Utilization of Augmented Reality to Showcase Historical Buildings in Medan City

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Abstract. Medan is the capital of the province of North Sumatera, Indonesia. Medan city is known as a city that has a lot of old buildings heritage legacy of the former Dutch. It is unfortunate as a result of the lack of maintenance and attention from the government and community making the historic buildings gradually demolished and replaced with new buildings. By using Image-Based-Modelling in the process of making 3D buildings. This application of Augmented Reality Tour is expected to be a recognition media, and can increase the interest in studying history.

1. Introduction
Indonesia is an archipelago that stretches from Sabang to Merauke. The archipelago consists of several islands, each island has a diversity of culture and history. Culture and history of each island if being excavated continuously has the potential to become a regional culture which is the area’s characteristic. One of the islands in Indonesia which has a lot of culture and history is Medan. Medan is the capital of North Sumatera province, Indonesia. Medan is the capital of the third largest city in Indonesia after Jakarta and Surabaya. Medan is known as a city that has many relics of old buildings. Some of these heritage buildings such as the Masjid Raya Al-Mashun, Maimun Palace, Tjong a Fie Mansion, and others. In 2009 from 800 historic buildings in Medan, now 20 percent has been lost and destroyed (kompas.com).

Augmented Reality or abbreviated AR is one of the technologies in the field of graphic design and multimedia. AR try to combine the virtual world (virtual) and the real world by adding the objects therein which in the real environment, in which the objects can interact with user. The main purpose of AR is to make user feel easier to find and receive information about an object. AR applied to various fields, such as medical, education, industry, and many others. In this study, AR directed to the field of tourism that focuses on historic buildings in Medan. The method that applied via Augmented Reality is Markerless by using Mid-Air. The method applied in this application is implemented on Android-based mobile devices that support.

2. Problem identification
The lack of awareness and ignorance of the public towards historic buildings in Medan, a 3D reconstruction of the building in the form of Augmented Reality is needed to attract people through electronic media such as tablets and smartphone.
3. Previous research
In this study the authors will make the application more attractive and interactive, where buildings that will be displayed in 3D, and user can see how the shape of building that has collapsed and some buildings that undergo reconstruction and change anything that happens on the buildings that will be discussed. Design and 3D concepts that will be made in this study refer to previous studies that have been done.

Gun A. Lee, Andreas Dünser, Seungwon Kim and Mark Billinghurst, 2012, with the title “CityViewAR: A Mobile Outdoor AR Application for City Visualization”. CityViewAR is an outdoor mobile Augmented Reality application to provide a visualization of AR information on the scale of the city. CityViewAR application provides information about the buildings affected by the earthquake. This study makes a 3D view of some buildings has collapsed when they stood up and gave some detail of information, in order to help people to have more information about how the current condition of the city before and after the earthquake.

Other studies such as, that conducted by Jaspen Anggastana Dalimunthe, 2017, entitled “3D Objek Bangunan Berbasis Augmented Reality Sebagai Media Pengenalan Bangunan – Bangunan Heritage Kota Medan”. In this study, the author provides information of the buildings and displays 3D models of heritage buildings in Medan by using Augmented Reality technology using USU logo as the marker. As for the boundary problem is Matsum City area and Kesawan with restrictions outside the buildings, and runs using a webcam. Thus, the other historical related multimedia application has been applied as a theme game using finite state behaviours [7].

4. Methodology
The methodology in this study consist of several design process, here’s the following explanation.

4.1. System planning
In Figure 1. There are stages to be carried out and traversed by user in using the application. Here’s the explanation:

4.1.1. Input. User run the MedanCitar application, then user will see the Home view. On the main menu there are 4 choices of historic buildings, after user selects, the application will show ARCamera display and provision of some extra buttons like info, and sliders. Through ARCamera will preform a 3D object that looks as if it overwrite the original building.
4.1.2. Process. Comprised of some process in making application, such as following:

a. Data
To collect and complete the data related to the topic, the data obtained based on books, field surveys and direct monitoring such as taking photos to determine the condition and shape of the object to be converted to 3D.

b. Modelling
After the data on this study has been gathered, go into the modelling process. The next stage is to conduct modelling process of 3D object of buildings that have been determined. The 3D model was built and is a major asset in Augmented Reality application.

The results of this method is 3D models based on existing photos. The method used for this 3D modelling process is Image-Based Modelling (IBM). 3D modelling process is done with the help of 3D Studio Max 2017 as 3D modelling software.

In the manufacture of 3D buildings made of type object such as the Standard Primitives: Box, Sphere, Cylinder, Torus, Teapot, TextPlus, Plane and others that will be modified into several modifiers. The purpose of the modifications is to make the object was formed similar to the shape of the actual building. As for some modifiers, such as bend, mirror etc. Some tools are also used in the manufacture of models such as Align, Spacing Tools and Array etc.

After all the 3D model is completed, export to .OBJ or .FBX. for Unity. When in Unity made UI for application display, and in Unity 3D model will be set to Mid Air. Mid Air consists of 2 options namely: Mid Air Positioner and MidAir Stage. Mid Air Positioner is used to determine the 3D layout position. Mid Air -> Mid Air Stage to be filled by 3D to match the point of Mid Air-Positioner. Both are interconnected, when opens Mid Air Stage adjust 3D to a predetermined point. Then go back to Mid Air Positioner, on the right there is inspector and enter into Mid Air Stage, inspector->anchor. Adjust the distance of the camera with 3D inspector. Then, compile, build & setting for the formation of an .APK file to be used in smartphone.

