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Development of AR Android Application for Disability and Elderly-Friendly Smart Home Control

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Abstract: In the rapidly evolving era of technology, smart homes have become a significant trend. This research aims to develop a smart home control model through an Android augmented reality (AR) application using a marker-based method. The marker-based approach utilizes physical markers recognized by the application to project virtual objects into the real world. The developed application enables users, including individuals with disabilities and the elderly, to easily control various features in a smart home using their Android devices. Physical markers used as references in the AR application are identified. Once a marker is detected, virtual objects appear above it, allowing users to control lights, fans, and various smart home devices. Testing has shown that the AR application with the marker-based method can accurately recognize markers and provide quick responses to user commands. Users have also reported a positive interactive experience. This research represents an innovative contribution to the development of disability-friendly and elderly-friendly smart home technology. It is expected that this technology will advance the creation of more inclusive, convenient, and efficient smart homes in the future.

Keywords: AR, Iot, Marker-Based, Smart Home.

1. INTRODUCTION

The projected number of people aged 65 or older worldwide is expected to more than double, rising from 761 million in 2021 to 1.6 billion in 2050. Meanwhile, the growth in the number of people aged 80 years or older is happening at an even faster rate. The phenomenon of population aging is an inevitable global trend. This is an inevitable result of demographic transitions – that is, the trend towards longer lives and smaller families – occurring even in countries with relatively young populations. In 2021, 1 in 10 people worldwide were 65 years and older. However, by 2050, this age group is expected to account for 1 in 6 people globally

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[1].
The existence of disability is part of humanity. Almost everyone at some time in their life will experience a disability, whether it is temporary or permanent. About 1.3 billion people, or about 16% of the world's population, currently have a significant disability, and this number continues to rise with population aging and the increasing prevalence of non-communicable diseases. A person's environment has a huge impact on the experience and level of disability. An inaccessible environment creates barriers that often hinder the full and effective participation of people with disabilities in society on an equal footing with others. Progress in increasing social participation can be achieved by overcoming these barriers and facilitating people with disabilities in their daily lives [2].

The smart home is an increasingly popular concept where devices and systems within the home can be connected and controlled through communication networks [3]. In a smart home, users can control various aspects of the home, such as lighting, temperature, security, and electronic devices, through mobile devices connected to the internet [4]. The purpose of the smart home is to increase the comfort, convenience, and security of the household [5]. The development of smart homes has become a significant global trend in recent years. Based on the Grand View Research report, it is predicted that the smartphone market will continue to grow rapidly and reach very high values in the next few years.

Augmented reality (AR) is a technology that provides a real-time, real-world view with the addition of visual, sound, or computer-generated GPS data [6]. The current application of AR is very broad and covers a wide range of fields. In education, AR is used to enhance the learning experience by providing interactive visualizations that enrich learning materials [7]. In the industrial sector, AR is used for employee training, equipment maintenance, and product design visualization [8]. In the tourism industry, AR can provide interactive travel experiences and virtual guides [9]. In addition, AR is also used in health, games, and marketing [10]. As technology evolves and the accessibility of AR tools increases, the potential applications become wider and more diverse. Augmented reality has been one of the innovations that changed the way to interact with the environment and provide increasingly immersive and engaging experiences [11].

One of the most important things in Augmented Reality (AR) is the method of implementing AR [12]. The implementation method is divided into two parts, namely Marker-based Tracking and Markerless Tracking. Marker-based is Augmented Reality that requires special markers to display objects [13]. While Markerless is no longer requires special markers to run it [13]. Face tracking, 3D object tracking, motion tracking, GPS-based tracking, User Defined Target, are examples of techniques that can be used using Markerless Augmented Reality methods.

The integration of Augmented Reality (AR) with the smart home opens up exciting new opportunities in the way users interact and control smart home systems [14]. By incorporating AR in smart home controller applications, users can get a more intuitive and interactive experience in operating smart home devices.

