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Augmented Reality-Based Minangkabau Dance and Musical Instrument Education (Innovation in Cultural Preservation)

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ABSTRACT

The digital era presents a challenge to preserving and introducing culture to today's society due to the currents of globalization and digitalization, making people less aware of their own culture. Minangkabau culture is one of them. Minangkabau culture originates in West Sumatra and includes various arts, including dance and musical instruments. Augmented reality is a technology that presents 3D objects in the real world in real time through gadgets. Through smartphones, users can see virtual elements in a real, interactive manner.In this study, researchers will build an Android-based application called "ARSTAM", which is useful for providing education to the public about dance and musical instruments in Minangkabau. The application was designed using Unity 3D, Blender, and the Vuforia Engine. The application was designed using the MDLC method because it is suitable for building Android software. It is hoped that this application will provide understanding and motivation for the public to learn more about Indonesian culture. The results of the usability test showed a percentage of 87.5%, which has a rating of very suitable for use by the general public.

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1. INTRODUCTION

The word budaya comes from Sanskrit "buddhayah", which is the plural form of buddhi, meaning things related to human reason and intellect. In English, budaya is called culture [1]. Indonesian local culture reflects a region's identity, passed down from one generation to the next. Each region has its own unique traditions, language, arts, and

customs [2]. Art is a human creation that possesses aesthetic value and can be enjoyed through various forms of expression, such as sound, movement, or other forms of expression. This is because art is a manifestation of human feelings. Art comes in many forms, including dance, painting, drama, visual arts, and music. In fact, art is highly developed everywhere, both internationally and in Indonesia, particularly in West Sumatra [3]. In West Sumatra, which is rich in culture and arts, there is dance art. Traditional dance art requires musical instruments to accompany the dance. The musical instruments used are traditional musical instruments native to West Sumatra. Traditional musical instruments are very important for the Minangkabau people; without traditional musical instruments, there would be no music to accompany West Sumatran traditional events [4]. Traditional dance is a dance that has developed over a long period within a particular region, custom, or ethnic group. This dance contains classical aesthetic values that are passed down from one generation to the next [5]. Minangkabau dance is one of the unique cultural heritages of Minangkabau, expressed through distinctive and beautiful dance movements, accompanied by musical instruments and carrying symbolic meanings.

We live in the digital age, with society becoming more connected to gadgets and digital technology. This has diminished understanding and awareness of existing cultures, resulting in the loss of cultural practices from public consciousness. Globalization has begun to change customs and culture within society, as well as changing the norms and tastes of society itself. With easily accessible media and information, Western culture can enter Indonesia. This can have both positive and negative impacts. The positive impact is that society is more open to new cultures and innovations, while the negative impact is that old cultural values will fade [6]. With globalization, a complex dynamic has emerged between the preservation and penetration of foreign cultures, creating a dilemma in maintaining cultural identity amidst the strong currents of globalization [2].

Based on data from previous research, there are still some who do not know the dances in Minangkabau. The dances that are known are only popular dances, such as the plate dance and the pasambahan dance. The need for information about dance is also minimal from the community, which is seen from the lack of interest in information about this dance, even though knowledge of traditional Minangkabau dance is very important to know because there are so many lessons in it and also needs to be preserved for future generations. Another reason people (especially the younger generation) do not want to learn or know about dance in Minangkabau is due to several factors. First, external factors, namely factors that come from outside, where the environment does not show how important Minangkabau dance is and the many modern dances that have emerged so that they attract the attention of the younger generation to prefer modern dance (the influence of modern developments). Second, internal factors, namely factors from within, the lack of community knowledge about traditional Minangkabau dance so that people are not interested in traditional Minangkabau dance. In this case, the influence of parents who have not perfectly instilled the meaning of Minangkabau customs and traditions to their children.

