IEESE International Journal of Science and Technology (IJSTE), Vol. 13 No. 3, September 2024, 15-21
ISSN : 2252-5297

Development and Evaluation of Android-based Augmented Reality for Computer Network Cable Identification: Improving Technical Education in IT Education

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Abstract. In the increasingly rapid development of technology, it encourages and facilitates human activities. One of them is education, which requires technology to implement the learning system to become effective and flexible. AR combines real and virtual objects in a real-time environment, providing a more immersive learning experience. AR-based applications use 3D objects, making it easier for students to understand network cables more clearly. At SMK YPT Banjarmasin, an AR application with marker-based tracking techniques is used to introduce network cables to 11th grade students of Computer Network Engineering and Telecommunications. By pointing the smartphone camera at the marker, students can see 3D objects and get descriptions, making learning more interesting and easier to understand. Overall, through black box testing of the AR application button when pressed, it performs its function correctly with 100% percentage against 3 different devices.

Key Words: *Augmented Reality, Network Cables, Android*

1. Introduction

Along with the rapid development of science and information technology in the era of modern globalization, technological sophistication is now an important need to facilitate various human activities, such as in the military, government, office, entertainment and others. One of them is the education sector, where the application of advanced technology can provide convenience in the teaching process.

Advances in science and technology, especially information technology, have a great impact on the preparation and implementation of learning strategies. The use of media can not only make the learning process easier and more effective, but also make learning more interesting. The learning process is a communication process that involves three main elements, namely the teacher as the sender of the learning message, the student as the receiver of the message, and the message itself in the form of content. In order to deliver learning messages more effectively, a tool is needed to facilitate the delivery of messages in the form of media [1].

Currently, the use of learning media by teachers, especially those based on information technology, shows a significant increase. The use of mobile devices in learning has become a necessity to facilitate the teaching and learning process. Mobile devices such as laptops, tablets, and smartphones have become a new alternative in learning that presents ease of learning because it can be accessed anytime and anywhere Many technologies have been created to make human life easier. One of them is telecommunication device technology or what we usually call smartphones. Smartphones are not only a telecommunication tool, but have many features that are very helpful in daily life, such as learning media, both learning media in the form of writing and pictures [2]. By using computer-based systems and applications, all data can be stored more efficiently and information processing can be done faster, more accurately and more efficiently. This is certainly much better than the old method that did not use computer technology.

SMK YPT Banjarmasin is a school that operates a vocational education system located at Jalan Rawa-sari ujung rt. 61 no. 1, Teluk Dalam Village, Central Banjarmasin District, Banjarmasin City 70117. The rapid development of information technology today encourages many schools, especially SMK YPT Banjarmasin, to start developing their information technology by creating an Android-based network cable detection application. However, until now, SMK YPT Banjarmasin does not have a computerized information system or Android-based application.

Based on the existing problem, I chose it because I want to provide a solution to the problem. Augmented Reality based applications with marker-based tracking techniques are expected to be a solution to practice network cable recognition at SMK YPT Banjarmasin, especially for grade 11 TJKT, both for teachers and students. The concept of this application is to introduce network cables at SMK YPT Banjarmasin through a camera installed on the user's smartphone. By pointing the camera to the marker, the user will get information related to the desired computer device. As a bonus, when the user points the camera at the marker, they will see the network cable object in 3D along with a description. This makes the learning process more interesting and interactive for students.

Received: April 20, 2024. Revised: July 01, 2024.

2. Literature Review

Augmented Reality provides the ability to present visual elements directly in the real world, making it easier to understand difficult and abstract concepts. According to Bacca et al. (2014), one of the main benefits of AR in education is its ability to display three-dimensional (3D) objects that help students understand previously difficult material, such as anatomical models of the human body, atomic structures, or chemical processes. AR allows students to see and interact with the object directly, increasing their engagement in the learning process [3].

One of the methods that is becoming increasingly popular in education is the use of games (gamification) to increase learning motivation. Dunleavy et al. (2009) showed that AR can be used to create fun and engaging learning experiences through AR-based games. A well-known example is the Pokémon Go app, which integrates the real world with digital elements in the form of games. In an educational context, AR-based games can encourage students to learn while playing, which increases their interest and motivation to understand the material [4].

