Mobile Augmented Reality for Learning Traditional Culture Using Marker Based Tracking

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Abstract. The purpose of this research is to design a mobile augmented reality for learning Batavia traditional culture on improving the knowledge of the citizen of Jakarta. Augmented reality is applied as an approach to enhance the interaction of users for improving their level of knowledge. The method used in this research is a marker-based method detection which resulted in a minimum response of less than 2 second, a minimum distance of 10 cm and a maximum distance of 50 cm, a minimum angle of 25 degrees and a maximum 80 degrees performed on the augmented reality marker. The result of this research is the marker-based tracking method applied on a mobile augmented reality has proven to be excellent and giving an increasing knowledge effect of the citizen of Jakarta for learning their traditional arts, architecture and weaponry.

1. Introduction

Mobile augmented reality is one of the most growing technology in an augmented reality environment. The uses of smartphone and tablets give a tremendous advantage for augmented reality technology developed as it is widely distributed and used by everyone at a rapid pace. This gives advantage and more possibility for an augmented reality research applied on mobile devices. Mobile augmented reality is a technology that carries the concept of presenting objects in the form of data, 2D and 3D object into real life. Researchers developed this technology, inspired by virtual reality technology, where humans are immersed in the virtual world. While virtual reality focused on creating a virtual world, augmented reality separates the walls from a virtual world and present virtual objects in the real world[1]. Several studies in the field of mobile augmented reality have been carried out especially in the fields of education and culture such as, an augmented reality for learning interior design[2], which gives user an interaction with 3d object surrounding interior building, then research on culture is also done by applying augmented reality on historical objects in museums [3],[4] historical objects are placed on markers at each point of location of the museum. The next study is the application of augmented reality at a historical location[5] where the marker used is a digital aerial photograph of historical locations, and research on the learning process of a campus guide using mobile augmented reality[6], where the use of mobile augmented reality create an autonomous learning process for the people to learn new location. From every study mentioned earlier, there was no measurement of the effectiveness of the markers used, a measurement is necessary to identify the accuracy of the markers used.

Based on previous research, this research aims to apply mobile augmented reality using a marker-based tracking method to measure the effectiveness of the marker for learning the traditional culture. The culture chosen for this research is Batavia culture which is an indigenous culture of Jakarta, where the spread starts from Jakarta, Depok and through Tangerang city area. The Batavia tribe was born
from a combination of ethnic groups who first settled in Jakarta with tribes from outside Batavia. Batavia has a diverse culture such as dance, traditional houses, customs and culinary. Traditional culture plays as an important asset to carry forward the culture of a nation that must be well preserved [7]. However, alongside with the modernization of urban lifestyle, some of the citizens tend to forget their local culture which resulted from the knowledge of their local traditional culture to fade away. Previous studies have been carried out as an effort to preserve culture with the help of technology such as a creative cultural information system[8], where the introduction of a cultural tradition such as clothes, art, and traditional houses are informed using websites. The next research for introducing culinary tradition was by creating a website with culinary information[9] where the focus of the research is introducing traditional foods. The next research is about developing an educational application for the introduction of mobile-based traditional music tools [10]. Based on several previous studies, interaction between the user and mobile device are still limited, the application developed is only intended for the type of cultural classification partially and does not optimize the devices used in developing applications for learning through mobile learning [11] while the younger generation in Indonesia tend to have a high level of awareness in using gadgets [12]. Innovation is needed to overcome this problem such as for the uses of mobile augmented reality.

The purpose of this research is to design a mobile augmented reality for learning Batavia traditional culture on improving the knowledge of the citizen of Jakarta. Augmented reality is applied as an approach to enhance the interaction of users for improving their level of knowledge. Marker-based tracking is used as a method to develop the mobile augmented reality marker. This method detects QR-code on the mobile device camera and capture major points for tracking an augmentable object on the marker used on the device. Testing is performed by calculating the minimum and maximum response based on the distance and angle from a marker. Based on those result, usability testing would be performed to the user for validating the uses of mobile augmented reality from the user point of view.

2. Method

Marker-based tracking method [13-14] is one approach to the method used in making an augmented reality. This method focuses on developing suitable markers when scanning by a camera to find the location of augmented reality objects. The marker-based tracking method selected in this study is due to the suitability of the method in the introduction of 3-dimensional object objects that require immovable objects. This method begins by acquiring an image acquisition by selecting alternative images to be chosen as a marker as seen in Figure 1.

![Figure 1. Example of Image Acquisition Marker](image-url)
After an image is selected for the image acquisition steps, a preprocessing is applied to the image by image greyscaling to eliminate image noise as seen in Figure 2.

![Figure 2. Comparison of Preprocessing Markers](image)

The last step of the marker based-tracking is the image acceptance to measure the feasibility and limit of the potential selected marker, and gives feedback to the user about the compatibility of the marker developed as seen in Figure 3.

![Figure 3. Potential Marker Image](image)

The chosen marker would be then used as a part of the marker in an augmented environment. Augmented reality was chosen as the approach of this research, to attract the attention of the younger generation and the local community. The advantage of using augmented reality is the increasing of interaction between the user and the augmented object to learn new knowledge such as the traditional culture of Batavia. Augmented reality has 3 inseparable interacting components, namely cameras, markers and applications, and its mechanism is illustrated as a flowchart in Figure 4.
Figure 4. Augmented Reality Mechanism

Figure 4 is an explanation of an augmented reality technology mechanism in this research. The use of augmented reality starts from running the application through a smartphone, then the user selects the type of Batavia cultural category. After choosing a category, redirect the smartphone camera at the marker which will bring up an augmented reality object according to the chosen cultural category.

