

North Sulawesi Traditional Musical Instrument Introduction Application Using Augmented Reality

Aplikasi Pengenalan Alat Musik Tradisional Sulawesi Utara Menggunakan *Augmented Reality*

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Abstract — North Sulawesi's traditional musical instruments are one of the cultures that must be maintained and preserved, especially by the younger generation. Traditional culture is slowly being replaced by modern culture. Cultural arts lessons in schools are mostly only through books. Students rarely see and hear North Sulawesi musical instruments directly, usually because traditional musical instruments are not socialized at school. Therefore, to make it easier for students at school to get to know North Sulawesi's traditional musical instruments, an application was created that uses augmented reality technology, with students' smartphones as the medium. This application will display a 3D model of a musical instrument and can be played via the buttons provided. Applications are made using the MDLC (Multimedia Development Life Cycle) method which contains 6 stages, namely concept, design, material collecting, assembly, testing, and distribution. The application was tested at SD Negeri 126 Manado with 3 stages of the questionnaire where the questionnaire stages 1 and 2 were a test of ability before and after the application was introduced, and stage 3 was a satisfaction questionnaire with the application. The ability test results after the application was introduced increased from 35.2% to 90%. In addition, there is also a questionnaire containing application satisfaction where 80% of respondents answered that the application had helped them get to know North Sulawesi's traditional musical instruments.

Key words — 3D, AR Camera, Augmented Reality, Traditional Musical Instruments

I. INTRODUCTION

Every part of Indonesia has its own traditional musical instruments. These traditional musical instruments have been passed down from generation to generation and are one of the cultures that must be preserved by the Indonesian people so that they are not forgotten by modern musical instruments. Each traditional musical instrument has its own uniqueness and is played with different techniques. Usually, traditional musical instruments are used to accompany traditional dances, traditional ceremonies, and/or traditional rituals that are held in each region of Indonesia. Even, traditional musical instruments can also be the identity of a region.

Modern and traditional music have different levels of development. Modern music has a faster rate of development and more enthusiasts than traditional music[1]. Most traditional musical instruments can only be found when there is a traditional event or when people travel directly to the location

where the traditional musical instruments are. Meanwhile, modern musical instruments can be found anywhere.

As time goes on, the times become more modern. This makes traditional musical instruments less popular. If left unchecked, traditional musical instruments could be forgotten by the public, especially children. Even, there are children who do not know the traditional musical instruments in their own region. Usually, this problem is caused by the learning of arts and culture in schools that seem boring and the lack and unevenness of adequate facilities and infrastructure in schools. In addition, there are other factors where traditional musical instruments are less socialized to the school environment. If this is left unchecked, traditional musical instruments will slowly disappear and be forgotten, replaced by modern musical instruments.

Due to the problems mentioned above, a solution emerged where using augmented reality technology, traditional musical instruments, especially in the North Sulawesi region, can be known and reminded to the public. The use of augmented reality is useful in displaying the 3D shape of each traditional musical instrument from North Sulawesi along with its sound. Therefore, the Application for Introducing Traditional Musical Instruments of North Sulawesi Using Augmented Reality was created.

A. Related Research

The following are some studies related to the topics discussed in this research. Existing related research became a reference in conducting this research.

1. Kristian Kuhon's research on table manners led to the development of a table manners learning application. This application is useful for introducing good and correct table manners through 3D objects. The application contains lessons on table manners rules that people need to know for formal meals. [2]
2. A research by Putra Rotinsulu resulted in an application that is useful for making it easier for users to find the locations of rooms in the Faculty of Engineering at Sam Ratulangi University. [3]
3. A research by Fransiskus Juniawan resulted in an augmented reality application that is used as a means of introducing traditional musical instruments from

Bangka. The application can provide a real-time view of the musical instruments that corresponds to the dynamic movement of the camera. [4]

