ISSN 2085-4552

Bacteria Recognition Application Model Using Marker-Based Augmented Reality for Android Mobile Devices

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Accepted on 03 August 2023
Approved on 20 December 2023

***Abstract*—This article aims to develop a multimedia application model for bacterial recognition using Marker-Based Augmented Reality (Marker-Based AR) technology for Android mobile devices. Marker-based tracking creates mobile augmented reality markers to increase user interaction in Marker-Based Augmented Reality systems. The software development method uses the Multimedia Development Life Cycle, which consists of 6 phases: concept, design, material collecting, assembly, testing, and distribution. The results of this study are a model of a multimedia application for bacterial recognition using Marker-Based AR, which has a marker-based tracking feature and displays bacterial objects in 3 dimensions along with their explanations and exercise questions. Based on user tests, it shows that the application model developed helps and makes it easier to learn about bacteria independently using Android mobile devices more easily and interestingly. This is proven based on beta testing towards users who scored 73.68%, which agrees.**

***Index Terms*—marker-based AR; augmented reality; bacteria recognition; MDLC; android**

I. INTRODUCTION

Today's learning process is increasing with current technological developments, which are growing. Various kinds of game-based computer technology and learning media can be used to improve the learning process at this time [1]. Until now, biology has been one of the compulsory subjects in schools. Bacterial learning material in Biology subjects seems difficult to understand. Sometimes, they don't pay close attention when the Biology teacher explains the material, so they are often left behind by the material being taught [2]. One solution to avoid being left behind by the material presented at school is to study alone. However, self-study seems unattractive because the learning material is still in the form of visuals in 2 dimensions [3], [4]. A good learning process must contain interactive, fun, challenging, and motivating aspects and provide more space to develop creativity and independence according to students' talents and interests. One solution is to create a learning media based on Augmented Reality technology, for example, the development of learning multimedia and virtual laboratories [5].

Augmented Reality is a technology that combines 2-dimensional and 3-dimensional virtual worlds into the realm of the natural world, after which objects or characters (objects) of the virtual world are projected into real-time [6]. Based on this, to attract interest in learning Biology, introducing bacteria with animation using Augmented Reality Technology combines 3-dimensional objects into the natural environment to increase interest in independent learning [7]. Sources of knowledge about various health can be modeled with animation using Augmented Reality to help explain an object because it is in the form of a book or reading material, so it is challenging to understand [8], [9].

This research was compiled concerning several previous studies, where these references are related to the topic raised, significantly Augmented Reality Technology. The results of this research include the first research regarding the application of Augmented Reality in currency recognition. The results of this research [10] produce a currency learning application model by scanning banknotes to display information related to the currency. The research in [11] concerns the application of augmented reality as a learning medium for cell biology material. This research displays 3-dimensional cell objects complete with part names but does not have the practice questions feature in the application. The research in [3] is the implementation of Augmented Reality Marker Tracking to display a 3-dimensional visualization of building objects (buildings) complete with the names of building rooms. The drawback is that they need a sound explanation or direction features. The research in [7] is the Application of Augmented Reality Technology in the Android-based digestive System Learning Media, where the research displays 3-dimensional digestive organ objects complete with material explanations. The application has no practice question features and a lack of audio descriptions. The research in [8] is the Application of Augmented Reality Technology as a Dental Health Education Media Model for Children. The research displays 3-dimensional dental objects

using the Augmented Reality Marker Based Tracking method. The application needs an explanation of text descriptions or practice questions. The research in [12] is the Application of Augmented Reality in Serious Game Education for Dental Diseases. This research displays 3-dimensional dental objects using the Augmented Reality Marker Tracking method and is complete with interactive game features from 3-dimensional dental objects. There needs to be an explanation of the dental object material. The research in [13] concerns the development of multimedia-based electrical circuit learning application models, but this study only uses 2-dimensional animation technology. When viewed from the use of methods in developing learning media application models, it can be done using the Multimedia Development Live Cycle (MDLC) approach, such as in the introduction of the image of the rupiah currency using Augmented Reality as various learning media [10] and the development of electrical circuit learning application models [13].

