Introduction to Sumba's traditional typical woven fabric motifs based on augmented reality technology

**Fairuz Iqbal Maulana, Bening Insaniyah Al-Abdillah, Ruth Rade Awang Pandango,
Andini Putri Maharani Djafar, Frihandhika Permana**
Department of Computer Science, School of Computer Science, Bina Nusantara University, Jakarta, Indonesia

Article Info

ABSTRACT

Sumba woven cloth is one of the points of pride in East Sumba and West Sumba. The process of making Sumba woven cloth is not easy, making the patterned cloth is really valuable. These various motifs have their own stories behind them. Sumba woven fabric is one of the cultural heritages that must be preserved. One way to preserve this cultural heritage is implementing technological developments, such as augmented reality (AR) technology on smartphones. The combination of culture and technology can play a role in preserving Indonesia's cultural diversity. In applying this technology, we use the analysis, design, development, implementation, and evaluation (ADDIE) method starting from the stages of analysis, design, development, implementation, and evaluation. In an implementation, there will be a woven fabric catalog book that becomes a marker to bring up a 3D model of Sumba woven fabric that has been knitted in the form of clothes. The results revealed that the shortest distance between the marker and the camera at which 3D objects may be displayed is 20 cm, and the marker's reading angle is just approximately 0°-45°. The average duration observed is 0.056 seconds, and the average speed obtained is 8.92 meters per second.

Corresponding Author:

Fairuz Iqbal Maulana
Department of Computer Science, School of Computer Science, Bina Nusantara University
Jakarta 11480, Indonesia
Email: fairuz.maulana@binus.edu

1. INTRODUCTION

Indonesia is a country with a very diverse culture. Each region has its own uniqueness. One of them is the unique culture of the typical cloth motifs that Sumba Island has. Sumba Island is located in the province of East Nusa Tenggara. One of the cultural uniqueness of Sumba Island is the culture of weaving cloth and having a distinctive cloth motif [1]. Sumba cloth has 6 types of distinctive motifs, each of which has its own local wisdom meaning, among which the motifs include: chicken motif, horse motif, deer motif, human motif, mamuli motif, and line motifs.

Along with the development of the times, such cultures have begun to fade because they have been replaced by the sophistication of the digital era [2] which increasingly attracts the interest of today's generation. This all-digital phenomenon should not be an obstacle in preserving and introducing local culture [3], in fact we can reverse the situation that technology that is so fast can help to introduce and attract the current generation's interest in studying and introducing cultural diversity in Indonesia.

In preserving culture as one of Indonesia's heritage [4] and symbols, especially the typical Sumba cloth, it can be used as an information medium capable of providing new knowledge about Sumba's typical fabrics [5]. This is the background for the creation of an augmented reality (AR) video-based system [6] as an

introduction to the typical Sumba woven fabric motif. AR technology is one of the media to introduce Sumba's typical fabrics and their historical stories in Mancangara by using two-dimensional objects and running on the Android operating system [7].

AR is a system development that has the characteristics of combining real and virtual environments [8], is interactive in real time [9], and can be integrated into three dimensions (3D) . Users may view the actual world, but with virtual items incorporated into the real environment, using this AR approach [10]. Consequently, AR enhances rather than replaces the physical world. For the user experience to be optimal, virtual and physical items should appear to cohabit in the same environment. AR was built for the purpose of increasing understanding of the surrounding environment and making the virtual environment [11] seem real in displaying relevant information [12]. Combining culture and technology is a creative innovation to introduce Sumba motif fabrics overseas based on AR [13]. A system or program that may be termed technological or scientific is no longer possible to construct.

Technology that blends virtual and real worlds is known as AR [14]. AR is able to manipulate real-world objects into the virtual world and make it in such a way that the objects look very real in 3D [15]. AR technology makes it very easy to study cultural collections such as woven fabrics where it is enough to point the camera towards the object so that the object will look real by also learning about Indonesian culture [16], you will not feel bored anymore.

