

## **AUGMENTED REALITY ON ANDROID OPERATING SYSTEM- BASED DEVICE; CASE STUDY: MOSQUE FINDER**

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### **Abstrak**

*Augmented Reality (AR)* telah menjadi salah satu trend penelitian dalam hal pemanfaatan pemodelan objek secara virtual. *AR* bekerja dengan memodelkan objek yang ada pada dunia nyata ke dalam dunia virtual dengan memanfaatkan piranti *input*. Piranti *input* yang dimaksud dapat berupa kamera, sensor, atau bahkan *GPS*. *AR* dapat bekerja secara *real time* dengan menampilkan pergerakan dari objek nyata dengan perwujudan model objek pada layar monitor. Penelitian ini mengembangkan *Augmented Reality* untuk pencarian lokasi masjid. *Augmented Reality (AR)* adalah teknologi yang menggabungkanobyek dua dimensi *virtual* ke dalam lingkungan tiga-dimensi kemudian menampilkan obyek *virtual* secara *real-time*. Untuk menerapkan konsep *AR*, aplikasi ini menggunakan sensor terpadu seperti *accelerometer*, kompas dan *Global Positioning System (GPS)*. Lokasi masjid dapat didownload dari *server* khusus dan disimpan dalam *smartphone*. Untuk mengantisipasi jika terdapat data baru pada *database*, aplikasi ini juga dilengkapi dengan fitur sinkronisasi dengan menggunakan layanan *web* dengan teknologi *XML*. Hasil percobaan menunjukkan bahwa pencarian lokasi masjid dapat dilakukan dengan lancar dengan teknik *augmented reality*. Rincian lokasi masjid dapat secara akurat ditampilkan pada perangkat ditangani.

Kata kunci: *Augmented Reality, GPS, Accelerometer.*

### **Abstract**

*Augmented Reality (AR)* has become one of research trends in the utilization of virtual object modeling. *AR* works by modeling objects that exist in the real world into a virtual world by using input devices. The input devices can be a camera, sensor, or even *GPS*. *AR* can work in real time fashion to show the movement of a real object by using a form of model shown at monitor screen. This research developed an *Augmented Reality* for locating a mosque. *Augmented Reality (AR)* is a technology that combines two-dimensional virtual object into a three-dimensional environment then displays the virtual objects in real-time fashion. To implement the *AR* concept, this application uses integrated sensors such as *accelerometer*, compass and *Global Positioning System (GPS)*. The location of mosques are downloaded from a dedicated server and stored in *smartphone*. In order to anticipate should there is an update of data at the *database*; this application is also equipped with synchronization feature using a *web service* with *XML* technology. Experiment results show that the mosques location searching can be performed smoothly with the *augmented reality* technique. The details of the location of the mosque can be accurately displayed at the handled device.

Key words: *Augmented Reality, GPS, Accelerometer.*

## INTRODUCTION

The mosque is home to a place of worship for Muslims. Location of the mosque during the search is still done manually, by looking at maps in hard copy or by asking to people to obtain directions to arrive at the mosque. However, the mosque location data in hard copy form is very rare to find. It is certainly very difficult especially for people from outside of an area to find the location of the mosque [1].

A modern method to find an address is based on Geographical Information System (GPS) applications. This application displays the information in the form of digital maps along with the image path and routing to arrive to the destination.

Augmented Reality is a technology that combines two-dimensional virtual object and three dimensional or in a real three-dimensional environment and then projecting the virtual objects in real-time manner [2]. Virtual objects display the information in the form of a label or virtual objects that can only be seen with a camera phone or a computer [3]. Augmented Reality system works by analyzing a real-time object captured in the camera. By the use of rapid development of mobile technologies, Augmented Reality can be implemented on devices that have GPS, camera, accelerometer and compass [4]. The combination of the three sensors can be used to give additional information from the object captured by the camera.

Azuma, R. et. al. [6] summaries of AR system characteristics with the use of optical and video approaches to blending virtual and real, and an introduction to the crucial problem of registration, including sources of registration error and error-reduction strategies [5, 6]. While Feiner, S., et. al. discussed about AR based on knowledge that graphics and text that present on surrounding world can be used to how to operate, maintain, or repair equipment, without referring to a separate manual books [7].

In this paper we designed and implemented Augmented Reality technology on android based mobile application to find location of mosque. Location of the mosque that was caught in camera will be labelled with distance information, the mosque's name and description of the mosque.

