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3D Building Visualization Based on Augmented Reality Using Marker Based Tracking Method

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Abstract

This research discusses the development of the “ARVincent” application, an Android-based Augmented Reality application used to visualize public buildings in 3D using the Marker Based Tracking method. The purpose of this research is to create interactive learning media that can help children recognize public buildings in a more interesting and educational way. The development was carried out using Unity and Vuforia as AR platforms, and SketchUp for 3D object creation. The final result is an application that is able to display a 3D model of a public building when a marker is recognized by the device's camera. Although limited to one object and can only be used offline, this application is proven to provide good visualization and easy interaction for users.

Keywords: *Augmented Reality, Marker Based Tracking, 3D Visualization, Android, ARVincent*

1. Introduction

Augmented Reality (AR) is a technology capable of combining the real world with virtual objects in real time. In the fields of architecture and education, this technology has great potential for use in various sectors, including education, healthcare, advertising, and architecture and urban planning [1].

This research stems from the need to introduce public buildings to children in a visual and engaging way. In this context, the "ARVincent" application was developed as a learning solution using Augmented Reality technology. It can display building models in 3D by scanning physical markers using the Marker-Based Tracking method, scanned using a mobile device.

The Marker-Based Tracking method is a fairly popular Augmented Reality technology technique. This method uses physical markers recognized by Augmented Reality software to position and display 3D objects on the user's display. The accuracy and stability of this method make it ideal for visualizing public buildings, where detail and precision are critical [2].

The accuracy and stability of this method make it ideal for visualizing public buildings. With ARVincent, users can see buildings visually and can help parents and teachers provide more enjoyable learning for children about the types of public buildings in their neighborhood [3]. After the "ARVincent" application is completed, the author will evaluate and review the "ARVincent" application to obtain data on its strengths and weaknesses, which will be used to refine and enhance its features.

2. Literature Review

3D Objects

A digital representation of a real object in three dimensions: length (X), width (Y), and height (Z), creates a sense of depth and volume. Viewing it from various angles results in a very similar image to what we see in the real world.

In various fields, such as art, design, architecture, and animation, 3D objects are also used to create realistic and interactive models. For example, in 3D modeling, objects are created with detail, including texture and lighting, resulting in a more immersive visual experience than 2D images [4]. In the digital world, a 3D object is a visual representation of a real or imagined object created using 3D modeling software. These objects can be still (static) or moving (dynamic) and can be used in various fields, such as animated films, product design, architecture, games, and even Virtual Reality (VR) and Augmented Reality (AR) technologies.

Augmented Reality

Augmented Reality technology is a technology that combines the real world and digital objects in an interactive, real-time way. The difference with VR (Virtual Reality) is that VR creates a completely virtual world or alters and replaces the real world with an artificial one. Augmented Reality (AR) adds layers of digital information, such as text, graphics, and video, to the physical world, creating new, more immersive, engaging, and informative experiences.

Augmented Reality technology uses various devices, such as smartphones, tablets, and special glasses, to project digital content into the real world. Users can then see and interact with digital objects present in their physical world. Augmented Reality utilizes various techniques, including image recognition, location tracking, and 3D mapping, to create a seamless and immersive experience [4].

Marker Based Tracking

It's a technique in Augmented Reality that uses visual markers as references to display digital elements in the real world. These visual markers typically take the form of images or unique patterns that can be recognized by a device (camera) to determine the location and orientation of the digital object being displayed.

Unity Software

Unity is a game engine platform commonly used to create interactive applications such as video games, 2D and 3D applications, virtual reality applications, and augmented reality-based applications that support marker processing and 3D object visualization. Unity also offers tools that enable developers to create cross-platform content, meaning applications created in Unity can run on various devices such as PCs, consoles, smartphones, and AR and virtual reality devices [5].
Currently, Unity is one of the most well-known and popular game engines worldwide. Unity focuses not only on games but also on all types of interactive content. Unity is also widely used in various other industries such as film, architecture, product design, automotive, and simulation training.

SketchUp

SketchUp is a 3D graphic design software used to create, modify, and visualize three-dimensional building objects. SketchUp is frequently used in various fields such as architecture, interior design, civil engineering, construction, and animation. SketchUp is renowned for its simple and intuitive interface and easy-to-learn tools, making it suitable for both beginners and professionals [6].
SketchUp is very popular among architects, interior designers, civil engineers, landscape designers, game and animation creators due to its ease of creating 3D designs quickly and efficiently, without requiring advanced technical skills.

3. Research Methods

Place and Time

The research was conducted in Medan from December 2024 to May 2025. The research implementation schedule table can be seen in Table 1 below.