Azhar et al. [17] researched a similar topic. Because AR makes it possible, they produce historically accurate material in an engaging interactive style that includes photos and other visual cues (AR). The purpose of this research project is to examine the effect of combining AR technology with traditional content on motivating individuals to study history. Users will be able to view historical events digitally with this project's AR application, which aims to improve on the traditional book. Another study was conducted by Izzaty, et al. [18] to determine which AR object designs are feasible for implementation in an AR book about folklore local Indonesian. There are three AR object designs in this study, each with its own specialty. The first design is an AR object that combines an image with the voice of a narrator. There are no animations in the second design, but there is a narration by the narrator. As part of the final design, an AR item that incorporates an animated film is created.

Ihsan et al. [19] conducted another related study on interactive learning using AR technology. An AR technology was used in the study to help children of early age recognize mathematical symbols and make math lessons more interesting and fun, as well as provide a variety of learning media to increase the interest of early childhood learners in mathematics. Additionally, Andrea et al. [20] conducted research on interactive learning using AR technology. The study makes a contribution to educational technology by using AR media. In addition to serving as a teaching tool, textbooks now have the capability of displaying 3D interactive elements. Tracking using markers was employed in primary school applications and geometry education. Magic boosed is the term used to describe the phenomenon. For textbooks, the marker-based tracking system is suitable. This marker works well on textbooks that are normally printed in black and white for primary school students [21]–[23].

In preserving culture as one of the heritage and symbols of the Indonesian nation [24], we can design futuristic and interesting information media to introduce and disseminate insights about Sumbanese woven fabric motifs [5]. AR technology is one of the technologies that we can use as a medium to introduce Sumba's typical fabrics along with detailed information. This research aims to create an augmented reality-based application to preserve and introduce the Sumba weaving motif culture digitally. By designing the introduction of the Sumba-based AR weaving motif, it is hoped that it will increase the interest of local and international communities to learn about Indonesian culture. Based on the background that has been described, the focus of the problem that will be discussed in this program is how to implement the cultural elements of the Sumba cloth motif into an augmented reality-based technology to preserve Indonesian culture. In this application development stage, we also conducted several trials to measure the accuracy of this application. We do tests that include distance testing, Limits of marker reading slope testing, testing of light intensity, and testing time tracking. In addition, the extent to which augmented reality-based application designs can be directly used and can answer challenges in the technocultural world, whether augmented reality-based applications can increase the interest of Indonesian people to love traditional culture.

2. RESEARCH METHOD

In this part, we go into the creation with suggested AR-based learning system in great depth. We need to take into account all academic features while submitting an application for educational purposes. Technology-wise, we employed the usage of AR to deliver educational and instructional information. Children may learn more effectively using AR since it meets all of their educational needs. Users see virtual learning stuff in real life and may interact with it in real time using AR techniques.

The method that is used to develop this application is analysis, design, development, implementation, and evaluation (ADDIE) model with the step analysis, design, development, implementation, and evaluation [25]. This model is relatively easy to grasp and very straightforward. Phases are handled one at a time in this approach. Each phase is well specified in the model. This approach contains milestones that are very obvious and understood. Figure 1 shows the ADDIE model step.
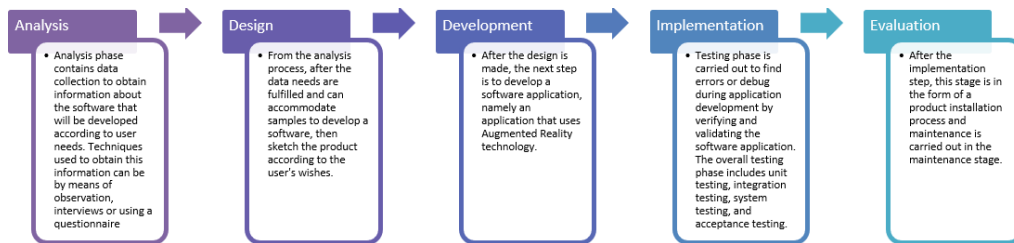

