Augmented reality for interactive promotion media at Faculty of Computer Science and Information Technology Mulawarman University

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Abstract. Showing the design and layout of the building using a model, making this model requires time and accuracy because the model is built on a scale that has been adjusted to the building to be made later, a problem that often occurs in modeling is the suitability of the scale and detail of the model. Augmented Reality as a variation of the virtual environment. Users of AR technology can see the real world, with virtual objects added to the real world. So, users see virtual objects and real objects in the same place. Submission of information by utilizing the three-dimensional visualization technique is very interesting because it can display the 3D model of an object before it is built in real terms. The Faculty of Computer Science and Information Technology Mulawarman University Samarinda has an exterior building design of a new building, but there are no interactive media that can display the exterior of the building as a whole and in detail. This application is able to be used to apply the 3D model of the building as a whole and can be seen from various viewpoints.

1. Introduction

Conventional planning in the field of architecture usually displays the design and layout of buildings using mockups, but the making of this model takes a considerable amount of time and accuracy because the model is built on a scale that has been adapted to the building to be created, a problem that often occurs in making models: scale, and the details of a model. One of the models that we often see in residential exhibitions and development exhibitions is exterior design models, by looking at the exterior design of a building, we will be able to assess the appearance of the original building, but sometimes the existing models cannot display the overall detail of the building Therefore, the application of AR to architecture, especially in exterior design is needed to help provide a better visual appearance and save time and costs [1].

Augmented Reality as a variation of the virtual environment or more commonly referred to as Virtual Reality. Virtual Reality technology really makes users immersed in a synthetic environment. When users sink into the environment, users cannot see the real world [2]. Instead, Augmented Reality technology users can see the real world, with virtual objects added to the real world [3]. So, users see virtual objects and real objects in the same place. At the moment, Augmented Reality is growing and many applications and libraries are being used to develop Augmented Reality [4]. Example ARToolkit, Flartoolkit, Goblin, and others. Submission of information by utilizing this three-dimensional visualization technique is very interesting because it can display the 3D model of an object before it is built in real terms. The Faculty of Computer Science and Information Technology Mulawarman University Samarinda has an exterior building design of a new building, but there are no interactive media that can display the exterior of the building as a whole and in detail. This application is able to be used to apply the 3D model of the building as a whole and can be seen from various viewpoints.
dimensional visualization technique is very interesting because it can display a three-dimensional model of an object before it is built in real term [5].

The Faculty of Computer Science and Information Technology Mulawarman University Samarinda has a design of exterior buildings from new buildings, but there is no interactive media that is able to display the exterior of the building as a whole and in detail. Then it starts from these problems the reason the authors chose this title is because the author will provide a solution to the problem above by building an interactive faculty of computer science and information technology building exterior design information media with 3D augmented reality technology that is packaged in Android-based applications and uses brochures as markers so that they become more interesting and can be used as a media for promotion of facilities at the Faculty of Computer and Information Samarinda Mulawarman University in the future.

Giving a real picture about the exterior of the campus building to prospective new students so that it can more clearly provide hope and guarantees that the faculty is developing towards a better direction. Promotions with brochures do have old-fashioned value but are proven to still work well. Directly the brochure can be taken anywhere when making an introduction.

2. Literature Review

2.1. Augmented Reality

Augmented Reality is defined as the incorporation of real and virtual objects in a real environment, runs interactively in real time, and there is integration between objects in three dimensions, namely virtual objects integrated in the real world [8]. Augmented reality allows perspective enriched by displaying virtual objects in the real world by inviting the audience that virtual objects are part of the real environment [9]. Augmented reality is a crossover between the real and virtual world [10]. Combining real and virtual objects is possible with appropriate display technology, interactivity is possible through certain input devices, and good integration requires effective tracking [11].

2.2. Mobile Apps

The mobile application is an application that makes it possible to do mobility by using equipment such as PDAs, cellular phones or mobile phones [12]. Mobile application, it can easily carry out various activities ranging from entertainment, selling, studying, doing office work, browsing. [13]. The mobile application is built with several mobile programming languages [4]. The example of mobile programming for mobile phones is JavaFx mobile, J2ME, C++, C# .NET and Flash Lite.

