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Augmented reality using Natural Feature Tracking (NFT) method for learning media of *makharijul huruf*

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Abstract. *Makharijul huruf* is the place of the letter *hijaiyah* (Arabic letters) from *alif* to *ya*. If someone mistakes in reciting a letter on al-Qur'an then the meaning of the word or sentence may be different from the meaning of the original word. Few learning media that provides information about *makharijul huruf* such as school academic books, books of *tajwid al-Qur'an*, etc. However, to make terms of visual and audio clearer we can use augmented reality technology as a learning media. Augmented reality for *makharijul huruf* requires a marker of *hijaiyah* in printing form. Tracking marker in this research using Natural Feature Tracking (NFT) method. In the application of learning this *makharijul huruf* will produce a 3D object visualization of the oral organs and audio sounds *hijaiyah* letters and explanations about *makharijul huruf*. The results of black box testing and beta testing states that this application can be accepted by users by obtaining a percentage of 91%. It can be concluded that applications built functionally have produced results as expected.

1. Introduction

Makharijul huruf is the place where letters of *hijaiyah* come out when someone recited letters in al-Qur'an. Learning about *makhorijul huruf* is very important, as much as possible must learn from an early age. The introduction of *hijaiyah* letters is usually done at the kindergarten level.

Children are generally exploratory and adventurous in nature. Encouraged by a strong curiosity, children are usually happy to explore, try, and learn new things. They like to dismantle pairs of toy tools that they bought. Children sometimes are involved intensively in the activities of watching, playing with, and doing things with the things he has. The nature of this child is actually the foundation and basic capital to be creative and innovative human beings. Therefore, teachers must creatively stimulate child development with a variety of activities as well as media and learning resources so that children are encouraged to develop their abilities and think creatively, constructively and innovatively. Teachers must avoid making monotonous activities and make children bored. The choice of learning methods that enable many children to be one of the solutions so that children are facilitated by their explorative nature, for example through experiments, projects and field trips [1].

Augmented Reality or AR is a technology that allows people to visualize the virtual world as part of the real world that is around effectively so that it makes the real world seem to be able to connect with the virtual world and an interaction can occur [2].

AR has several methods that can be used as a marker detection algorithm or an object. One method that can be used as a marker tracking is Natural Feature Tracking (NFT) which is an algorithm in the Vuforia library to detect image patterns.

At present there are many fields that implement AR technology, one of which is in the fields of education and health. In the world of education, AR is used for media presentations. This will certainly attract the attention of children when learning about *makhorijul* letters and *hijaiyah* letters by using AR technology, where at this time they may also get used to the presence of AR because it is not uncommon for children's toys to be accessed via mobile phones and using AR technology. For example, gift cards with AR technology when buying chocolate sticks can display cartoon characters that kids enjoy doing.

2. Theoritical Frameworks

Makharij has a root word from the verb *kharaja* which means out. The origin of the word is then made into a form of eating *isim* (which indicates a place), so that it becomes *makhraj* which means a place out. While *makharij* is the plural form of *makhraj*. What is meant by *makhorijul* letters are places where letters come out of the reader's mouth. All letters have a place of origin issued by the reader, thus forming a certain sound. If the letter is not removed from its original place, then it makes it obscure for the reader himself and the listener, and cannot be distinguished from one letter to another [3]. The letter of hijaiyah is the plural form of *al-harfu* which means the smallest part of the pronunciation which cannot form its own meaning unless it must be strung together with other letters. Whereas *Hijaiyah* is spelling. The purpose of spelling here is Arabic spelling as the native language of al-Qur'an. Therefore, what is meant by *hijaiyah* letters are Arabic spelling letters as the native language of the Qur'an [3].

Augmented reality is one of the breakthroughs used lately in the field of interaction. The use of this technology will be very helpful in conveying information to the user. Augmented Reality is an interaction technology that combines the real world and the virtual world. The purpose of using Augmented Reality technology is to add understanding and information to the real world where the Augmented Reality system takes the real world as a basis and combines several technologies by adding contextual data so that one's understanding becomes clear [4].

