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An Interactive Book With Augmented Reality For Learning The Cirebon Mask Dance

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Abstract - Today, augmented reality has an important role in human activity, especially in the field of education. The increasing capabilities of mobile devices also contribute to augmented reality to reduce real world distance with the virtual world. This paper will discuss the design and testing of iBook as media of learning the Cirebon mask dance art. IBook is a form of optimisation of traditional books based on augmented reality. The iBook designs will interact with virtual objects through direct touch on the application interface (pinch and swipe). The technical testing of iBook is a test of marker less reading ability and audio response time test. The markerless detection test resulted in minimum response time less than 1 second, minimum distance of 64 cm and a maximum distance of 3 cm, a minimum angle of 23° and a maximum angle of 90°. Tracking test obtained a minimum distance of 3 cm and a maximum distance of 71 cm, a minimum angle of 90° and a maximum angle of 16°. Any markerless detection and tracking can be done in unobstructured condition of no more than 50%. The testing of audio content obtained activation response time less than 1 second with original duration equal to active duration.

Keywords – Augmented Reality, Swipe and Pinch Interaction, Interactive Book, Learning Media, Cirebon Mask Dance

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I. INTRODUCTION

Performing art of Cirebon mask dance that originally serves as a medium of community entertainment by Sunan Gunung Jati or Syarif Hidayatullah consists of value of life philosophy and values of piety in religion [1]. Cirebon mask dance performance that has an educational value and the value of local wisdom is in great demand by local and international community, but it slowly begins to be abandoned especially by the people of Cirebon. The majority of people in Cirebon prefer to watch and hold modern performances than traditional art performances. Based on these facts, DISBUDPARORA (Department of Culture, Tourism, Youth and Sports) of Cirebon Regency proposes to make traditional art as a subject in primary school.

According to [2] as an art teacher, traditional arts learning in school is very requiring a high level of teachers' understanding of various types of regional arts while the competence of art teachers usually focus on one area of art. The results of observations in several bookstrores in Cirebon also indicate the unavailability of attractive learning media to motivate learners in learning the Cirebon mask dance art.

Today, the role of technology becomes the main topic as a medium to optimize human performance as in the field of education. The increasing capabilities of mobile devices or smartphones and tablets play a role in education as a learning medium. The role of technology as a learning medium can provide collaborative, interactive and communicative learning activities to enhance the creativity and effectiveness of each learner.

Augmented reality is a visual technology that combines objects or virtual worlds into real-world view in real-time [3]. The role of augmented reality in the field of education gains deep attention because of its ability to bridge the gap and bring a more tangible approach to learning experience [4]. The attractive and interactive augmented reality display is able to increase student understanding of the learning process faster, better and longer to remember lessons [5]. The use of augmented reality as a learning medium is also capable of supporting learning activities with the model: controlled group and experimental group [6], and self-directed learning approaches as well as task-based approaches [7].

The research that pioneered the utilization of augmented reality in the field of education was conducted by [8]. Until now, various studies with the topic of augmented reality as a medium of learning continue to be done to minimize negative attitudes that can slow the learning process. Several previous studies have focused on the process of displaying virtual objects using a fiduciary marker, in the form of black and white box images added to the learning medium. In its development, the form of fiduciary marker that can reduce the aesthetics of the learning medium has evolved into markerless.

The research belonging to [9] designs augmented reality-based audio applications using a fiduciary marker on papers as a therapeutic and learning medium for children with autism spectrum disorder through storytelling activity. The test results show that the application design can facilitate therapeutic activities that include: building cooperation to flow control, attention control and using the children's own voices to foster attention. The research belonging to [10] also designs augmented reality applications using a fiduciary marker on papers as a learning geometry medium for children with disabilities. Test results show that the use of augmented reality can improve learning motivation and low frustration tolerance in children with special needs.

