And., Intl.,J., Appl Sci., Eng., Tech, Vol. 03, No. 02, July 2023
e-ISSN: 2797-0442

The Implementation of Augmented Reality Based on Vuforia and Unity for Interactive Learning in Introducing Ragam Randang Objects

Zulfadli[1*], Budi Sunaryo[1], Reihan Hanafi Wiyanatra[1], Randi Proska Sandra[2]
[1]Faculty of Industrial Technology, Universitas Bung Hatta, Indonesia
[2]Faculty of informatic engineering, State University of Padang, Indonesia
[*]Corresponding author, e-mail: zulfadli@bunghatta.ac.id

Abstract— *Augmented Reality (AR) is a technology that combines objects from the real world and virtual or virtual objects with real-time or direct conditions. The merging of real and virtual objects occurs because of the right technological support while the interactions that are carried out can occur using certain devices. AR is a variation of Virtual Environments (VE), better known as Virtual Reality (VR). This VR technology allows users to fully immerse themselves in a virtual environment. While Augmented Reality technology is developing very fast, many applications in Indonesia use AR technology. This study uses the waterfall system development method, where the research flow will follow the phases of the waterfall. This application is built using Unity and Vuforia. The purpose of this research is an interactive application to make it easier for students and museum visitors to understand augmented reality through mobile devices. So that museum visitors and students can see objects containing information interactively*

Keywords: Augmented Reality, Vuforia, Unity 3D.

1. Introduction

Augmented Reality was introduced in 1992 by Thomas Preston Caudell, a researcher at Boeing. He created an AR application for industrial use, enabling the visualization of assembly diagrams. At present, there exist numerous definitions of AR [1]. AR is a technology that incorporates real-world objects and virtual or virtual objects with real-time or direct conditions [2]. The fusion of tangible and virtual objects is made possible through the implementation of robust technological support, while user interaction is facilitated through specific devices[3]. Augmented Reality AR represents a distinct branch of the broader Virtual Environment technology, commonly referred to as Virtual Reality. VR technology allows users to merge into an entire virtual environment [4]. While Augmented Reality technology is rapidly growing, many Indonesian applications already use AR.

The utilization of augmented reality technology in educational settings has gained significant attention in recent years[5]. This literature review explores the implementation of AR, specifically using Vuforia and Unity, for interactive learning in introducing "Ragam Randang" objects. "Ragam Randang" refers to the diverse range of traditional Padang dishes, and this review aims to investigate how AR enhances the understanding and appreciation of this cultural heritage [6].

1.1. Ragam Randang Objects

The Adityawarman Museum in Padang is a place dedicated to preserving the history and culture of West Sumatra, including culinary culture such as rendang [7]. The museum has a special room called

Received: July 10, 2023, Revised: September 09, 2023, Accepted: September 15, 2023
https://doi.org/10.25077/aijaset.v3i2.84

the "Rendang Museum" which aims to introduce various aspects of the history, variations, and philosophy behind rendang, a famous dish from West Sumatra [8].

In the Rendang Museum, visitors can see a map that shows the origins and variations of rendang, including various types of ingredients and spices used in its preparation[9]. Furthermore, the museum also showcases traditional kitchen utensils used by ancestors in preparing rendang, including tools made of wood and clay.

The Adityawarman Museum plays a crucial role in introducing the culture of West Sumatra, especially rendang, to the world. A visit to this museum is also a good way to understand the history and cultural richness of Indonesia, as well as to appreciate the culinary heritage of the archipelago.

The museum offers affordable entrance tickets, making it accessible to many people. Visiting the Adityawarman Museum is a great way to celebrate and take pride in Indonesia's cultural richness and West Sumatra's culinary heritage. In addition to understanding the history, visitors can also learn how rendang became the world's number 1 tastiest food and gained the attention of world-class chefs like Gordon Ramsay. Through the Adityawarman Museum, Indonesia can introduce its identity and culinary culture to the world in a more profound way.