Unity 3D is a game engine or software that was created to make a game application, which has been equipped with an IDE (Integrated Development Environment) or in other words unity does not require software development such as Delphi or Ms. Visual C ++ in terms of application development, because Unity already has its own code editor and compiler [5]

The Rational Unified Process (RUP) method is a software engineering method developed by collecting various best practices contained in the software development industry. The main characteristic of this method is to use use-case driven and iterative approaches for the software development cycle. RUP uses the concept of object oriented, with activities that focus on developing models using the Unified Model Language (UML). The picture below shows that the RUP has, namely: The first dimension is drawn horizontally. This dimension represents the dynamic aspects of software development. This aspect is elaborated in the development stage or phase. Each phase will have a major milestone that marks the end of the beginning of the next phase. Each phase can stand up from one iteration. This dimension consists of Inception, Elaboration, Construction, and Transition. And he second dimension is described vertically. This dimension represents the static aspects of the software development process which are grouped into several disciplines. The software development process described in several disciplines consists of four important elements, namely who is doing, what, how and when. These dimensions consist of: Business Modeling, Requirement, Analysis and Design, Implementation, Test, Deployment, Configuration and Change Management, Project Management, Environment [6].
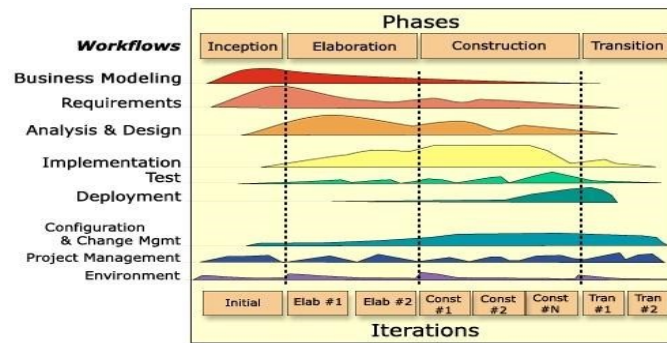
Figure 1. Rational Unified Process (RUP) [6].

Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that enables the creation of Augmented Reality applications. Vuforia uses Computer Vision technology to recognize and track markers or target images and simple 3D objects, such as boxes, in real-time [4].

Vuforia is the world's most used platform for AR development, with support for leading mobile phones, tablets and eyewear. Developers can easily add sophisticated computer vision functions to Android, iOS and UWP applications, to create an AR experience that realistically interacts with objects and environments. More than 50,000 Vuforia-powered applications have been published on the App Store and Google Play. Vuforia also supports an active developer ecosystem with more than 375,000 registered developers and more than 45,000 projects under development [7].

UML orf Unified Modeling Language means a standard modeling language. UML has syntax and semantic. When we make a model using the UML concept there are rules that must be followed. How the elements in the models relate to one another must follow the existing standards. UML is not just a diagram, but also tells the context.

3. Analysis And Design

3.1. System Architecture
System architecture in the application *makharijul* augmented reality letters can be seen in the following figure 3.
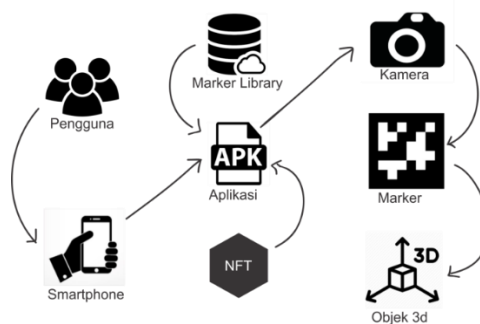
Figure 2. System Architecture

Figure 3 explains how the process of making this application is built by using Augmented Reality technology. The following are the components forming the system, including: (a) 1. Users are users of the Augmented Reality application *Makharijul* Letters and *Hijaiyah* Letters. (b) 2. Mobile or smartphone is the media used as a liaison between the user and the application of Augmented Reality *Makharijul* Letters and *Hijaiyah* Letters. (c) Marker library is a marker storage database that has been provided by vuforia. (d) NFT is a marker recognition method used in the augmented reality method in the vuforia library. (e) The camera is used to scan marker images that have been provided previously, so that tracking markers can be done. (f) Marker is a picture of *hijaiyah* letters that has been provided

by the author. (g) 3D objects are visualizations displayed on the Augmented Reality application *Makharijul* Letters and *Hijaiyah* Letters.

3.2. Use Case Diagram

Use Case Diagram is modeling to illustrate the interaction between actors with the system to be created. Use Case Diagrams on this menu combination application can be seen in Figure 4.

Figure 3. Use Case Diagrams

3.3. Activity Diagram Application Augmented Reality Makharijul Letters And Letters Hijaiyah

Activity diagrams illustrate the various activities flow in the system that is being designed, how each flow starts, decisions that might occur, and how they end. Activity diagrams can also illustrate parallel processes that might occur in several executions.