2.3. Unity3D

Unity 3D is a cross-platform based game engine. Unity 3D can be used to create a game that can be used on computer devices, Android, iPhone, Playstation, and X-Box. Unity 3D is an integrated tool for creating games, building architecture and simulation. Unity 3D can be used for PC games and online games. The use of online games requires a plugin, namely Unity.

3. Method

The method used in this study is the research and development method, namely by developing a product and testing the effectiveness of the product.

3.1. Marker Based Tracking

An Augmented Reality marker is an image that can be detected by a camera and used with software as a location for virtual assets placed in a scene [6]. Most are black and white, although colors can be used as long as the contrast between them is well recognized by the camera [7]. Figure 1 describes the
marker processing algorithm and the steps associated with image processing and detection of potential marker stages, which are summarized as follows:

3.1.1. Initial Image Acquisition

Origin image acquisition is the initial prerequisite stage in the marker detection process and the sequence of other steps in the marker detection algorithm may be different. In particular, potential markers can be rejected at each stage of the marker detection process, after it has been identified that potential markers cannot be markers.

3.1.2. Grayscaling

Grayscale images are more often used in modern image detection and recognition systems than color images, because the use of grayscale images significantly simplifies calculations and algorithms. The most common color-to-grayscale conversion algorithm is based on the use of the red, green and blue channels represented as R, G and B. The main principle of this conversion method is to change the colors in the image to shades of gray.

3.1.3. Thresholding

Thresholding is an effective technique used for image segmentation and making binary images from gray scale images. In the output image all pixels with a luminance level above the specified threshold can be represented by 1, namely white, while pixels the luminance value can be set with 0, i.e. black. Thresholding is very useful for separating gray pixels of objects from background gray pixels, so that the foreground and background can be easily identified as a result.

3.1.4. Identification of Connected Components

Analysis of the connected components is carried out in connection with binary images to fill the gaps in the area that are well connected and finally identify the closed area in the image. This algorithm first scans each pixel in a binary image, checks its connectivity to all eight pixels surrounding it, and records the equivalence between neighboring labels. Then, the algorithm divides the element into a closed area and finally produces a labeled map of the connected component.

3.1.5. Object Contour Extraction

The object contour in the image needs to be extracted to determine the curve that represents the marker boundary. This curve will be used for the extraction of marker angles in the future. Enhanced boundaries can be extracted with a set of edge detection algorithms. Some algorithms include the Marr-Hildreth edge detector, the Canny edge detector, the Boolean function based edge detector and several other methods.
3.1.6. Edge Extraction and Marker Angles

The introduction of marker square requires edge and angle extraction carried out by a polygon approach algorithm called the Douglas-Peucker algorithm. This algorithm is based on finding the dimensions of distance for each point on the line and simplified curve reconstruction. Using this algorithm, marker angles are found as simplified square points.

3.1.7. Implementation

After identifying the coordinates of the angle of the marker, which should be perpendicular, but usually can be found at different angles. These angles, whether perpendicular or at different angles, represent two sides of a square and correspond to the axis. Therefore, the position of the camera with respect to the facility and the initial reference point can be determined. The idea behind this is that if the camera angle changes, the projection size will adjust. By knowing the camera position and reference point, it is possible to draw 3D model projections.

3.2. Metode Multimedia Development Life Cycle

This study has an object pattern development method used is Multimedia Development Life Cycle, which consists of 6 stages, namely concept, design, collecting, assembly, testing and distribution.

3.2.1. Concept Stage

Author determines the purpose of the application and its users. The purpose of the application is to visualize the 3D model of the faculty of computer science and information technology building and its supporting facilities. The building is made using a 3D model in order to provide exterior information on the building in various points of view.

3.2.2. Design Stage

The design stage is the stage for designing the right media to use in the application figure 2. The first stage is to point the camera at the physical brochure, the physical brochure is used so that the reading of the marker is more accurate because the marker on the physical brochure cannot move as in the brochure in the form of a photo file. User scans a room marker by pointing the camera at the marker. The second stage is reading the marker on the brochure, at this stage the camera is reading the marker on the physical brochure. The third stage is detecting markers. The application tries to detect patterns on the markers that appear on the camera. The fourth stage is to display three-dimensional objects. At this stage the AR application has finished detecting the marker then displays a three-dimensional image in accordance with the marker that was made. Then the application renders the three-dimensional object by displaying a three-dimensional model above the marker if the marker is detected.
3.2.3. Stage Collecting Material
The author first asked for the design of the building model in the form of sketches at the Mulawarman University rectorate. Using this sketch, markers of augmented reality and three-dimensional models will be created to be used in the application. The description of the sketch can be seen in Figure 2.