Figure 1. Five method step development this application

Once the target marker image is in the camera view of a smartphone or tablet, real-world educational content is made available through this application. Users can view or interact with additional environments associated with the target image in their notebooks or notebooks in this way, allowing them to view and observe virtual 3D content in the physical world. Figure 2 illustrates the complete workflow of the application [26].
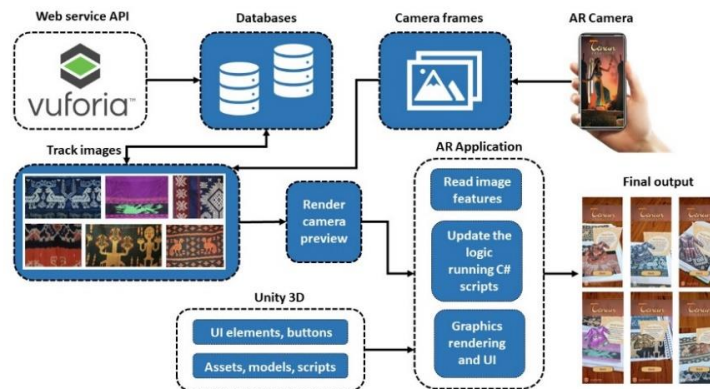

Figure 2. Working on mobile AR applications. A smartphone is used to scan predefined target images with the AR camera. When a target is identified, 3D visuals are superimposed on the camera screen

It can explain that:
- Devices that can be used are android smartphones, iOS, or tablets by scanning target markers in the form of book pages or images of Sumba cloth motifs
- Vuforia stores the features on the target page in its database. Using the vuforia database, newly acquired features are compared with those already stored for the target image or are referred to as markers. Adding virtual content to the target image surface occurs when features in the database match the image. In the process of creating a database with vuforia, there will be a license key to be used when entering the database into unity. After the database on vuforia has been created, please download it and put it in the project on unity.
- The AR application visualizes the content of the Sumba shirt motif with images captured through a smartphone camera.

3.   RESULTS AND DISCUSSION
3.1. Design the apps and 3D modelling
In making 3D model assets, we use Paint3D from Windows 10 software based on fabric patterns from photos of typical Sumba fabrics. We use the basic model of women's clothing based on 2D, then we develop it into a 3D model with Paint3D software. Figure 3 illustrates the development 3D model with Paint3D

software. In Figure 3, a 3D clothing object is created using Paint3D software. In Figure 3(a), a 3D object of clothing is made to make the basis of the model before the fabric motif is given. Then in Figure 3(b), it is continued by adding the Sumba woven fabric motif to look like in the image below. After the assets have been created, then proceed with the design of AR using the Unity3D software as shown below. Figure 4 illustrates the design process in unity software. The marker used is in the form of images of various Sumba woven fabric motifs found in catalog books. Figure 5 is the marker Sumba woven motif.

| (a) | (b) |
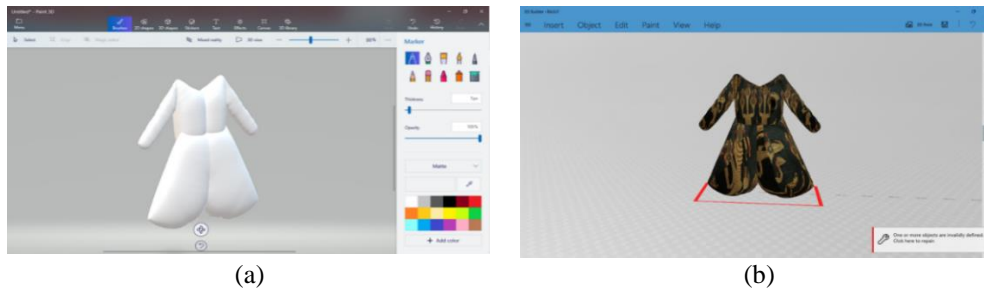
Figure 3. Asset 3D: (a) creation and (b) after being given a motif