AR is also being used to enhance practical experiences and active learning in education. Cai et al. (2018) showed that by using AR, students can conduct simulations of experiments or practices without having access to expensive or hard-to-reach equipment. For example, in science, AR can help students conduct risky chemistry or physics experiments, or in architecture learning, where students can design and modify 3D models of buildings that appear in the real world. Such active learning can improve problem-solving and critical thinking skills [5].

The COVID-19 pandemic accelerated the use of technology in education, including the application of AR for distance learning. Ibáñez & Delgado-Kloos (2018) emphasized that AR enables the development of remotely accessible learning content by providing a more immersive learning experience, even when students are not present in the classroom. For example, AR-based learning materials can be accessed through mobile devices or AR glasses, allowing students to interact with the material outside of the designated time and place. This is critical to creating more inclusive and flexible access to education [6].

Based on various studies, AR has been shown to improve student engagement and learning outcomes. Radanti et al. (2020) showed that the use of AR in education can significantly increase student motivation and comprehension compared to traditional learning methods. This is mainly due to AR's ability to provide a more dynamic and interactive learning experience. In addition, AR can also help students overcome learning problems such as lack of attention, interest in the material, or difficulty understanding complex concepts [7].

Although AR has a lot of potential in education, there are some challenges that need to be considered in its implementation. Fowler et al. (2015) identified several obstacles, such as hardware limitations (e.g., mobile devices that are not capable of running complex AR applications), content development costs, and limitations in teacher training to make the best use of this technology. In addition, social and cultural factors also play an important role in the acceptance of this technology in educational settings. Therefore, more research is needed to address these challenges and develop more effective solutions [8].

In an AR study conducted by Ana Yulianti et al. (2019), the folk tale "Batu Belah Batu Bertangkup" was explored using augmented reality technology. Based on the user validation, 90% of the respondents strongly agreed that the folktale should be presented in augmented reality [9].As for other studies on AR, Nunditya et al. (2017) focused on plants using augmented reality technology. The implementation results show that the created application is consistent with the planned design. During the alpha testing, each feature of the application was tested with positive results. The average time to scan a marker was 65.9 milliseconds. Respondent satisfaction was 89.3-89.[10] and other research conducted by Ilham M et al. 2021 raised the issue of learning local area network wiring for vocational high school students. produced on the black box testing on the AR-based LAN wiring learning application implemented with the description of all successes, and based on the background and research objectives of this Augmented Reality solution made with the description of successes [11].

Augmented Reality has great potential to change the way we learn and teach. This technology not only improves the understanding of abstract concepts, but also makes learning more fun, interactive, and practical. However, there are still challenges to using this technology in education, such as limited devices and lack of training. With further research and development, AR can be a very effective tool for improving the quality of education in the future.

Problems found in learning research in schools show that the use of media in the form of books and projectors makes the learning process less attractive to students. In Computer Network and Telecommunications Engineering (TJKT), which is based on books, students feel less involved. However, Augmented Reality (AR) technology can make the learning process more interesting and make it easier for students to understand the material, especially in learning the types of network cables and their explanations.

3. Proposed Methodology

In this system, several things are proposed that are the limitations of the problem that will be provided with solutions or alternatives with the intention of explaining the needs that must be met by the system to be designed. Based on the results of the analysis, an augmented reality application for computer device recognition will be created using Unity software.

Received: April 20, 2024. Revised: July 01, 2024.

The design of this game uses object-oriented modeling analysis using UML (Unified Modeling Language). This design identifies the components of a system that is designed in detail, consisting of a use case diagram, activity diagram, and sequence diagram. Use case diagrams are used to illustrate how a system to be built works so that users can more easily understand it. Here's a use case diagram for AR applications in Figure 1.

