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Implementation of Augmented Reality Technology for Computer Hardware Learning

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ABSTRACT : *The majority of current learning methods still use conventional methods in displaying visual objects, one of the cases that occurs today is learning in one of the courses at the Yogyakarta University of Technology where computer hardware or hardware is still only displayed in the form of visual images in the module so that students do not know what it actually looks like. Based on these problems, this research aims to provide solutions by utilizing Augmented Reality AR technology to be able to visualize computer hardware in 3D. In its use, the media used is to use an android application that can be installed and run by students and lecturers. The application is designed to be more informative and interactive so that it is expected to help students and lecturers to learn and understand the forms of computer hardware.*
KEYWORDS : *Android, Mobile Application, Augmented Reality, Computer Hardware.*

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I. INTRODUCTION

Hardware is the physical component of a computer system that consists of various components that work together to run a computer system. These components can be broken down into the central processing unit, memory, storage, terminals, and printers [1]. Computer devices continue to evolve as technology advances and the latest devices usually have better performance than before. Computers open the door to an ever-expanding arena of knowledge and technology [2]. Therefore, an understanding of computer devices is essential for students as basic knowledge.

In the world of education, learning or the introduction of computer hardware is still done in the old way in the form of pictures on the module. This method is considered less effective because students cannot know the original form of computer hardware studied, therefore a new method is needed to produce effective and efficient learning by displaying each hardware component in the form of 3-dimensional images. This research aims to design an android-based application that utilizes Augmented Reality (AR) technology as a learning medium about computer hardware.

Augmented Reality has become a bridge from the virtual to the real world [3]. Augmented Reality (AR) is the technology that enables the overlaying of physical objects with computer-generated virtual perceptible data in real time to provide an interactive user experience in the real environment [4]. It is predicted that the technology will experience significant growth momentum in the near future and thus lead to a substantial increase in the number of users [5]. Over the years, Augmented Reality (AR) has been investigated in different applications to understand how it can facilitate learnability [6]. Therefore, the holding of this research is as a form of contribution to the development of Augmented Reality media as a learning medium [7].

The development of this AR application uses the C# programming language and the Unity 3d application and Vuforia as the database. The C# language is expressive in implementing all the features of a modern object-oriented programming language [8]. The language is designed to be simple, modern, secure, and can be used to build various types of applications such as desktop, web, mobile, games, and web services. The software development tool (SDK) Vuforia was also used, which contains many libraries that facilitate the creation of augmented reality mobile applications and provides different types of options for viewing, taking video and for exploration of recurring events of the captured images, in order to calculate in real time the position of the camera and the location of the markers [9]. Vuforia AR Software Development kit utilizes technology to recognize and analyze camera input from the real world developed by Qualcomm and fully supported by the Unity game engine [10].

II. RESEARCH METHOD

The current system for learning media for the introduction of computer hardware still uses printed media in the form of books. This makes students less insightful because there are no physical examples. After the author analyzes the previous learning media about computer hardware, the author conducts research, where the research aims to innovate the existing system. The system to be created is a system that focuses on hardware learning, and produces augmented reality-based educational media products for computer hardware learning. Below is the application architecture diagram.