Figure 4. Augmented design process in Unity software
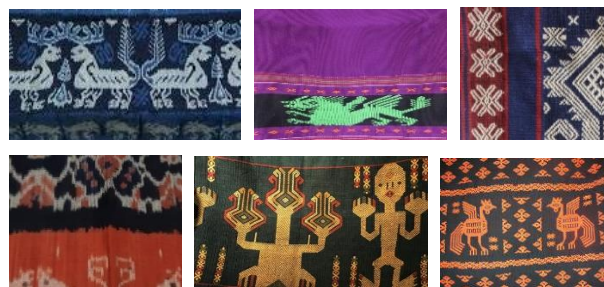

Figure 5. Marker with Sumba woven motif picture

In Figure 6, the main page view, we use a photo that looks like a woven cloth to illustrate the traditional use of the fabric. The main menu is designed with the traditional background of the Sumba islands. This is to bring cultural values from Sumba. In Figure 6(a), we can see the implementation of a photo of a motif cloth user. After clicking on the screen, a menu option will appear on the application, as shown in Figure 6(b).

On the main menu there are 3 buttons, including button START to running the AR program, then MOTIF for an explanation of Sumba's typical woven fabric motifs, then there is a HELP button to provide directions to the user how to use it. Then we test to run Kainsumba AR application on smartphone Android and here are the results of the test. Figure 7 illustrates the test of Kainsumba AR application.

(a)   (b)
Figure 6. Main page view: (a) main page display and (b) main menu display
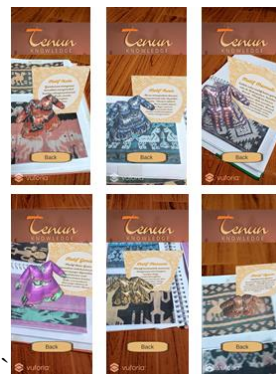

Figure 7. Testing Kainsumba AR application

The 3D model of the Sumba woven fabric that has been made appears according to the motif of each marker in the catalog book. In Figure 7, we apply 6 Sumba woven fabric motifs is chicken motifs, horse motifs, deer motifs, human motifs, mamuli motifs, line motifs. We also carried out several tests such as distance testing, testing of light intensity, and time tracking testing to measure the capabilities of the applications we created.

3.2. Distance testing and tracking speed

The closer the camera is to the marker in the testing distance, the larger the marker, the easier it is for the camera to identify it and record a clear picture of it. Table 1 shows that a variety of timings have been met. The longer it takes to render an item, the closer the camera is to the marker. The marker can be reliably detected and a 3D object generated at a distance of 20 cm from the camera. Despite this, the marker cannot be identified at a distance of 100 cm since there is not enough information to adequately identify the patterns in the marker. The distances in the table above are measured in centimeters, while the times are measured in milliseconds (ms). You can see this in Table 1: When you convert cm to meters (the distance and time values are shown in meters), you get these values (in meters and seconds) in Table 1.

Table 1. The results of the table marker distance test

Distance (cm)	Time (ms)	Description
20	00.25	Detected
40	00.38	Detected
60	00.51	Detected
80	01.13	Detected
100	-	Not Detected

Varying tracking speeds result in different marker distances, as has been discovered. In this experiment, the camera's marker distance was varied from 20 cm to 100 cm, resulting in data on the scanning time of the marker vs distance. In Table 2, tracking speed uses the speed formula, namely v=s/t where v=speed (m/s). s=distance traveled (m). t=travel time (s). From the data that has been obtained in Table 1, then processed

with the tracking speed result, as shown in Table 2 and elucidated in the tracking speed graph in Figure 8. Objects show at different speeds when being tracked. The greater the distance between the marker and the camera during the object rendering phase, the longer the operation will take.