The research belonging to [11] designs augmented reality applications using fiduciary marker and markerless on papers as a medium for learning structural analysis for early-stage students in civil engineering course. Test results show that the role of virtual objects and forms of interaction in the application has a good potential to support the learning process. Another study conducted by [12] designs augmented reality applications using markerless on papers for learning animals archaeological. Test results on the application design can improve the learning process more interactive and fun. Innovative research done by [13] designs augmented reality applications using markerless on puzzles, flash cards and match cards to teach vehicles, professions, colors, numbers, animals, shapes, objects, fruits and vegetables for young children in early childhood education.

Based on the above research, augmented reality technology is able to support learning activities with various media and learning models. Broadly speaking, previous research that discusses the use of augmented reality applications as a learning medium is done by adding fiduciary marker and/or markerless to media: 1) papers 2) books and 3) props. In addition to discussing the capabilities of augmented reality applications in displaying virtual objects, the focus of subsequent research is the form of interaction of virtual objects and multimedia content (text, audio and video).

The research belonging to [14] designs book and card based augmented reality using markerless. The built application consists of learning modes and play mode. Users will be given 24 questions in play mode, where cards are used to answer questions. Another function of the card that has been created is as a "button" to change the mode in the application. When the user is in learning mode, the application will display the virtual objects according to the identified book page and the user's touch on the book page will activate the audio content.

The research belonging to [15] also designs augmented reality based book using markerless. The study adds four virtual buttons on the application interface to scale up of virtual objects, scale down of virtual objects, rotate of virtual objects and enable video content. Research belonging to [16] even applies five virtual buttons on application to activating audio and video content, displaying virtual objects and displaying digital information.

In its development, research augmented reality as a medium of learning which originally focused on the process of displaying virtual objects has been developed through additional user interaction. Additional user interaction will make the application look more attractive and interactive. The most common forms of user interaction applied to augmented reality applications are: 1) touch on markers 2) use of marker as a button and 3) virtual buttons on the application interface.

This research aims to design augmented reality-based applications that are applied to the book as a medium for learning the Cirebon mask dance art. Updates are made on the interaction aspects of virtual objects by applying swipe interactions to rotate virtual objects and pinch interaction to resize virtual objects directly on the application interface. The results of the application design will be tested technically in the form of ability to detect and track markerless and audio response capability.

II. RESEARCH METHOD

The design of the application in this research is divided into four stages of creating and registering markerless, creating audio content, creating virtual objects and creating applications. This section will describe each phase of the application creation that will be applied to iBook media.

A. *Markerless Creation and Registration*

The initial stage of markerless creation is to get front-facing photos from the Cirebon mask using the Sony Nex 5 mirrorless camera. Each Cirebon mask photo(*.jpg) is then processed using Inkscape application into a realist illustration image. In total there are 5 pictures of realist illustrations that will be registered through the TMS(Target Management System) on the Vuforia portal. Detailed markerless or image target information successfully registered on the Vuforia is shown in Table 1.

Table 1. Detailed Image Target Information

No.	Image Target	Rating (stars)	Dimension (pixels)	Resolution (dpi)	Bit depth	File size (mb)	Print size (cm)
1		5	2223 x 2818	299	24	1,75	15,00 x 11,88
2		5	2244 x 2835	299	24	2,00	15,00 x 11,88
3		5	2223 x 2818	299	24	0,98	15,00 x 11,88
4		5	2244 x 2835	299	24	1,97	15,00 x 11,88
5		5	2244 x 2835	299	24	1,89	15,00 x 11,88

**information: dpi = dots per inch, mb = megabyte, cm = centimeters*

B. *Audio Content Creation*

The second stage is the creation of audio content using “Voice Recorder” application on Samsung J5 Prime smartphone. Each recording is then processed using the Audacity application to reduce noise for better sound quality. Audio content is expected to be able to optimize the delivery of information and attract the attention of users while interacting with virtual objects. Detail information about the audio content that has been created is shown in Table 2.

