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Development of augmented reality application for introducing tangible cultural heritages at the lampung museum using the multimedia development life cycle

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Abstract

Museum Lampung is one of the largest museums in Lampung Province which has a collection of tangible cultural heritage. If the museum visitors are seeking information about the collections, they will be assisted by museum guides orally. However, the limited number of guides are not enough to serve visitors during the school holidays. Therefore, to help visitors to find information about its cultural heritage collection, Augmented Reality (AR) technology was developed. AR is a technology that can display 3D objects in a real environment. The AR application that will be built is developed with the MDLC approach, where this method is suitable for developing multimedia applications. This research produces an application that can display 3D objects when the user's camera is directed to the collections of Museum Lampung and provides information related to these objects. Based on the test results on aspects of perceived usefulness, convenience, intention, and user friendliness, generally respondents answered "Agree" with a percentage of 83%. This indicates that the application is acceptable to the user.

Keywords: Augmented Reality; MDLC; Museum; Cultural Heritage

Introduction

The existence of museums in Indonesia has an important role in preserving, fostering, and developing community's cultural and historical awareness. Visitors of the museum can benefit from tangible and intangible cultural heritage. Based on PP No. 19 of 1995, it is stated that the museum is an institution, a place to store, preserve, secure, and exhibit objects as material evidence of human culture, nature and the environment, it is used as a means to support, to protect and preserve the nation's cultural wealth. So, it can be said that the museum has an important function as a place to preserve and as a source of information on cultural heritage [1]. Cultural heritage can be interpreted as a form of legacy resulting from human thoughts and works in the past which normatively have philosophical values as a form of symbols in people's lives [2]. One type of cultural heritage that is stored in a museum is a tangible cultural heritage. Tangible cultural heritage is grouped into two, namely immovable heritage and movable heritage [3]. Immovable heritage includes historical buildings, monuments, archaeological sites, etc. Meanwhile, the movable heritage includes paintings, sculptures, furniture, etc. The largest museum in Lampung province is the Museum Lampung. It is located in the city of Bandar Lampung and it was inaugurated on September 24, 1988. This museum accommodates up to 4,735 collections, among which there are prehistory objects of cultural heritage.

Every object in the museum has a function, use and history of its time. Visitors of the museum will usually be accompanied by a guide who will explain the objects in the museum. In the Museum Lampung there are six guides. However, six is not enough to serve visitors during the school holidays. If one guide must assist 10-15 people per group from each visitor arrival. For individual visitors and local visitors, it is possible to go around the museum without a guide. For this reason, technology is needed that is able to provide clear information about the collections in the Lampung museum, especially for tangible cultural heritage objects. One technology that can be used to help provide information about the existing collections in the museum is Augmented Reality, abbreviated as AR. AR can be used as an assistance to provide an overview by bringing up 3D objects in the real world and providing detailed information to provide comprehension to the user [4]. The use of AR applications requires camera to be able to interact with virtual objects. The AR application has a simple working system, namely by means of the application detecting images through a camera which is usually called a marker. The marker has a function for identification media which will be read by the camera then the camera will render a 3D object on top of the marker [5]

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To build an AR application, a system development method is needed. The system development method employed is adapted to the application being built and should be based on the development needs. The development of AR applications will involve multimedia elements, including text, audio, visuals and animation. So the development method used is the Multimedia Development Life Cycle (MDLC). MDLC is a system development approach for multimedia applications with stages including concept, design, collecting material, assembly, testing, and distribution [6]. Several studies that developed AR applications using the MDLC system development approach showed good results. For instance, research on the development of learning applications for the solar system with AR and developed using the MDLC approach [7]. This research produces applications that can run well and can provide convenience for teachers in delivering material about the solar system. Other research, regarding the development of machine learning media with AR technology and the MDLC system development approach [8]. The results showed that 89.60% of users were satisfied with the developed application, which was obtained based on beta testing. Furthermore, research on the application of AR which is implemented with the MDLC approach in the housing catalog as a marketing medium at PT. San Esha Arthamas [9]. In this study, beta testing result showed that the average value was 88%, this indicates that the application could be included in a "Good" category.

