Journal of Artificial Intelligence and Engineering Applications

Website: https://ioinformatic.org/

15th October 2025. Vol. 5. No. 1; e-ISSN: 2808-4519

Augmented Reality-Based Medical Equipment Learning Application

Nur Annisa Hasanuddin[1]*, Andi Wafiah[2], Hasnawati[3]

[1,2,3]Informatics Engineering Study Program, Muhammadiyah University of Parepare
Corresponding author E-mail[1], Corresponding author E-mail[2]*

Abstract

The rapid development of information technology offers significant opportunities for innovation in learning media, particularly in the healthcare field. One technology that can be utilized is Augmented Reality (AR), which allows users to directly interact with virtual objects in three-dimensional form. This study aims to design and develop an AR-based medical equipment learning application to help students recognize and understand medical instruments more effectively and interactively. The application was developed using Unity and Blender to create 3D object visualizations and was tested using black box and white box testing methods to ensure system reliability. The test results show that the application runs well and is positively received by users, as it can display interactive 3D models of medical equipment, provide descriptions, and offer evaluation quizzes. Therefore, this application has the potential to serve as an innovative supplementary learning medium, addressing the limitations of laboratory equipment and enhancing students' understanding of medical instruments.

Keywords: *Augmented Reality, Learning Application, Medical Equipment, Android, Interactive Media*

1. Introduction

Learning media are tools or resources used in the educational process to deliver information and facilitate understanding of the material [7]. These media can take the form of teaching materials, visual aids, or digital platforms such as videos, animations, multimedia presentations, or interactive applications. The effective use of learning media plays a crucial role in introducing new material, as it can increase students' interest, motivation, and comprehension, including in the learning of medical equipment.

One technology that can be utilized in interactive learning media is Augmented Reality (AR). AR enables the display of virtual objects in two- or three-dimensional form within the real world through devices such as smartphones. This technology allows students to visually and interactively explore medical equipment without having to use the physical tools directly in a laboratory. It also provides an effective solution to the common limitations of medical equipment availability and the high costs associated with procurement.

Today, smartphones are not only used for communication, entertainment, and information access, but also as a platform for AR-based learning. Through AR learning applications, students can interactively access information about medical tools, including their form, function, and usage [1]. With the rapid advancement of technology in Indonesia, the integration of multimedia learning with AR presents a promising innovation in the field of education.

The AR-based medical equipment learning application developed in this study is designed to provide an in-depth learning experience through realistic digital 3D visualizations of medical tools. This application is expected to expand students' knowledge of medical equipment without relying entirely on the availability of physical tools in laboratories. As such, this research offers an innovative step toward supporting more effective, interactive learning that aligns with current technological developments.

Furthermore, the adoption of AR-based learning in healthcare education not only addresses equipment limitations but also supports independent and self-paced learning. By providing interactive 3D visualizations, descriptive content, and evaluation tools, this application enables students to actively engage with the material, reinforcing both theoretical understanding and practical skills. Ultimately, this research is expected to contribute to the development of innovative learning strategies in medical education, fostering improved competency among future healthcare professionals.

2. Theoretical Foundations

2.1. Application

An application is a computer program designed to perform specific functions according to user needs. Applications can be used on various devices, ranging from computers to mobile devices, and are available in different types such as educational, business, and entertainment applications. In the educational context, applications serve as a medium for accessing, managing, and delivering learning materials in a more interactive and flexible manner [6]. Mobile-based applications have become increasingly popular because they can be accessed anytime and anywhere, supporting a learning process that is not limited by time and location.

2.2. Learning Media

Learning media refers to any form of tool or resource used to convey messages and facilitate the teaching and learning process. These media can take the form of printed materials, visual aids, interactive multimedia, or digital applications. The proper use of learning media can increase learning interest, motivation, and effectiveness [3]. In health education, digital learning media make it easier to present visual materials that are difficult to explain verbally, such as the form and function of medical equipment.