4. A research by Farhan Saputra. The result of this study is an application that has been developed for the identification of traditional musical instruments of East Java. This application has several buttons on the main menu, including a marker scan button, a quiz button, a user guide button, an about & contact button, and a button to exit the application. [5]
5. A research by Yovi Apridiansyah. The result of this study is the creation of an Android application about dol, a traditional musical instrument of Bengkulu, which is useful for increasing knowledge about dol musical instruments interactively using Android. The application has several menus, namely introduction, practice, info, and exit. [6]
6. A research by Meylisa Rasjid. The result of this study is the development of an application about the traditional musical instrument from North Sulawesi, kolintang, using augmented reality. The application uses markers and displays five types of kolintang along with their sounds. [7]
7. A research by Dwi Kurniawan. The result of this study is an application to introduce bamboo and tin musical instruments. There are 2 buttons on the main menu, namely "Musik Bambu" and "Musik Seng". In addition, there is a brief explanation of the musical instruments, their notes, and how to play them. [8]
8. A research by Niko Rianto. The result of this study is an augmented reality application that aims to introduce traditional Lampung musical instruments. This application is expected to be a new alternative for learning about traditional Lampung musical instruments. This study took a case study at SDN 1 Rangai Tri Tunggal Lampung Selatan. When the camera is directed at the marker, a 3D object appears along with a menu to enlarge and reduce the object of the musical instrument. In addition, there are note buttons for each musical instrument that emit a variety of sounds. [9]

B. Traditional Musical Instrument

Traditional musical instruments are a type of musical instrument from a region that has been passed down from generation to generation. Traditional musical instruments are a culture that should be preserved. Usually, traditional musical instruments are used to accompany traditional dances. In addition, traditional musical instruments can also be used in certain events, such as traditional ceremonies. There are many ways to play traditional musical instruments, such as plucking, blowing, hitting, and rubbing. These methods also apply to modern musical instruments. It is not uncommon for traditional musical instruments to be played alongside modern musical instruments. [10]

C. Application

A software program that performs a specific task for the user is called an application. The application can also be used by the

target audience of the application. Applications can also be interpreted as problem solving by using data processing. Certain programming languages are used in applications to process data. [11]

D. Augmented Reality

Technology that combines two-dimensional or three-dimensional virtual objects into a real environment is called augmented reality or augmented reality. These two-dimensional or three-dimensional objects are projected into the real-time environment. [12]

Augmented reality can be used on smartphones. The development and construction of this augmented reality is one of its technological advantages. Augmented Reality can be used to solve problems in various fields such as health, education, and entertainment. Augmented reality uses a combination of computer vision and image processing technologies. This technology searches for information from an image in real time. [13]

E. Marked Based Tracking

A marker is a 2D image that is used as a target to display a 3D object in augmented reality. The marker has a pattern that allows the camera to detect the marker, which is then integrated with the 3D object. The computer will then recognize the position and orientation of the marker so that the 3D object can appear. [14]

F. Unity 3D

Unity 3D is a game engine that is cross-platform or multi-platform, meaning that users can create games that can be run on various operating systems and devices such as Windows, Mac, Android, iOS, PlayStation, and others. Users can already use Unity 3D by activating a free license.

Unity 3D is equipped with an IDE (Integrated Development Environment) that serves as a code editor and compiler, so it does not require its own software development. [15]

When making a game, users will need to create scenes and buttons that are required by the game. To control and generate functions in the game, users can use a script editor that uses the C# programming language. Users can use the script editor that is included in the Unity 3D game engine. In addition, users can also use other applications such as Visual Studio or Notepad++.

G. Blender

Blender is an open-source software used to create 3D images. Blender supports the entire 3D workflow, including modeling, animation, simulation, rendering, compositing, rigging, and motion tracking. Blender can also be used for video editing and game creation. Blender is multi-platform and can be used on a variety of operating systems.

H. Canva Pro

Canva is a graphic design tool that can be accessed online. Canva has a variety of templates, features, and unique fonts to help users create beautiful designs easily. Canva users can create designs for posters, flyers, brochures, greeting cards, PowerPoint presentations, social media posts, videos, and much more. Canva can also be used to design logos. Canva provides a feature where you can collaborate with a team to work on a project.

