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Simulation Application for Personal Computer (PC) Assembly Using Augmented Reality Technology on Android Platform

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Abstract. The rapid growth of information and communication technology has introduced new opportunities in education, including the use of Augmented Reality (AR). This study presents the development of an AR-based simulation application for Personal Computer (PC) assembly on Android devices. The application is designed to provide an interactive and structured learning experience, particularly for vocational high school students and technology enthusiasts. The development process follows the Multimedia Life Cycle method, consisting of concept, design, material collection, assembly, testing, and distribution. Through 3D visualizations, users can explore and interact with PC components, enabling independent learning without requiring physical hardware. The application was evaluated through Alpha and Beta testing to measure its effectiveness in improving technical knowledge and assembly skills. The results indicate that it enhances learning motivation, conceptual understanding, and technical competence while offering an engaging and immersive learning experience. Further development is recommended to improve device compatibility and add interactive features. This application demonstrates the potential of AR as a modern technology-based learning tool that supports digital literacy and student competencies in the digital era.

Key-words: *Augmented Reality, PC Assembly, Multimedia Life Cycle, Interactive Learning, Vocational Education*.

1. Introduction

The rapid advancement of information and communication technology has transformed various aspects of human life, including education. Among the innovations reshaping educational practices is Augmented Reality (AR), a technology that integrates real-world environments with interactive digital elements. AR offers the potential to revolutionize how students engage with learning materials, particularly in technical and practical fields.

Personal Computer (PC) assembly is an essential skill for vocational high school (SMK Muhammadiyah 2 Banjarmasin) students and technology enthusiasts seeking to deepen their understanding of hardware systems. However, traditional learning methods, such as textbooks and video tutorials, often fall short in providing a hands-on experience or a comprehensive understanding of the intricate assembly process. These methods lack interactivity and fail to replicate the real-world challenges faced during PC assembly.

To address these challenges, this study aims to develop a simulation application utilizing AR technology, designed specifically for Android devices. The application allows users to visualize and interact with 3D models of PC components, offering a step-by-step guide to the assembly process. This immersive and interactive approach not only bridges the gap between theoretical knowledge and practical skills but also minimizes the risks associated with handling physical components during training.

The AR-based simulation application is intended to provide an accessible and effective learning tool that enhances technical understanding, boosts confidence, and fosters interest in technology-related subjects. By leveraging widely available Android devices, the application ensures flexibility and ease of access for users, enabling them to learn anytime and anywhere.

This study explores the design, development, and evaluation of the application, assessing its effectiveness in improving users' understanding and skills in PC assembly. Through this initiative, the research seeks to contribute to the development of innovative educational tools that align with the needs of 21st-century learners, promoting technological literacy and competency in the digital era.

2. Literature Review

The integration of Augmented Reality (AR) technology into education has gained significant attention in recent years due to its ability to merge real-world environments with interactive virtual components. AR has been widely recognized for enhancing educational experiences by providing immersive and engaging learning environments, particularly in technical and vocational education (Azuma, 1997; Billinghurst & Duenser, 2012).

PC Assembly as a Learning Context

Personal Computer (PC) assembly involves combining various hardware components, including processors, motherboards, RAM, and storage devices, into a functioning computer system. Traditionally, the process is

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taught using static materials, such as textbooks or instructional videos, which often fail to convey the complexity of the task effectively (Smith, Johnson, & Edwards, 2020). These methods lack the interactive and hands-on experience required for students to fully understand the intricate details of PC assembly.

The Role of AR in Technical Education

AR technology offers a unique opportunity to address these limitations. It enables users to interact with 3D representations of objects in real-time, providing a realistic simulation of complex processes (Wu, Tsai, & Hsu, 2019). In technical education, AR has been shown to enhance conceptual understanding and practical skills, particularly in tasks requiring precision and step-by-step execution. Research by Lee and Kim (2020) demonstrated the effectiveness of AR-based learning tools in improving students' performance in electronic component assembly. The study highlighted that AR allows learners to practice tasks repeatedly in a risk-free environment, fostering confidence and competence.