Table 2. Detailed Audio Content Information

No.	File Name	Duration	Bit rate (kbps)	File size (kb)	File type
1	Suara Panji	00:00:16	128	261	MP3
2	Suara Pamindo	00:00:16	128	265	MP3
3	Suara Rumyang	00:00:17	128	275	MP3
4	Suara Patih	00:00:17	128	279	MP3
5	Suara Kelana	00:00:18	128	291	MP3

**information: kbps = kilobyte per seconds, kb = kilobyte*

C. *Virtual Objects Creation*

The third stage is the creation of 3D virtual objects that represent the shape of Cirebon mask. 3D virtual object modeling process is done using Blender application. The design result of 3D virtual objects will be given by using original image of Cirebon mask with UV Mapping technique to make it look more real. The process of creating 3D virtual objects is shown in Fig.1.

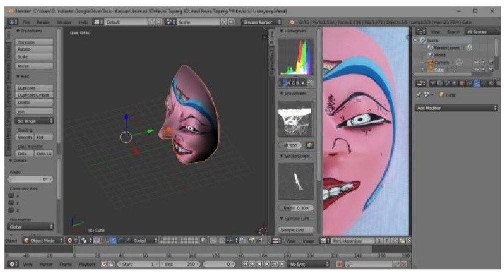

Fig.1. Creation of 3D Virtual Object

D. *Application Creation*

The last stage is the creation of application that will run on smartphone device with the Android operating system. The process of creating iBook application

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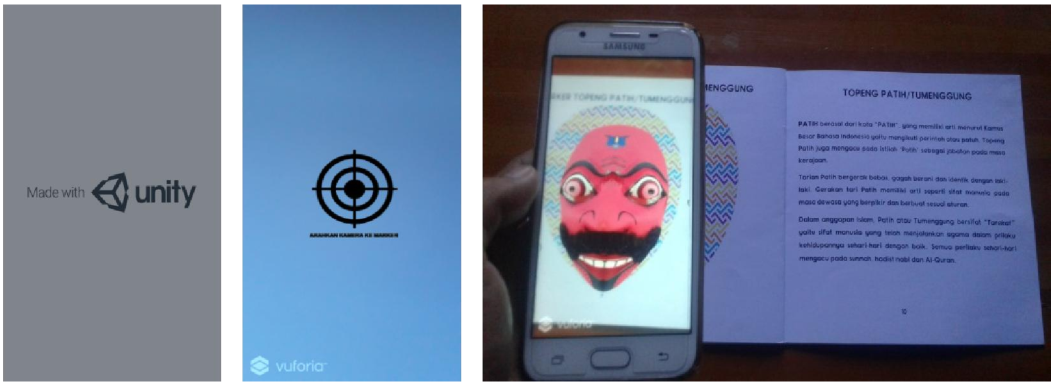
is done by using Unity3D application with C# programming language. The Unity3D application is then linked to the Vuforia SDK that serves as the library marker. The process of rendering virtual objects, audio content and interaction schemes in application is done by using OpenGLES 2.0 module. The results of the application interface are shown in Fig.2.



Splash screen *Standby* *Main interface*

Fig.2. Application Interfaces

III. RESULT

The results of the application design will be tested technically in the form of ability to detect and track markerless [17] and audio response capability.

A. *Markerless Detection Testing*

The purpose of this test is to find out the minimum requirement in recognizing markerless on various smartphone. This test consist of several parts:

a) Response Time

This test aims to determine the time during the process before the application detects markerless until the virtual objects displays for the first time. The test results are shown in Table 3.

Table 3. The Results Of The Test Response Time

No.	Smartphone	Time (seconds)
1	Samsung J1 Ace	< 1
2	Samsung J5 Prime	< 1
3	Samsung J7 Prime	< 1

b) Minimum Distance

This test aims to determine the minimum detection distance to the limit of the detection distance of the smartphone to markerless. The testing process is done by directing the smartphone from the furthest position to then approach markerless. This illustration of the test process can be seen in Fig.3 and the test results are shown in Table 4.

