Learning the Diatonic Scale in a Mini Gamelan Musical Instrument based on Augmented Reality

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ABSTRACT
One effort to preserve Indonesian traditional culture is education in arts and culture. In schools, with limited time, media and learning resources available, the material presented cannot be well received. This method of learning traditional musical instruments uses mini gamelan musical instruments on Android which are very effective and can be accessed anywhere so that students can easily learn them for independent learning. Augmented Reality as a method for learning traditional musical instruments in Indonesia is one way to introduce traditional musical instruments for beginners who want to know or want to know what the shape and tone of the sound in the traditional mini gamelan musical instrument are. This application for learning traditional musical instruments may be expected to increase the love for traditional musical instruments. As is known, it is very rare to find traditional Indonesian musical instruments played in public places, even though the combination of other traditional musical instruments is very pleasant to listen to and play. The results of this augmented reality application will be applied and run on the Android mobile platform, to run this application you will use the Android smartphone camera. Then this smartphone will display traditional musical instruments in 3D form which will appear and virtual buttons will appear so that users can recognize these traditional musical instruments based on their 3D shape and can play notes based on the available mini gamelan musical instrument objects.

General Terms
Markerless and marker-based mobile Augmented Reality musical instrument learning platform

Keywords
Augmented Reality, traditional musical instruments, mini gamelan

1. INTRODUCTION
In this modern era, multimedia technology is widely used in various fields such as education, health, publications or advertising, and others. Multimedia is the use of computer information in displays that combine text, graphics and video so that users can navigate, interact, create and communicate with computers. In today's increasingly sophisticated era of globalization, the development of information and communication technology is very rapid. Computer technology is also developing very rapidly in terms of hardware and software, which are used in an integrated manner to convey information and knowledge in visual form [1]. Learning media is something that can convey and convey messages from sources in a planned manner so as to create a conducive learning environment where recipients can carry out the learning process effectively and efficiently [2].

What is famous in Indonesia as a typical musical instrument is Javanese Gamelan, Javanese gamelan is a type of gamelan music. The main components that make up gamelan musical instruments are bamboo, metal and wood. Each instrument has its own function in gamelan music performances. For example, the gong's role is to close a long rhythm and provide balance after the previous music has been decorated by a gending rhythm. The Javanese view of life expressed in gamelan music is harmony in speaking and acting so as not to give rise to explosive expressions and to create tolerance between people. The distinctive rhythm produced is a combination of sound types from each unit of gamelan equipment. Hypothetically, Javanese people before the influence of Hinduism knew ten skills, including wayang and gamelan. Philosophically, Javanese gamelan is an inseparable part of Javanese life. This is because the Javanese people's philosophy of life is related to their cultural arts in the form of Javanese gamelan and is closely related to the development of their religion. In Indonesia, there are several types of gamelan, namely Javanese gamelan, Balinese gamelan and Sundanese gamelan. [3].

Indonesia is a large country, a country rich in cultural values and traditions. One of the values of Indonesian culture is having traditional musical instruments in every region. Learning media about musical instruments can currently be found in the form of books, learning applications and posters. Currently, learning media such as books about traditional musical instruments are very difficult to find, this can happen because of the lack of public interest in reading about traditional musical instruments which only consist of pictures and writing [4].

One medium that can be used as a solution to this problem is by utilizing augmented reality (AR) technology. Augmented reality technology is a computer world technology that combines the real world and the virtual world. Augmented reality technology is a technology that is currently being developed rapidly, augmented reality technology also supports various platforms, one of which is the Android platform. By combining augmented reality technology with one of the cultures, namely traditional bamboo music instruments typical of the Minahasa land, information on musical instruments will be presented from a different perspective using 3-dimensional objects with a smartphone, making it easier for users to play this virtual application.