In this research, an AR application for introduction of tangible cultural heritage at the Museum Lampung was developed using the MDLC system development method. The application was built based on a smartphone with the Android operating system using Unity and Vuforia as the manufacturing tool. The application would display 3D objects along with information and explanations about the collections of the Lampung museum with markers using objects in the Museum Lampung.

Method

The approach used in developing the AR application for the introduction of tangible cultural heritage at the Museum Lampung used the Multimedia Development Life Cycle (MDLC) method. **Figure 1** shows the stages in the MDLC approach.

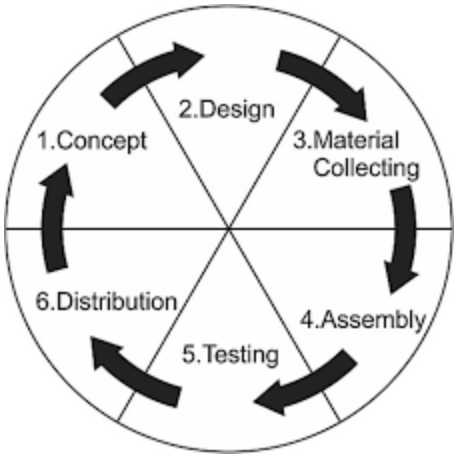

Figure 1. The Method Steps of Multimedia Development Life Cycle (MDLC)
(Source: Soetopo, 2003 [10])

The following is an explanation of each step in the MDLC system development method.

A. Conception Stage

Conception stages are the stage of formulating the purpose of the developed application and determining the users [11]. At this stage, the purpose of designing a developed multimedia application was described from the user identification, application type, application purpose and other general matters.

B. Designing Stage

At the designing stage, specifications that was developed were regarding architecture, appearance, style, and determination of the requirements needed in application development [12]. In this study, the system was designed using use case diagrams and activity diagrams.

C. Material Collection

This stage is the stage where the developer collected the materials needed to build the application [13]. The materials collected can be in the form of text, images, audio, video, animation, 3D objects and other required contents or materials.

D. Assembly

The assembly stage is the stage where the developer will make applications from collected contents and materials at the collecting material stage [14]. This work was often carried out simultaneously with the assembly

stage, so that if the project being developed was system authoring, it can use dummy content to be used before the project is complete [15]. In this research, the assembly stage employed software including: Blender software to create 3D objects and Unity software to combine all contents and materials.

E. Testing

The testing stage was aimed to ensure whether the application can work properly and according to user needs [16]. Tests carried out by testing beta testing. Beta testing is a direct test in an actual environment [17]. Beta testing was carried out based on the Technology Acceptance Model (TAM) approach. TAM is a measurement of the factors that influence user behavior towards technology acceptance [18]. The variables in TAM included perceived on usefulness, convenience, intention, and usability. The usefulness perception variables consist of: working faster, increasing job performance, productivity, effectiveness, simplifying work and useful at works. The convenience variable consists of: easy to learn, controllable, good and easy to understand, flexible, easy to be used and easy to master. Intention variables consist of: its use to complete work, accessibility time, future use plans, continuous use plans and user expectations on its continuity. Meanwhile, the friendliness variables consist of: actual use, intensity, frequency of use, according to the minimum time, satisfaction and recommendations. So, in this study, a questionnaire will be given to application users with questions based on the variables in TAM.

F. Ditribution

At this stage the system was considered as feasible to use then the application was distributed. Distribution was done by making it into a format that can be used by users to be inserted into the storage media so that the application could be ready to run [19]. The distribution stage in this research was conducted by saving the learning application into *apk format so that the application can be installed on a smartphone with the Android operating system.