Figure 2. Apps Usability Design Flowchart

Author collects data in the form of Design Photos from the dioramas of the faculty of computer science and information technology building available at the building of the Mulawarman university directorate. The data can be seen in Figure 3.

Figure 3. Sketch of faculty of computer science and information technology Building
3.2.4. Assembly Stage
Author combines all the data that has been obtained and then compiled and arranged according to the design. The assembly phase is done by developing augmented reality in the Unity 3D Engine application. The application was developed in the form of an offline application so it does not require an internet connection. The next step is to design the models and markers that are needed. 3D models can be created with the GoogleSketchup application while markers are made from screenshots on GoogleSketchup.

3.2.5. 3D Model Design
Make an Augmented Reality application in offline form there are types of 3D models that are suitable and not suitable. The type of 3D model that is suitable for development on AR in offline form has the extension .fbx, .obj and .blend. Whereas the file format that is not suitable for offline AR development is a 3D file with the extension .max and .3ds. Therefore, consideration is needed in determining the 3D model maker application. The 3D model design for this application was created using GoogleSkechUp, where the GoogleSkechUp file that was designed can be exported to the * .fbx extension file that is suitable for offline application development. The design made is a 3D model of the building and a parking lot and a model marker. The 3D model can be seen in Figure 5.
Figure 5 is a building 3D model that will be used in this augmented reality application. The model based on a sketch at the design stage.

3.2.6. Marker Design
Marker designs can be made using Adobe Photoshop, Corel Draw, etc. Here the author uses Google SketchUp to design marker images. But not all images can be targeted, Vuforia provides a Target Management System that will assess the good or bad images used. Assessment is calculated from the number of stars produced (from 1 star to 5 stars), the more stars the better the image quality is used. This rating determines how well an image can be detected and tracked using Vuforia SDK, so users will be able to immediately see 3D models when the marker is scanned. The image has been created and then uploaded on the Vuforia Developer website so images in *.jpg or *.png can be converted to *.unity format. This file will be used as a marker on the Unity 3D Engine. Markers can be seen in figure 6.

Figure 6 is a plan that is used as a marker for a building model. Markers are made based on measurements obtained in June 2018. Inside the marker, there is a front page of the building in the form of a .jpg file. Vuforia ranked 5/5 for this marker. The brochure can be seen in figure 6.
Figure 7 is a brochure design that will later be used as an information medium and also serves as a place to place markers for building models. Markers are made based on measurements obtained in June 2018. Figure 8 shows that there was an exchange of data between the android device and the local database side after the camera scanned the marker. The cellphone camera scans the marker and will send data to the android device then the android device will request information from the local database in the form of a 3D model. Then the android device will display the 3D model to the user.

3.2.7. Testing phase
Author tests the applications that have been assembled. Trials are run to see errors and shortcomings in the application. The results of the implementation of augmented reality in the application can be seen in the sub-section of program implementation.

3.2.8. Stage Distribution
Author saves the application where it is specified. This storage area is planned for application distribution. This application is expected to be stored on the faculty of computer science and information technology website as a medium to provide information about the faculty of computer science and information technology unmul building.

4. Result and Discussion

3.1. Implementation Results
The results of application development in the form of an android application with the extension .apk. How to install this application is almost the same as installing an android application in general, but
because this application is installed manually and not from the Google Play Store, it requires application settings. In this section, we will explain the implementation of the program which includes the implementation of the Augmented Reality application interface. Main Page Interface In Figure 9 there is a main page display. Inside the main page, there is a start button in the middle of the main page interface. Users here can press the start button to enter the home page.

Figure 9. Home menu

Building Model 3D view on the Start page, Figure 10 show us the center of the scan page serves to display the input results from the camera that has scanned the scanned marker. When a building marker is scanned, the building's 3D model will appear.