2. LITERATURE REVIEW
Several research results have been carried out by previous research in the field of research to be carried out.

in this research discusses the introduction of traditional West Sumatran musical instrument arts with augmented reality based on mobile devices. In this research, we discuss the application of traditional musical instruments from West Sumatra to

introduce traditional musical instruments using augmented reality technology[5].

in this research discusses the application for introducing Indonesian traditional musical instruments using augmented reality. This application can be a means to introduce traditional Indonesian musical instruments. User interaction using buttons in this application makes it easier for users to run the application. In this research, all functions can run as expected, such as marker, audio, text, 3D model and rotation functions so that information can be displayed on each marker. However, in this research, what can be developed is being able to add features to the application such as the sound of each musical instrument and being able to build 3D objects that are more precise or perfect so that they look the same as real traditional musical instruments[6].

2.1 Markerless Augmented Reality

the markerless method is a method used in Augmented Reality (AR). This method does not require a target to display components of the detection to display digital elements[7].

Markers have various techniques that have been developed by Qualcom, including the following
a. Face tracking is a system that detects or carries out a facial recognition process by recognizing parts of the facial surface such as the eyes, nose or mouth and will ignore other objects besides the surface of the face [7].

b. 3D Object tracking is the process of recognizing objects in 3 dimensions which is carried out using a scanning process provided by the system. This technique will recognize objects in 3 dimensions from the scan results [7].

c. Motion Tracking is the process of recognizing movement in body parts. Usually this technique is used for the process of making films in CGI or computerized form by recognizing every part of the body movement [7].

d. GPS Based Tracking is an identification process by determining the position, location or location using GPS, the compass will display the direction as desired. GPS based tracking is also usually used for the creation process of a game [7].

2.2 Marker Based

AR marker base technology is Augmented Reality using markers or object markers that have patterns that can be read via webcam media on a computer or mobile device. The visuals used can be in any form, the most commonly used are printed QR codes or special symbols as markers.

Marker based AR works by calculating and orienting markers to position content. That way, the marker will display 2-dimensional and 3-dimensional objects and can be seen through the device so that students can see it. An example of using marker-based AR is filters on Instagram[8]

In this application you can see the markers that have been provided in the Augmented Reality application, The marker base used can be seen in Table 1.

Table 1. Marker Based

NO	Marker	Note
1		Do
2		Re
3		Mi
4		Fa
5		Sol
6		La
7		Si

8		DO

2.3 Diatonic Scale

The diatonic scale is a series of seven notes or tones in one octave in a regular arrangement. In it there are two combinations of pitch distances or intervals, namely 1 and ½. Examples of diatonic tones are do-re-mi-fa-sol-la-si-do, which are arranged successively from low to high. Diatonic scales are used in songs or popular music that are modern or contemporary in orientation. The diatonic scale itself is divided into two types, namely major diatonic and minor diatonic. Each type has a different sequence or arrangement of notes. Examples of musical instruments that use diatonic scales include piano, organ, harp, harmonica, pianica, flute, clarinet, saxophone, flute, and so on. Then these musical instruments use diatonic scale tone components in the notes they produce[9].

2.4 Mini Gamelan

Traditional Javanese musical instruments are instruments made or modified for the purpose of producing music. Traditional Javanese musical instruments are instruments made to produce traditional Javanese music. The Special Region of Yogyakarta (DIY) is one of the regions in Indonesia which is located on the island of Java and has strong traditional music supported by traditional Javanese musical instruments. Traditional Javanese musical instrument. Especially in DIY, one of them is gamelan. Gamelan is a musical ensemble that usually features metallophones, xylophones, drums, and gongs. The term gamelan refers to the instruments which are one complete unit that is played together. Gamelan comes from the Javanese word gamel which means hitting/drumming. [10] A picture of a mini gamelan can be seen in fig1

Fig 1: Mini Gamelan

3. ANALYSIS OF THE PROPOSED SYSTEM

3.1 Functional Analysis

Functional requirements are an analysis of requirements related to the facilities required by the system in general. The following are some of the functional requirements needed for diatonic scale learning media applications:

a) This application can display mini gamelan animations in 3D form

b) This application can play mini gamelan so that people can find out the sound of the diatonic scale on the musical instruments provided.