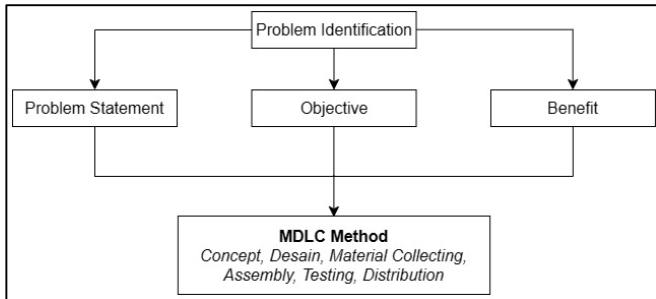


Figure 1. Framework

II. METHOD

A. Framework

This application development used the MDLC research method, which has 6 stages in the process. In addition, literature studies, observations, and interviews were used to collect data. The framework can be seen in Figure 1.

B. System Development Method

The method used in this study is the Multimedia Development Life Cycle (MDLC). MDLC has 6 stages, namely concept, design, material collecting, assembly, testing, and distribution, as shown in Figure 2.

1) Concept

This stage is the activity of identifying the purpose, concept, and users of the program/application to be created.

2) Design

This stage is the process of creating detailed specifications for the structure of the program, its appearance, and any requirements for the application. At this stage, the design of the application is created so that all the needs of the system in the application can be clearly described.

3) Material Collecting

This stage is the activity of collecting the materials needed for the application, such as videos, audio, images, and so on.

4) Assembly

This stage is the process of organizing the materials that have been collected based on what was created in the design stage.

5) Testing

This stage is the activity of testing whether the application can run well and meet expectations. This stage also includes activities to check if there are any errors in the application.

6) Distribution

This stage is the activity of distributing the application so that it can be used by users. After that, analysis and evaluation are carried out to develop the application so that it becomes even better.

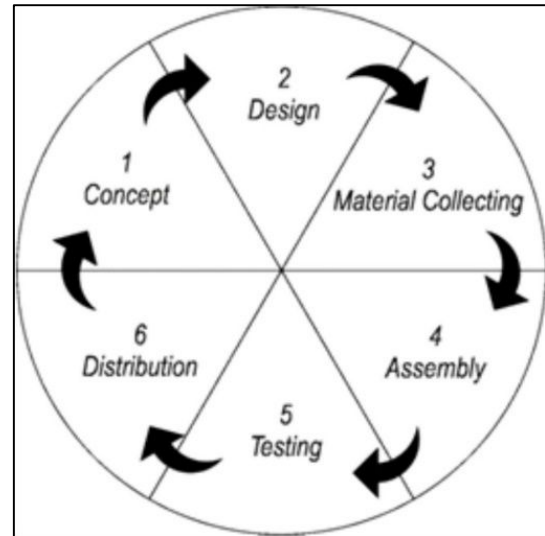


Figure 2. Multimedia Development Life Cycle

III. RESULT AND DISCUSSION

An application for introducing traditional musical instruments from North Sulawesi using augmented reality was successfully created as a result of research that has been conducted. The application was created using the stages contained in the Multimedia Development Life Cycle (MDLC) method.

A. Concept

The concept phase is the first stage that is carried out by the researcher, where the purpose of the application, the application users, and the application functions are identified and determined.

1. The purpose of this application is to introduce and remind students about the musical instruments in the province of North Sulawesi.
2. The use of augmented reality in this application allows students to see the 3D shape of each musical instrument. Showing the 3D shape along with the sound of each musical instrument can make the introduction of musical instruments more interesting than just using a book.
3. This application uses marker-based tracking. Students only need to point the AR camera at the marker and the 3D object and sound button will appear.

B. Design

During this stage, the application design is created to clearly describe all the requirements of the system in the application. This stage can be developed using use case diagrams and activity diagrams.

