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Introduction to AR-Based Gymnastic Equipment & Movement Variations

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ABSTRACT

Silver Gym is a fitness center in the Kasihan area, Bantul, Yogyakarta which provides various types of exercise equipment such as dumbbells, Smith machines, treadmills and others. The problem faced by Silver Gym in Kasihan, Bantul, Yogyakarta, is the wide variety of gymnastic equipment and movements that are difficult for members to memorize and understand, often leading to incorrect execution and muscle injuries. This issue arises due to a lack of knowledge regarding the correct use of equipment and movements. To address this, the research aims to design and develop an augmented reality (AR)-based application that introduces gym equipment and exercise variations, helping users understand the function and proper usage of the equipment. The application is developed using Unity 3D and is equipped with 3D objects and information about the names and functions of the gym equipment. The methodology used in this research involves the design and implementation of AR technology within the application. The result of the study is the creation of an AR-based application that provides interactive visual knowledge to users, with the goal of reducing injury risks due to incorrect movements and maximizing the workout results for Silver Gym members.

Keywords: *Gym, AR, 3D Object*

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INTRODUCTION

Silver Gym is a fitness center located in Kasihan, Bantul, Yogyakarta, that provides various gym equipment such as dumbbells, smith machines, treadmills, and more. Fitness exercise itself is a weightlifting sport that utilizes equipment and various movement variations. The abundance of available equipment makes it difficult for members to memorize and use them according to their training programs. Additionally, a lack of understanding of movement variations can lead to injuries if performed incorrectly. Mistakes in movements can result in muscle injuries, requiring members to undergo longer recovery periods, thereby hindering muscle development. Based on these issues, this study aims to design and develop an application to introduce gym equipment and movement variations using Augmented Reality (AR) technology with Unity. The application will display gym equipment and movement variations in an interactive visual format with object

recognition and rendering features. With this application, users will receive assistance in identifying gym equipment and understanding techniques and movement variations more effectively. This application is expected to help beginners learn the basics of fitness exercise and support experienced athletes in improving their movement techniques. Furthermore, the use of AR in the fitness world has been proven to have great potential in supporting sports activities for various age groups, including the elderly.

According to research by (Suryani et al., 2023) in *"Fitness Guide Application for Seniors Using Augmented Reality Technology"*, AR technology can help improve the fitness of the elderly by reducing the risk of falls and decreasing muscle strength due to aging. This suggests that AR can be widely applied in the field of fitness to enhance users' health and independence. The application of AR in education has also been discussed by (Sari et al., 2023) in *"Development of Interactive Learning Videos Based on Augmented Reality in Sub-theme 1 of Amazing Order"*, stating that AR technology provides a more engaging learning experience and motivates users to understand the material more effectively. Additionally, research by (Amdani et al., 2022) shows that using AR technology in visual learning can improve conceptual understanding better than conventional methods, as it allows direct interaction with virtual objects that can be observed from various angles. Augmented Reality technology itself is an advancement in the field of technology that integrates the real world and the virtual world through computers, allowing users to interact with the system in real-time (Ripansyah et al., 2021). According to (Mustaqim, 2016), AR is a technology capable of merging two-dimensional or three-dimensional virtual objects into a real environment and then displaying or projecting them in real-time.

AR can be used to help visualize abstract concepts for understanding and structuring an object model, making it a more effective medium aligned with the objectives of educational media. AR uses marker-based tracking methods as a system reference to display 3D objects accessible through mobile devices. With this technology, gym equipment visualization can be displayed interactively, providing a deeper experience for users in understanding the function and usage of the available equipment. According to (Setiawan & Dani, 2021), AR consists of two-dimensional and three-dimensional virtual objects built by technology and projected in real-time while being closely integrated with the actual environment. This demonstrates that AR can provide a more immersive and realistic experience in learning and visual object exploration. Learning with AR technology has interactive elements that allow students to experience learning situations realistically, stimulate imagination, and encourage critical thinking skills (Azizah & Sejati, 2023). This aligns with the research of (Amdani et al., 2022), which shows that using AR technology in visual learning enhances conceptual understanding better than conventional methods.