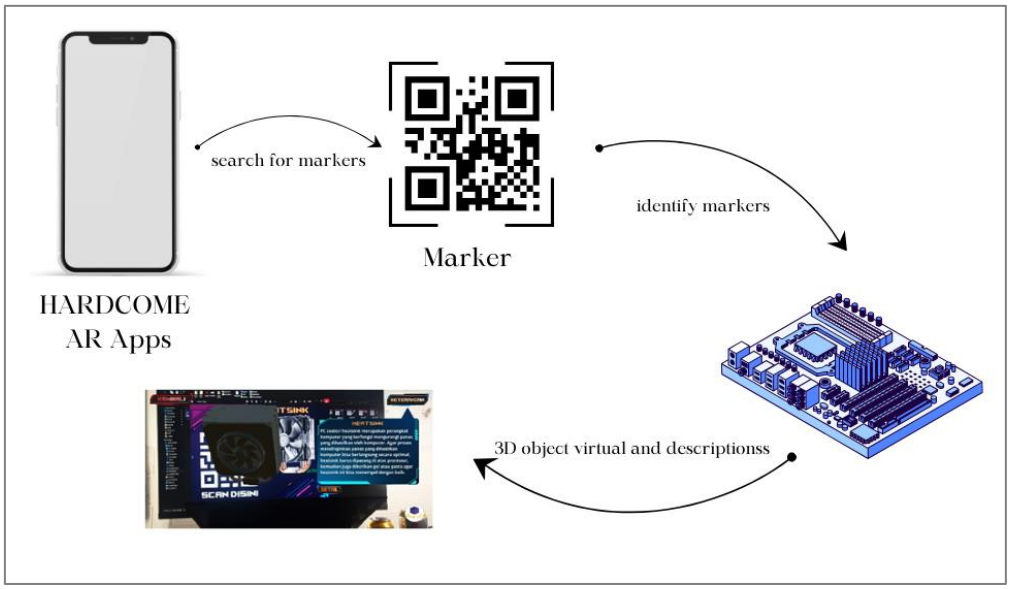

Fig. 1. Architecture Diagram

The "HARDCOME" application can be installed on smartphones with the android operating system. The application will use the camera to search for markers. once the marker is identified, the 3D object and its description will appear on the smartphone screen.

A. Data Collection Procedure

The author uses a case study of Yogyakarta University of Technology which is located in the Special Region of Yogyakarta. the following is how the author obtained the data:

1) Observation

In addition to conducting interviews, direct observations to the field are also carried out to make it easier to analyze data for system design. Observations were made at the Yogyakarta University of Technology.

2) Interview

The data source used in this research is by conducting direct interviews with lecturers teaching Technology Application courses, from lecturers teaching technology application courses explaining that it is a little difficult to explain computer hardware or computer hardware that is still displayed in the form of visual images in modules only because there are no physical examples so that students do not know what it really looks like. So in this study the authors provide a solution to the problem by utilizing Augmented Reality AR technology to be able to visualize computer hardware in 3D.

B. System Design Logic

Design logic is a process that can help ensure that the developed system meets user needs and can fulfill its purpose. UML sequence diagrams are used for dynamic modeling [11]. To read a sequence diagram, the first thing to do is to identify the objects involved in the scenario, then follow the sequence of messages sent between objects. Class diagram is an important model in object-oriented software development [12]. It describes the classes in the system, the relationships between them, and the attributes and operations of each class. Using these tools, practitioners can model their software systems in UML and perform many different operations such as model management, analysis, simulation, user collaboration, project management, model transformation, documentation, etc [13].

1) Sequence Diagram

The design of Sequence Diagram aims to describe the interactions that occur between objects in a process that occurs in the system based on time sequence.

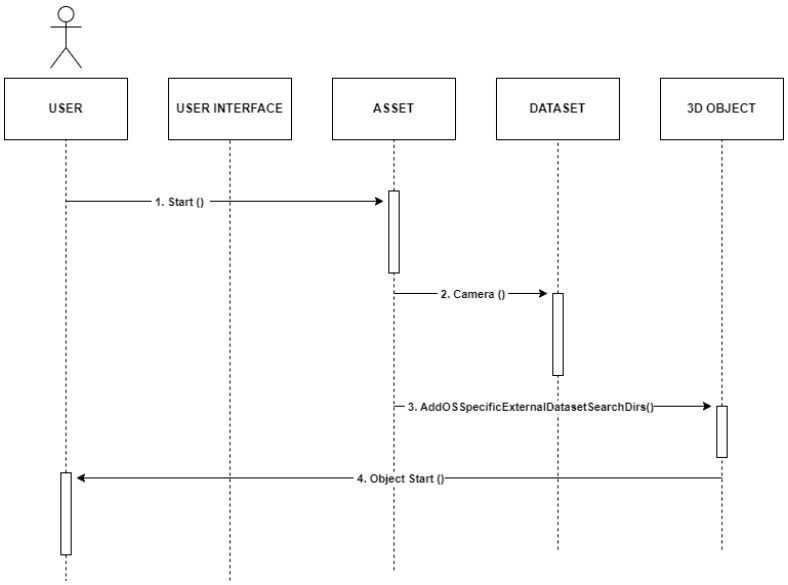

Fig. 2. Sequence Diagram

The figure explains how the system flows to process messages that will be received by the user. The sequence diagram below shows the flow of the main method when the user selects the start menu. The register activity starts with the user opening the start menu page displayed by the register UI. The register UI will contact the User object to execute the start() method. The start() method will go to the register asset to run the camera() method. After successfully registering the dataset, the user will be directed to the register view.