Based on the background and previous studies, we conducted this research to develop a multimedia application model for bacterial recognition using Marker-Based Augmented Reality (Marker-Based AR) technology for Android Mobile Devices. Marker-based tracking creates mobile augmented reality markers to increase user interaction in Marker-Based AR systems [14]. Meanwhile, the Android mobile application development method uses the Multimedia Development Life Cycle (MDLC). The results of the development of the Marker-Based AR bacterial recognition multimedia application model are expected to help biology learning to attract the joy of learning for both children and adults in terms of understanding the names of bacteria.

II. METHODS

The method used in developing the Bacteria Recognition Application Model Using Augmented Reality is the Multimedia Development Life Cycle (MDLC), which was introduced by Luther and Sutopo [15], [16] with stages covering concept, design, material collecting, assembly, testing, and distribution.

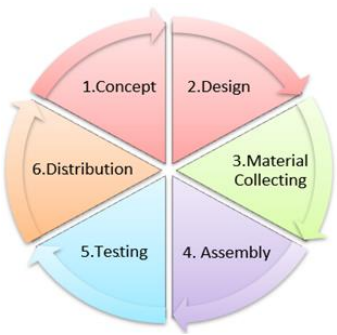

Fig. 1. Activity workflow based on the MDLC method

The MDLC method is very suitable because all stages can cover everything needed to develop a multimedia-based application model [17]. Figure 1 is an activity workflow based on the MDLC method [13].

The explanation based on the activity in Figure 1 is as follows: the concept contains the application concept, application objectives, user segmentation, and the device used. Design is the stage of making specifications regarding application architecture, style, appearance, and material requirements; material collecting is the collection of materials for everything needed to make applications. Material materials include clipart images, photos, animations, videos, audio, etc. This stage is generally carried out in parallel with the assembly stage. Assembly is the stage where all objects or materials are arranged and made based on a predetermined design; Testing is a testing phase carried out to check the application being developed so that it can run well; and distribution is this stage, the application model that is made will be packaged or stored on offline and online storage media.

A. *Concept*

This stage contains the application concept, objectives, user segmentation, and the device used. Table 1 is a description of the application concept.

TABLE I. APPLICATION CONCEPT

Info	Description
Name	Recognition Bacteria
User	All people who know Indonesian (preferably students)
Feature	Marker-based tracking, conveying information with 3-dimensional augmented reality objects along with descriptions, audio, and questions
Video	One way
Image	Images in .jpg format
Audio	Sound in mp3 format.

The devices used in making bacterial recognition applications are in the form of hardware and software. Hardware is used to develop and test applications made starting from the needs of personal computers (PCs) and Android smartphones. Software is a tool for designing, developing, and testing applications, including Adobe Photoshop, Adobe Audition, Unity 3D, and Android Studio IDE.

B. *Design*

The design stage is the application program architecture specifications to describe each scene using a storyboard, as shown in Table 2, and the navigation menu structure, as shown in Figure 2.

TABLE II. STORYBOARD DESIGN

Scene	Content	Description
Scene 1	Splash Screen	It is the opening of the application before going to the next page, displaying the Unity logo.
Scene 2	Main Menu	The application's main menu with navigation buttons Starts Marker-Based AR, Exercises, Settings, About, and Exit.
Scene 3	Start Marker-based AR	This page is a Start Marker-based AR for scan markers, showing detailed 3D bacterial objects and material descriptions for scanned objects on features.
Scene 4	Exercises Question	Displays Exercise Questions taken from several bacterial materials.

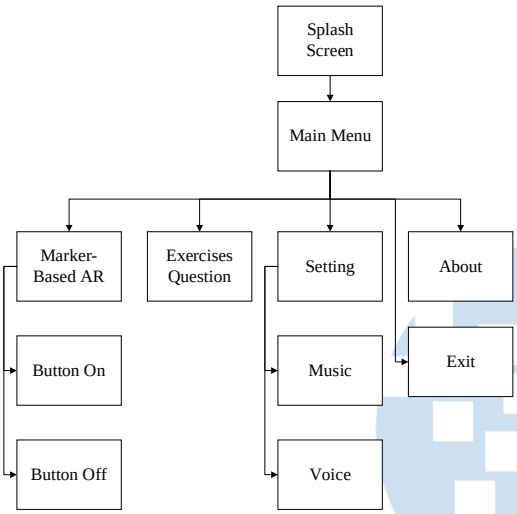

Fig. 2. Structure menu navigation

The navigation structure is a picture of the organization and relationship between scenes in the application so that a sequence of information flows is formed. The existence of a navigation structure gives the application explicit information activities. The navigation structure in this application uses a hierarchical navigation structure. The hierarchical navigation structure relies on branching to display information based on specific criteria; the display on the main menu is the master page, and the branching is called the slave page.