2.3. Medical Equipment

Medical equipment refers to instruments, apparatus, machines, or implants used to prevent, diagnose, treat, or restore a patient's health. Examples include stethoscopes, thermometers, defibrillators, and incubators. Mastery of medical equipment knowledge is essential for healthcare students to support practical skills and the quality of medical services. However, the limited availability of medical tools in educational laboratories often becomes an obstacle in the learning process, making technological innovations necessary to overcome these challenges [5].

2.4. Android

Android is a Linux-based, open-source operating system developed by Google. It is widely used on mobile devices due to its flexibility, large application ecosystem, and support for the latest technologies. The platform also supports the development of AR-based applications with good performance across various types of devices. Utilizing Android for learning media offers advantages in terms of cost, device availability, and ease of application distribution [2].

2.5. Augmented Reality (AR)

Augmented Reality is a technology that integrates two- or three-dimensional virtual objects into real-world environments in real time [4]. AR allows users to directly interact with digital objects as if they existed in the physical environment, thereby increasing engagement and understanding. In medical equipment learning, AR can present the form, function, and operation of medical tools interactively, helping students understand the material without having to use physical equipment directly (Wahyuddin & Hasnawati, 2023).[8]

3. Research Methodology

This study employed a qualitative approach focusing on an in-depth understanding of medical equipment. Such an approach enables the exploration of users' perceptions, needs, and experiences related to the use of a medical equipment learning application. The application was developed using Unity and Blender software to create 3D object visualizations. Data were collected through observation, interviews, and literature review. The research was conducted at the Fatimah Nursing Academy in Parepare City over a period of approximately two months in 2024.

3.1. Use case diagram

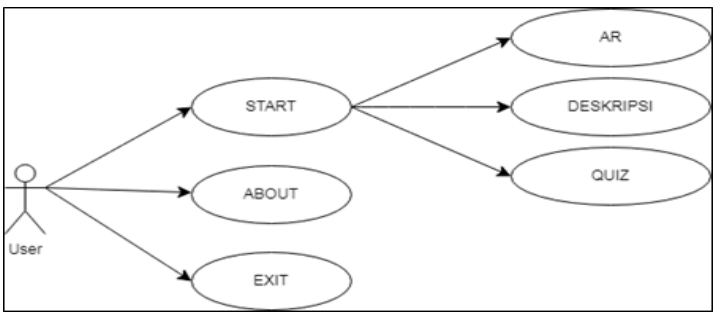


Fig. 1: Use Case Diagram

The diagram above illustrates the flow of application usage by the user, beginning with three main options: Start**,** About, and Exit. When selecting Start**,** the user can proceed to three learning features: AR to display interactive 3D objects, Description to view explanatory material, and Quiz to test understanding through quizzes. Meanwhile, the About menu provides information about the application, and Exit is used to close the application.

4. Results and Discussion

4.1. Interface Implementasi

1. Initial Screen



Fig. 2: Initial screen

Figure 2 shows the simple initial screen of the application. At the top, there is the application title written in uppercase and bold letters, clearly highlighting the identity of the application. There are three main buttons arranged vertically Start**,** About, and Exit each functioning to access the main features, view application information, and exit the application

2. Main Menu



Fig. 3: Main menu

Figure 3 presents the main menu page of the application, consisting of three main feature options: AR**,** Description, and Quiz. Users can choose to view medical equipment objects in Augmented Reality, read explanations or descriptions of the equipment, or test their knowledge through quizzes. The interface is designed to be simple and user-friendly.

3. AR (Augmented Reality) Feature

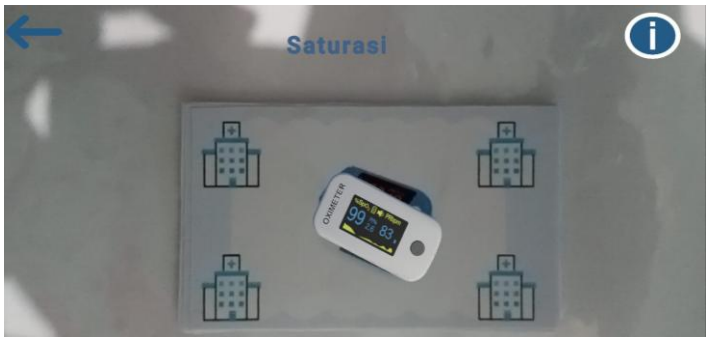


Fig. 4: AR (Augmented Reality) feature

Figure 4 displays the AR (Augmented Reality) feature of the application, which allows users to view 3D models of medical equipment in real-world settings through the device's camera. When this feature is accessed, users can point the camera at the 3D medical equipment objects, rotate, zoom in, and observe the details of each tool interactively, thereby enhancing understanding of their form and function. This application also includes a YouTube video link that provides visual explanations of how each piece of equipment is used.