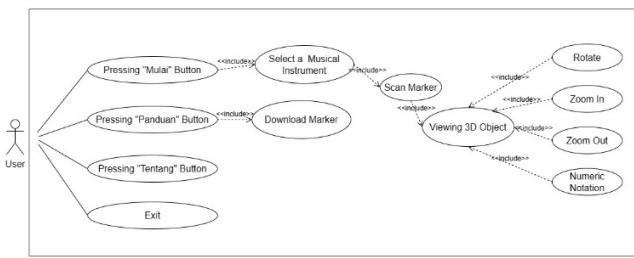


Figure 3. Use Case Diagram

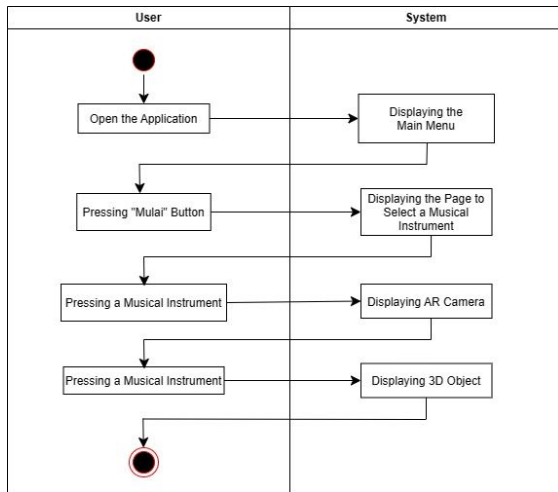


Figure 4. Activity Diagram of "Mulai" Button

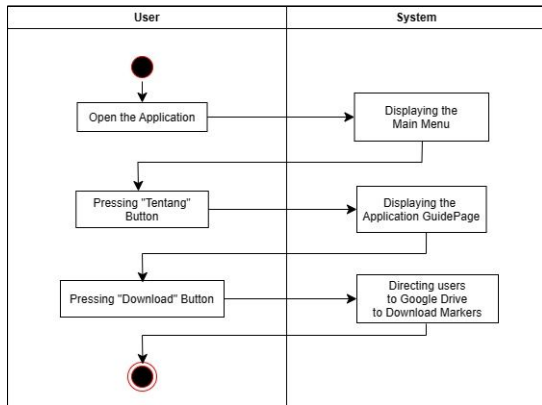


Figure 5. Activity Diagram of "Panduan" Button

1) Use Case Diagram

The illustration of the North Sulawesi Traditional Musical Instrument Recognition Application Using Augmented Reality is described using a use case diagram so that the workings of the application can be seen. The use case diagram of this application can be seen in Figure 3.

2) Activity Diagram

Activity diagram is a diagram that describes the workflow or processes that occur within a system. In addition, the activity diagram contains information about objects, states with transitions, and events. This diagram is an extension of the use case diagram which has an activity flow. Figure 4 shows the activity diagram of the "Mulai" button. Figure 5 shows the activity diagram of the "Panduan" button. Figure 6 shows the activity diagram of the "Tentang" button. Whereas Figure 7 shows the activity diagram of the "Keluar" button.

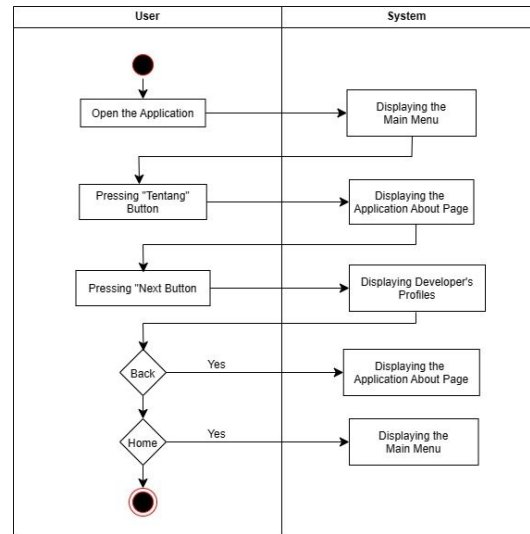


Figure 6. Activity Diagram of "Tentang" Button

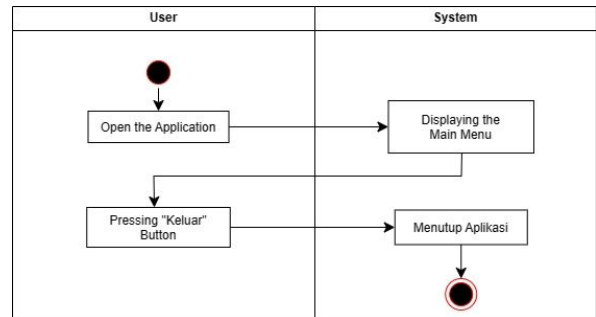


Figure 7. Activity Diagram of "Keluar" Button

TABLE I
MATERIALS FOR APPLICATION DEVELOPMENT

| NO | PICTURE | REFERENCE |
|----|---------|---|
| 1 | | The images of musical instruments come from various sources, namely the Pinawetengan Museum, the Ma'azani Studio, and the internet. |
| 2 | | The audio of each musical instrument used in the application was recorded directly using a smartphone. |

C. Material Collecting

Material Collecting, or material collection, is a stage in which researchers collect the materials needed to create an application. These materials are in the form of data, including journals, the internet, and visiting museums to obtain clear images and sounds of each musical instrument, as shown in Table I.

