification of additional data on server

On the information page, there is a button 'Direction' that can be used to display a map and a route from current user position to the intended location of public facilities. This feature uses the API provided by Google to ask questions along the route. Results of maps and routes can be seen in Figure 6.

If there is additional data on the server, there will be a notification on the mobile device. The notification can be seen in Figure 7.

CONCLUSION

In this research, we have developed an application for searching the public facilities location. From the experiment that has been done, it can be concluded that the application can perform a reading with precise position and direction, and can search for existing public facilities in the database in accordance with the direction intended by the application with a certain predetermined diameter range. By using local data mechanism, the application has a high speed to search and display the results on the display device that meets criteria of augmented reality.

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