1.2. Augmented Reality in Education

Augmented reality is a technology that overlays digital content onto the real world, creating a blended experience for users[10]. In the realm of education, AR has been harnessed to engage students and facilitate immersive learning[11]. This section explores the key benefits of using AR for educational purposes[12]:

- Engagement and Motivation: AR applications can captivate learners' attention by offering interactive and visually stimulating experiences.
- Enhanced Understanding: AR can help students visualize complex concepts, making abstract ideas more tangible.
- Personalized Learning: AR allows for customization, enabling students to learn at their own pace and style.
- Real-World Application: AR bridges the gap between theoretical knowledge and real-world application, promoting practical understanding.

1.3. Vuforia and Unity as AR Development Tools

Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that helps simplify the application development process for AR applications[13]. The Vuforia SDK is also available for integration with Unity, known as Vuforia AR Extension for Unity[14]. Vuforia is an SDK provided by Qualcomm to assist developers in creating AR applications for mobile phones (iOS, Android). The Vuforia SDK has been successfully used in several mobile applications for both platforms[15].

Vuforia, coupled with Unity, is a powerful combination for creating AR applications[16]. Vuforia provides computer vision technology to recognize and track objects or markers in the real world, while Unity is a versatile game engine that facilitates the creation of interactive 3D content[17].

Together, they enable developers to build immersive AR experiences[18]. This section discusses their roles in AR-based educational applications:

- Vuforia's Object Recognition: Vuforia's object recognition capabilities are essential for identifying and tracking Ragam Randang objects, making them come to life in the AR

environment.

- Unity's Interactive Environment: Unity allows developers to create 3D models, animations, and interactive elements, enabling users to explore Ragam Randang objects in a dynamic and engaging way.

Unity 3D application is the game engine, and it is a picture, graph, sound, input, and other software intended for a game, although it doesn't necessarily have to be a game[16]. Unity 3D runs on the Microsoft Windows and Mac OS X operating systems. Applications created with Unity 3D can run on Windows, Mac, Xbox 360, PlayStation 3, Wii, iPad, iPhone, and Android. Unity can also create browser-based games using the Unity Web Player plugin. [19]

Android is an operating system developed by Google that utilizes a Linux kernel and incorporates various software, including Open Source, among others. Mobile devices that run on Android can be used for touch-based devices such as smartphones and tablet computers [20].

1.4. AR Applications in Cultural Education

Augmented reality has been increasingly adopted in cultural education settings to preserve and promote heritage [21]. The following points highlight AR's contributions in this context:

- Cultural Preservation: AR applications can digitally archive cultural artifacts, ensuring their preservation for future generations.
- Interactive Learning: AR enhances cultural education by offering interactive experiences, allowing users to engage with cultural objects and historical contexts.
- Accessibility: AR can make cultural heritage accessible to a wider audience, transcending geographical limitations.

The hypothesis of this research is that the use of AR technology will provide a better interactive learning experience for visitors. Specifically, the use of AR technology is expected to improve visitors understanding of various cultural objects. However, there are challenges in implementing AR applications, particularly related to the User Interface (UI) of cultural objects, which hinders comfortable access to information[22]. Therefore, this hypothesis states that if these challenges can be overcome, the use of AR technology will offer significant benefits in enhancing visitors understanding and explanations of cultural objects.

2. **Method**

The data collection method employed in this research is: Observation: Observing the needs of users who will use the Mobile-based Augmented Reality application as a learning tool for the introduction of AR objects in the Multimedia Workshop course. Literature review: A series of activities related to the data collection method of literature, involving reading, note-taking, and analyzing research materials.