Augmented Reality technology enables learning to be more interactive by incorporating digital elements such as 3D objects, audio, and educational content into the physical environment, thereby improving students' understanding of topics such as the Solar System (Azizah et al., 2023). This approach can also be applied in the fitness world to provide a more engaging learning experience and help users understand exercise techniques and movement variations more effectively. With these interactive elements,

users can explore gym equipment and movement variations in greater depth, enhancing training effectiveness and reducing the risk of injury due to incorrect techniques. Additionally, AR allows users to interact with virtual objects in real-time, providing a more immersive and realistic learning experience (Setiawan & Dani, 2021). Moreover, (Carolina, 2023) explains that AR is a technology that integrates the virtual world with the real world. AR is used as a learning medium that provides clear, real-time, engaging, interactive, and educational information, thereby increasing users' effectiveness in understanding the presented material. Previous research by (Nazilah et al., 2021) shows that an AR-based application using marker-based tracking has been successfully implemented to introduce ASEAN country landmarks, increasing students' interest and understanding.

A similar approach can be applied in the fitness world to provide a more engaging learning experience and help users understand exercise techniques and movement variations more effectively. Additionally, research by (Gerung et al., 2023) in *"Augmented Reality Introduction to Gym Equipment for Beginners"* highlights how AR can be applied in the fitness world to improve understanding of gym equipment usage. AR technology enables users to explore 3D objects and data in real-time, offering a more engaging and informative visual experience. (Amdani et al., 2022) also emphasizes that applying AR in education can increase learning appeal and accelerate users' comprehension of a concept. Thus, implementing AR in this application can provide a solution for users to understand various movement variations that align with the available gym equipment. To ensure a focused study, several limitations are established. This study is based on data obtained from Silver Gym, and the developed application will be designed to run on Android devices with version 8.0 Oreo.

The primary focus of this application is the introduction of gym equipment and movement variations in fitness exercise. Therefore, this study does not cover other aspects such as workout programs or nutrition in the fitness world. Furthermore, technological trends, as mentioned by (Suryani et al., 2023), indicate that AR will continue to evolve and have a greater impact on human life, including in the fields of fitness and health. (Amdani et al., 2022) also emphasizes that AR's rapid development opens up great opportunities in various industries, including healthcare and sports, to improve efficiency and effectiveness in learning and practice in everyday life. Additionally, (Husnita, 2024) states that Augmented Reality (AR) is not just a tool to add fun elements in the classroom but serves as the foundation for a fundamental transformation in how we teach and understand knowledge. By maximizing the potential of AR, education can become more inclusive, engaging, and effective in preparing future generations to face complex global challenges.