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Data from previous research showed that 60% and 40% of respondents answered correctly on a questionnaire about traditional Minangkabau musical instruments, which was given to 80 fifth-grade elementary school students in five observed schools. The conclusion from the data above is that there are still people who are unfamiliar with Minangkabau dance and musical instruments [7], [8].

AR is a technology that brings 3D virtual objects into the real world via a smartphone, unlike VR, which makes us enter a virtual world so we can see 3D virtual objects [4]. AR offers the advantage of being easily accessible using a smartphone, because today's society is dependent on mobile technology, especially the younger generation, who make smartphones the center of their lives. AR allows users to interact directly with 3D objects, providing an educational and engaging experience that can engage audiences.

This research focuses on the development of an augmented reality (AR) application—named ARSTAM—designed for education in Minangkabau dance and music, to promote the culture. The novelty of this study, compared to previous research, lies in its content, which features a "dual-domain cultural integration" by synchronizing dance content with musical instruments. While earlier studies have developed AR applications to promote cultural arts, they have generally been limited in scope—focusing on only one aspect, such as AR for musical instruments or AR for dance animations [9], [10], [4]. In reality, however, the essence of Minangkabau performing arts lies in the fact that the music and the choreography are intrinsically linked, forming a single, inseparable rhythmic unity. Combining these diverse components within an AR platform is essential for providing a comprehensive cultural learning context. Furthermore, it enhances the system's functional complexity through real-time audiovisual synchronization, offering an immersive and adaptive educational medium for the younger generation—ultimately helping to rekindle their appreciation for cultural heritage.

2. RESEARCH METHOD

The application was built using the MDLC (Multimedia Development Life Cycle) method because this method is suitable for multimedia-based or mobile applications [11]. This method was discovered by Luther and developed by Sutopo [12]. As shown in Figure 1, this method consists of six stages: concept, design, material collection, assembly, testing, and distribution. These six stages do not have to be sequential in practice; they can be interchanged. However, the concept stage should be the first step [13].

The concept phase is when the developer analyzes the requirements for building an application. Non-functional requirements for an application include ease of use, stable performance, and cost-effectiveness. The contents of the musical instruments are saluang, talempong, flute, bansi, drum, tansa, tambourine, and rabab. Dance art content includes, among others, the Indang dance, the Piring (plate) dance, and the Rantak dance. The hardware and software used in the application design are as follows: The Blender version

used in designing the ARSTAM application is Blender 4.3. The Vuforia package used in designing the ARSTAM application is version 11-4-4. The Unity Hub used to build the ARSTAM application is version 3.10.0, with editor version 6000.0.27f1. Visual Studio 2022. The target Android specifications for running the ARSTAM application are Android 10 (minimum) with a 64-bit system. Laptop specifications for creating AR applications: minimum AMD Ryzen 5/Intel Core i5 processor, with a minimum of 8 GB of RAM; SSD storage is recommended for faster or more optimal loading or rendering processes. The laptop specifications used in the production of the ARSTAM application are: AMD Ryzen 5, 16 GB of RAM, 512 GB SSD. Marker resolution: 669 x 384, 347 x 512, 669 x 448, 637 x 451, 669 x 513, 1024 x 768, 1280 x 853, 589 x 323, 640 x 362, 429 x 524, 310 x 330 pixel. The application is targeted at individuals who are proficient in using Android smartphones—such as the general public, students, members of art studios, or anyone else with an interest in learning. The functional requirements for the application are as follows: The application can detect markers, the application can display 3D objects after scanning the marker, the buttons are functional, the audio sound of the 3D object is played when playing, lean touch on the 3D object (drag, zoom, rotate) is functional.

The design phase is the stage in which the developer creates the application's design by adhering to multimedia principles [9]. This includes designing the navigation flow and system logic (using UML or flowcharts), the database, 3D architecture and media (asset design specifications), and the application's user interface (via storyboards or UI/UX design). UML is a software modeling language that has been standardized as a medium for writing blueprints to help programmers or developers build software, like an architect creating blueprint documents used by construction companies to build a building [14].