Results and Discussion

A. Concept

At the concept stage, the main measure was to determine the purpose of designing the application by firstly determining expectation, and potential users. At this stage, the purpose and the audience or users of the application was clearly determined. The purpose of the AR application was to introduce tangible cultural heritage at the Museum Lampung. Visitors could easily find information about the museum collections and assist museum guides in providing explanations about existing collections, especially tangible cultural heritage at the museum. Users of this application were planned for the public and museum visitors who were interested in the tangible cultural heritage.

B. Design

At this stage, the researcher employed *use case diagrams* and *activity diagrams*. *Use case diagrams* describe the interaction between users and the system and their activities on the system [20]. *The use case diagram* of the AR application for the introduction of tangible cultural heritage at the museum can be seen in **Figure 2**.

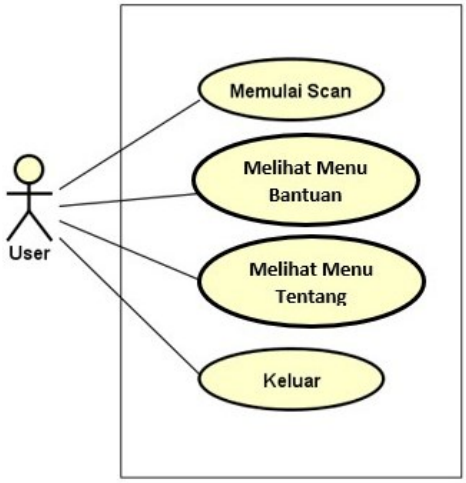

Figure 2. *Use Case Diagram* of AR Application of Intoroduction of Tangible Cultural Heritage at the Museum Lampung

While *the activity diagram* is a description of user activity on all menus on the system [21]. *The activity diagram* of the AR application for the introduction of tangible cultural heritage at the Museum Lampung can be seen in **Figure 3**.

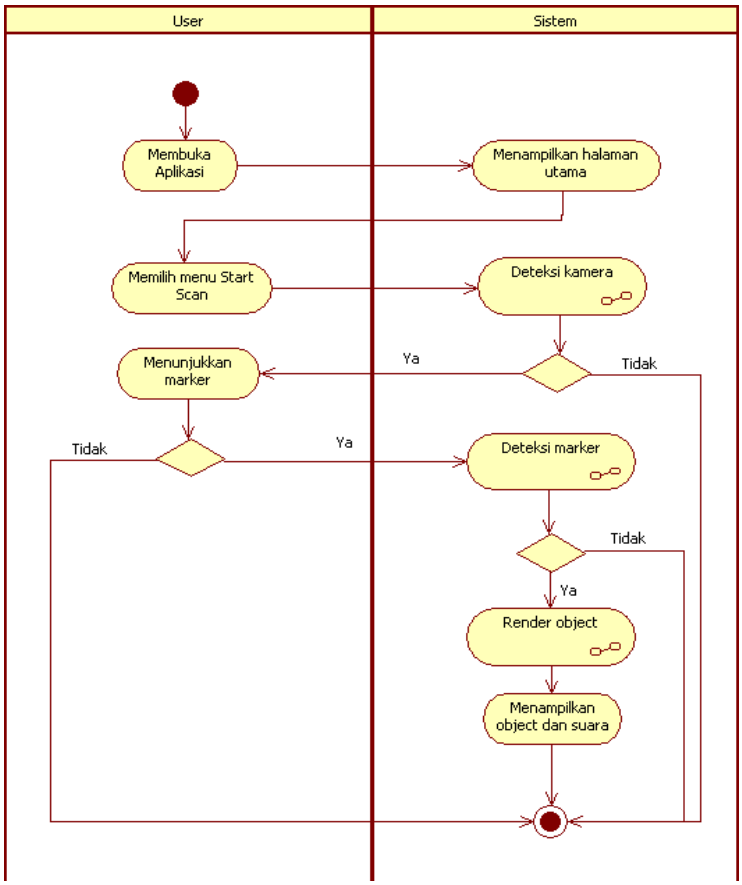

Figure 3. *Activity Diagram of* AR Application of Tangible Cultural Heritage at the Museum Lampung