METHOD

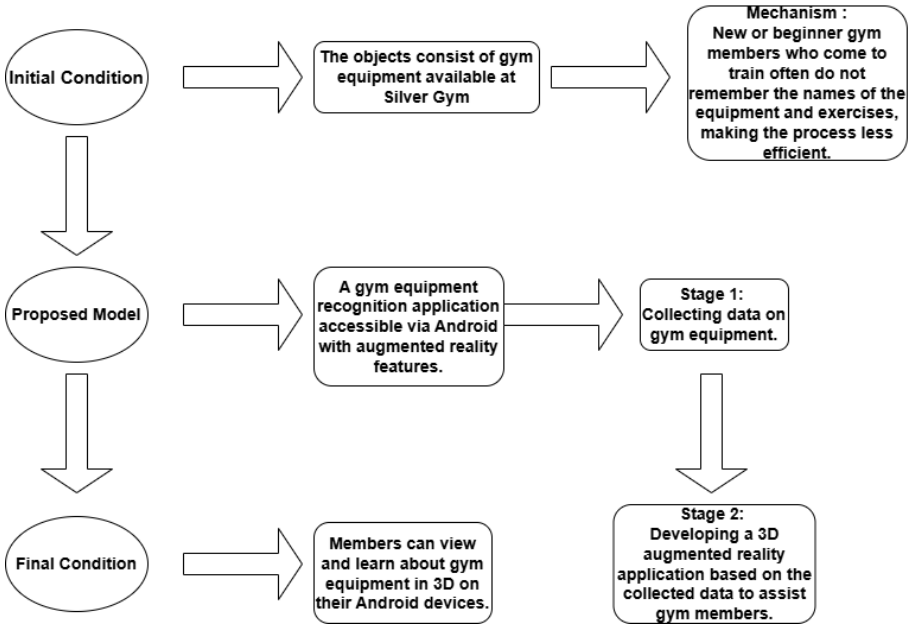

Figure 1. Research Framework

A research framework is the fundamental structure used to guide the research process from start to finish. This framework includes various essential elements that assist researchers in planning, conducting, and analyzing their studies in a systematic and organized manner. These elements typically include the background of the problem, which outlines the context and reasons behind the selection of the research topic, including the issues or phenomena to be studied. The problem formulation clearly defines the specific research questions to be answered or the issues to be addressed through the study. Additionally, the research design serves as a crucial component that determines the overall methodology, including data collection techniques, analysis methods, and the approach used to ensure the validity and reliability of the research findings.

Based on Figure 1, the research framework above identifies the problem in this study as the lack of understanding and knowledge among gym members regarding gym equipment. New or beginner members often have to ask questions before starting their workouts. This situation is inefficient for members who need to interrupt others to seek explanations before beginning their training programs. The proposed system in this study is a gym equipment recognition application using Augmented Reality (AR) that can be accessed through Android devices. The researcher will collect data, including objects such as gym equipment, which will later be displayed in a 3D Augmented Reality application. The final outcome of this system is an AR application that can display gym equipment along with explanations in 3D on Android devices. This application is designed to help members perform their workouts more efficiently without interrupting or disturbing other members.

The research method is a series of processes used in a study to obtain data with the aim of achieving results and addressing the research problem. This study employs a

qualitative method, which is related to quality or value based on existing facts. In qualitative research, several stages are conducted, including interviews, observations, and literature studies. Interviews are carried out as a communication method to obtain information from subjects or respondents through structured or unstructured questions posed directly by the interviewer to gym members. Next, observation is conducted by directly observing all activities at the research location, including interactions and the use of equipment by gym members. Additionally, a literature study is used as a method to obtain information and relevant materials for this research by searching for and reviewing references from various sources, such as journals and books, to strengthen the theoretical foundation of this study.

Table 1. Data Collection Time

Date	Schedule
6 March 2024	Interview with the owner of Silver Gym
7 March 2024	Interview with the members of Silver Gym
8 March 2024	Observation at Silver Gym
9 March 2024	Gaining references from literature studies on the application of augmented reality to the human body organs.

The researcher uses a model architecture aimed at providing an overview of the Augmented Reality-based gym equipment recognition application to be developed, ensuring it functions optimally according to requirements. This design includes the identification of system components, which are detailed using UML design. The system design can be seen in the following image:

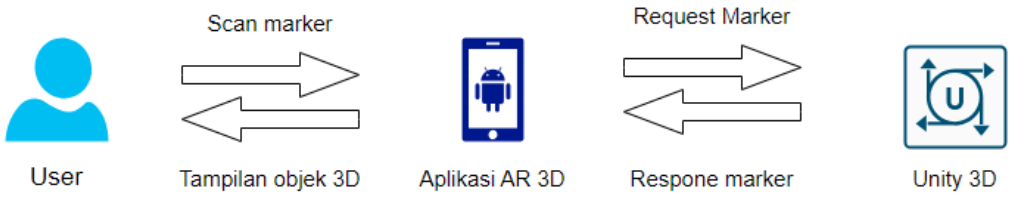

Figure 2. Model Architecture

The hardware required by researchers to develop the application can be seen in the following table:

Table 2. Hardware Requirements

Computer	Smartphone
Processor : Intel(R) Core(TM) i3-6006U	Device : Redmi 12
RAM : 4GB	CPU : Octa-core Max 2.00GHz
VGA : Intel VGA 2GB Nvidia GeForce	GPU :Arm Mali-G52
	Chipset : MediaTek Helio G88
	RAM : 12GB

In the development of Augmented Reality (AR) applications, hardware specifications play a crucial role in ensuring optimal performance. For computers, an Intel Core i3-6006U processor with 4GB RAM and an Intel VGA 2GB Nvidia GeForce graphics card can be used for basic development tasks such as programming and light simulations, although higher specifications may be required for more complex rendering processes. According to Putra et al. (2023), AR application development requires sufficient GPU performance to handle rendering and tracking processes effectively, ensuring smooth user interactions. Meanwhile, for testing and implementation on mobile devices, the Redmi 12 smartphone with a MediaTek Helio G88 chipset, Octa-core CPU up to 2.00GHz, Arm Mali-G52 GPU, and 12GB RAM offers sufficient performance to run AR applications smoothly and responsively. The combination of these devices allows developers to build and test AR applications efficiently, although optimization is still necessary to ensure compatibility and a good user experience across different devices.