A use case diagram is a description of a system's functions from the user's perspective. It outlines the typical interactions between the system's users and the system itself, providing an overview of how the system is used [15]. Figure 2 shows the use case diagram for the ARSTAM application, where the user interacts with the home menu, and each menu displays its respective content. An activity diagram represents the flow of a system as it executes user commands from start to finish, as shown in Figure 3.

An AR database is designed in the Vuforia Engine. An "image target" is an image scanned by an AR camera to trigger the appearance of a 3D object. The Vuforia Engine is required to convert an image into an image target (or marker); it serves as a platform for AR databases. Images are uploaded to a Vuforia Engine database to be transformed into image targets, after which the image target database is imported into Unity.

A user interface and a storyboard are created during the design of an application to make its flow and purpose clearer. Figure 4 shows the user interface as well as the storyboard. Scene 1 shows the splash screen that appears when entering the application, before displaying the main menu. Scene 2 displays the main menu. Scene 3 shows the About app. Scene 4 shows the developer profile. Scene 5: The user taps Start AR. Scene 6 displays a guide app. Scene 7 shows a 3D object that appears after a successful scan.

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Following the design phase, the next stage is material collection—the process of gathering all the components required for the application development [9]. Design and material collection can be carried out concurrently with the assembly phase. During the assembly phase, the application is built using Unity, an interactive game engine capable of supporting both 2D and 3D-based games. Once the application has been built, the final step is testing, which allows the developer to determine whether the application runs successfully. Once testing has been completed and the application is functioning properly, the next stage is distribution, in which the designed program is stored on a storage medium so that it can be disseminated and used by end users. [13], [16], [9].

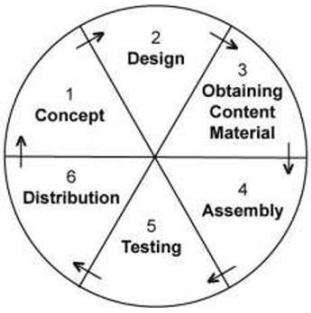

Figure 1. MDLC Method [12]