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With the use of AR applications, users can see an enhanced visual display directly on the mobile device. For example, when a user points the device's camera at a device in the house, such as a lamp, the user can see a display that shows the status of that light, as well as accessible control options. Thus, users can interact with smart home devices visually and directly [15].

2. MATERIALS AND METHODS

2.1 NodeMCU ESP8266

NodeMCU is an ESP8266-based open-source development board and firmware that facilitates the creation of Internet of Things (IoT) products. A low-cost microcontroller with full support of TCP/IP protocol stack and WiFi capabilities, the ESP8266 WIFI module enables IoT platforms. Unlike Arduino and Raspberry Pi, NodeMCU has built-in support for wireless networks [16].

2.2 Relay

An electrically controlled switch is what an electronic device called a relay does. Its job is to use external electrical signals to control the current flowing through a circuit.. Depending on the original configuration, the relay may serve as a breaker (normally open) or a normally open (normally closed) contact. Depending on the original configuration, the relay may serve as a breaker (normally open) or a normally open (normally closed) contact. In general, the existence of relays is very important for the management and control of electronic devices, automation systems, and industrial applications that require precise control of electric current [17].

2.3 Jumper Cables

Jumper cables are critical elements in electronics, connecting circuits temporarily. With short lengths and flexible conductors, it allows efficient circuit assembly. Made of conductive materials, such as metal, ensures a steady flow of signals. Very useful in prototype trials and electronic experiments. Become a flexible solution for design development without losing circuit reliability. Important in applications that require temporary connections between electronic components [18].

2.4 Arduino IDE

Arduino IDE is a code editor that can be used to organize Internet of Things (IoT) circuits. It is helpful for beginners and can work with different microcontrollers. This means developers can manage and program IoT devices easily.

2.5 Visual Studio Code

The Visual Studio Code code editor app, created by Microsoft, can be used on all desktop devices for free and has many features and extensions that make it a top choice for developers. Even almost all operating systems, such as Windows, Mac OS, and Linux, are supported by Visual Studio Code.

2.6 Unity 3D

Unity 3D is a game engine that functions as software to process images, graphics, sound, and

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input to create various types of games. Although its primary purpose is for game creation, Unity 3D can also be used in other contexts that require interactive processing of visual and audio elements [19].

2.7 Blynk & Blynk Server

Blynk is a platform used to control Internet of Things (IoT) networks. In this study, blynk is used as a basic controller that will be developed into an AR application. Blynk Server is a cloud server owned by the Blynk platform that is responsible for all interactions between smartphones and IoT devices.

2.8 Methods

The application that will be produced is an application that can be used to control a smart home or smart home by utilizing Augmented Reality (AR) technology. The method used in this Augmented Reality (AR) application is Marker-based. The following is the system architecture of the application.