C. Material Collection

In this study, the materials needed were 3D objects of tangible cultural heritage in the Museum Lampung, application support graphics, audio in the form of back sound and narration, as well as other supporting components. After determining the concept and design, the next step was to create a 3D object from the cultural heritage collection in the museum using Blender software. **Figure 4** presents the process of creating 3D objects which was later be used for AR applications.

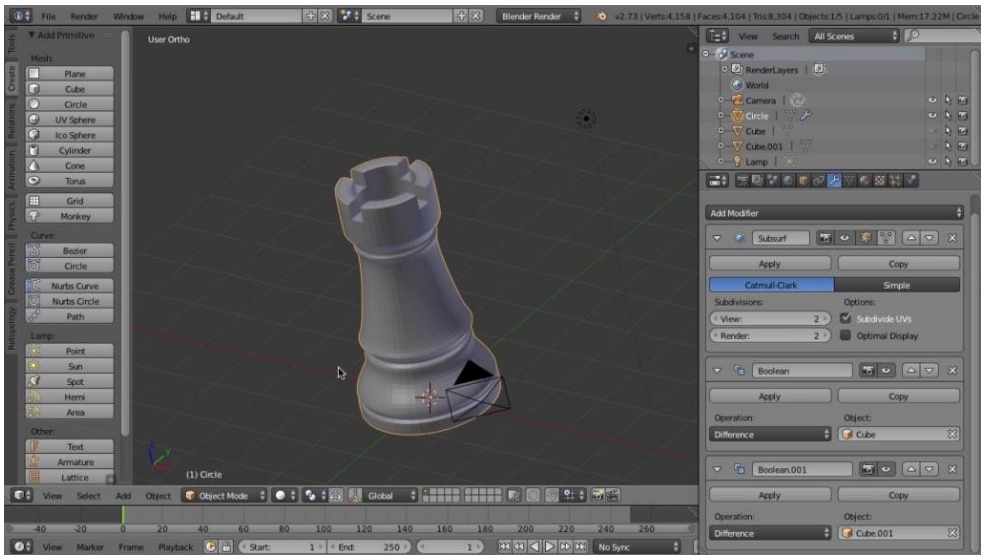

Figure 4. The Process of Designing 3D Objects in Blender

After the required 3D objects had been collected, then other components such as text, audio and narration were gathered.

D. Assembly

In this research, the *assembly* stage employed *software* including: Blender *software* to create 3D objects and Unity software used to combine all contents and materials. After all 3D objects had been created, then required packages were added to build AR applications on the Unity *software*, namely AR Foundation (**Figure 5**, the process of adding the AR Foundation package to Unity). Unity *package* AR Foundation was a library in Unity that is used for developing AR-based applications. The AR Foundation had provided facilities for designing markers. After all the required 3D materials, graphics and audio were collected, they would then be entered into the Unity *software*. Unity has the facility to make applications work on the Android operating system, this is because Unity has the Android SDK and Java Development Kit (JDK) facilities that can build and run programs on Android *smartphones*.