4.1.3. Output. The output of the UI menu of 4 objects. When user selects one of the buildings, the system will adjust the 3D to be displayed. User also can view the 3D object changes from year to year.

4.2. Interface Design
This stage is the interface design of Medan City of Augmented Reality (MedanCitar) application. This design is the layout design of the application display to be built.

| No. | Design |
|-----|--------|
| 1.  | Figure 1: |

Information:
A Home or main menu of the application, the availability of menus that can be selected by user.
2. **Figure 2:**

Information:
When user has selected one of the four buildings. It provides some additional buttons such as information, slider, rotation, sound and exit.

3. **Figure 3:**

Information:
When user selects from one of the historic buildings sound is automatically engaged and began to play backsong, user can also disable the backsong by pressing the sound back.

4. **Figure 4:**

Information:
When user selects the information button (i) user can see brief information about the building.

5. **Figure 5:**
Information:
If select the slider, user can see the 3D buildings and any changes that occur to the building.

6. Figure 6:

Information:
At Home there is “Tentang” regarding information about the application and the purpose of the application is made.

5. Result and analysis
For application display carried out some implementation testing of the system design. As for the explanation as following:

a. UI Installation and Activation
The following view is a display during the installation process and activation display of the first to appear when open the application before and after the application installation process. The interface can be seen in Figures 2 and 3.

Figure 2. Installation Process.

b. Main Menu Display
The main menu display is a display which first appeared at the time application is run. Main menu display can be seen in Figures 3.
When trying Augmented Reality Tour, application will stabilize the position of user with smartphone camera along with the buildings. When user open MedanCitar application, there are 4 menu options of the historic site objects in this study.

c. Augmented Reality Tour Display

In Figures 4 and 5 display using Maimun Palace menu.

![Figure 4. Maimun Palace Menu Display.](image)

Figure 4. Maimun Palace Menu Display.

![Figure 5. Maimun Palace Augmented Reality Display.](image)

Figure 5. Maimun Palace Augmented Reality Display.

d. UI Display Information from Historic Buildings

This view is a page that will provide brief information on the historical buildings selected by user. This page will display a popup in the center of the page that contains the information shown in Figure 6.

![Figure 6. Maimun Palace Information Display.](image)

Figure 6. Maimun Palace Information Display.
5.1. System testing
At this stage, the test carried out based on the application performance, the 3D changes display and if the 3D follow directions of user’s perspective. This test aims to see whether markerless can be detected well by ARcamera. Test is done by opening the application, then the ARcamera will detect markerless based on the direction of the camera.

5.1.1. Interface testing. Here is the interface test which can be seen in Table 1.

Table 1. Interface Testing Results.

| Component Tested | Result |
|------------------|--------|
| 3D view of historic buildings | Succeed |
| Display of 3D changes of historic buildings | Succeed |
| 3D view of the building based on the direction of view | Succeed |
| Display of 3D changes during day and night | Succeed |
| Display popup historic building information | Succeed |

5.1.2. Augmented reality testing on historic building. Augmented reality in a historic building aims to test whether the application can display a 3D augmented reality alteration of historic buildings is appropriate or not. In this application, a historic building that become object of this study is Maimun Palace, Masjid Raya Al-Mashun, Tjong A Fie Mansion and Density Deli. For 3D changes in Maimun Palace there are 4 changes, namely in 1890, 1925, 1970, 2012. For 3D changes that occur in Masjid Raya Al-Mashun there are 4 changes, namely in 1906, 1909, 1980, 2017. For 3D changes that occur in Tjong A Fie Mansion there are 2 changes, namely in 1922 and 2008. For 3D changes in Density Deli there is just 1 change that occur, namely in 1906. Can be seen in table 4.5 for more details.

Table 2. Augmented Reality Testing on Historic Buildings.

| Target | Result | Status |
|--------|--------|--------|
| Masjid Raya 1906 | | Succeed |
| 1909 | | Succeed |
5.1.3. Testing Based on Direction of View. The test is based on user’s position aims to detect whether 3D buildings remain an appropriate position. If user directs the camera toward top, bottom, left and right of the building if the 3D buildings remain in position and do not follow to move. For the test result based on the direction of view can be seen in Table 4.7, the test is done on the Density Deli building and Masjid Raya Al-Mashun.

Table 3. Testing Based on Direction of View.

| Direction of View’s Position | Result | Status |
|-----------------------------|--------|--------|
| Top                         | Succeed|        |
| Bottom                      | Succeed|        |
| Left                        | Succeed|        |
| Right                       | Succeed|        |
5.1.4. Testing Based on Time. Testing based on time done in morning, noon and night to see the effect of light intensity also has an effect or not, if in Table 4.5 is done during the morning and noon then will be fully tested at night, to see the test result can be seen in Table 4.8. Test carried out on the Masjid Raya Al-Mashun.

| Target     | Result | Status |
|------------|--------|--------|
| Masjid Raya 1906 |        | Succeed |
| 1909        |        | Succeed |
| 1980        |        | Succeed |
| 2017        |        | Succeed |

5.1.5. Testing Additional Features. To be fully tested against additional features in the application to see if the features are running well or not. Those additional features are rotation, zoom and sound.

| Features | Result | Status | Info |
|----------|--------|--------|------|
| Rotation |        | Before |      |
6. Conclusion
From the research can be concluded that:
1. This application can show changes according to the stages in 3D with the corresponding results.
2. 3D still can be displayed with the help of illumination of the surrounding buildings, but if the lighting was minimal, indicator can not perform tracking so it can not display the 3D.
3. To be able to use this application a smartphone with a gyro sensor that is stable enough is needed so that when user rotates 360° buildings remain stable.

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