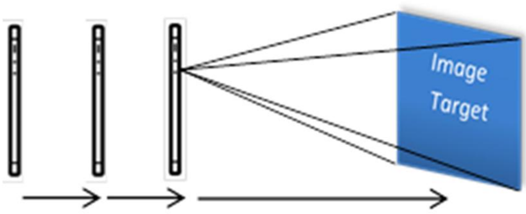


Fig.3. Illustration of Minimum Distance Testing

Table 4. The Results Of Detecting Minimum Distance

No.	Smartphone	Average distance
1	Samsung J1 Ace	64,076 cm
2	Samsung J5 Prime	55,082 cm
3	Samsung J7 Prime	57,390 cm

**information: centimeters*

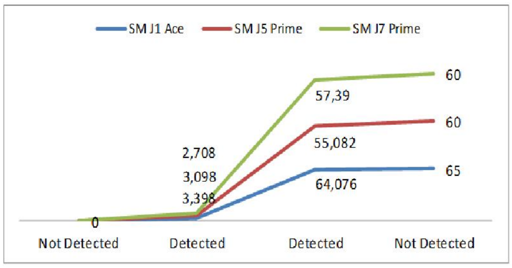


Fig.4. The Results of Detecting Minimum Distance

c) Minimum Angle

This test aims to determine the minimum angle that becomes the limits of smartphone detection angle to markerless. The testing process is done by directing the smartphone to markerless from angle 0° to 90°. This illustration of the test process can be seen in Fig.5 and the test results are shown in Table 5.

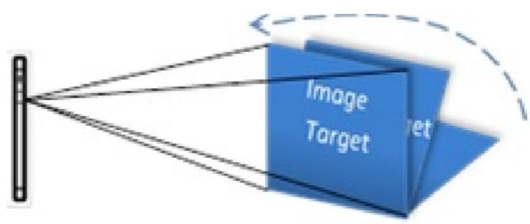


Fig.5. Illustration of Minimum Angle Testing

Table 5. The Results of Detecting Minimum Angle

No.	Smartphone	Average angle
1	Samsung J1 Ace	23,90º
2	Samsung J5 Prime	23,72º
3	Samsung J7 Prime	22,52º

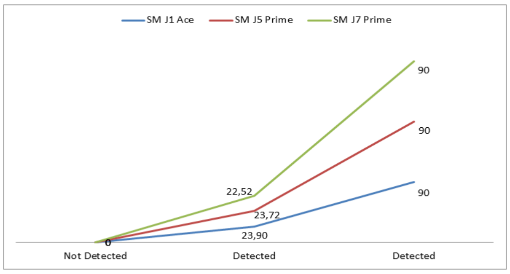


Fig.6. The Results of Detecting Minimum Angle

d) Surface Area

This test aims to determine the minimum width of markerless which became the standard smart-phone detection of markerless. The testing process is done by directing the smartphone to markerless which is blocked on certain part with the percentage parameter that is 25%, 50%, 75% and 90%. This illustration of the test process can be seen in Fig.7 and the test results are shown in Table 6.

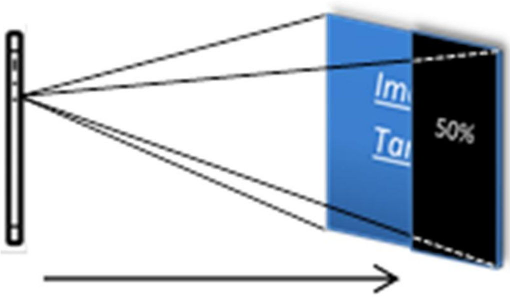


Fig.7. Illustration of Surface Area Testing

Table 6. The Results of Detecting Surface Area

No.	Smartphone	25%	50%	75%	90%
1	Samsung J1 Ace	√	√	*x*	*x*
2	Samsung J5 Prime	√	√	*x*	*x*
3	Samsung J7 Prime	√	√	*x*	*x*

**information: √ = detected x = not detected*

B. Markerless Tracking Test

The purpose of this test is to determine the extent of application capability on various smartphone when the application to detect markerless reaches undetected condition. This test consist of several parts:

a) Maximum Distance

This test aims to determine the maximum detection distance that becomes the limits of smart-phone tracking distance to markerless. The testing process is done by directing the smartphone from a minimal position until maximal position from markerless. This illustration of the test process can be seen in Fig.8 and the test results are shown in Table 7.