Figure 10. Building's 3D model appear

3.2. Marker Detection Test
This marker detection test is carried out to find out things that affect the marker detection process. Testing of marker detection includes testing of light intensity, testing marker distance to the camera, occlusion testing (marker deterrence blocked by something) and marker paper testing. This test is
carried out using a device that has been determined in the application testing device specification requirements in chapter 3.

a. Light Intensity Testing
Light intensity testing is carried out with different lighting conditions. Author uses the Lux Light Meter application found on the Google Play Store to measure light flux per unit area. The results of light intensity testing can be seen in Table 1.

| Light intensity (lux) | Information | Time detect (Second) |
|----------------------|-------------|----------------------|
| 0-95                 | Fail        | -                    |
| 96-300               | Sometime    | 6                    |
| > 300                | Succeeded   | 4                    |

The results of testing the light intensity above, at 0-95 lux, the application failed to detect the marker because the lighting was too dark so the camera could not detect markers while 95-300 lux could sometimes detect markers. The intensity of light at more than 300 lux is rated the most appropriate lighting level to be used in detecting markers.

b. Marker Distance Testing
Marker distance testing is done with different distance conditions between the camera and the marker. Author uses the Distance Meter application which is found to measure the marker distance to the camera. The results of the marker distance testing can be seen in Table 2.

| Distance (cm) | Information |
|--------------|-------------|
| 0 – 10       | Fail        |
| 10 - 60      | Succeeded   |
| 60 - 80      | Sometime    |
| > 80         | Fail        |

The results of testing the distance above, at a distance of 0-10 cm, the application failed to detect markers while, at a distance of 10-60 cm it was considered the most appropriate distance to be used in detecting markers. At 60-80 cm, the camera sometimes fails to detect markers. Distances of more than 90 cm, the application fails to detect markers because the camera's distance is too far away from the marker.

c. Occlusion Marker Test
Testing of marker occlusion is done by covering the marker with an object. The author covers the marker at a ratio of 20%, 40%, and 50% of the marker. The results of marker occlusion testing can be seen in Table 3.
Table 3. Occlusion Marker Test

| Level of Occlusion | Picture | Information |
|--------------------|---------|-------------|
| 20%                | ![Picture](image1) | Markers can be detected quickly and 3D objects can be displayed. |
| 40%                | ![Picture](image2) | Markers can still be detected and 3D objects can be displayed. |
| 50%                | ![Picture](image3) | Markers are still detected but the detection time is long, and the 3D objects displayed are sometimes lost. |

The results of testing the marker occlusion above, when markers are covered by 20-40%, the application successfully detects markers and 3D models can be displayed while at 50% occlusion, applications sometimes fail to detect markers because some patterns in the marker are covered.

d. Marker Paper Testing
Paper marker testing is carried out with different paper marker conditions. Here the author uses HVS paper as a marker and the state of the paper is dry, wet and tangled. The results of paper marker testing can be seen in Table 4.
**TABLE 4. Marker Paper Testing**

| Paper       | Picture | Information                      |
|-------------|---------|----------------------------------|
| Dry paper   | ![Marker Paper Testing (Dry)](image) | Markers detected and 3D objects can be displayed |
| Tangled paper | ![Marker Paper Testing (Tangled)](image) | Markers not detected and 3D objects cannot be displayed |
| Wet paper   | ![Marker Paper Testing (Wet)](image) | Markers remain detected and 3D objects can be displayed, but sometimes disappear |

Based on table 4, the results of testing paper markers on dry paper, the application succeeded in detecting markers while on paper tangled applications failed to detect markers because folds on paper were detected as patterns that made it difficult for the camera to scan the actual marker. Wet paper, the application will be a little difficult to detect markers if there is a pattern on the marker paper which fades with water.

5. **Conclusions**

Academic promotion brochures are important and very important for the community to know in detail about the faculty of computer science and information technology. Interactive media with augmented reality can prove to be a new way to be able to do promotions using information technology. This application is able to be used to implement 3D models of faculty of computer science and information technology building buildings as a whole and can be seen from various viewpoints (adjusting markers). The augmented reality, the 3D model displayed on android can provide information to users
about the exterior design of faculty of computer science and information technology buildings more clearly. Giving a real picture about the exterior of the campus building to prospective new students so that it can more clearly provide hope and guarantees that the faculty is developing towards a better direction. Promotions with brochures do have old-fashioned value but are proven to still work well. Directly the brochure can be taken anywhere when making an introduction.

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