Effectiveness of AR in Enhancing Learning Outcomes

Studies have consistently found that AR enhances learning outcomes by making abstract concepts tangible and interactive. Bacca et al. (2014) noted that AR applications promote higher engagement levels and deeper learning by allowing users to visualize and manipulate virtual objects in real-world contexts. In PC assembly, AR-based simulations can provide a detailed understanding of component connections and functional relationships, minimizing errors and enhancing practical skills (Chen, Wang, & Liu, 2022).

Challenges in Implementing AR

Despite its potential, implementing AR in education presents challenges. These include the need for advanced hardware, software compatibility, and technical expertise for developing and deploying AR applications (Billinghurst & Duenser, 2012). Additionally, the cost and accessibility of AR-capable devices may limit its widespread adoption in certain regions. Addressing these challenges requires careful consideration of resource constraints and user needs during the development process.

Relevance of Android Platforms for AR Applications

Android, as a widely used mobile operating system, provides a cost-effective and accessible platform for delivering AR applications. With tools like AR Core, developers can create AR-based educational applications that run efficiently on a broad range of devices (Rahman, Abdullah, & Hartono, 2021). This accessibility ensures that users, particularly students in resource-limited environments, can benefit from AR technology without requiring specialized equipment.

Existing Studies on AR-Based PC Assembly Simulations

Previous research has explored AR-based applications for technical training, such as machine assembly and electronic component installation (Wu et al., 2019; Lee & Kim, 2020).
However, limited studies focus specifically on PC assembly simulations. This gap highlights the need for applications that cater to this niche, leveraging AR to simplify complex processes and provide a structured learning experience.

3. Proposed Methodology

This study adopts the **Multimedia Development Life Cycle (MDLC)** methodology, which includes six systematic stages: concept, design, material collection, assembly, testing, and distribution. These stages ensure the structured and efficient development of the AR-based simulation application for PC assembly on the Android platform.

3.1. Concept

The concept stage involves defining the purpose, objectives, and target audience of the application. The primary goal is to develop an interactive AR-based simulation application that simplifies the PC assembly learning process. The target audience includes vocational high school students and technology enthusiasts. The application aims to enhance technical understanding, reduce assembly errors, and provide a realistic and engaging learning experience.

3.2. Design

The design phase focuses on creating the application's interface and user interaction flow. Key elements include:

- **Navigation Structure**: A hierarchical structure is developed to connect menus such as "AR PC," "Tips PC," "Help," and "About."
- **User Interface (UI)**: The UI is designed for simplicity and intuitiveness, ensuring accessibility for users with varying levels of technical expertise.
- **3D Models and Animations**: High-quality 3D models of PC components are created, including processors, motherboards, RAM, and other hardware. Animations are integrated to demonstrate assembly steps interactively.

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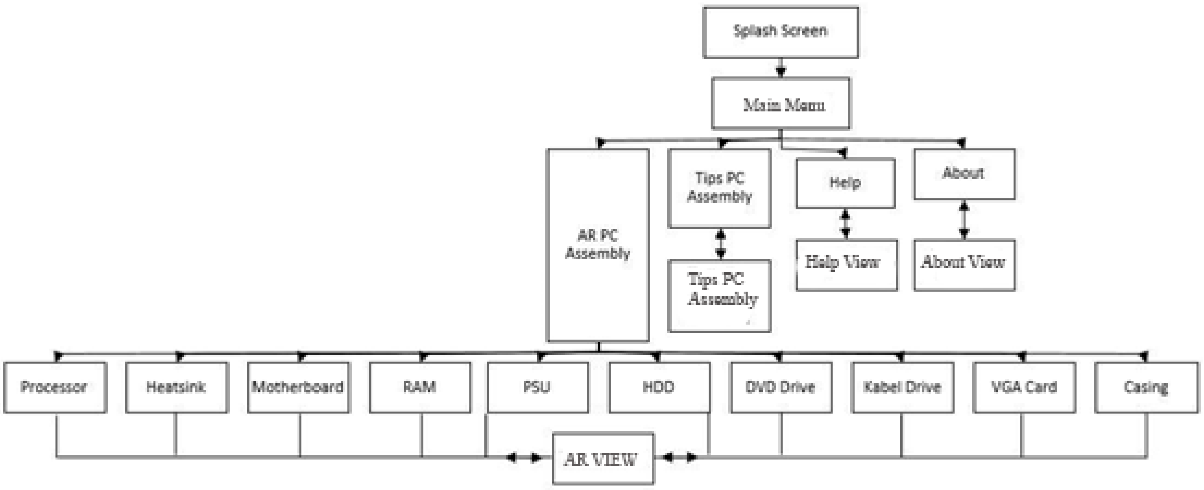