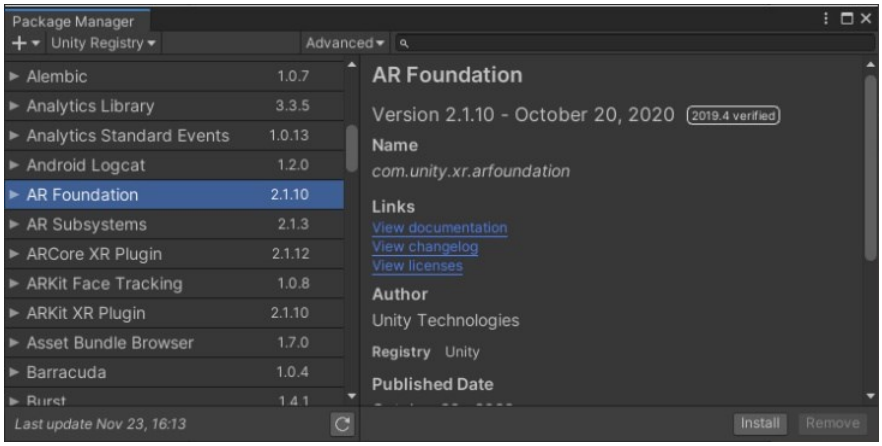

Figure 5. The Process of Adding *Package* AR Foundation in Unity

Designing the application started from designing the *scene* and *coding*. *Scene* in the form of a sequence of events from application features that were developed based on a previously made design and then it was coded using the C# language in Unity through MonoDevelop. After the coding was complete, then debugging or running the application and making sure there were no errors in the coding that had been designed in accordance with the desired features and functions. If the application had no errors, then the application designed by changing the format to .APK so that it can be run on Android devices. The process of building settings in Unity is shown in **Figure 6**.

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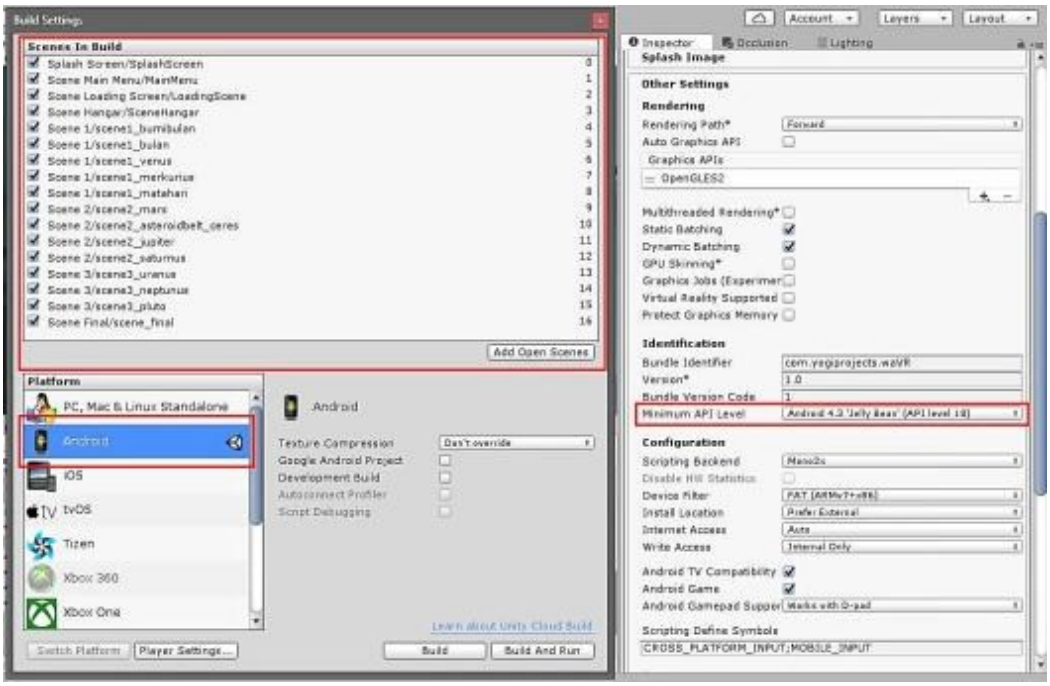

Figure 6. Process of *Build Setting* in the Unity

After the *assembly* process was completed, the application was ready to use. The AR application for the introduction of tangible cultural heritage at the Lampung museum began with the main menu containing Start Scan, Help, About, and Exit, as shown in **Figure 7**.