4. Description Page



Fig. 5: Description page

Figure 5 shows the description page of the application, which provides complete information about the displayed medical equipment. Each item includes a general explanation, its main function, and its usage instructions. This page is also equipped with a YouTube video link that offers a visual demonstration of how each medical tool is used.

5. Quiz Page



Fig. 6: Enter name

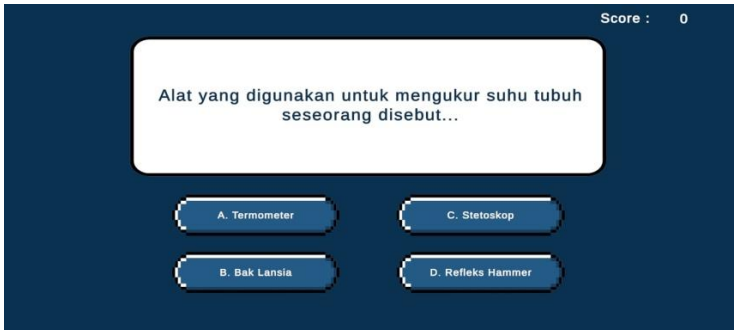


Fig. 7: Quiz page

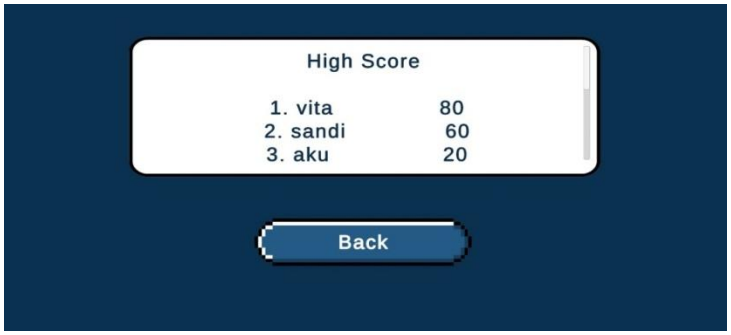


Fig. 8: Final score page

The figure above shows the Quiz page, where users are presented with questions related to the medical equipment they have learned about. Each question is accompanied by several answer choices, and users are required to select the correct one. If the chosen answer is

correct, they can proceed to the next question. This feature is designed to test users' understanding in an interactive and engaging way. Users enter their name, start the quiz, and then select the correct answers.

6. About Page

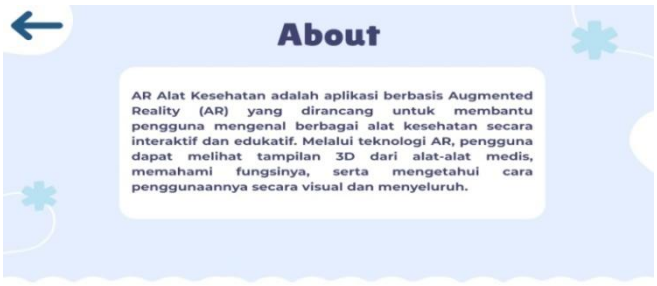


Fig. 9: About Page

Figure 10 shows the quiz page, where users are presented with questions related to the medical equipment they have studied. Each question has multiple-choice answers, and users must select the correct one. If the chosen answer is correct, they can proceed to the next question. This feature is designed to test the user's understanding in an interactive and enjoyable way. Before starting, users are required to enter their name and then proceed to answer the questions.

4.2. Black Box Testing

This testing uses the *Black Box Testing* method, which focuses on testing the system's functionality without directly examining the source code. The purpose is to ensure that each function in the Augmented Reality-based medical equipment learning application works as expected. The results of the *Black Box* testing are presented in the table below.