Figure 1. Use Case Diagram AR Application

3.3. Material Collection

This stage involves gathering all resources required for application development, including:

- **3D Models**: Accurate representations of PC components with detailed textures.
- **Audio Files**: Sounds for navigation and transitions to enhance user experience.
- **Technical Data**: Accurate information about component functions and assembly procedures.

3.4. Assembly

The application is developed using Unity, a versatile game engine, with AR Core for Android integration. The process includes:

- Importing 3D models, textures, and audio into Unity.
- Creating interactive AR functionality using AR Core SDK.
- Implementing user interactions through touch gestures, enabling users to rotate, zoom, and interact with 3D models.
- Writing scripts in C# for functional components such as navigation, animations, and guidance.

3.5. Testing

Testing is conducted in two phases:

- **Alpha Testing**: Focuses on identifying and resolving technical issues, ensuring that all features function as intended.
- **Beta Testing**: Evaluates user experience and effectiveness through questionnaires and interviews with target users. Feedback is used to refine the application and address usability concerns.

3.6. Distribution

The final application is distributed via platforms like Google Play Store and cloud storage. Detailed user guides are included to assist with installation and operation. Accessibility is prioritized to ensure the application is widely available to the target audience.

Data Collection and Analysis

Quantitative and qualitative data are collected using:

- **Questionnaires**: Assess user satisfaction and understanding before and after using the application.
- **Interviews**: Explore user experiences and gather suggestions for improvement. The data is analyzed using statistical methods to evaluate the application's impact on users' technical skills and learning outcomes. Expected Outcome

The proposed methodology aims to produce a user-friendly AR-based simulation application that provides an interactive and effective learning platform for PC assembly. The application is expected to enhance users' technical skills, boost confidence, and offer a modern solution for technical education in the digital era.

4. Experimental Result and Discussion

4.1. Experimental Results

The experimental results highlight the effectiveness and functionality of the AR-based simulation application for PC assembly on the Android platform. The application was tested through a series of evaluations focusing on user interaction, learning outcomes, and system performance.

Splash Screen Display

The Splash Screen is the first page displayed when users access the application. The interface design can be seen

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on figure 2.

Figure 2. Splash Screen Display Results

4.3. Main Menu Display Results

This page contains 5 buttons, namely the AR pc button, Info pc, About, and help, quit from the application. The interface result can be seen on Figure 3:

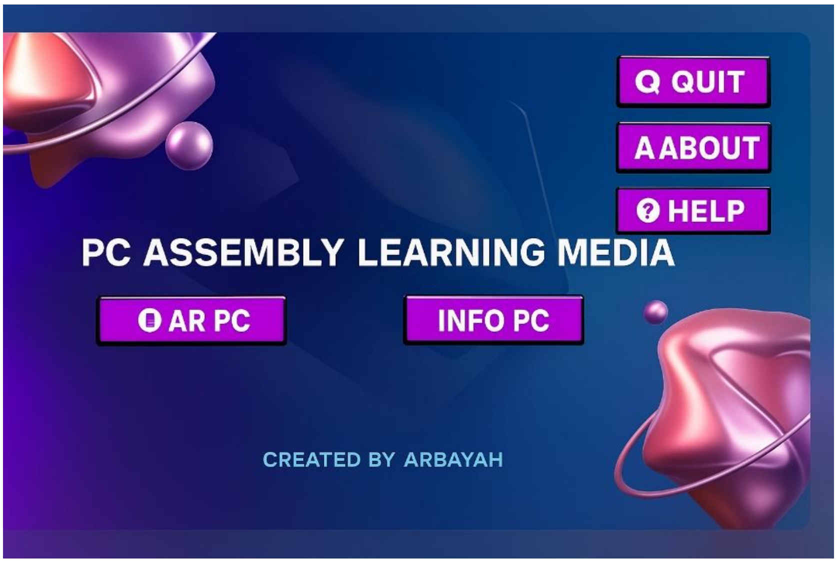

Figure 3.Main Menu Display Results

4.4. Result of the AR PC Selection Page Display

The AR PC selection menu page is the page that will be displayed when the user presses the start button. and this page contains information about PC components, namely pressing the CPU button, CMOS battery, VGA card, RAM, processor, power supply, motherboard, heatsink, hard disk, DVD ROM. The result of the page can be seen on Figure 4:

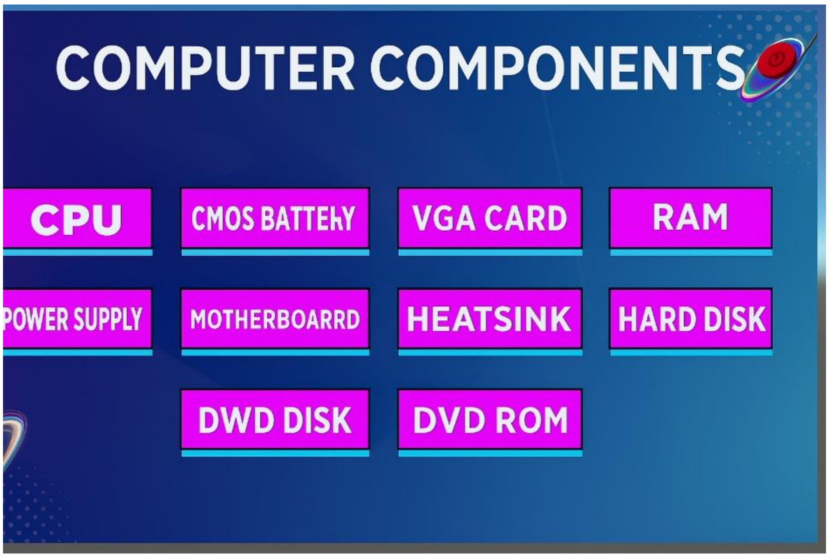

Figure 4.Display Result of AR PC Selection Page

Figure 4.4 Display Results of PC Components Page

4.5. Result of the PC Info Page Display

The PC Info menu page is the page that will be displayed when the user presses the start info button. This page contains steps for assembling a PC. The result of the page can be seen in on Figure 5:

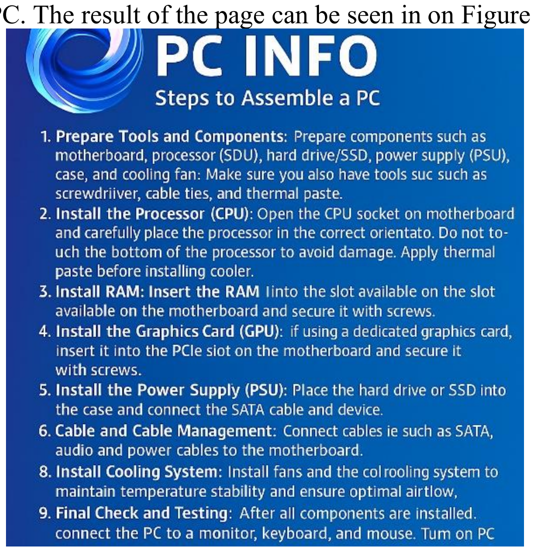

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Figure .5 PC Info Display Result