Table 1: Research Implementation Schedule Table

No	Activity Plan	December 2024				January 2025				February 2025				March 2025				April 2025				May 2025			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Formulation Of The Problem																								
2	Data Collection																								
3	Implementation																								
4	Testing and Evaluation																								
5	Report Preparation																								

Devices and Tools

The following is the hardware and software used during the research process. The hardware used was a laptop with the following specifications:

a. Intel® Core™ i7-1065G7 CPU @1.30GHz
b. 8GB RAM
c. Keyboard
d. Touchpad
e. Display with a resolution of 1920 x 1080 pixels

The software used is:

a. Windows 10 64-bit Operating System
b. Unity Software
c. SketchUp Software

3.1. Method of Collecting Data

The data collection methods used in this study include the following :

3.1.1. Observation Method

Observing how children interact with existing educational technology, both inside and outside the classroom. Observation can help understand children's needs and preferences when using applications.

3.1.2. Interview Method

Ask parents and teachers directly to collect quantitative data about their interests and desires for Augmented Reality-based educational applications.

3.1.3. Literature Study Method

Collecting theoretical data through journals, print media, or reference sources from the internet.

3.2. Development Steps

3.2.1. Create a 2D building sketch to upload to Vuforia

For the first step, the author provides a general building sketch to upload to the target manager in Vuforia. The general building sketch can be seen in Figure 1 below.

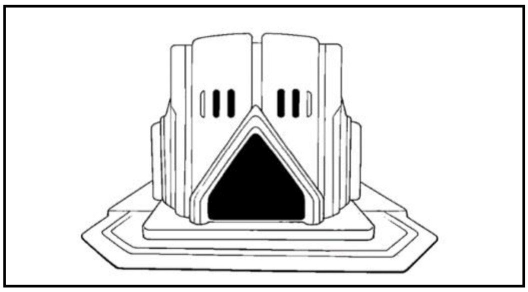

Fig. 1: Building Drawing Sketch

3.2.2. Convert building images into markers via Vuforia

After uploading all the 2D public building images to be used, you can download the 2D public building image database in Unity Editor format for use in Unity3D. To use the 2D images in Unity, you first need to create a license database to obtain the license key you will enter. The Vuforia license key is shown in Figure 2 below.

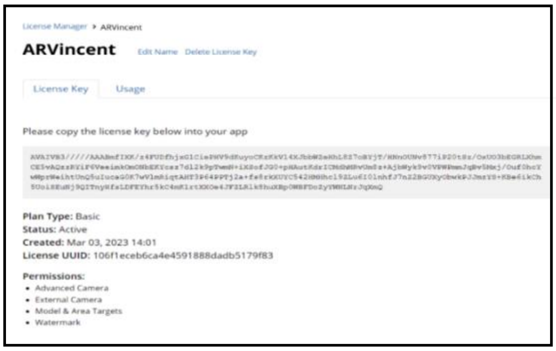

Fig. 2: Vuforia License Key

3.2.3. Creating a 3D object of a general building using SketchUp and combining markers and 3D objects in Unity

Once the license key is available, the Vuforia plugin will be installed and the database downloaded from Vuforia will be imported. This will then merge the 3D objects into Unity, where they were created using SketchUp. The 3D objects created in SketchUp can be seen in Figure 3: 3D Objects in SketchUp.

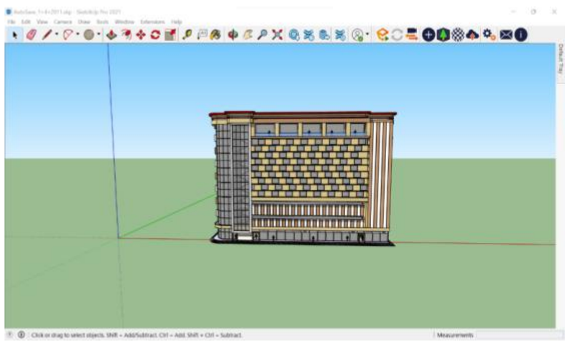

Fig. 3: 3D Objects in SketchUp

3.2.4. Designing application interfaces using Adobe Illustrator

As for the display design carried out on the application carried out on the ARVincent application, the author uses the Adobe Illustrator application as a place to create the user interface and as a place to simulate the display that will be used by the user and create 3D ARVincent objects using the SketchUp application.

4. Results and Discussion

The ARVincent application has been successfully developed and displays several main views :

4.1. Results

4.1.1. Flash Form

Displaying the initial logo of the ARVincent application which uses Augmented Reality technology with the Marker Based Tracking method can be seen in Figure 4 Flash Form below.

Fig. 4: Flash Form

4.1.2. Main Menu Form

The main menu form display results in the ARVincent application that uses Augmented Reality technology with the Marker Based Tracking method can be seen in Figure 5 Main Menu Form. This form functions as navigation to four buttons, namely the "Play" button to display the camera, the "Tutorial" button to display how to use the application, the "About" button to display author information and the "Exit" button to exit the application.