A use case diagram is one type of diagram in the Unified Modeling Language (UML) used to illustrate the interaction between actors (users or other external systems) and the system being developed. The use case diagram provides a high-level view of the system's functionality by highlighting the interactions between actors and the system's main functions. Below is the use case diagram for the AR-based gym equipment recognition application system, as shown in the following figure:

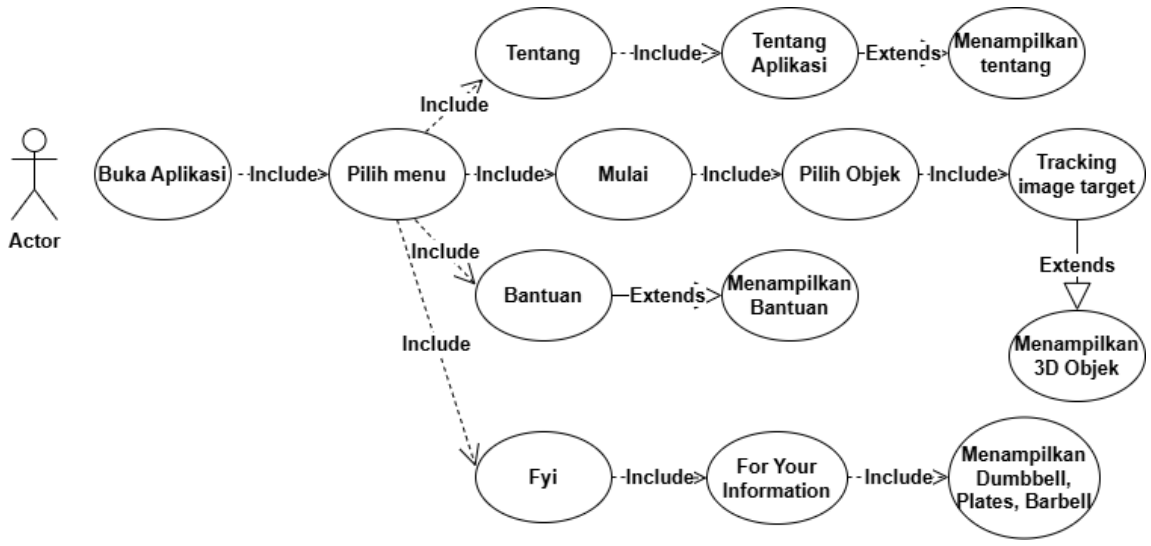

Figure 3. Use Case Diagram AR

In the figure above, an actor opens the application and then selects the available menu options such as Start, About, and Help. The Info menu contains an explanation of the application. In the Gym AR menu, the user can start the application by selecting the type of equipment and then choosing an object. The application will then track the selected object and display it in 3D. The Help menu provides assistance to help users navigate and use the application.

A class diagram is one of the types of diagrams in the Unified Modeling Language (UML) used to illustrate the static structure of a software system, including the classes within the system, the attributes each class possesses, and the relationships between these classes. The class diagram provides a high-level view of the object structure in the system and the relationships between these objects. The class diagram can be seen in the figure below :