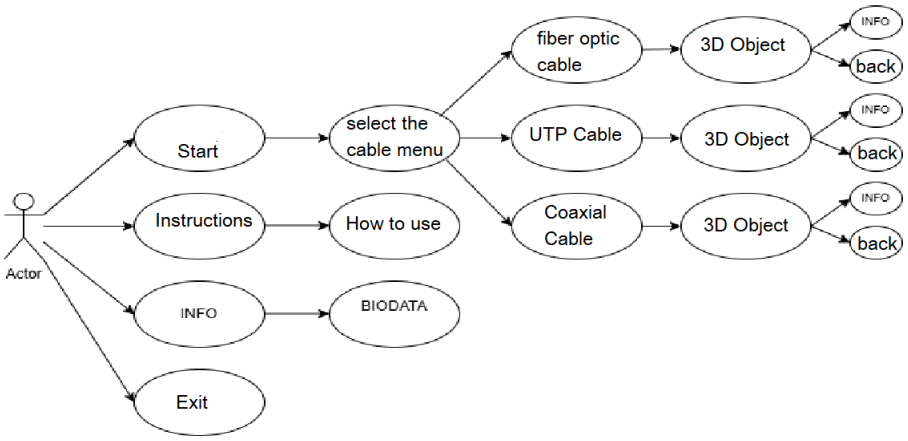

Figure 1. Use Case Diagram AR Application

From the use case image above, we can see that when the user accesses the application, there are 4 main menus, namely Start, Instructions, Info, and Exit. In the Start menu, the user can first select a menu before the augmented reality starts after the user selects one of the menus. Before accessing the existing functions, the user first points the camera at the predetermined marker, then the system initializes the marker and displays a 3D object with information related to the device. The process of displaying AR is explained in Figure 2.