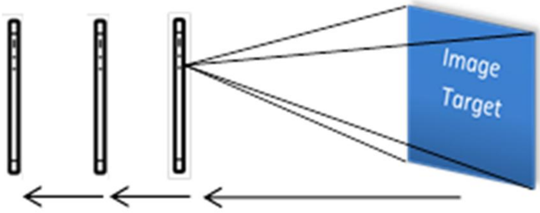


Fig.8. Illustration of Maximum Distance Testing

Table 7. The Results of Tracking Maximum Distance

No.	Smartphone	Average distance
1	Samsung J1 Ace	71,392 cm
2	Samsung J5 Prime	62,164 cm
3	Samsung J7 Prime	64,960 cm

**information: centimeters*

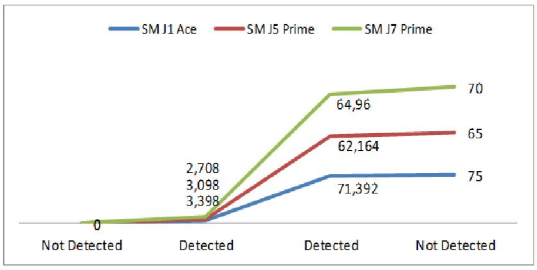


Fig.9. The Results of Tracking Maximum Distance

b) Maximum Angle

This test aims to determine the maximum angle that becomes the limits of smartphone tracking angle to markerless. The testing process is done by directing the smartphone to markerless from angle 90º to 0º. This illustration of the test process can be seen in Fig. 10 and the test results are shown in Table 8.

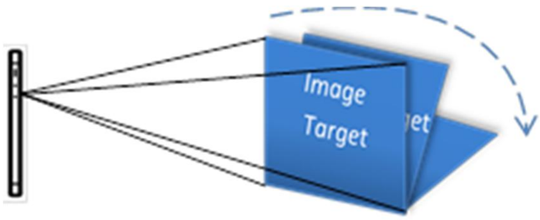


Fig.10. Illustration of Maximum Angle Testing

Table 8. The Results of Maximum Angle

No.	Smartphone	Average angle
1	Samsung J1 Ace	18,76º
2	Samsung J5 Prime	15,90º
3	Samsung J7 Prime	17,06º

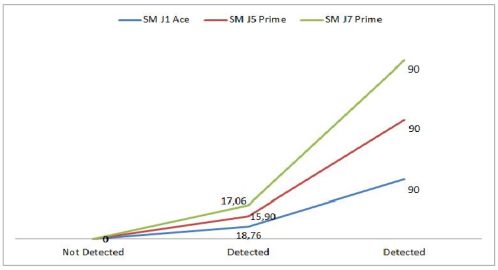


Fig. 11. The Results of Tracking Maximum Angle

c) Surface Area

This test aims to determine the minimum width of markerless which became the standard smartphone tracking of markerless. The testing process is done by directing the smartphone to markerless which is blocked on certain part with the percentage parameter that is 25%, 50%, 75% and 90%. This illustration of the test process can be seen in Fig. 12 and the test results are shown in Table 9.

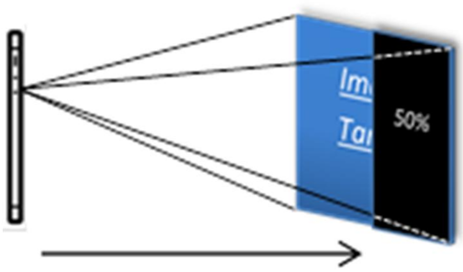


Fig. 12. Illustration of Surface Area Testing

Table 9. The Results of Tracking Surface Area

No.	Smartphone	25%	50%	75%	90%
1	Samsung J1 Ace	√	√	*x*	*x*
2	Samsung J5 Prime	√	√	*x*	*x*
3	Samsung J7 Prime	√	√	*x*	*x*

**information: √ = detected x = not detected*

C. *Audio Testing*

The purpose of this test is to determine the application's ability to activate audio content through markerless detection. The testing process consists of two stages of testing the initial response and testing the duration of audio. Initial response test is done by calculating the time during which the application process activates audio for the first time. Next, the audio duration test is performed by comparing the time of the audio duration to the time during which audio is enabled. The test results are shown in Table 10.