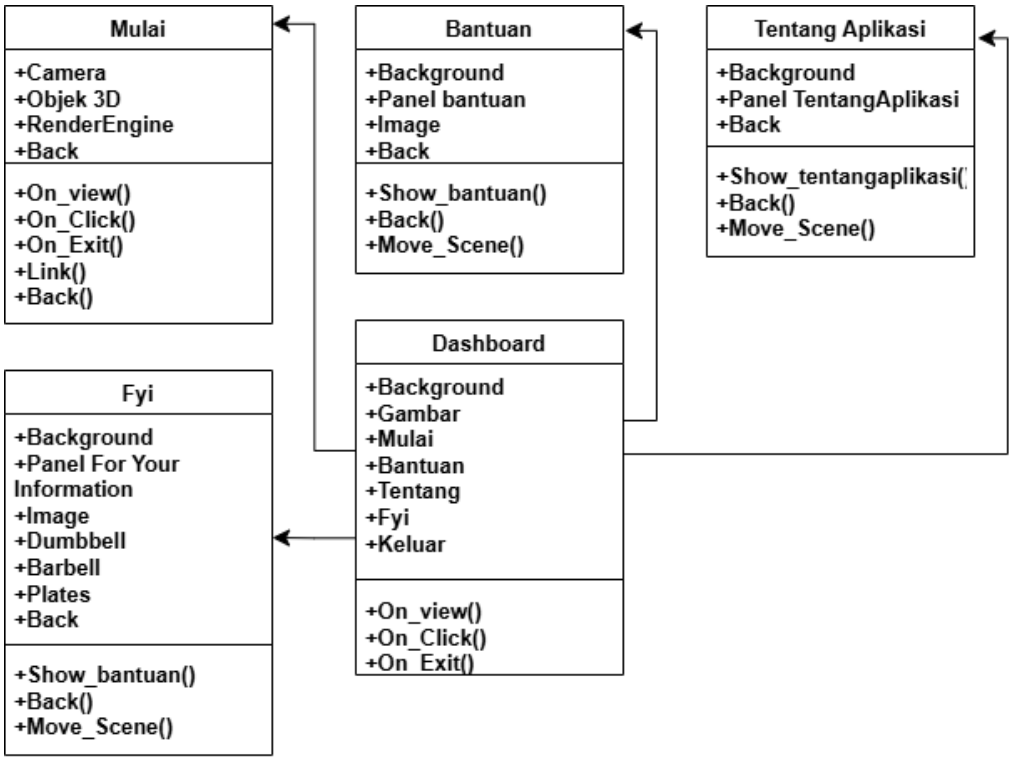

Figure 4. Class Diagram

FINDING AND DISCUSSION

Based on the research conducted, the Augmented Reality (AR) application for Gym Equipment Introduction and Movement Variations has been successfully designed to display 3D objects through the camera on Android devices. This application allows users to control and view gym equipment in an interactive three-dimensional form, providing a realistic visual experience. Additionally, the application is capable of displaying objects effectively, although adjustments related to distance, angle, and lighting are required to ensure optimal marker detection. The presence of this application is expected to help gym members recognize the names of equipment and understand Augmented Reality technology, thereby enhancing user engagement and comprehension of gym equipment usage.

Results

Figure 5. Main Page

Figure 5 represents the main page of the AR Gym application, which contains several buttons that users can click, including the Start, Help, About, FYI, and Exit buttons.

Figure 6. Bantuan

Figure 6 represents the help page of the application, which provides guidance on using the AR Gym application for users.

Figure 7. Tentang Aplikasi

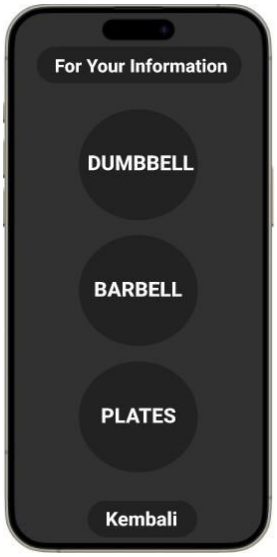

Figure 7 represents the about page, which provides a brief explanation of the AR Gym application for users.

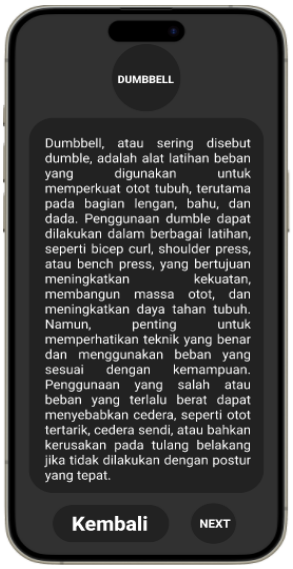

Figure 8. For Your Information

Figure 8 represents the "For Your Information" page, which displays several buttons that users can click.