4.6. Result of the ABOUT US Page Display

The ABOUT US menu page is the page that will be displayed when the user presses ABOUT. This page contains the profile of the AR creator. The result of the page can be seen in Figure 6:

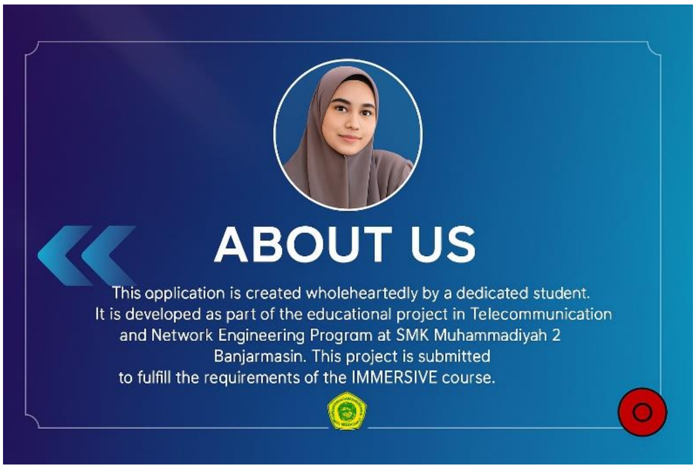

Figure 6 Display Result of ABOUT

4.7. Result of the HELP Page Display

The HELP menu page is the page that will be displayed when the user presses HELP. This page contains information that can be accessed when assistance is needed. The result of the page can be seen in on Figure 7:

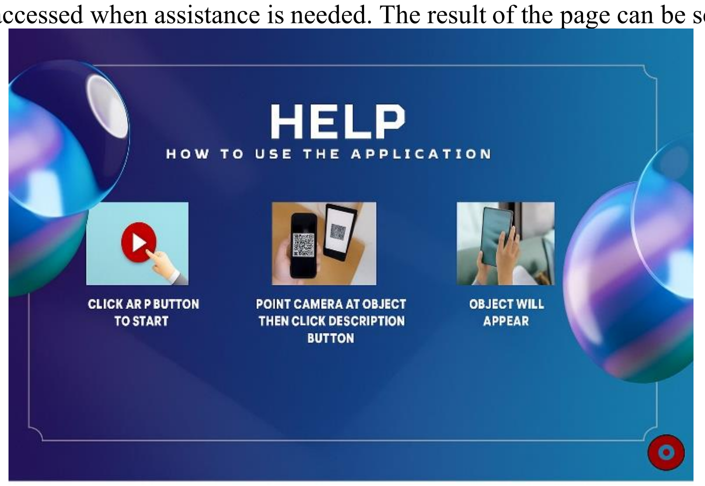

Figure 7 HELP Display Result

4.8. Discussion

4.8.1. The Role of AR in Enhancing Learning

The results affirm the transformative potential of AR in technical education. The ability to visualize and interact with 3D models allows users to bridge the gap between theoretical knowledge and practical skills. Compared to traditional learning tools like books or videos, the AR-based application offers a more engaging and interactive experience.

4.8.2. User Engagement and Accessibility

Feedback from users indicated high levels of engagement. The AR environment allowed users to practice PC assembly steps repeatedly, building confidence and familiarity with the components. The choice of Android as the platform ensured accessibility, making the application available to a wide audience, including those with limited resources.

4.8.3. Limitations and Challenges

While the application proved effective, several challenges were identified:

- **Device Dependency**: Performance varied based on device specifications, with low-end devices experiencing slower rendering.
- **User Familiarity**: Some users required an initial orientation to understand AR navigation,

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particularly those new to AR technology.
- **Limited Scenarios**: The application focused primarily on basic PC assembly steps, lacking advanced scenarios for experienced users.

4.8.4. Comparison with Traditional Methods
The application outperformed traditional methods by providing a hands-on simulation experience. Users reported a better grasp of PC assembly procedures and felt more confident attempting real-world assembly. However, the results also emphasize that combining AR simulations with physical practice enhances overall learning.

