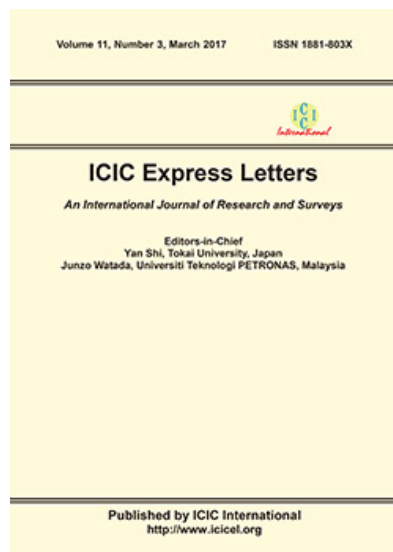Editorial Board   Aims & Scope   Information for Authors   Contents   Subscription   Submission   Publication Ethics   Digital Preservation Policy   Contact

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AN INTERACTIVE MOBILE AUGMENTED REALITY SYSTEM FOR LEARNING HUMAN VISION STRUCTURE

Ahmat Adil, Samsul Hadi and Bambang Krismono Triwijoyo

Department of Computer Science
Faculty of Engineering and Design
Bumigora University
Jl. Ismail Marzuki, Mataram, West Nusa Tenggara 83231, Indonesia
{ ahmat.adil; 1510530039; bkrismono }@universitasbumigora.ac.id

ABSTRACT. *This study aims to design and implement interactive mobile Augmented Reality (AR) for learning the structure of the human visual sense, as a tool in the teaching and learning process between teachers and students by visualizing 3D objects from the visual structure of the human eye. The methodology used in developing this application is Luther Sutopo's development method, where this method consists of 6 stages, namely concept, design, material collection, assembly, testing, and distribution, with visualization techniques using the marker recognition engineering framework. In this study, a prototype mobile application model was made using augmented reality technology to display the structural parts of human vision and several diseases of the human sense of sight. This research aims to serve as a teaching aid media for teachers and students in interactive 3D learning for recognition of human visual senses. The results of the AR-based model trial on interactive mobile augmented reality conducted on 39 respondents, showed that 85.04% of the acceptance questionnaire answers agreed and strongly agreed that the model in application content was supportive and useful for users because it could provide an overview of the structure of the human eye.*
Keywords: An interactive mobile application, Augmented reality, Human vision

1. **Introduction.** Augmented Reality (AR) is a technology that has potential and has an impact on learning and education. On the other hand, the increasingly widespread use of mobile devices has led to increased interest in integrating the benefits of mobile learning and AR applications, especially in learning that requires visual illustrations, such as in learning the structure of human vision that is difficult to visualize directly, so that AR technology is very suitable as an alternative solution. One of the studies that use AR technology is an intuitive semi-automatic offline robot programming method based on augmented reality and Stereo Vision (SV) systems [1]. This study produces effectiveness in robotic task implementation.

This article describes the results of the design of an interactive mobile augmented reality system for learning human vision structure. Research on the mobile AR learning system is still in its early stages and the embryonic stage [2,3], and [4] provides an overview of Mobile Augmented Reality (MAR) information and its potential used in education.

Numerous studies have found that mobile devices play a major role in education today and look at the impact and benefits of these devices concerning a potential pedagogical perspective [5-8]. The rapid development and increase in the use of mobile phones have enabled Mobile Augmented Reality (MAR) [9,10] and is starting to develop rapidly. Previous research that used MAR in learning was a mobile Augmented Reality (AR) system for learning dental morphology [11]. The AR system can facilitate the learning process which can be done anywhere and anytime without requiring supervision. Visualization of

discrete structural members using AR together with interactive 3D models has been proposed by [12]. The results of the study indicate that the AR design concept utilized has the potential to contribute to student learning. Meanwhile, [13] presents a mobile augmented reality system, called DiedricAR, which is aimed at studying descriptive geometry. The results give students the possibility to use ubiquitous learning to the highest degree by interacting with didactic content. A prototype of human skeletal anatomy learning using MAR has also been developed by [14], who concluded that students are satisfied with the model in terms of its usefulness and features and can have a positive impact on their learning process. A 3D anatomical structure learning model using Augmented Reality (AR) technology has also been proposed by [15]. The results of the model can help young medical students to learn complex anatomical structures better and faster than traditional methods. Several previous similar studies show that AR and MAR technology in learning can improve student understanding, but there is no learning model for the human visual structure that uses these technologies, so that reason motivates this research.