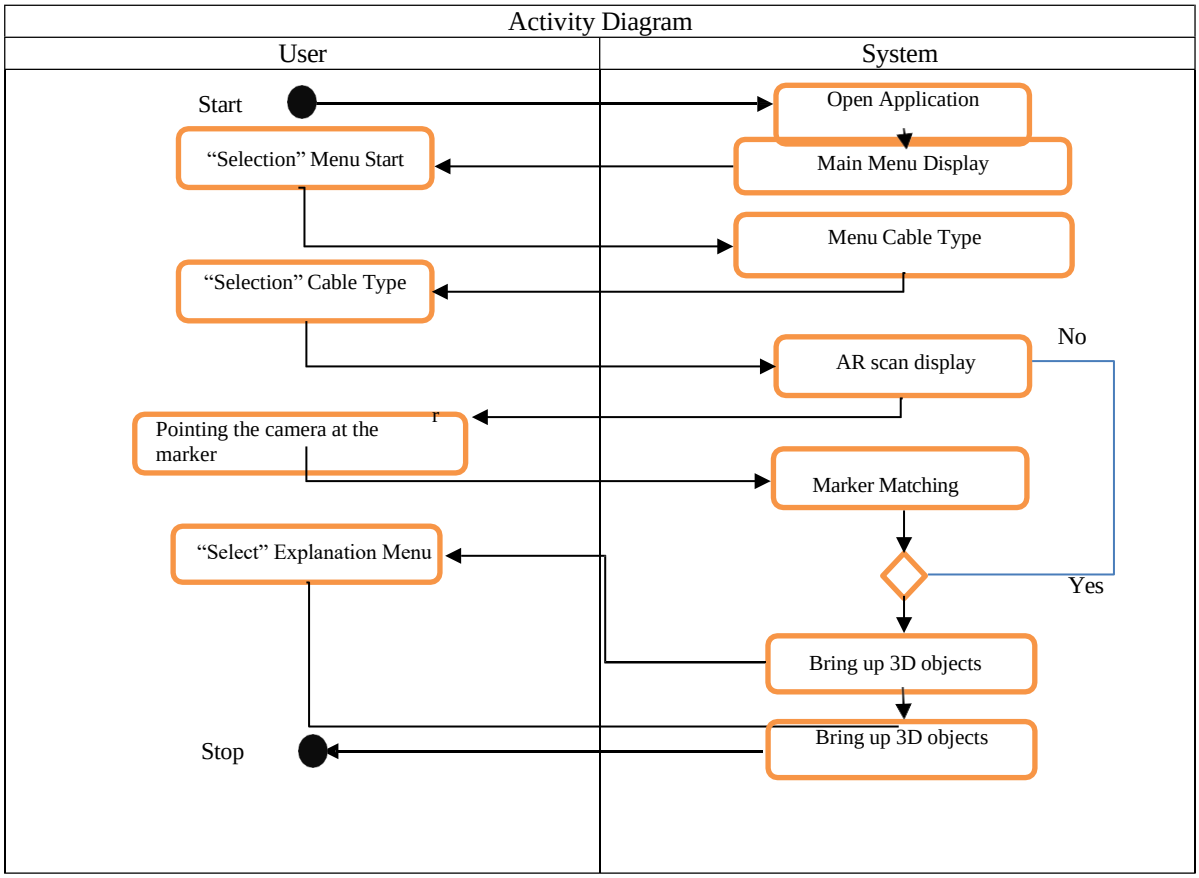

Figure 2 Activity Diagram Displaying AR

In Figure 2, the activity diagram shows AR explaining that when the user opens the application, the system displays a splash screen, then the main menu page appears, the user selects the start menu button, then the system displays the cable type menu that the user will select, then the user selects the cable type, then the system displays the augmented reality camera mode, the user hovers the camera over the network cable type marker, then the system matches the marker, if yes, then the system displays a 3D object of the network cable type selected by the user, otherwise the system re-reads the marker, then the user selects the Explanation button, then the system displays the description of the selected network cable, the user selects the Back button, then the system returns to the network cable menu selection.

4. Implementation Result

The implementation phase is a continuation of the design phase. In this stage, the designed system is implemented and tested. Here are the specifications of the hardware used to develop augmented reality applications to get to know computer network cables in Table 1.

Table 1. Hardware Spesification. Source: (Research Data, 2024)

Hardware	Information
Device	Acer Aspire 3
Processor	Intel Celeron N5100 @1.10Ghz
Memory	4 Gb
SSD	256 Gb
Graphics	Intel UHD Graphics
Camera	Webcam 640x480
Screen size	14 Inch HD LED LCD

The following are the specifications of the software used to create the augmented reality application of computer network cable recognition in Table 2.

Table 2. Software Spesification. Source: (Research Data, 2024)

Software	Information
Operating system	Windows 10 Pro 64-bit
Software	Unity, Blender

The following is an implementation of the created application, namely computer device detection augmented reality. The following is the augmented reality display for computer network cables:

a. Splash Screen Page View

Here is the display of the computer network cable introduction splash screen augmented reality in Figure 3.

Figure 3 Splash Screen Display Results

In figure 3. Splashscreen is the first home screen that appears in the application in the form of an image before entering the application page when running on a smartphone.

b. Main Menu Page View

Here's what the main augmented reality menu display of computer network cabling looks like Figure 4.

Figure 4 Main Menu Display Results

In Figure 4. Main menu, users can select 4 menu buttons, namely Start, Exit, Hint and Info. Start button to start the AR application, Exit button to close the application, Hint button to display instructions on how to use the application, Info button to display the creator's information.

c. Cable Select Page View

The cable selection page looks like this Figure 5.

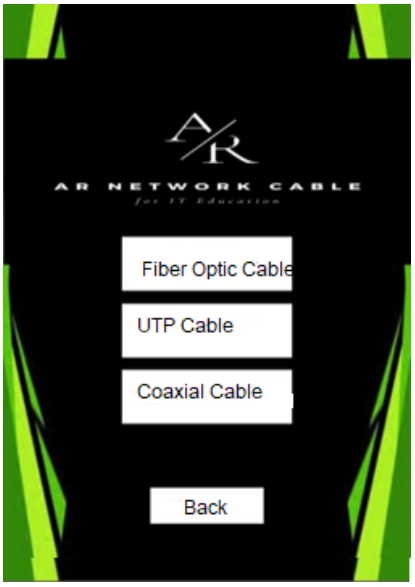

Figure 5 Results of the Select Computer Network Cable Page Display

in Figure 5. Computer Network Cable Selection Page Users can select the cables to view in 3D and their descriptions.

d. 3d object display AR fiber optic cable

Here is a 3d object display of AR fiber optic cable in Figure 6.