Figure 7. The Main Manu of AR Application of Tangible Cultural Heritage at the Museum Lampung

To start using this application the user can select the Start Scan menu. This menu is a menu where users can scan and direct the smartphone camera to objects or collections of tangible cultural heritage owned by the Museum Lampung as a marker. After the application detects the presence of a marker, the application will display a 3D object right on the scanned object and display information related to the object. The use of the Start Scan menu can be seen in **Figure 8**.

Figure 8. *Start Scan* Manu that Displays 3D Objects and Information from the Collection of the Museum

E. Testing

Furthermore, to ensure that the application can be accepted by users, testing should be carried out. The test conducted by administering questionnaires using the Technology Acceptance Model (TAM) approach. The variables in the TAM were used as questions therefore it tested several aspects including: perceived usefulness, convenience, intention, and usability. The usefulness perception variables consist of: work faster, job performance, increasing productivity, effectiveness, simplifying work and accessible. The convenience variable consists of: easy to learn, controllable, good and easy to understand, flexible, easy to be mastered and easy to use. Intention variables consist of: used to complete work, time efficiency, future use plans, sustainable use plans and user expectations on the apps continuity. Meanwhile, the usability variables consist of: actual use, intensity, frequency of use, according to the minimum time, satisfaction and recommendations. This questionnaire was given to 30 respondents/visitors with 23 questions. **Figure 9** is a graph of the percentage of the number of visitors who answered "Agree" on the questionnaire variables.

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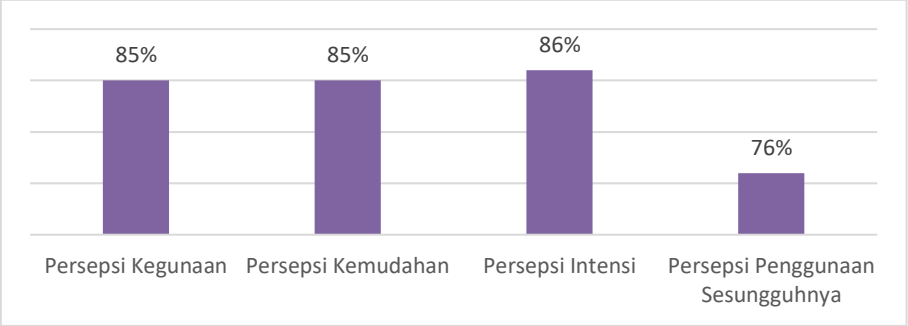

Figure 9. Presentation Graphic of Testing Using TAM

Based on the test results, it was found that 85% of users agreed that the developed application was useful, then 85% of users agreed that the application was convenient, then 86% of users had intended or were interested in using it, and 76% of users agreed to seriously really use the app (usability). From the results of the four variables, if the average is taken, it can be said that 83% of users can accept this application based on the TAM approach.

F. *Ditribution*

Applications that are fully ready to use must be prepared and adapted to the actual environment to be distributed to users according to the desired market. The distribution stage in this research was conducted by saving the learning application into *apk format so that the application can be installed on a smartphone with the Android operating system.

Conclusion

According to the research that has been carried out, it can be concluded that the system development approach with the Multimedia Development Life Cycle (MDLC) can be used to develop AR applications because this method is suitable for multimedia applications where the stages carried out focus on combining multimedia elements such as : text, graphics, 3D objects and audio. The developed application has the ability to display 3D objects when the application user's camera is directed to the collection in the Museum Lampung and provides information related to these objects. This can assist visitors to find information about the tangible cultural heritage that exists in the museum and it can make the work of the museum guide easier. Based on the results of testing with the TAM approach on aspects of perceived usefulness, convenience, intention, and usability, the average respondent answered "Agree" with a percentage of 83%. This indicates that the application is acceptable to the user.

Acknowledgement

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