4.8.5. Implications for Future Development
To address the identified challenges and expand the application's utility:
- **Optimization for Low-End Devices**: Enhancing the application for smoother performance on low-spec devices will increase accessibility.
- **Advanced Features**: Adding advanced assembly scenarios, quizzes, and component compatibility checks will broaden the application's scope.
- **Integration with Physical Practice**: Providing guidance for transitioning from virtual simulations to physical assembly can ensure comprehensive skill development.

5. Conclusion
The development of the **Simulation Application for Personal Computer (PC) Assembly Using Augmented Reality Technology on Android Platform** demonstrates the significant potential of integrating AR technology into educational tools for technical and vocational training. This application effectively addresses the limitations of traditional PC assembly learning methods by providing an interactive and immersive platform that enhances both conceptual understanding and practical skills.
Through systematic stages of design, development, and evaluation, the study achieved the following key outcomes:
1. **Improved Learning Outcomes**: Users reported increased understanding and confidence in PC assembly processes, with reduced errors compared to traditional methods.
2. **Interactive and Engaging Platform**: The 3D visualizations and AR interactions made the learning process more engaging, allowing users to practice in a risk-free environment.
3. **Accessibility and Flexibility**: The application's compatibility with Android devices ensures it is accessible to a wide range of users, including those in resource-limited settings.

Despite its success, the study highlighted challenges such as device compatibility issues and the need for advanced learning scenarios. Addressing these limitations in future iterations could further enhance the application's effectiveness and broaden its application scope.
In conclusion, this AR-based simulation application represents a step forward in modernizing educational tools for technical training. By leveraging AR technology, the application not only improves technical literacy but also supports the development of critical 21st-century skills. This research contributes to the growing field of technology-enhanced education and provides a foundation for future innovations in immersive learning solutions.

References

1. Azuma, R. T. (1997). A Survey of Augmented Reality. *Presence: Teleoperators and Virtual Environments*, 6(4), 355-385. https://doi.org/10.1162/pres.1997.6.4.355
2. Bacca, J., Baldiris, S., Fabregat, R., Graf, S., & Kinshuk. (2014). Augmented Reality Trends in Education: A Systematic Review of Research and Applications. *Educational Technology & Society*, 17(4), 133-149.
3. Billinghurst, M., & Duenser, A. (2012). Augmented Reality in the Classroom. *Computers & Education*, 54(3), 728-740. https://doi.org/10.1016/j.compedu.2010.08.017
4. Chen, S., Wang, Z., & Liu, H. (2022). The Impact of Augmented Reality Technology on Technical Training: A Comparative Study. *International Journal of Technical Education*, 15(1), 45-61.
5. Lee, J., & Kim, S. (2020). Developing an AR-Based Assembly Learning Application for Electronic Components. *Journal of Educational Technology*, 8(2), 110-123.
6. Rahman, F., Abdullah, M., & Hartono, A. (2021). Optimizing AR Core for Android- Based Educational Applications. *Journal of Mobile Computing*, 13(2), 87-95.
7. Smith, J., Johnson, P., & Edwards, R. (2020). *Understanding PC Assembly: A Practical Guide for Beginners*. New York: Tech Press.
8. Wu, Y., Tsai, C., & Hsu, L. (2019). Augmented Reality-Based Training in Engineering Education: Case Study on Machine Assembly. *Educational Technology Research & Development*, 67(5), 1009-1030. https://doi.org/10.1007/s11423-019-09663-5

Received: Desember 20, 2024. Revised: March 12, 2025.

9. Luther, W. (2004). *Multimedia Concepts: Life Cycle and Beyond*. Pearson Education.
10. Chang, K.-E., Chang, C.-T., Hou, H.-T., Sung, Y.-T., Chao, H.-L., & Lee, C.-M. (2014). Development and Evaluation of an Augmented Reality-Based Training System for Enhancing Assembly Skills. *Interactive Learning Environments*, 22(6), 688-708. https://doi.org/10.1080/10494820.2012.745435