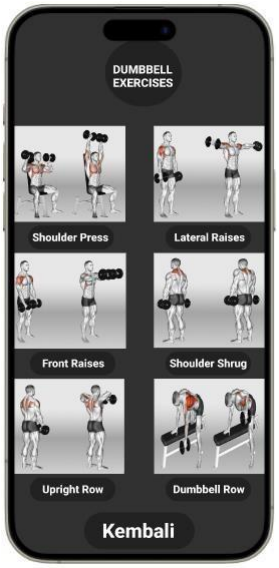

Figure 9. Dumbbell

Figure 9 represents the Dumbbell page, which provides educational information about using dumbbells. The Dumbbell Exercise page displays several variations of movements using dumbbells.

Figure 10. Barbell

Figure 10 represents the Barbell page, which provides educational information about using barbells. The Barbell Exercise page displays several variations of movements using barbells.

Figure 11. Plates

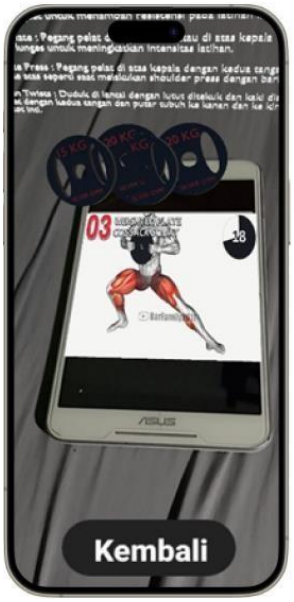

Figure 11 represents the Plates page, which provides educational information about using plates. The Plates Exercise page displays several variations of movements using plates.

Figure 12. Mulai

Figure 12 represents the Start page, which displays markers and 3D objects detected by the AR camera.

DISCUSSION

The results of this study indicate that the application of Augmented Reality (AR) technology in a gym equipment recognition application can help users understand the function and proper use of equipment more interactively. By displaying 3D visualizations and relevant information, this application provides a more in-depth learning experience compared to conventional methods. This is important because errors in using gym equipment and performing exercises can lead to serious muscle injuries, hinder physical development, and reduce workout effectiveness. With this application, users, especially beginners, can gain a better understanding of correct exercise techniques, minimizing the risk of injury and optimizing workout results.

These findings align with previous research indicating that the use of visual and digital-based technology can enhance comprehension and improve the effectiveness of physical training. As stated by Dorgo (2009), digital-based training can increase adherence to exercise routines and improve movement accuracy. Additionally, Mujib et al. (2022) found that integrating AR into fitness applications enhances users' understanding of complex movements and increases engagement in the learning process. Juras et al. (2019) also emphasized that AR-based applications in sports training can enhance motor learning by providing real-time feedback and movement correction. Thus, this application confirms that AR can be an effective solution for supporting fitness technique learning and gym equipment usage.

Although this application offers significant benefits, there are several limitations to consider. This study focuses solely on introducing gym equipment and exercise variations without covering complete workout programs or the nutritional aspects of fitness. Additionally, the application is only developed for Android devices with a minimum version of 8.0 Oreo, which may limit access for users with older devices or those using iOS-based systems.

CONCLUSION

Based on the research conducted, it can be concluded that hardware specifications play a crucial role in the development of Augmented Reality (AR) applications. In this study, a computer with an Intel Core i3-6006U processor, 4GB RAM, and an Intel VGA 2GB Nvidia GeForce graphics card was used for basic application development, while a Redmi 12 smartphone with a MediaTek Helio G88 chipset, Octa-core CPU up to 2.00GHz, Arm Mali-G52 GPU, and 12GB RAM was used for testing and implementation. This combination of devices enables efficient AR application development and testing, although optimization is still necessary to ensure broader compatibility and a better user experience. Additionally, factors such as distance, angle, and lighting need to be considered to ensure optimal marker detection within the application.

Overall, the AR-based Gym Equipment and Movement Variation Recognition application developed in this study is capable of displaying 3D objects through an Android camera with interactive features that allow users to recognize gym equipment and movement variations. The application can control the display of 3D objects effectively,

although certain technical aspects, such as camera angles and lighting, still need improvement to enhance marker detection accuracy. With this application, Silver Gym members are expected to have an easier time understanding the proper use of gym equipment and exercise techniques, thereby reducing the risk of injury and improving workout effectiveness. The integration of AR technology in the fitness field represents an innovative approach to providing a more interactive and modern learning experience for users.

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