3.2 Analisis non fungsional.

These non-functional needs include hardware and software requirements that must be owned to run the application to be created. The following are several non-functional requirements that must be met by the system.

1. Software Requirements

In this research, researchers used several software to support the creation of this application

1. Blender
2. Unity 3D
3. Vuforia SDK

2. Hardware Requirements

In the process of making this application, researchers used 1 laptop and one smartphone for experiments, with the following specifications for each:

1. ASUS Vivobook Pro laptop
a. Processor: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz 3.30GHz
b. Memory : 16GB
c. Edition : Windows 11

2. Redmi Note 11 smartphone
a. OS : Android 11, MIUI 13
b. CPU: Snapdragon 680 Octa-core Max 2.40Ghz
c. GPU: Adreno 610
d. RAM : 8 GB
e. Camera: 50mp camera

4. SYSTEM DESIGN

UML is used to provide a general description of specifications, design, model, and document aspects of a system.

4.1 Use Case Diagram

The Use case diagram is used to describe an interaction between students regarding the system that will be created. The variations in the use case sequence provide a big picture of the expected functionality of a system seen from the students' point of view.

The use case diagram for designing augmented reality-based diatonic scale applications consists of 7 use cases, namely application start use case, main menu use case, start menu use case, 3D menu use case, help menu use case, exit menu use case, and use case song notes[11]. The system use case diagram is shown in Fig 2.
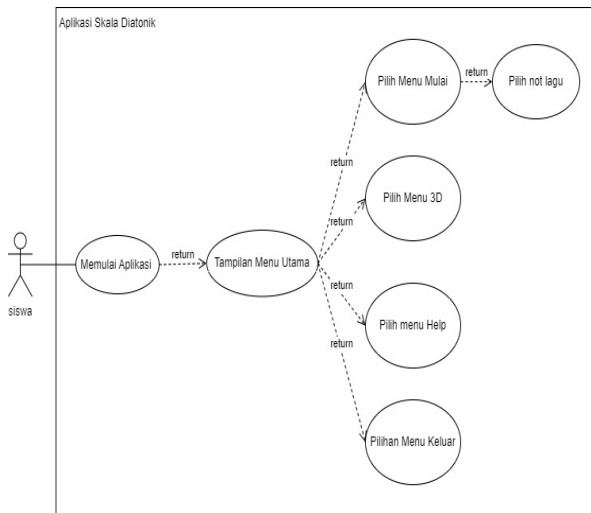
Fig 2: Use Case Diagram

4.2 Flowchart

Flowcharts play an important role in deciding a step or functionality of a programming project that involves many people at once. Using a process flow chart for a program will be clearer, more concise, and reduce the possibility of misinterpretation[12]. The system flowchart is shown in Fig 3.
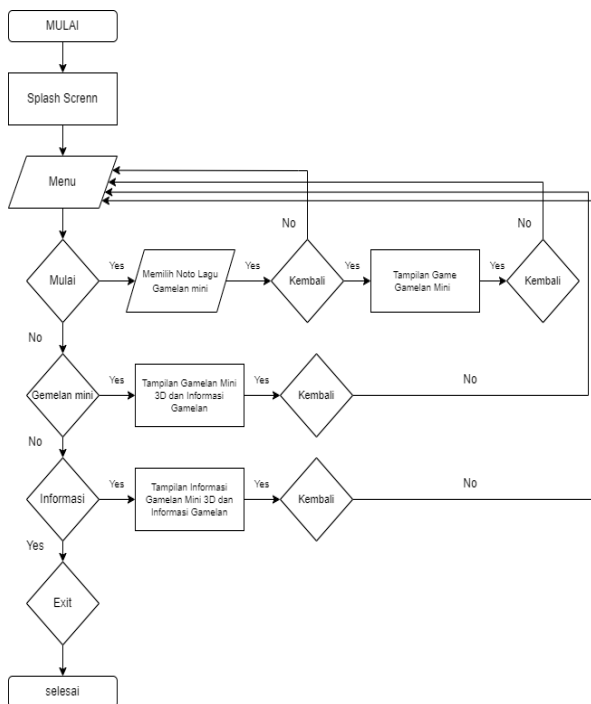