Table 2. The results of the table tracking speed

No	s	T	V
1	0.2 m	0.025 s	8 m/s
2	0.4 m	0.038 s	10.52 m/s
3	0.6 m	0.051 s	11.76 m/s
4	0.8 m	0.113 s	7.07 m/s
Amount	2 m	0.227 s	8.81 m/s
Average	0.5 m	0.056 s	8.92 m/s
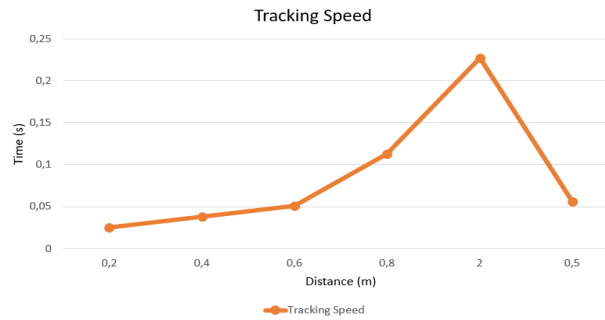
Figure 8. Tracking speed chart with time intervals

3.3. Limits of marker reading slope testing

Putting the marker reading slope to the test. This is used to compute the deadline for reading the slope, which will allow you to read the marker before the deadline. The distance between the camera and the marker can be as near as 20 cm. Table 3 shows the reading of the test slope boundary marker during the testing phase. The slope of the marker reading is only apparent from 0° to 45° in the visible portion of the reading.

Table 3. The results of the table slope test for marker reading

Angle	Description
0°	Detected
15°	Detected
30°	Detected
45°	Detected
60°	Not Detected

3.4. Light intensity testing

When determining the light's intensity, the greater and smaller the light, the less likely the camera would catch the marker picture accurately. In this experiment, we use the distance between the camera and the marker, which is at a distance of 20 cm. According to Table 4, the optimal setting for using the AR software is one with moderate illumination that is neither too bright nor too dark. This Kain Sumba AR performs admirably in low-light circumstances ranging from 01.1 Lux until 03.9 Lux and in bright ones ranging from 15.6 Lux until 1672 Lux.

Table 4. The results of the table light intensity test

No.	Light (Lux)	Description	Status
1	00.5 Lux	Very Dark	Not Detected
2	01.1 Lux	Dark	Detected
3	03.9 Lux	Dark	Detected
4	15.6 Lux	Bright	Detected
5	1672 Lux	Bright	Detected
6	2160 Lux	Very Bright	Not Detected

3.5. Testing time tracking

Time measurements are obtained in testing the tracking time by scanning alternately using two devices, namely an android Asus Zenfone Max Pro M1 3 GB RAM and POCO X3 8 GB RAM. The Asus Zenfone Max Pro M1 has a 16 MP camera, and the POCO X3 has a 64 MP camera. The hardware differences between the two cameras from our tests don't seem to have much impact on the measurements taken. According to Table 5, the results of the Kainsumba AR tracking time for marker scanning differ because the device's RAM is different. The scanning time of the marker, as shown in Table 5 and the tracking time graph in Figure 9, indicated that an Android Asus Zenfone Max Pro M1 should be utilized in place of a POCO X3 8 GB RAM. If a device has 8 GB RAM, the Kainsumba AR tracking time is faster because RAM is more versatile in accessing and storing data, such as the ability to save data as temporary memory. This is shown in Figure 9.

Table 5. The results of the table tracking time test

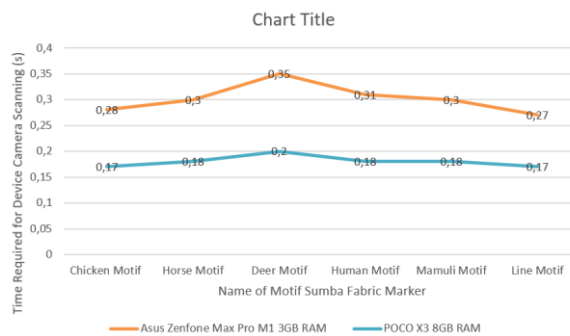| Name of Motif Sumba Fabric Marker | Time required for device camera scanning (seconds) | |
	Asus Zenfone Max Pro M1 3GB RAM	Android POCO X3 8GB RAM
Chicken Motif	00.28	00.17
Horse Motif	00.30	00.18
Deer Motif	00.35	00.20
Human Motif	00.31	00.18
Mamuli Motif	00.30	00.18
Line Motif	00.27	00.17