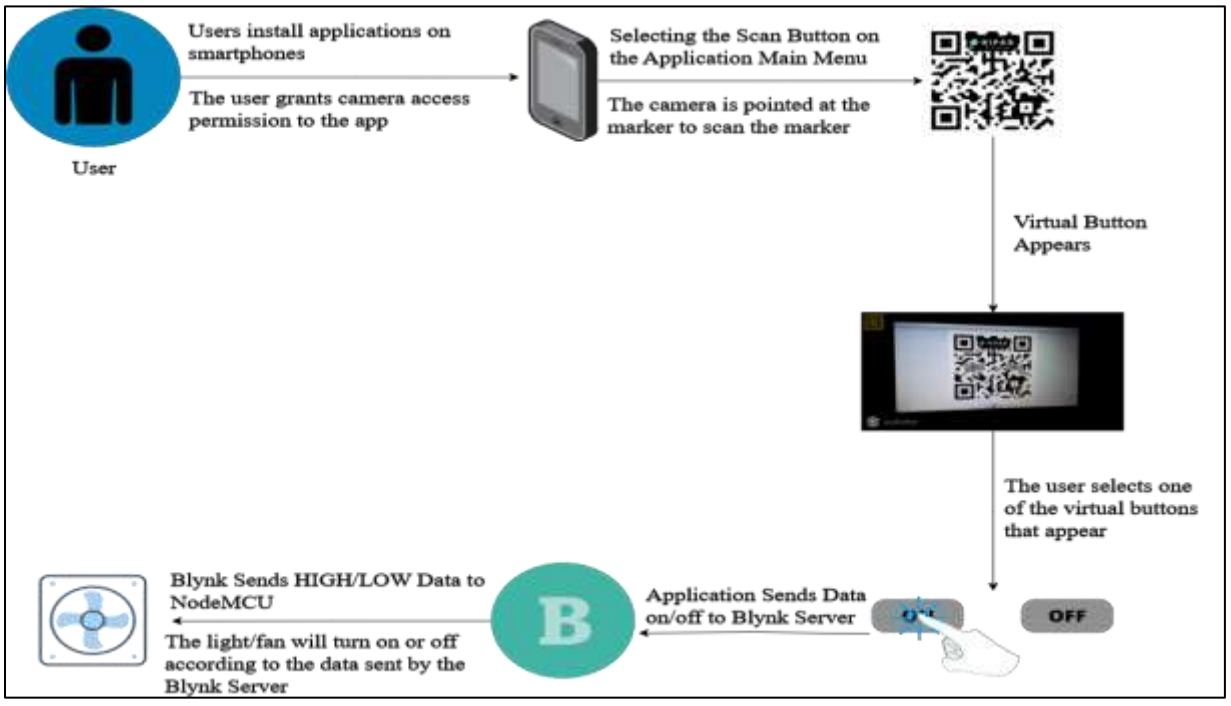


Figure 1. System Architecture

The architecture of the system can be seen in figure 1 above. In the image can be seen the use of the application starting from the installation of the application. Once the app is installed, the user will be asked first to allow the use of the camera. After that, users can directly press on the "scan" button to enter the application's AR mode.

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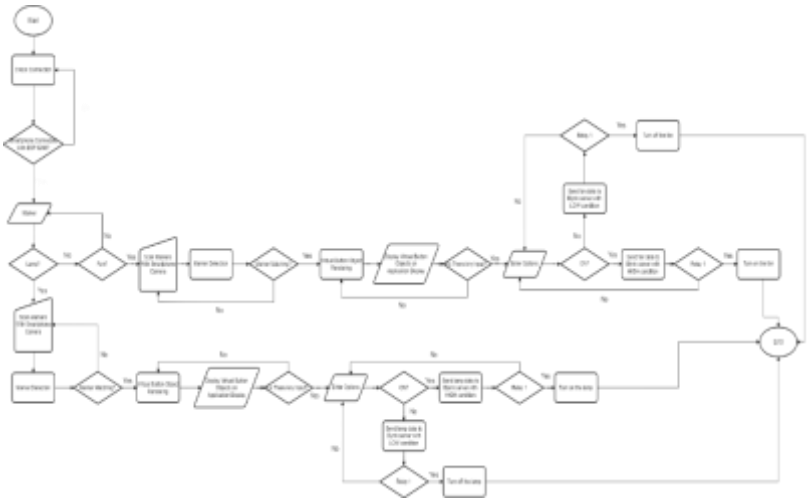


Figure 2. Flowchart of the Merging of Augmented Reality and the IoT

Figure 2 above is an overview of the application flow. First, the application will check the smartphone connection with ESP8266. If the smartphone and ESP8266 are connected, then the user can immediately scan the marker that has been provided. After the marker is scanned, a virtual button will appear. If the user presses the virtual button, the application will send data to the Blynk Server according to the button command pressed. After the command reaches the Blynk Server, the HIGH / LOW data will be sent to the ESP8266 MCU Node to be used to turn off / on the lights/fan.

The integration between the application, Blynk Server, and NodeMCU ESP8266 plays an important role in this system. The application sends commands from the user to the Blynk Server, which then sends data to the NodeMCU ESP8266. The NodeMCU ESP8266 acts as a link between physical devices, such as lights or fans, and the control system contained within the application. Thus, users can easily control the device through virtual buttons in the app's AR mode.