3.4. Sequence Diagram Application Augmented Reality Makharijul Letters

Sequence Diagram is one of the diagrams in UML, this sequence diagram is a diagram that illustrates dynamic collaboration between a number of objects. Its purpose is to indicate the sequence of messages sent between objects as well as interactions between objects. Something that happens at a certain point in the system execution. In Figure 6 the following is a sequence diagram in this application.
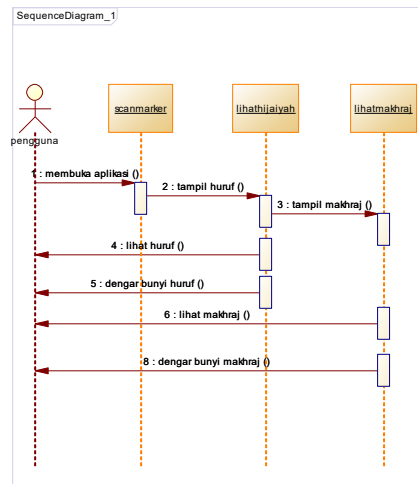
Gambar 4. Sequence Diagram

3.5. Natural Feature Tracking

Natural Feature Tracking (NFT) contained in the vuforia library functions to determine whether an image can be recognized or not based on pattern recognition by detecting the angular points of the pattern in the image. The goal is to make detecting feature patterns easier. Basically the Vuforia library uses NFT (Natural Feature Tracking) in which there is a natural feature tracking approach namely SIFT (Scale Invariant Feature Transform). SIFT is used to detect "feature points" and determine the scale of the marker (target image) by mapping the coordinates value [17]. Figure 7 below shows the steps to detect markers in Natural Feature Tracking (NFT).
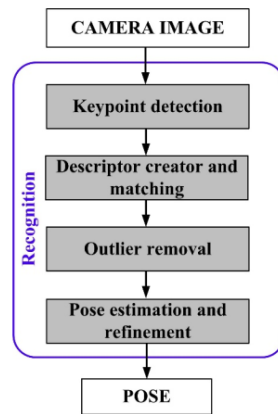
Figure 5. steps for detecting markers [18]

3.6. Interface Design

Interface design is one of the most important parts in software development, because the first impression of a user is how the interface or appearance of a software is presented. Here is the interface of the software that will be built : Main Interface Display, *Hijaiyah* Letters Scan Page Interface, *Makharijul* Hurricane Information Interface Page and Interface page See *Makhraj*.

Figure 6. Interface Design

4. Implementation and Testing

Implementation of the interface aims to make the interface and function functions in accordance with the previous design. Next in this section the results of the interface that have been made and the explanation are explained.
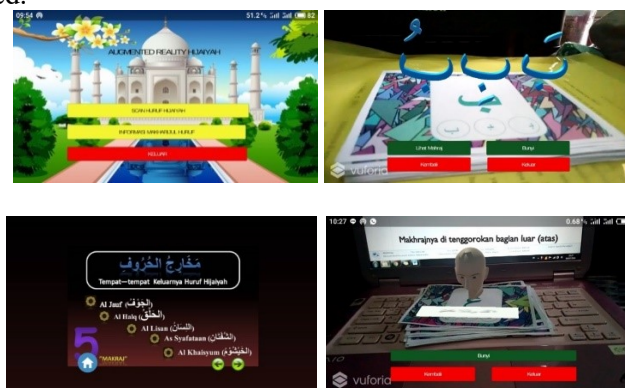

Figure 7. Implementation of the interface

4.1.1. Main interface implementation
Figure 12 shows the main menu interface in the augmented reality application *makharijul* letters and *hijaiyah* letters. On this page there are also several menus available including, scan button *hijaiyah* letters, *makharijul* letter information button and exit button.

4.1.2. Implementation of hijaiyah letter scan display
Figure 13 shows a page that displays a visualization of 3D *hijaiyah* letters, where *hijaiyah* letters on a previously scanned marker will appear in 3d.

4.1.3. Implementation of the display of makharijul letters
Figure 14 is the *Makharijul* letters information interface page on the augmented reality application of *Makharijul* letters and *hijaiyah* letters which serves to show brief information about the types of letters.

4.1.4. Implementation of the display Makharijul *of makharijul letters*
Figure 15 shows an interface page to see *makhraj* in the application of augmented reality makharijul letters and *hijaiyah* letters that serve to show information about the location where the *makhraj* letters have been scanned before. On this page there is also a sound button that serves to display the audio location of the letter *makhraj*.

5. Conclusion
After going through the stages in accordance with the Rational Unified Process (RUP) software development method and the Natural Feature Tracking algorithm in the development of this augmented reality application, it can be concluded (a) The application has been designed and built using augmented reality technology with the Natural Feature Tracking (NFT) method for learning makharijul letters and hijaiyah letters for android. Learning makharijul letters and hijaiyah letters using augmented reality technology on an android device can be an alternative media introduction that is more interesting because it can display the hijaiyah and makhraj letters in three dimensions, and can play audio audio sound pronunciation of hijaiyah letters clearly so that it can be easily understood. (b) Based on the results of the test on each letter sound and makhraj as well as the object letters and makhraj are all appropriate and can be displayed properly. So it can be concluded that the application that was built functionally has issued results that are as expected.

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