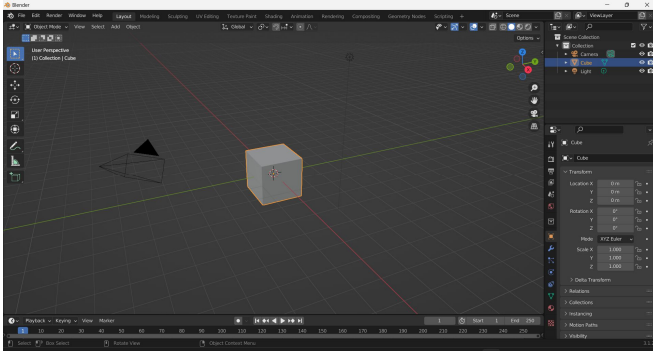


Figure 8. Blender Start Screen

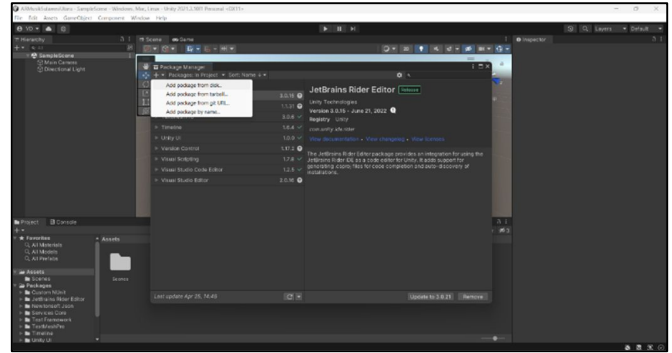


Figure 10. Activity Diagram of "Panduan"