Table 1: Black Box Testing

Function Name	Form of Testing	Description	Test Result
Launch Application	Open the application	The application opens and displays the main page	Success
Main Menu	Access the main menu page	Displays three feature options: AR, Description, and Quiz	Success
Quiz	Click the Quiz button, enter a name, and select answers	Users must enter their name before the quiz starts. The system displays quiz questions, proceeds to the next question and shows the final score at the end	Success
AR Feature	Click the Start button in the main menu	Displays 3D medical equipment models in Augmented Reality along with a link to a YouTube video explaining how to use each tool	Success
Medical Equipment Description	Click the Description button in the main menu	Displays complete information about the medical equipment	Success
Exit	Click the Exit button	Closes the application	Success
About	Click the About button	Displays information about the application	Success

Based on the testing results, all functions were found to operate correctly, achieving a 100% success rate.

4.3. White Box Testing

White Box testing of one of the application's features, demonstrating the results of program logic path testing (path testing) on that feature. This testing was carried out to ensure that each independent path in the flowgraph operated according to the designed logic.

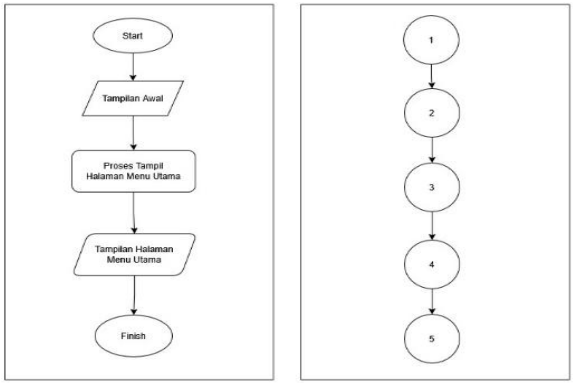


Fig. 10: White Box Testing

1. Calculating Cyclomatic Complexity V(G) based on Edges and Nodes

The formula: V(G) = Cyclomatic complexity

E = Number of edges
N = Number of nodes
P = Predicate nodes

Calculation: V (G) = E – N + 2
= 4 – 5 + 2
= 1

Solution (P) = P + 1
= 0 + 1
= 1

2. Based on the cyclomatic complexity calculation from the above flowgraph, the value is: 1
3. The independent path in this flowgraph is:
   Path 1 = 2 – 3 – 4 – 5
4. Initial Menu Matrix Graph

Table 2: White Box Testing

	1	2	3	4	5	E-1
1		1				1 - 1 = 0
2			1			1 – 1 = 0
3				1		1 – 1 = 0
4					1	1 – 1 = 0
5						0
	SUM (E + 1)					0 + 1 = 1

The White Box testing results for the AR feature show that all logical paths (independent paths) have been tested and functioned as intended.

5. Conclusion

Based on the results of the research and development conducted, it can be concluded that the Augmented Reality (AR)-based medical equipment learning application is capable of serving as an interactive and engaging educational medium to help users understand various types of medical equipment visually and informatively. By utilizing AR technology, the application can display 3D models of medical tools in real-time through a mobile device camera, allowing users to see the shape, function, and name of the equipment in a more realistic and enjoyable manner.

Application testing showed that users, both from student groups and beginner healthcare professionals, responded positively to the use of AR in the learning process. The application has proven effective in increasing learning interest and enhancing understanding of materials that were previously difficult to grasp using only two-dimensional images or text.

Therefore, this application is suitable for use as a supplementary learning medium, particularly in health education, and has the potential to be further developed by adding more interactive features and expanding the range of medical equipment covered.

6. Suggestions

Following the completion of this research, the author provides the following suggestions:
1. Further develop the AR-based medical equipment learning application by adding additional interactive features such as animated quizzes on medical equipment functions or virtual simulations of how to use the tools.
2. Expand the collection of medical equipment to include tools from various medical fields to ensure more comprehensive learning coverage.
3. Enhance the application's usability and accessibility so it can benefit users from various educational and professional backgrounds.

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