3. RESULT AND DISCUSSION

In this study, the creation of the application began with the creation of markers using the Canva application. Canva is a graphic design application that is useful for creating, designing, and editing designs online. This application is suitable for beginners. With Canva, designers can create different types of designs such as greeting cards, posters, brochures, infographics, and presentations. Application. Canva is available in web, iPhone, and Android versions. In this study, Canva was used to design a marker that will be used as a medium to display virtual buttons.

The next process is the creation of an application interface using the Unity 3D application. By using Unity 3D, users can develop various types of applications, simulations, virtual experiences, and so on. The advantage of Unity 3D lies in its intuitive capabilities and support for various platforms, making it easier for developers to create creative works easily and efficiently.

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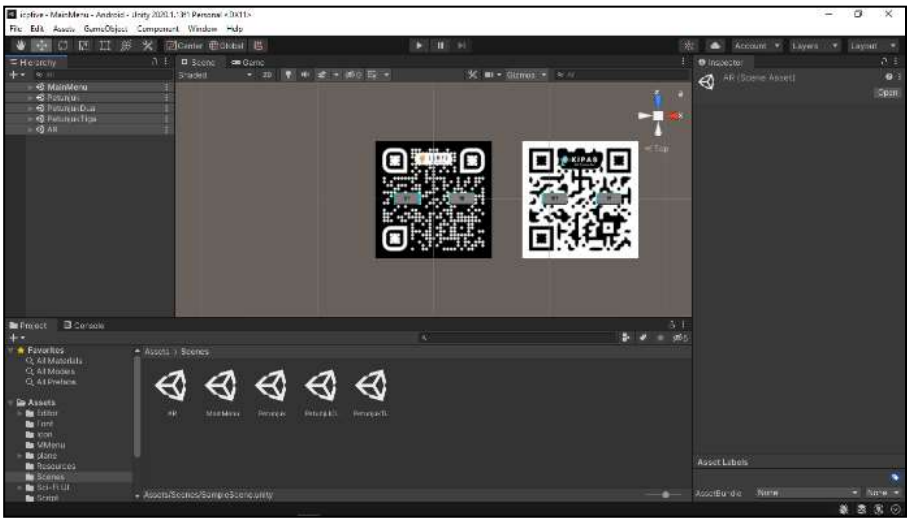


Figure 3. Creating AR Scenes



Figure 4. Create the Main Menu Scene



Figure 5. Creating a Tutorial Scene

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In the pictures above can be seen the process of making the application interface. Figure 3 is the display that will appear if the markers provided are scanned using the application. The display in the application is also called AR mode. Figure 4 is the process of creating the application's main menu interface. On this main menu, there are scan, hint, and exit buttons. Furthermore, Figure 5 is the process of making instructions for using the application. The instruction scene itself has 3 child objects which are 3 steps to use the application. Each of these child objects is then combined in 1 parent object "Petunjuk".

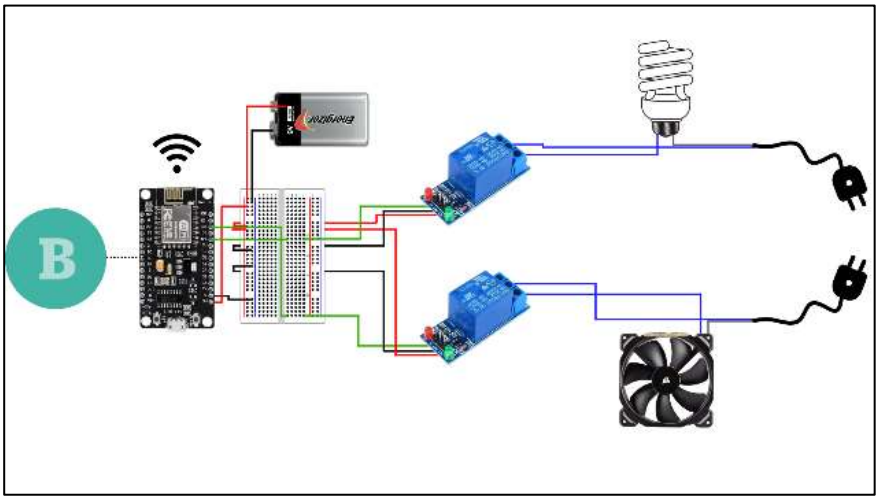


Figure 6. IoT Component Formation

In the picture above can be seen all the necessary IoT components. These components include the NodeMCU ESP8266, breadboard, 9V battery, 5V relay, lamp, small fan, plug, and cable as a link. All of the above components must be interconnected to be able to build an IoT system.