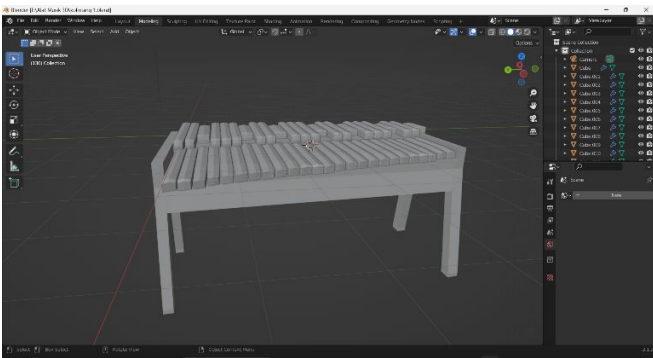


Figure 9. Creating 3D Model

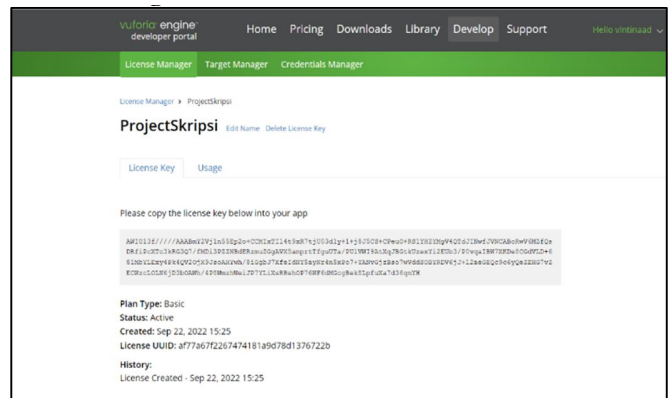


Figure 12. Creating License Key

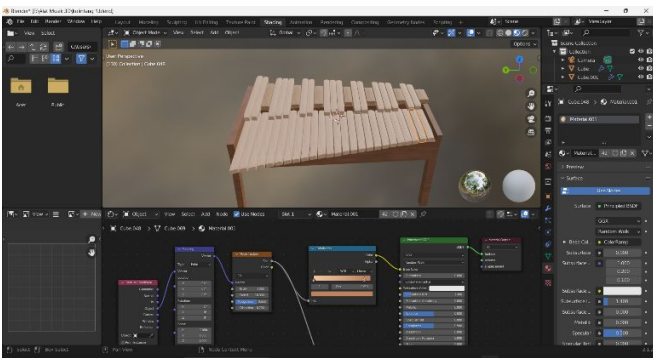


Figure 10. Adding Texture

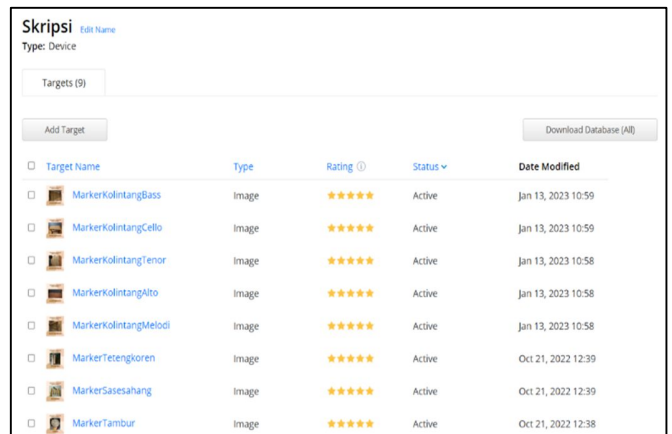


Figure 13. Creating Database

D.Assembly

Assembly is the stage where the application is created. The application is created based on the design that has been designed in advance. The data that has been collected is also added to the application. The assembly process begins with the creation of 3D models of each musical instrument using Blender. Then the application is created using Unity and Vuforia.

1) 3D Object Creation

The 3D object creation stage uses the Blender application. The 3D objects created were 9 3D objects of musical instruments. Figure 8 shows the initial view when Blender is opened.

3D objects are created in Blender by adding meshes and using modifiers to shape them into musical instruments, as seen in Figure 9. After the musical instrument model is created, textures are added in the Shading menu as seen in Figure 10. At this point, the musical instrument model is given a color that is similar to the original.

2) Application Development

The next stage is to create the application. All 3D objects that have been created in Blender previously, will be inserted into the application. Application development uses Unity Engine version 2021.3.10f1.

Before the application is created, Vuforia must be added to the Unity application as seen in Figure 11. Vuforia uses a license key that will later be inserted into the application. The license key is created through the License Manager website at developer.vuforia.com.

License key is created through License Manager website at developer.vuforia.com as shown in Figure 12. The license key that has been created, is inserted into Unity by pressing Window>Vuforia Configuration.