2) Class Diagram

Class diagrams are used to display several classes that exist in the software to be developed. Class diagrams describe the structure and description along with the relationship between one class and another. The following is a class diagram of the hardware recognition augmented reality application.

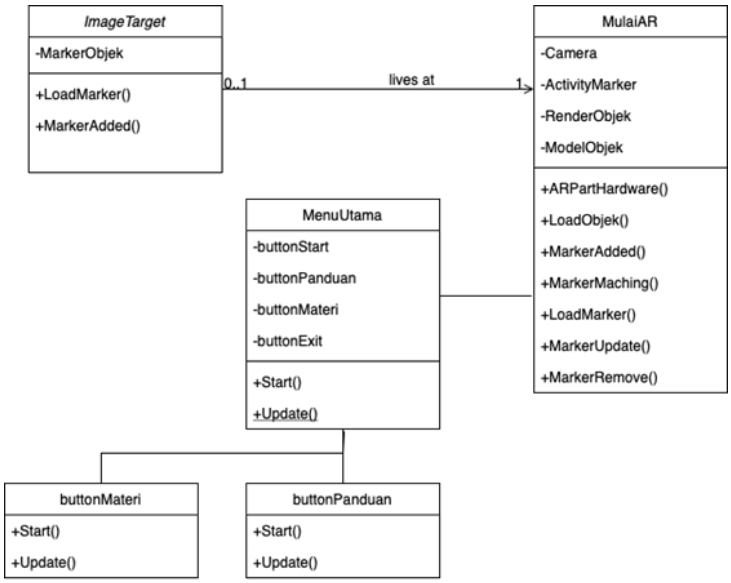

Fig. 3. Class Diagram

C. Physical Design

This application interface design will explain the application interface, 3D object information and hardware-related information. This application aims to facilitate users about hardware information in 3D and related information.

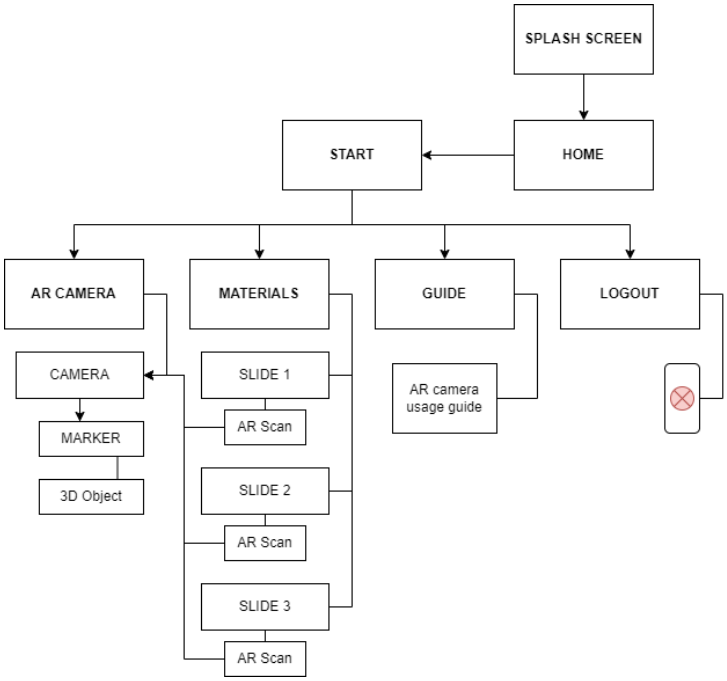

Fig. 4. Application Sitemap

III. DISCUSSION AND RESULT

This section will explain the concept of prototype design and AR program development for interactive learning that will explain the output design of the application. Prototyping and program development is done using Unity tool and Vuforia database with C# programming language.

A. Implementations

1) Splash Screen

The splash screen page is the first display when the user runs the application. The splash screen page is displayed as an opening page before entering the main menu page.