The system development method used is the waterfall model (Ian Sommerville, 2011), which explains that there are five stages in the waterfall method, namely:

a. Requirements Analysis
   Before developing software, a developer needs to understand and comprehend the user's requirements for the software. This can be achieved through various methods such as discussions, observations, surveys, interviews, and more. The gathered information will be processed and analyzed to acquire comprehensive data on the user's software requirements. Hardware requirements:
   a) Processor : AMD Ryzen 5 2400G
   b) GPU/ : NVIDIA GeForce GTX 1650 Super

c) Memory : 8 GB

Software requirements:

a) Unity HUB 2021.3.15f1
b) Vuforia Engine v10.12.3
c) Microsoft Windows 10/11

b. System Design

The information obtained from the requirements analysis phase is then implemented in the system design phase. The design is created to provide a comprehensive overview of what needs to be done. This phase helps the developer prepare the hardware requirements for the overall creation of the software system architecture.

The steps are as follows:

a) Capture the source image of the Ragam Randang map as shown in Figure 1.

Figure 1. Ragam Randang Map

b) Build QR Code as show Figure 2.

Figure 2. QR Code for Marker

c) Designing the UI as shown in Figure 3.

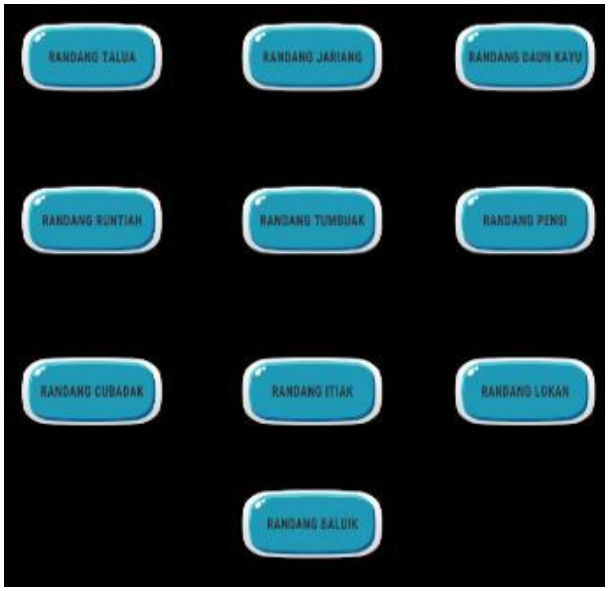

Figure 3. UI and the Button

d) Design Application Flowchart based on Figure 4.

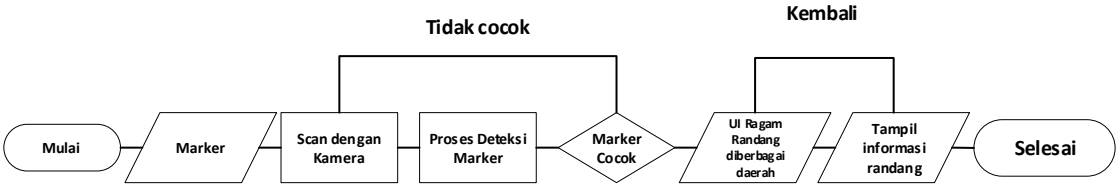

Figure 4. Application Flowchart

c. Implementation

This application is developed as a tool to display the origin information of Ragam Randang in West Sumatra. Subsequently, the UI will display the names of different types of Ragam Randang through QR-shaped markers that have been labelled as Table 1.

Table 1. Ragam Randang AR Application

NO	MARKER	BUTTON	OBJECT
1			
2			

And these are the results of each object, as shown in Figure 5 :