The purpose of this research is to build an interactive model for learning the structure of the human eye using mobile augmented reality so that students can understand the structure of the 3D human sense of sight in more detail visually. The contribution of this research is to provide a complete and effective eye structure learning tool by utilizing MAR technology.

The paper is organized in the following order, the first part is an introduction, Part two presents the system design and visualization process. Part three shows the experiment and result. Finally, Part four will conclude the study.

2. **System Design.** Model development was carried out by adopting the Multimedia Development Life Cycle (MDLC) from Luther [16]. Figure 1 shows a schematic of the six steps of the MDLC.
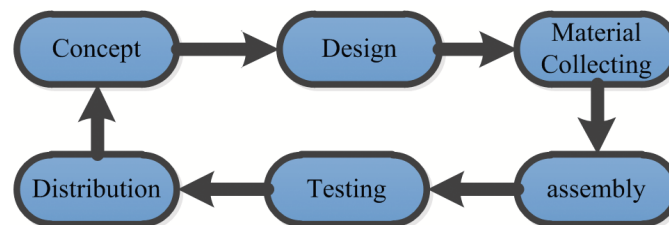

FIGURE 1. Multimedia development life cycle [16]

The following is an explanation of the results of each stage of the model development.

2.1. **Concept.** At this stage, the first is collecting data about the anatomical structure of human vision, to make a visual model. The second is the identification of users who in this case are students. The third is an analysis of device requirements.

2.2. **Design.** At this stage, production design, visualization of human visual structure objects, navigation structures, and interface designs are carried out.

2.3. **Material collecting.** At the data collection stage, it was carried out to obtain valid data through observation, questionnaires, interviews, and literature studies which were used to create augmented reality applications for visualizing human visual structures.

2.4. **Assembly.** This stage is the stage of making all objects based on concepts that have been designed and will be implemented. There are three processes in the assembly stage, UV Sphere Mapping, animation creation, and Making AR Marker.

2.5. **Testing.** At the testing stage, it is carried out to know the extent to which the application is made with existing concepts, as well as identify errors that may occur in the application. Testing of the prototype model was carried out using a questionnaire filled out by 37 prospective users after using the mobile augmented reality model for learning the structure of human vision. The questionnaire contains six questions related to the functionality of the model. Each question has five answer choices on a scale of 5, one is very bad, two is not good, three is enough, four is good, and five is very good. To calculate the total percentage of the questionnaire results (Y), the following equation is used [17].

$$Y = \left(\frac{\sum t}{p \times q}\right) \times 100\%$$ (1)

where t is the total value of the scale of respondents' answers, q is the number of questions, and p is the number of respondents.

2.6. **Distribution.** The distribution stage is carried out to deploy the model that has been tested to users, in this case, students who will study the structure of human vision. This stage is not discussed in this study.

3. **Experiments and Results.** This section describes the results at the material collecting, assembly, and testing stages, respectively in the following subsections.

3.1. **Material collecting.** Figure 2 shows some of the materials that have been collected for the application manufacturing process. The materials were obtained from the page http://www.rockthe3d.com/35-free-high-res-realistic-human-eye-textures/. These materials will then be used at the assembly stage.

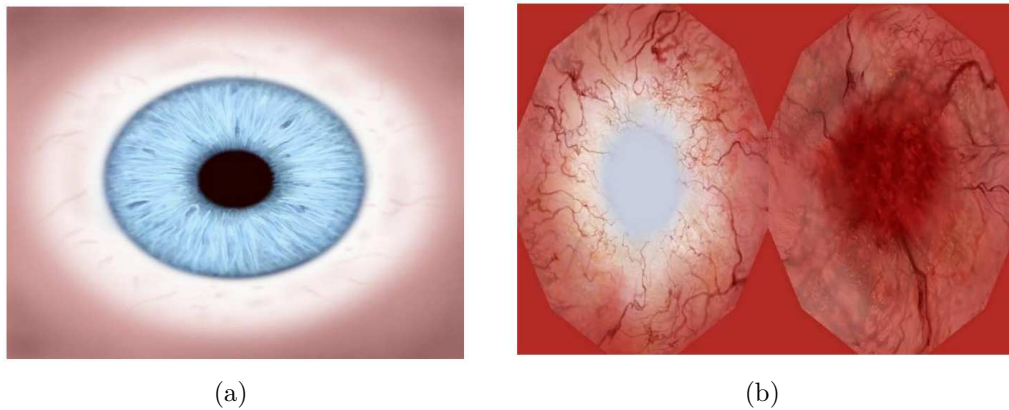(a)   (b)