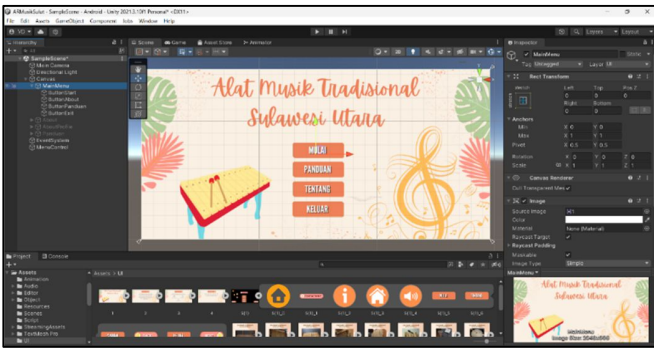


Figure 14. Creating Application UI



Figure 17. Application Start Screen

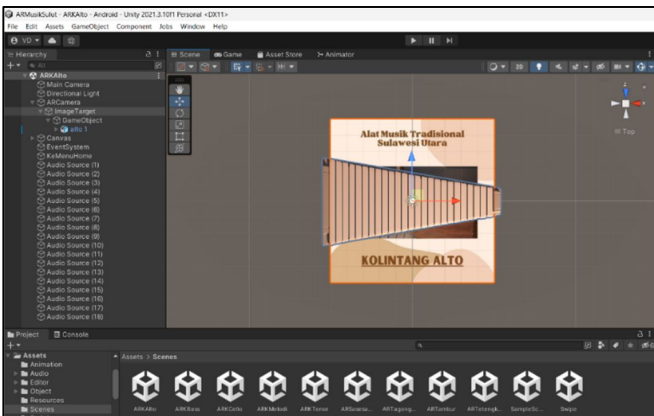


Figure 15. Adding Image Target and 3D Object



Figure 18. "Panduan" Menu View



Figure 19. "Tentang" Menu View

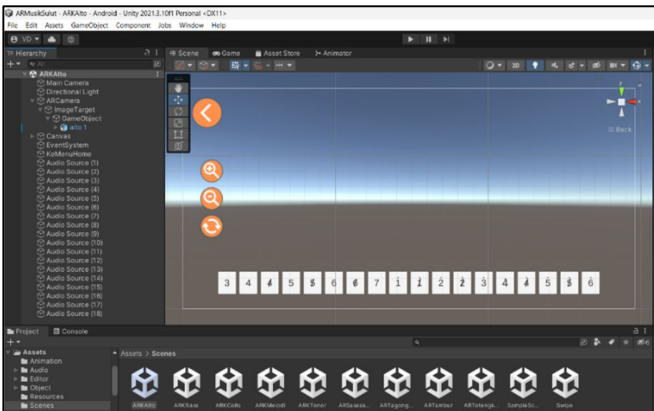


Figure 16. Creating Buttons on AR Canvas



Figure 20. "Mulai" Menu View

The license key is then inserted into the App License Key field and then press Add License. Next, create a database that contains image targets of each musical instrument. The database is created through the Target Manager that is available in the developer.vuforia.com website as shown in Figure 13 and downloaded.

Next, create the layout and place the necessary buttons as seen in Figure 14. In addition, create a scene and add audio. Figure 15 is the view on the AR Camera, which contains the Image Target. The 3D object is added to the image target and the size and position are adjusted. Figure 16 displays the view that is found in the canvas of each musical instrument.

E. Testing

After the assembly stage is complete, the next stage is testing or testing of the application. This is done to check whether the application is running properly and meets expectations. In addition, errors or errors are checked and then analyzed and repaired.

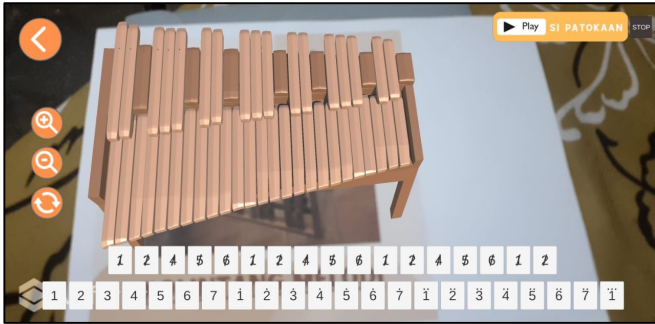


Figure 21. AR Camera View

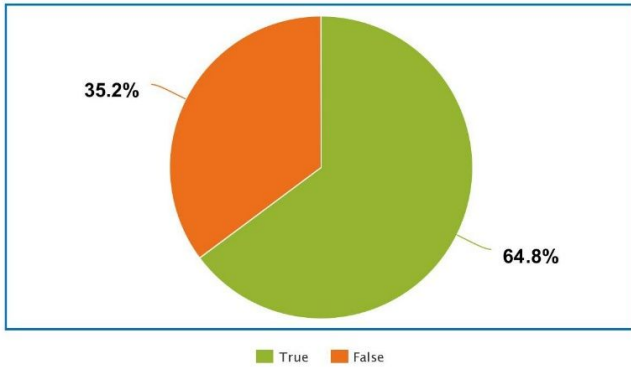


Figure 22. Phase 1 Testing

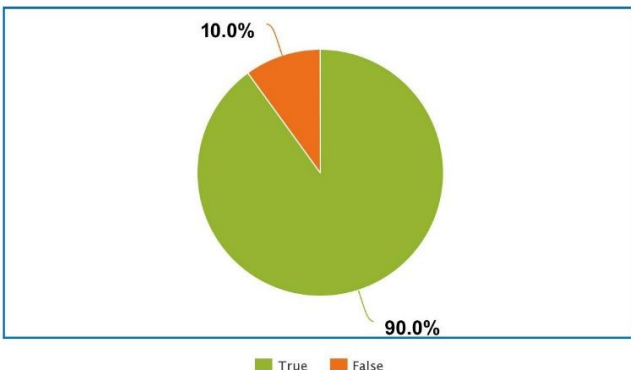


Figure 23. Phase 2 Testing

1) Alpha Testing

The application was tested using a Samsung Note 9 smartphone. The application size on the smartphone is 104 MB. Figure 17 is the initial view of the application. When the application opens, the Main Menu view will appear, which contains a title about the application and main buttons such as "Mulai", "Panduan", "Tentang", and "Keluar".