## INCORPORATING GPS, ACCELETOMETER, AND GOOGLE MAPS

In order to implement the system, this research uses sensors implanted in recent smartphones, i.e. accelerometer, compass and Global Positioning System (GPS). The accelerometer is used to detect should the is a movement of the smartphone, in terms of its axis and ordinate. The data is then used to calculate the display of objects to search on smartphone's screen. The compass is used to show directions of the map, and the GPS is used to tag the location of a user. The data obtained from GPS is used to calculate distance from the user's current location and a mosque. Then, it is used to find shortest path to travel to a selected mosque. The route can also be displayed on map along with the shortest path.

## AUGMENTED REALITY ARCHITECTURE

By implementing a client-server system on the network, the client application can update database in and out of the server. Data retrieved from the server mosque then stored in internal storage media for mobile phones. In general, the architecture of the system is shown in Figure 1.

This process performs calculations to obtain the coordinates of the mosque to be shown on mobile devices. As the data of longitude and latitude of a mosque is stored in a database located on mobile devices, thus the calculation takes less time to finish. The calculation procedure is shown at Figure 2.



Figure 1. The Application Architecture.

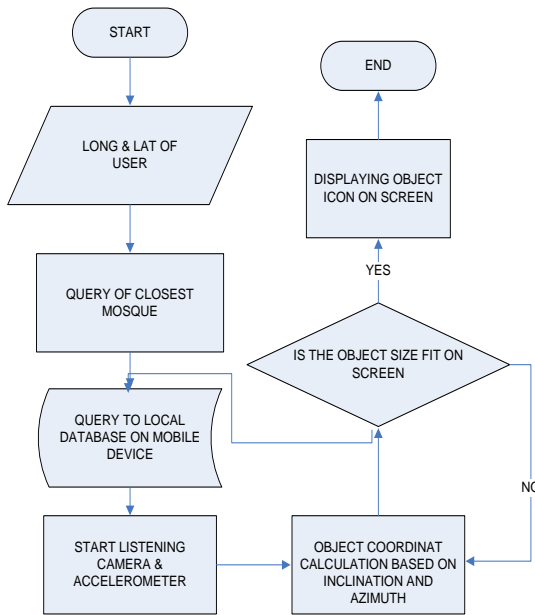


Figure 2. Flowchart Calculation of Augmentedreality.

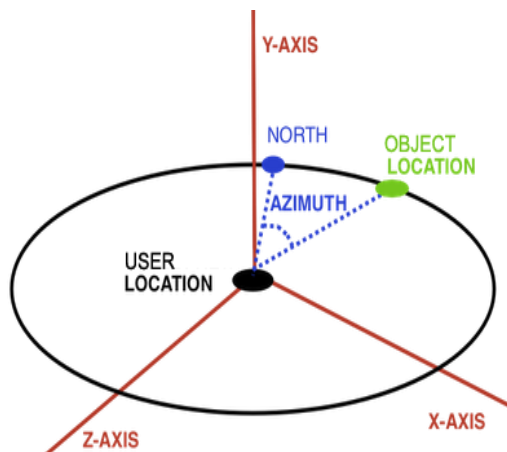


Figure 3. Illustration of Azimuth Angle.

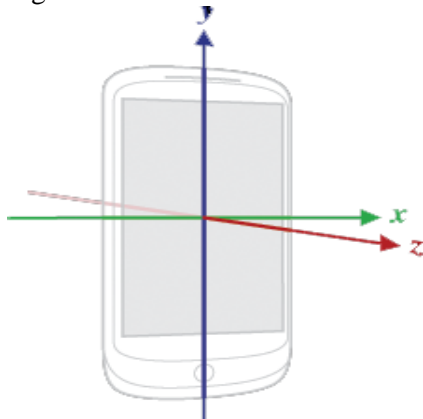


Figure 4. Accelerometer in Android Device.

### Calculation of The Azimuth Angle

In a common navigation system, there is the term azimuth, which is the angle between magnetic north (zero degrees) to the destination that we are headed relatively to the northern corner. Azimuth angle at each point is calculated based on the arc-tangent angle between the differences in latitude with the location of users divided by the difference in longitude. The illustration of azimuth angle is shown in Figure 3.

After obtaining the azimuth angle at any point, the next step is to find the location horizontally to display the location of the mosque. Azimuth angle is updated continuously to enable the system to display the position of the mosque on the screen when the user moves the mobile device.

### Calculation of The Angle of Inclination

Vertical angle of inclination angle is formed between the location of the user and the location of the mosque. This can be done using a GPS point elevation. Having obtained the height of each point, the next step is to determine the vertical angle between two points using trigonometri formula. By reading the accelerometer sensor on mobile phone, each mosque will be displayed on the screen based on the angle of the mobile device screen and the coordinate of each mosque. X-axis represents horizontal line, Y-axis represents vertical and the Z-axis represents the distance of the mosque. An accelerometer in android is shown in Figure 4.