C. Material Collecting

This stage is a collection of 4 materials, namely 3-dimensional objects, audio, images, and text. The process of collecting the four materials is presented in the following figure.

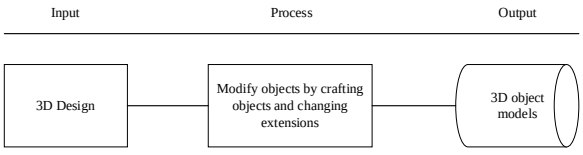

Fig. 3. 3D Model Object Collection Process Diagram

The 3-dimensional object model to be used is created using the Blender software. Format 3D objects using the .fbx extension to avoid errors when importing into Unity 3D.

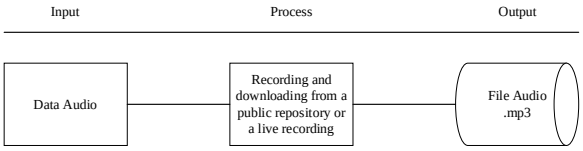

Fig. 4. Audio Collection Process Diagram

Audio is needed so that the application is more exciting and feels alive because the presence of audio is one of the elements of completeness in the application. The audio files are obtained by downloading from the public repository, and the recordings are made directly. This audio file is used for the background and an explanation of the material with audio in each scene. The audio format uses the .mp3 extension, which has a smaller file size.

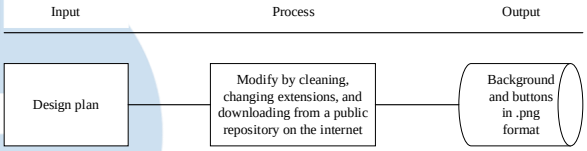

Fig. 5. Image Gathering Making Process Diagram

Image data consists of backgrounds, buttons, and markers where 3-dimensional objects appear. The format has extensions .png and .jpg for 3D image objects and augmented reality markers. Image management is done using Adobe Photoshop.

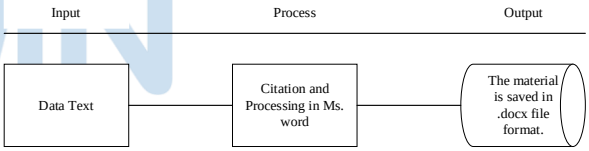

Fig. 6. Text Collection Making Process Diagram

Text data in the application of bacterial recognition is used as material delivery. The material used in the Android-based marker-based augmented reality bacteria recognition application model consists of Clostridium difficile, Escherichia Coli, Klebsiella Pneumonia, Neisseria Gonorrhoeae, Pseudomonas aeruginosa. These materials were obtained from research journals and citations in Microsoft Word and stored in .docx format.

D. Assembly

The assembly stage is the stage of the development process for marker-based augmented reality learning media applications using materials and data that have been collected. The development of this application is based on the design stage, such as storyboards, flowcharts, and navigation structures where every

material that has been collected will be designed. The application development process uses Unity 3D software. Figure 7 is an example of implementing 3D objects using Unity 3D.

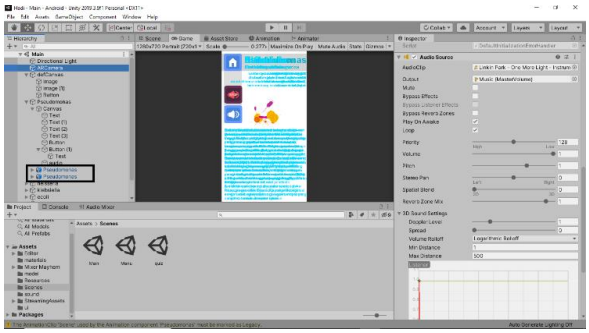

Fig. 7. An example of implementing 3D objects using Unity 3D

E. *Testing*

Testing the Marker-Based Augmented Reality (Marker-Based AR) bacteria recognition application model is carried out based on the functionality of each navigation button, marker-based AR features, and limited users distributed. The testing process uses alpha-testing and beta-testing methods[18].