Figure 18 shows the view when the user presses the "Panduan" button in the main menu, which shows how to use the application. Figure 19 shows the view when the user presses the "Tentang" button in the main menu, which displays a brief explanation of the application and the creator. Figure 20 is where the user can select the application that will be viewed in 3D. Figure 21 is the view after the user scans the marker that matches the selected musical instrument. Figure 22 is the testing result before the application was introduced. Figure 23 is the testing result after the application was introduced.

TABEL II
BLACK BOX TESTING

| No | Feature | Description |
|-----|---|-------------|
| 1. | Installing Application | Success |
| 2. | Pressing the "Mulai" button | Success |
| 3. | Pressing the "Panduan" button | Success |
| 4. | Pressing the "Tentang" button | Success |
| 5. | Pressing the "Keluar" button | Success |
| 6. | Clicking the "Download" button | Success |
| 7. | Clicking the home icon | Success |
| 8. | Pressing the "Next" button | Success |
| 9. | Pressing the "Back" button | Success |
| 10. | Pressing the musical instruments button | Success |
| 11. | Sliding the button with picture | Success |
| 12. | Displaying a 3D object | Success |
| 13. | Pressing the Zoom In button | Success |
| 14. | Pressing the Zoom Out button | Success |
| 15. | Pressing the Rotate button | Success |
| 16. | Pressing the back button at AR Camera | Success |
| 17. | Pressing the music sound button | Success |

2) Black Box Testing

Black box testing is a testing method that is used to check and ensure that the components within an application are functioning or not and are running properly. If there are components that are not running properly, then they will be repaired. The results of black box testing are displayed in Table II.

F. Distribution

After the final testing stage, the next step is distribution, which is the final stage. The distribution stage is carried out by building the application in .apk format. Then, the application is given to the school, namely teachers and students, so that it can be used. The distribution stage is also an evaluation stage so that the application can be developed further. The results of the evaluation can be used as input for the application.

IV. CONCLUSIONS AND SUGGESTIONS

A. Conclusions

Based on the research results that have been conducted, the conclusion that can be drawn from the Application for Introducing Traditional Musical Instruments of North Sulawesi Using Augmented Reality is that the process of recognizing objects and sounds from traditional musical instruments of North Sulawesi is made easier by using augmented reality technology in a more realistic way. As seen in the application satisfaction test, 80% of students answered "Yes" and 20% others answered "Maybe" to the question of whether the application can help them in the introduction of traditional musical instruments of North Sulawesi. The application can also help students to recognize the shape and sound of traditional musical instruments of North Sulawesi. This is supported by the increase in the number of correct answers from 35.2% to 90% after the application was introduced.

B. Suggestions

This research still requires some further study in order to develop this application further. Therefore, the advice that can be given is that the augmented reality application that has been created can only be used with the Android platform. The next developer can make this application develop into one that can be used on other platforms. In addition, the next developer can add other traditional musical instruments.

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Valentina Dhamayanti, the eldest of three siblings. Born in Manado, February 14, 2001. The author is the eldest of 3 siblings. The author began her education at TK Katolik Malaikat Pelindung (2005-2006), then the author continued her education at SD Katolik 4 Manado (2006-2012), after that continued her education at Sekolah Dian Harapan Manado (2012-2015), then continued her education at SMA Negeri 9 Manado (2015-2018). After that, in 2018 the author continued her S1 education at the Faculty of Engineering, Department of Electrical, with a bachelor's degree in Computer Science at Sam Ratulangi University. During her studies, the author became a member of one of the organizations, namely the Electrical Engineering Student Association (HME), and became a member of the software development field in the Unsrat IT Community (UNITY) community in the 2021/2022 period.