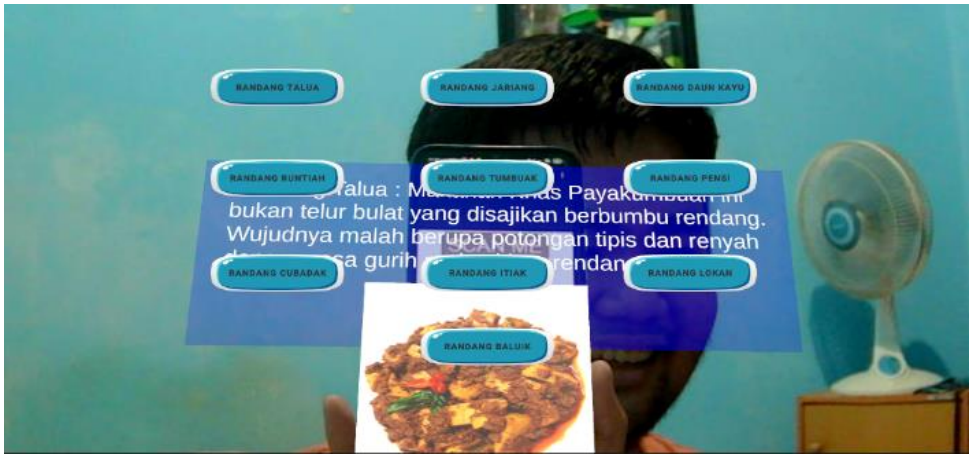

Figure 5. Scan Results of Randang Talua

d. Deployment and Maintenance
Installation and maintenance of the hardware and software systems are conducted to deploy the implementation of the system unit. The software used to develop the application is Unity3D and Vuforia.

Table 2. Ragam Randang AR Application

No	Testing	Process	Results
1	Installing the App	The installation process is successfully completed on the Android smartphone.	Successfully
2	Running the Application	Runs smoothly and accessible	Successfully
3	Precise Marker Detection	Object shown	Successfully
4	Precise UI Button Detection	Object shown	Successfully
5	UI detection triggers when one of the buttons is pressed. The button disappears and transitions to a new scene with a "Back" button to ensure that the displayed information is not obstructed by the Ragam Randang UI.	The UI is still on the screen, and the Ragam Randang information is being obstructed by the UI.	Failed

In this phase, the process of monitoring, evaluation, and making changes or improvements, if necessary, is carried out. Software maintenance includes updating Unity and Vuforia software. UI improvements are made to ensure that the Ragam Randang information is not obstructed by the UI as shown in Table 2.

3. Result and Discussion

The research aimed to implement Augmented Reality (AR) based on Vuforia and Unity for interactive learning, specifically in introducing "Ragam Randang" objects. Several key findings and results emerged from this study: Educational Significance of AR: Augmented Reality has gained

prominence in educational contexts due to its ability to engage learners effectively. Its benefits include increased engagement, enhanced understanding of complex concepts, personalized learning experiences, and the application of theoretical knowledge to real-world scenarios.

Vuforia and Unity as AR Development Tools: Vuforia, in conjunction with Unity, serves as a robust combination for creating AR applications. Vuforia provides object recognition capabilities, allowing for the identification and tracking of Ragam Randang objects. Unity, as a versatile game engine, facilitates the creation of interactive 3D content. Cultural Significance of Ragam Randang: Ragam Randang represents a significant cultural and culinary heritage, particularly in Padang, West Sumatra. The Adityawarman Museum is a vital institution dedicated to preserving the history and culture of the region, including Ragam Randang.

Purpose of the AR Application: The primary objective of this research was to develop an interactive AR application to enhance understanding and engagement for students and museum visitors. This application aimed to make Ragam Randang objects more accessible and informative through mobile devices. Challenges in Implementing AR: The research identified challenges related to the User Interface (UI) of cultural objects that hindered easy access to information. Overcoming these challenges was essential to ensure a seamless AR experience for users.

4. Conclusion

In conclusion, this research explored the implementation of Augmented Reality (AR) using Vuforia and Unity to introduce "Ragam Randang" objects, a significant cultural and culinary heritage in Padang, West Sumatra. The study revealed that AR has substantial educational potential, providing interactive and engaging learning experiences for students and museum visitors. By leveraging Vuforia and Unity, developers can create immersive AR applications that enhance understanding and appreciation of cultural objects like Ragam Randang. However, challenges related to UI design need to be addressed to ensure a user-friendly experience.Ultimately, the integration of AR technology into cultural education, as exemplified by the Adityawarman Museum, serves as a valuable tool for preserving and promoting cultural heritage. It offers the opportunity to make cultural artifacts more accessible, engaging, and informative, transcending geographical limitations and introducing Indonesia's rich cultural identity to the world in a profound way.

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