F. *Distribution*

Distribution is the stage where the application will be stored in a storage medium. If the storage media is not enough, compression of the application is carried out. This stage can be called the product evaluation stage to improve it. The results of this evaluation can be used as input for the concept stage of further product development. At this stage, product packaging is distributed by uploading it to the Google Play Store, which the public can download.

III. RESULTS AND DISCUSSION

A. *Result*

This research results in a bacteria recognition application model using marker-based augmented reality for Android mobile devices. Some examples of interface displays on Indonesian-language Android smartphones are shown in Figure 8 and Figure 9.

The alpha test was carried out using currently circulating Android mobile devices with the lowest Android operating system specification, version 6. The results of the alpha testing show that 90% of the functionality of each navigation button and marker-based AR feature function correctly.

Beta testing involved 25 grade X high school students/respondents/users by completing an objective questionnaire. The questionnaire was calculated using a Likert scale with a range of values for each question, from 1 to 5 [19]. The results of Beta testing on users obtained a weight of 73.68% agreeing to the answers to each positive question, so we can conclude that the Marker-Based AR bacteria recognition application model for Android mobile devices can be well received and helps in facilitating learning of Biology subjects especially bacterial material in grade X high school.

Fig. 8. Interface display of Main Menu and Marker-Based AR results

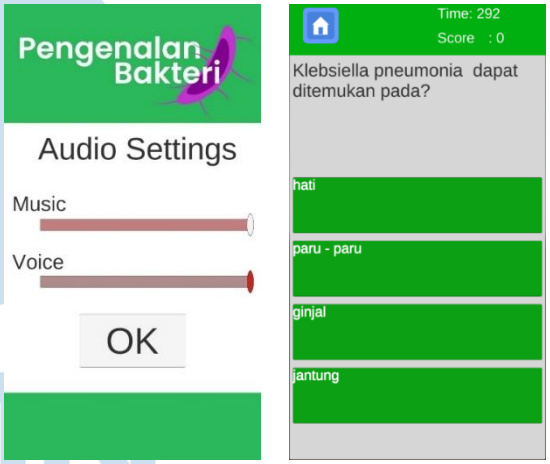

Fig. 9. Interface display of audio settings and interactive exercises question.

B. *Discussion*

This research produced a Marker-Based Augmented Reality (Marker-Based AR) bacteria recognition application model for Android mobile devices that can help students and the general public learn about bacteria. As for knowing the alignment of the research results with previous research, a comparative study of the results was carried out. Research conducted by Julian Sahertian and Risa Helilintar [11], Feby Zulham Adami [7], Tonny Hidayat [8], and Muhammad Faqih [12] produced learning media based on Augmented Reality. It did not have practice question features, whereas the research has added a practice question feature and marker-based tracking augmented reality. Then, in terms of the use of learning media application model development methods, previous researchers generally used the waterfall approach. At the same time, in this study, the Multimedia Development Life Cycle (MDLC)

approach is very suitable because all stages can summarize everything needed to develop an application-based model. Multimedia [17].

The implications of the results of this study produce learning media based on Augmented Reality technology to build community interest in learning, especially among students still in school. Independent knowledge through Android mobile devices can quickly broaden the general public's insights or students' knowledge about bacteria. Interestingly, this is proven based on beta testing of users, obtained a value of 73.68%, which agreed.

IV. CONCLUSION

Based on the results and discussion, we successfully developed the Android-based bacterial recognition application research from previous research by adding practice questions features, detailing 3-dimensional objects, and adding animation to 3-dimensional objects to make them exciting and interactive. Besides that, the results of alpha testing showed that 90% of system functionality and marker-based AR features functioned well. In contrast, 73.68% of users agreed they were well received for beta testing and helped facilitate learning Biology subjects, especially bacterial material.

ACKNOWLEDGMENT

The Authors wish to acknowledge Institut Teknologi Garut, which supports and funds this research publication.

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