3. Results and Discussion
3.1 Requirement Analysis
The results of the requirement analysis were through literature studies and observations of daily activities of Batavia community located in South of Jakarta. Data obtained during observation are three categories of Batavia culture to be developed in this research. The first category is an art of traditional doll called “Ondel-ondel”. The second category is a traditional house, which explained the architecture of a traditional houses of Batavia. The last category is the traditional weapon called “Belati”. A classification based on different type of category can be seen in Table 1.

| No | Art          | Traditional Art | Traditional Weapon |
|----|--------------|-----------------|--------------------|
| 1  | Ondel-Ondel | Batavia Traditional House | Batavia Dagger |

3.2 Marker-Based Tracking Implementation Result
Marker-based tracking uses a camera and a marker to determine the location of an augmented object and help determine the position of a marker coordinate system. Marker-based tracking is usually a combination of a square black and white color and with black borders and white backgrounds [15]. The black and white properties of a marker-based tracking, produce an advantage for the marker, as the effort of generating a preprocessing from a colorized image are unnecessary which resulted by a reduced time response of an augmentable object. At the moment, a marker-based tracking is the best marker to be used as a marker which needed a quick time response of an augmentable object. The marker properties of this research can be seen in Table 2.
Based on table 2, three-step is performed to determine a marker which is image acquisition, preprocessing and acceptance. During the image acquisition process, a black and white image is chosen as a marker. During the preprocessing phase, the computer will compute, recognize and generate the position and orientation of the marker. The acceptance phase is to see whether the result of a generated marker which in this case, the marker created is an excellent marker with a 5 per 5 scale augmentable.

3.3. Augmented Object Appearance
Some appearances of the augmentable object are as follows:

![Augmentable Object Appearance](image)

**Figure 5.** Augmentable Object Appearance

The appearance of an augmentable object shown in Figure 5, are views of a perfect augmentable object of Batavia weapon which is called “Belati” and a traditional Batavia house in a form of 3...
dimensional. This view is shown when the user selects the “Belati” button on the main menu of the application, then the user aims at the marker to see the augmentable object.

3.4 Marker-Based Tracking Test

Testing of a marker-based tracking is performed to determine the time response of an augmentable object. The testing parameters used are distance, angle, time response, and detection as shown in Table 3.

| No | Name               | Distance (Cm) | Angle | Time Response | Detection |
|----|--------------------|---------------|-------|---------------|-----------|
| 1  | Batavia Weapon     | 10            | 25    | 1.65          | Detected  |
|    |                    | 10            | 80    | 1.83          | Detected  |
|    |                    | 50            | 25    | 1.5           | Detected  |
|    |                    | 50            | 80    | 1.98          | Detected  |
| 2  | Ondel-Ondel        | 10            | 25    | 1.34          | Detected  |
|    |                    | 10            | 80    | 1.44          | Detected  |
|    |                    | 50            | 25    | 1.65          | Detected  |
|    |                    | 50            | 80    | 1.66          | Detected  |
| 3  | Batavia House      | 10            | 25    | 1.55          | Detected  |
|    |                    | 10            | 80    | 1.45          | Detected  |
|    |                    | 50            | 25    | 1.77          | Detected  |
|    |                    | 50            | 80    | 1.95          | Detected  |

The number of augmentable objects test was three augmentable object. The number of the detected test were 12 and time responses for every test performed are an average of 1.64 second time responses. Based on the results, it can be confirmed that the marker can be detected efficiently and serves as an excellent marker for this research on mobile augmented reality.

3.5 Usability Testing

A usability testing is performed as a way to validate the mobile augmented reality developed meets the requirement of the user on increasing the cultural tradition learning of Batavia culture showed on Table 4.

| No | Usability Test Case             | Range (1-100) |
|----|---------------------------------|---------------|
| 1  | Menu interface design           | 80            |
| 2  | Augmented reality object design | 80            |
| 3  | Marker reliability              | 92            |
| 4  | Component completeness          | 92            |
| 5  | Ease of use                     | 95            |
| 6  | Application interaction         | 80            |
| 7  | Knowledge transfer              | 95            |
| 8  | Augmentable object completeness | 95            |
| 9  | Augmentable object accuracy     | 95            |
| 10 | 3d object similarity            | 96            |
|    | Total                           | 900           |
|    | Average                         | 90            |
Based on the result in Table 4, most of the usability test score is above 80, 70% of the data analyzed are given a score from 90 to 96, 30% are given a score from 80 to 89, the least usability score is 80 and the maximum is 96, the average score of the usability score is 90 which indicates the usability test performed are successful.

The marker testing and the usability testing result, confirm that the marker chosen for this research is proven to be suitable for the mobile augmented reality application and can help improve the learning process of the users.

4. Conclusion

Implementing marker-based tracking on an augmented reality environment was successful where every detection test performed on a different direction and angle of the marker was excellent, and the approach on using augmented reality to for learning the traditional culture of Batavia culture based on the usability testing was also successful where given score was more than 90 on average. Implementing augmented reality could be considered to increase the learning process of the user.

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