Fig 3: Flowchart

5. IMPLEMENTATION AND RESULTS AND DISCUSSION

Based on the research that has been carried out, objects are created using Blender software and applications are created using Unity software. With appropriate hardware, then the objects that have been created are implemented into Unity 3D.

5.1 Home Display

The home display here has 4 options when the user enters the application. The first is the start button, mini gamelan button, information button, and exit button The Home View interface is shown in Fig 4.

Fig 4: Home Display

5.2 Start View

If the user selects the Start button, the user will be asked to choose what song notes they want to play. In the application, there are five notes for the song "my balloon", bald hoe, and our mother Kartini. The song note selection display is shown in Fig 5.

Fig 5: Song note selection display

5.3 Gemalan Mini 3d display

Display when the user selects the mini 3d gamelan button. Users can see mini 3D gamelan objects and get information about what gamelan is along with the sound of the notes. The Gamelan Mini 3d interface is shown in Fig 6.

Fig 6: Gamelan Mini 3d Display

5.4 Information Display

Information display to make it easier for users to understand how to use the application. In the information display here there are 2 buttons that explain how to run the application properly. The Information Display Interface is shown in Fig 7.

Fig 7: Information Display

5.5 Results

At the testing stage during the creation of this application, many features can be accessed. Using the black box testing method, which can be seen in Table 2 and 3 Results

Table 2. Results
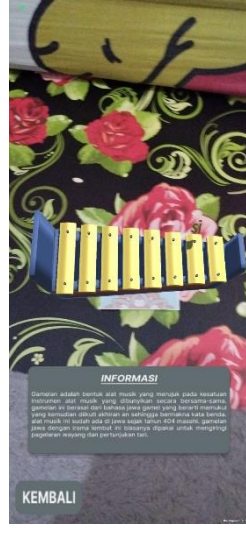
NO	Testing Scenarios	Expected Results	Conclusion
1	Click the start button	Displays the main page	Succeed

2	Click select the song notes menu	Displays the diatonic scale song note selection menu	Succeed
3	Click select Note diatonic scale	Displays 3D objects	Succeed
4	Click on mini gamelan	Displays 3D objects with markings and produces Javanese gamelan sounds, and there is also information about mini gamelan.	Succeed
5	Click information	Displays information about how to play the application	Succeed
6	Click the button Return	Exit the page	Succeed
7	Click the Exit button	Exit the application	Succeed

Table 3. Results

NO	Note	Hasil	Conclusion
1	Do		Succeed

2	Re		Succeed	5	Sol		Succeed
3	Mi		Succeed	6	La		Succeed
4	Fa		Succeed	7	Si		Succeed

8	DO		Succeed

6. CONCLUSION

Overall, the Augmented Reality-Based Diatonic Scale Learning project on Mini Gamelan Musical Instruments combines modern technology with gamelan music traditions to provide an interesting and useful learning experience for users. This project provides an opportunity to learn, practice and experiment with diatonic scales via mini gamelan musical instruments in an interactive manner, enriching musical understanding and improving the user's musical skills. then that strengthens the application of augmented reality technology in the future. Among them, by providing solutions to problems found, such as visualization quality and human-computer interaction. This will increase the effectiveness and efficiency of augmented reality technology in various fields, for example education. Then the suggestions are expected to help improve the quality of user experience in enjoying augmented reality technology which is increasingly advanced and sophisticated. It is hoped that systems that have shortcomings can be developed further and need to add features and improvements related to existing limitations.

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