Table 1. Relation between pins

No	Dari	Komponen	Ke	Komponen
1.	Vcc	9V battery	Positive	Breadboard
2.	Ground	9V battery	Negative	Breadboard
3.	3V	ESP8266	Positive	Breadboard
4.	Ground	ESP8266	Positive	Breadboard
5.	D2	ESP8266	IN	5V Relay Fan
6.	D4	ESP8266	IN	5V Relay Lamp
7.	Vcc	5V Relay Fan	Positive	Breadboard
8.	Ground	5V Relay Fan	Negative	Breadboard
9.	Vcc	5V Relay Lamp	Positive	Breadboard
10.	Ground	5V Relay Lamp	Negative	Breadboard

Table 1 above represents the relationship between pins in the component arrangement. The components that have been provided are connected so that the IoT system can be run. Pin D4 on the ESP8266 is connected to the IN (input) of the 5V relay for the lamp. While the D2 pin

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is connected to the IN of the fan 5V relay. The function of IN itself is to control the connection or disconnection of current on the relay.



Figure 7. App Main Menu

Figure 7 above is the display of the main menu in the application. In the main menu itself, there are scan, tutorial, and exit buttons.



Figure 8. Application AR Mode



Figure 9. Scanning Markers

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Figure 8 above is the application display in AR mode. In this mode, users can scan the markers that have been provided. If the markers do not match, the application will not generate a virtual button like in figure 8 above. On the contrary, if the scanned marker matches the database that has been stored in the application, then the virtual button will appear as shown in Figure 9. Users can also press the "back" button on the upper left side of the screen to return to the main menu page.



Figure 10. Tutorial Page (Petunjuk)

In Figure 10 above can be seen the application user guide page. Users can use the page to see the complete procedures for using the application. The instructions page on the application is three pages as shown above. The page is also equipped with images so that it can make it easier for users to understand how to use the application.

Table 2. App Test List.

	Device	**Types of Android**	**Installation Process**	**Application Running Process**
1.	Samsung Galaxy A5 (2017), 32 GB, 3 GB RAM	Android 8.0 (Oreo)	Installed	The application runs smoothly
2.	Vivo y30, 128 GB 4GB RAM	Android 12	Installed	The application runs smoothly
3.	Sony Xperia Z5, 32 GB, 3 GB RAM	Android 7	Installed	App crashes when opened
4.	Xiaomi Redmi 5 Pro, 64 GB, 4 GB RAM	Android 10	Installed	The application runs smoothly
5.	Samsung Galaxy S5, 32 GB, 2 GB RAM	Android 6 (Marshmallow)	Not Installed	-

From the test results in Table 2 above, it can be seen that the application built can be this research can be installed and run well on the Android 8.0 operating system and above. And for Android 7, the application can be installed but crashes when the application is opened. As for Android 6, the application cannot be installed at all.

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4. CONCLUSION

Based on the research and testing conducted, the results show that the merging of Augmented Reality (AR) and the Internet of Things (IoT) in the context of a smarthome has great potential. By leveraging Blynk servers as a link between IoT devices and AR applications, the technology offers significant business value in the future. Although IoT has grown rapidly, the use of AR as its controller is still not common. The apps developed in this study offer an attractive look and a pleasant interaction experience with the smart home. Note, however, that these applications require active access to control IoT devices, which can be lacking in some contexts. As such, the study provides insight into the potential of developing Android AR apps that enable manual smart home control that is friendly to people with disabilities and the elderly.

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