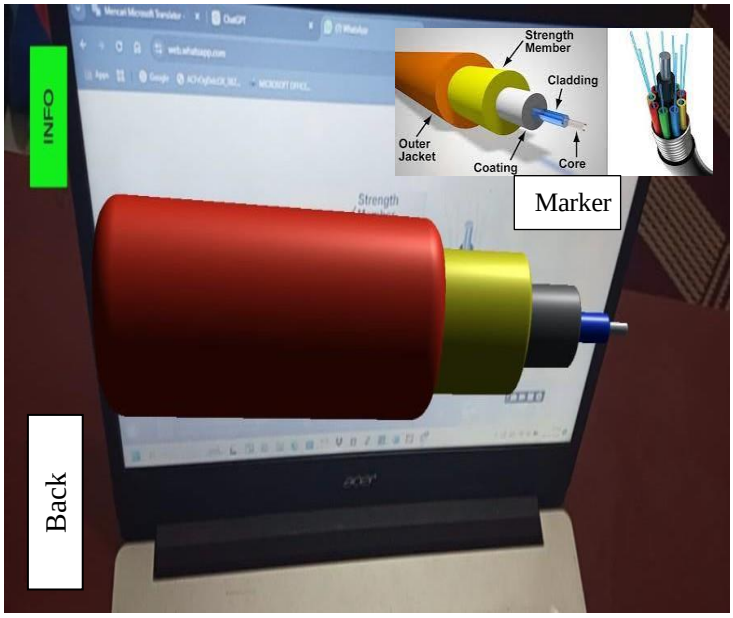

Figure 6. 3D object page view results AR fiber optic cable

In Figure 6. The 3D AR object of the fiber optic cable, contains a 3D object and then there are 2 buttons, namely, the back button to return to the page of the cable selection menu, and the info button to display the description of the fiber optic cable.

e. Fiber Optic Cable Info Page View

The following is the view of the information of the fiber optic cable shown in Figure 7.

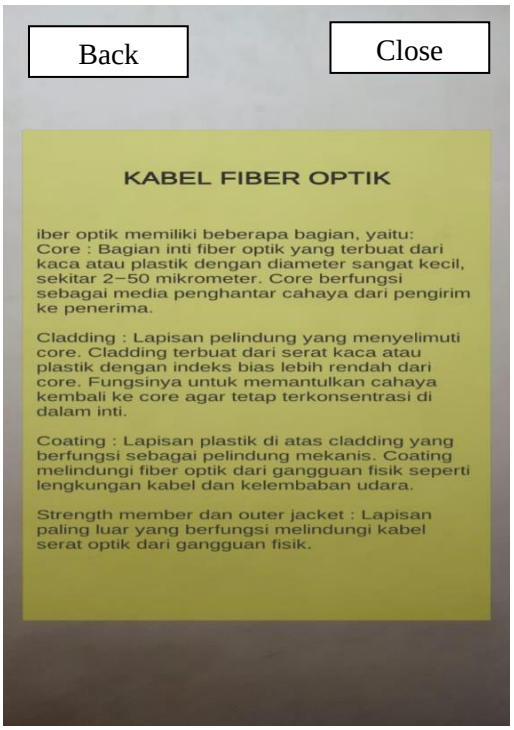

Figure 7. Fiber Optic Cable Info Page View

In Figure 7, there is a description of the fiber optic cable, a Close button to close the description popup, and a Back button to return to the cable selection.

5. Conclusion

With the existence of an augmented reality application for the introduction of computer network cables, the author can conclude that this application is very effective as a learning medium at SMK YPT Banjarmasin. This application makes it easier for students to understand and learn about computer network cables in a more interactive way.

In addition, this application also helps teachers to deliver material in a more interesting and easy to understand way for students, especially in introducing computer network cables. By using this application, students of SMK YPT Banjarmasin can gain a clearer knowledge of computer network cables, which can ultimately improve their understanding of the material being taught. Overall, through black box testing on the AR application button when pressed, it performs its function correctly with 100% percentage against 3 different devices.

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Received: April 20, 2024. Revised: July 01, 2024.