Figure 9. Chart of tracking time

4. CONCLUSION

Rapid and rapid technological developments can help preserve cultural arts by digitizing, such as AR technology. AR technology is implemented in recognition of Sumba woven fabric motifs using markers. In the results of this study, the device used affects the speed of tracking through markers. Furthermore, this tracking speed has a substantial impact on distance. The longer the tracking method takes, the larger the marker separation. However, when the distance between the marker and camera decreases, the tracking process becomes faster. The average detection distance of a marker is 0.5 m, the average detection time is 0.056 s, and the average speed is 8.92 m/s. Each successfully identified marker displays a 3D object that corresponds to the detected marker at a distance of 20 cm to 80 cm and a marker tilt angle of 0° to 45°.

Another test on lighting levels, between 15.6 lux and 1672 lux in bright condition, Kainsumba AR can work well in reading markers. Likewise, in conditions of sufficient lighting ranging from 01.1 Lux to 03.9 Lux. Other than that lighting level, the program can't work and can't detect the markers that have been created. In the distance test, the maximum distance that can read the marker and bring up the 3D model is 80 cm. Testing based on distance produces an accuracy rate of 80%, testing based on light intensity produces an accuracy rate of 65%, and the slope limit test produces an accuracy rate of 80%. The accuracy of success on each test is less than 100% can be caused by the pattern on the marker not being clearly read by the camera on the device. The hardware differences between the two cameras from our tests don't seem to have much impact on the measurements taken. However, for a more in-depth measurement, it is necessary to conduct further research on the hardware between the two smartphone devices.

We hope that this research project will become a futuristic and interesting information medium to introduce and spread insights about Sumba woven fabric motifs with AR technology and is expected to increase the interest of local and international communities to learn about Indonesian culture. We also hope that every

lesson about Indonesian culture will no longer feel boring but can make the next generation more enthusiastic about learning Indonesian culture.

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BIOGRAPHIES OF AUTHORS

Fairuz Iqbal Maulana, S.T., M.Eng., M.T. is a lecturer at the College of Computer Science, Bina Nusantara University, Indonesia. He earned two Master's degrees, the first in the field of Interdisciplinary Program of Information System, Pukyong National University (PKNU), Busan - South Korea, and the second in the School of Electrical Engineering and Informatics (STEI), Bandung Institute of Technology (ITB), Indonesia with specializes in Multimedia and Games. His research fields are Game programming, Computer Vision, Facial Recognition, Augmented Reality, Virtual Reality for education, Internet of Things. He is the head of the Digital Technopreneur Laboratory in Malang campus. He can be contacted by email: fairuz.maulana@binus.edu.

Bening Insaniyah Al-Abdillah is an undergraduate student at Bina Nusantara University (BINUS) Malang campus. She studied science in the Computer Science study program. She can be contacted at email: bening.alabdillah@binus.ac.id.

Ruth Rade Awang Pandango is an undergraduate student at Bina Nusantara University (BINUS) Malang campus. She studied science in the Computer Science study program. She can be contacted at email: ruth.pandango@binus.ac.id.

Andini Putri Maharani Djafar is an undergraduate student at Bina Nusantara University (BINUS) Malang campus. She studied science in the Computer Science study program. She can be contacted at email: andini.djafar@binus.ac.id

Frihandhika Permana, S.Pd., M.Kom. is a lecturer at Bina Nusantara University Computer Science, Indonesia. He holds a Master's degree in Computer Science, Universitas Brawijaya, Indonesia, with a research topic, namely The Connectivity Between Leap Motion and Android Smartphone for Augmented Reality (AR)-Based Gamelan. His research fields are Game programming, Augmented Reality, Virtual Reality. Currently developing all the labs at BINUS Malang campus. He can be contacted by email: frihandhika.permana@binus.edu