Android capture accelerometer sensors on 3 sets (m/s<sup>2</sup>):

- Value [0]: the value of the x-axis accelerometer
- Value[1]: the value of the y-axis accelerometer
- Value [2]: the value of the z-axis accelerometer

### RESULT AND DISCUSSION

The experiment was conducted using a mobile device with the following specifications

- Name : Sony Ericsson Xperia x10 mini
- Processor : 600 MHz
- Connection : 3G
- OS : Android v2.1 (Eclair)

The experiment was divided into two scenarios, namely the functionality experiment and performance experiment.



Figure 5. Searching a Mosque.



Figure 6. Listing Nearby Mosques.



Figure 8. Deleting a Mosque Data.



Figure 7. Inserting/Modifying a Mosque Data.



Figure 9. Synchronising Mosque Database.



Figure 10. Search Trials Mosque Yapita.



Figure 11. Search Trials Manarul Ilmi Mosque.



Figure 12. Search trials Nur Mosque Baitul.

Accelerometer sensor to calculate the acceleration sensed from the device. In this sensing mechanism, the gravity influences the values produced by the accelerometer sensor. Thus, to obtain the accurate value of the movement, the values produced by the sensor needed to be filtered first. This research uses high-pass filter to remove the gravity influence.

The next step is to change the value in the units of degrees, where the value 900 is located at the horizontal axis, the value of 450 is at a half up / down, and 00 in a straight line up / down.

**Functionality Experiment**

This experiment aims to verify the functionality of each feature of this application. The functions tested in this experiment are:

1. Searching location of a particular Mosque (Figure 5). When searching a mosque, the application displays the result on the screen with additional information (name of the mosque, distance, and short description).
2. Listing nearby Mosques (Figure 6). This function displays the closest mosques to the location of the user.
3. Inserting, deleting, and updating Mosque data (Figure 7). This function enables the user to modify the content of the database.
4. Synchronising Mosque database (Figure 8). To keep the mosque updated, this application synchronises its database with the server, either manually or periodically. Should the process is successful, the report will be displayed as shown in Figure 9.

**Performance Experiment**

This experiment aims to measure the accuracy of digital compass for locating mosques. This experiment scenario is performed by comparing the calculated azimuth angle obtained from the application with the calculated azimuth angle obtained using the azimuth angle as shown in Equation (1).

$$\tan \alpha = \frac{\sin L}{(\cos \phi 1)(\tan \phi 2) - (\sin \phi 1)(\cos L)} \dots (1)$$

$\phi 1$  = Latitude at position 1, Longitude zero

$\phi 2$  = Latitude at position 2, Longitude L  
(positive eastward)

$\alpha$  = Azimuth

The first experiment used the azimuth angle calculation equation. This calculation is implemented with javascript programming language. In this experiment, the user location is selected using the Google Map location coordinates as follows:

Latitude : -7.27

Longitude : 112.79

while the Mosques used for the experiments are shown in Table 1.

Table 1. Azimuth Angle Calculation Result.

No	Location	Angle	Distance (m)
1	Name: Mosque Yapita Keputih Lat: -7.29 Long: 112.79	181 <sup>0</sup>	1146
2	Name: Mosque Manarulllmi Lat: -7.28 Long: 112.79	236 <sup>0</sup>	571
3	Name: Mosque BaitulNur Lat: -7.28 Long: 112.80	149 <sup>0</sup>	869

Then, the location of the mosques can be displayed on map. The map produced is labelled with direction line from user’s location to the mosque along with the distance. The map of each direction is shown at Figure 13 – 15.

Based on the observations of the experiment results, the digital compass embedded in the device has a high degree of accuracy. This is concluded by comparing the manual calculation of azimuth with the azimuth calculation performed by the mobile device, using trigonometric equations, that is only 1, 6 0 difference. In addition, the mosque icon the the screen is able to adjust to the movement of the device in a real time fashion.

**CONCLUSION**

The idea of developing a real time digital compass for searching mosque is feasible to implement. This conclusion is obtained from experiment results that show that this application is accurate to find location of a mosque. In addition, should there are new mosques to be added, this application is able to synchronise with its server.



Figure 13. Direction to Mosque Yapita Keputih.



Figure 15. Direction to Mosque BaitulNur.



Figure 14. Direction to Mosque Manarullmi.

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