Fig. 5. Splash Screen

2) Home Page

The interface for the Home of the app, appears when the user opens the app.

Fig. 6. Home Page

3) Main Menu

Interface for the main menu of the Hardkom AR application, there are several features in it, namely search AR camera, Material, Guide.

Fig. 7. Main Menu

4) AR Menu

Interface for the AR menu, on this menu there is an option to enter the AR camera.

Fig. 8. AR Menu

5) AR Camera

The interface for the camera is a place to display virtual objects of computer hardware in the form of 3D models.

Fig. 9. AR Camera

6) Materials Menu

Interface for the Material menu, on this menu there is an option to enter the material slide.

Fig. 10. Materials Menu

7) Materials Slide

Interface for the material slide menu, on this menu there are material slides.

Fig. 11. Materials Slide

8) Guide Menu

Interface for the AR Camera usage guide menu.

Fig. 12. Guide Menu

B. Discussion of Result

After the implementation of the application program is complete, then the program testing process is carried out, whether there are errors or not. Application testing is carried out using the black box testing method to find out whether all application functions run as they should. Black box testing is a test conducted to observe the input and output results of software without knowing the code structure of the software.

Table 1. Splash Screen Testing Result

Test Class	Test Scenario	Expected Result	Result
Splash Screen	Open Apps	Display logo and background animation	Successful
	Enter the main menu	Display the logo and background animation, then display the main menu page	Successfull

Table 2. Main Menu Testing Result

Test Class	Test Scenario	Expected Result	Result
Main Menu	Enter the AR Menu	Display AR model options	Successful
	Enter the Materials Menu	Displays material options related to computer hardware	Successful
	Select the Guide Menu	Display the guide menu page	Successful
	Chose the logout button	Apps Closed	Successfull

Table 3. Motherboard Model Testing Result

Test Class	Test Scenario	Expected Result	Result
Select the Motherboard Model	Display AR camera page and Motherboard virtual model	Successfully display the motherboard model	Successfull
	Choosing a Keyboard Model	Display AR camera page and virtual keyboard model	Successfull
	Choosing a Mouse Model	Display AR camera page and virtual mouse model	Successfull
	Choosing a Motherboard Model	Display AR camera page and Motherboard virtual model	Successfull
	Choosing a Hard Drive Model	Display the AR camera page and Hardisk virtual model	Successful
	Choosing a Heatsink Model	Display AR camera page and Heatsink virtual model	Successful
	Choosing an SSD Model	Display the AR camera page and SSD virtual model	Successfull
	Choosing a RAM Model	Display AR camera page and RAM virtual model	Successfull
	Choosing a Processor Model	Display AR camera page and virtual model Processor	Successfull

Table 4. AR Camera Testing Result

Test Class	Test Scenario	Expected Result	Result
AR Camera	Scanning the motherboard marker 	Detect and display the motherboard model 	Successfull
	Scanning the hardisk marker 	Detect and display the hard drive model 	Successfull

	Scanning the hardisk marker 	Detect and display the hard drive model 	Successfull
	Sanning the hardisk marker 	Detect and display the hard drive model 	Successfull

Table 5. QR Code Scan Distance Testing Results

Test Class	Result		
	15 cm distance	30 Cm distance	60 Cm distance
Motherboard Marker	Detected	Detected	Not Detected
Hardisk Marker	Detected	Detected	Not Detected
Heatsink Marker	Detected	Detected	Not Detected
VGA Marker	Detected	Detected	Not Detected

The tables above show the results of testing using black box testing techniques. Based on the results of testing the application, it is concluded that all application features such as menus and application buttons work as they should. Testing a distance of 0cm - 60cm on a 9cm x 9cm marker image can also be detected properly.

IV. CONCLUSION

Based on the test results and analysis in this study, the following conclusions can be drawn:

1. This research successfully developed an Android-based computer hardware introduction learning application named "HARDKOM" or AR Computer Hardware.
2. "HARDKOM" application can be used as an additional learning media for computer hardware introduction material.
3. Based on black box testing of the "HARDKOM" application that has been carried out, it shows that the features in the application run well and the marker can also be detected.

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