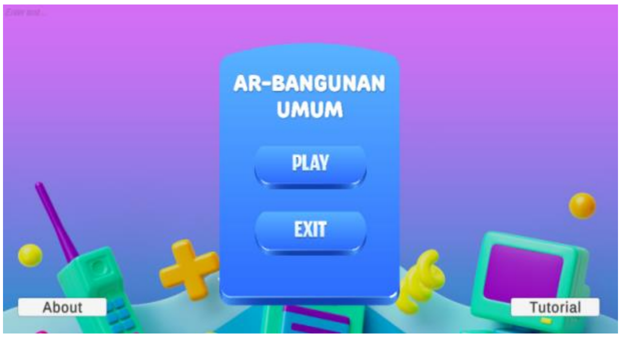

Fig. 5: Main Menu Form

4.1.3. Play Form

The Form Play display results in the ARVincent application that uses Augmented Reality technology with the Marker-Based Tracking method can be seen in Figure 6. Form Play displays a single Exit button to return to the Main Menu Form.

Fig. 6: Play Form

4.1.4. Tutorial Form

The results of the Tutorial Form display in the ARVincent application, which uses Augmented Reality technology with the Marker-Based Tracking method, can be seen in Figure 7. The Tutorial Form will display a guide on how to use the ARVincent application to the user.

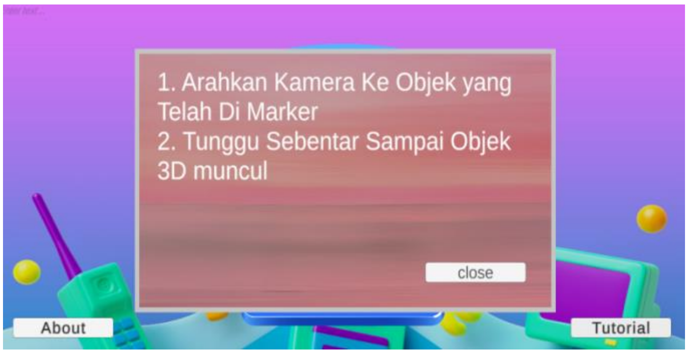

Fig. 7: Tutorial Form

4.1.5. About Form

The display results of the About Form in the ARVincent application that uses Augmented Reality technology with the Marker Based Tracking method can be seen in Figure 8 About Form. The About Form will display the author's name and the author's Student ID code.

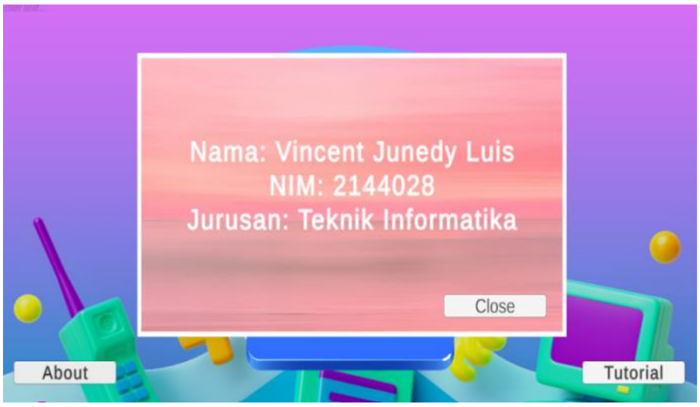

Fig. 8: About Form

4.2. Discussion

4.2.1. Advantages

Some of the advantages obtained from the ARVincent application which uses Augmented Reality technology with the Marker Based Tracking method designed by the author, include:

a. The ARVincent application is designed to allow users to interact with building objects directly, creating a more engaging and interactive experience.
b. The ARVincent application helps users in visualizing building objects.
c. This application can also be used to create learning from teachers to students, especially in terms of visualizing the 3D form of buildings and providing additional information.
d. In terms of improving marketing activities or introducing building objects, this application will be able to display objects or present information that is more interesting and interactive.
e. By being operated via mobile phone, this application will be easier to run so that it can reach a wider user audience.

4.2.2. Disadvantages

There are several shortcomings in the ARVincent application which uses Augmented Reality technology with the Marker Based Tracking method designed by the author, including:

a. The ARVincent application can only be run in offline mode.
b. The ARVincent application cannot update automatically if changes are required.
c. The ARVincent application can only display one 3D building object.

5. Conclusion

The ARVincent app demonstrates the effectiveness of Augmented Reality technology with Marker-Based Tracking for visualizing public buildings in 3D. This app can be used as an accessible and engaging interactive learning tool for children. However, for further development, it is recommended that the app support more 3D objects, an online mode, and an automatic update feature.

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