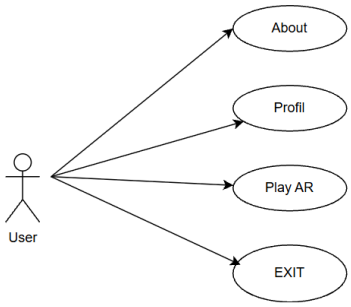

Figure 2. Use case diagram

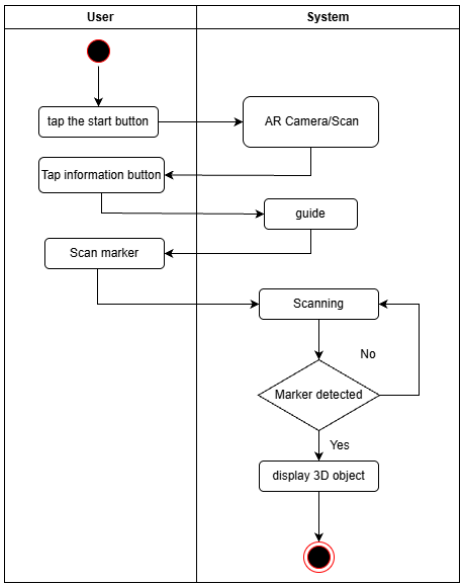

Figure 3. Activity diagram

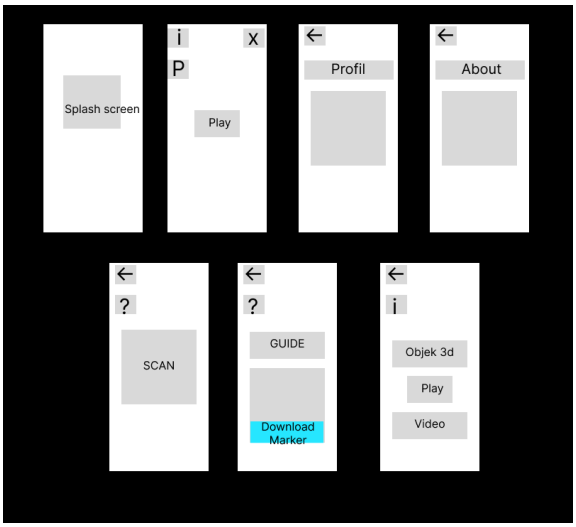

Figure 4. Wireframe (UI design) & storyboard

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3. RESULTS AND DISCUSSION

Table 3 presents the results of black-box testing—a method based on application functionality, used by developers for software debugging. The black-box test results indicate that the application functions properly. The scanning screen provides instructions on how to use the feature. Users can manipulate 3D objects through gestures such as dragging, rotating, and scaling. A "play" button is also available to trigger animations and audio associated with the 3D objects, while a video player button on a 3D object directs the user to a YouTube video. The next test is a marker detection test. According to Table 4, the test results indicate a 100% marker detection success rate. The average response time is 1.33 seconds, indicating that the marker is reliably detected in normal room lighting. The next test is to conduct direct user testing (a usability test) by administering a 3-question questionnaire to 33 respondents. The researcher kept the confidentiality of the respondents' data. Respondents filled in the data once because the researcher limited the responses to one person, with proof of name, Gmail address, and different Android devices to prove the data was genuine and not manipulated by the researcher. The Likert scale is as follows: strongly disagree (SD) = 1 score, disagree (D) = 2 score, neutral (N) = 3 score, agree (A) = 4 score, strongly agree (SA) = 5 score. According to Table 5, the average percentage is 87.5%, indicating that the application is very suitable for use. The questionnaire results showed that this application runs on various Android devices, such as Oppo, Redmi, Infinix, Vivo, and others. It can run on a minimum of 3 GB of RAM. The app has a very high feasibility rating. It boasts a responsive marker detection rate and user satisfaction.

3.1. Black box Testing

Table 3. Black box testing

Scene/UI	Testing Scenario	Status
	Display splash screen	Succeed

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	Displays the main menu	Succeed
	Display menu developer	Succeed
	Display menu info/about APK.	Succeed
	Display Object 3D and animation	Succeed

3.2. Marker Testing

Table 4. Marker testing

Marker Name	Response Time (Seconds)	Status
Bansi	0,19	Succeed
Saluang	0,09	Succeed
Serunai	0,39	Succeed
Tambur	0,09	Succeed
Tansa	0,09	Succeed
Rebana	0,49	Succeed
Rabab	7,92	Succeed
Talempong	0,09	Succeed
Indang dance	5,14	Succeed
Plate dance	0,09	Succeed
Rantak dance	0,09	Succeed

3.3. Usability Testing

Table 5. Usability testing

No	Indicator	SD	D	N	A	SA	Total Score	Percentage	Category
1	The application is easy to use	2	0	1	11	19	144	87,3%	Very good
2	I gained insight into various types of Minangkabau dance and musical instruments and had a pleasant experience using an augmented reality technology-based application.	2	0	0	10	21	147	89,1%	Very good
3	The application runs smoothly in operation	2	0	1	13	17	142	86,1%	Very good

4. CONCLUSION

This research has successfully developed an innovation that integrates dual artistic content—an advancement over previous studies that focused on a single scope (separate content). Questionnaire results indicate that the application has successfully met user satisfaction. This application has limitations: it is only accessible on Android, and the amount of content available is still quite limited. Future research could further develop the application by, for example, expanding the range of artistic content or enabling access on iOS devices. Additionally, it is recommended to incorporate a questionnaire feature to assess the extent to which users understand the material.

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