Table 10 . The Results of Audio Testing

No.	Smartphone	File name	Original duration	Time (seconds)	Test duration
1	Samsung J1 Ace	Suara Panji	00:00:16	< 1	00:00:16
		Suara Pamindo	00:00:16	< 1	00:00:16
		Suara Rumyang	00:00:17	< 1	00:00:17
		Suara Patih	00:00:17	< 1	00:00:17
		Suara Kelana	00:00:18	< 1	00:00:18
2	Samsung J5 Prime	Suara Panji	00:00:16	< 1	00:00:16
		Suara Pamindo	00:00:16	< 1	00:00:16
		Suara Rumyang	00:00:17	< 1	00:00:17
		Suara Patih	00:00:17	< 1	00:00:17
		Suara Kelana	00:00:18	< 1	00:00:18
3	Samsung J7 Prime	Suara Panji	00:00:16	< 1	00:00:16
		Suara Pamindo	00:00:16	< 1	00:00:16
		Suara Rumyang	00:00:17	< 1	00:00:17
		Suara Patih	00:00:17	< 1	00:00:17
		Suara Kelana	00:00:18	< 1	00:00:18

IV. DISCUSSION

Technical testing of application design in the form of capability for detection and tracking markerless and audio response capabilities has been carried out. Based on the analysis of the test results, there are several important points that will be explained as follows:

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The markerless design results that become a trigger for displaying virtual object and audio content get a five-star rating from the Vuforia portal. This explains that the markerless detection and tracking process can be carried out easily by the application user. The ease of the markerless detection process results an average time to display virtual objects that is less than one second. The markerless detection and tracking process can even be carried out with 50% obstructed conditions.

The success of markerless detection and tracking processes is strongly influenced by the distance of smartphone to markerless. Detection test results were conducted by directing the smartphone from the furthest position to markerless, start from an average distance of 64 cm to 3 cm for the first time displaying virtual object. Next, the results of tracking test conducted by directing the smartphone from the closest position to markerless, start from an average distance 3 cm to 71 cm until the virtual object is not displayed.

Another factor influencing the success of markerless detection and tracking is the angle of the smartphone to markerless. Detection test results conducted by directing the smartphone to markerless starting from 0^O to 90^O angle can be carried out from an average angle of 23^O to 90^O. Next, the angle tracking test results conducted by directing the smartphone to markerless from an angle of 90^O to 0^O can be carried out from an average angle of 90^O to 16^O until the condition of the virtual object is not displayed.

Test results in activating audio content through markerless detection also produce an average of less than one second. This explains that good quality of markerless will affect the ability of the application to display virtual objects and audio content as well. Next, the results of the duration comparison of the audio content is the original duration of the audio content equal to the duration when the audio content is activated.

V. CONCLUSION

This paper has succeeded in building an augmented reality-based application that is applied to book as a medium for learning the Cirebon mask dance art. Application testing is done on Android smartphone devices form entry level to high level to become the standard use of iBook. The process of markerless detection on iBook can be done from 64 cm to 3 cm with 23^o angle to 90^o. Next, the markerless tracking process on iBook can be done from distance of 3 cm to 71 cm with 90^o angle to 16^o. Any markerless detection and tracking process on iBook can be done in an unobstructed condition of no more than 50%. The markerless detection process for displaying virtual objects takes less than a second and to enable audio content, it takes less than a second with the original audio duration condition equal to the duration of audio active.

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