FIGURE 2. (a) Outer eye texture; (b) inner texture of the eye

3.2. **Assembly.** This stage is the process of making an object model in 3D on the computer. The software used in this modeling stage is Blender 3D. The choice of Blender 3D as software for creating 3D objects is because this software has special features for making 3D models, making the modeling process easier and the interface easy to understand.

Figure 3 shows the use of a UV sphere to create a 3D eye object. The UV sphere in front of the selected eye is partially extruded so that it extends forward. Furthermore, the UV sphere mapping, animation making, Making AR Marker processes, and creating an interface of mobile augmented reality were carried out in succession, which is described in the following subsections.
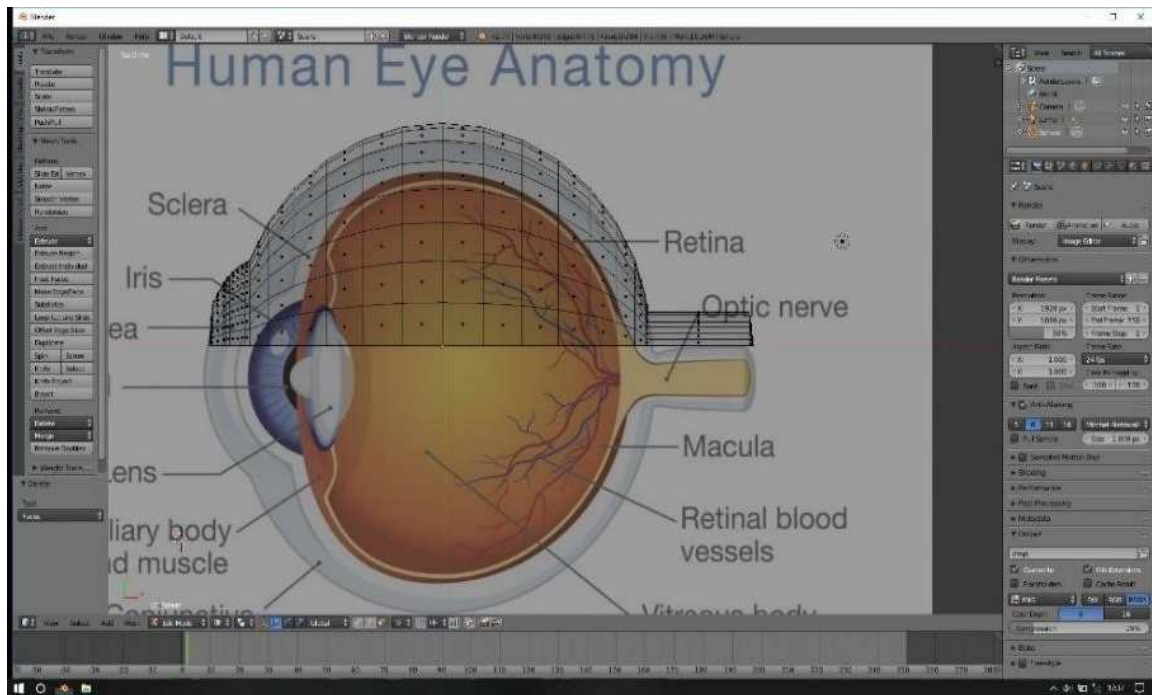
FIGURE 3. The process of creating a 3D retina object

3.2.1. *UV sphere mapping.* UV sphere mapping process is done to make the surface of 3D objects into 2D surfaces, and this process is needed to facilitate texturing on 3D objects. The UV mapping process is still using Blender 3D software. Adding a user perception layer to the blender to make texturing easier, then adds an image texture, and chooses the image texture to use. After that, connect the image texture editor node to the editor node that is already in the Blender 3D software. Figure 4 shows the results of placing the texture on the eye object.
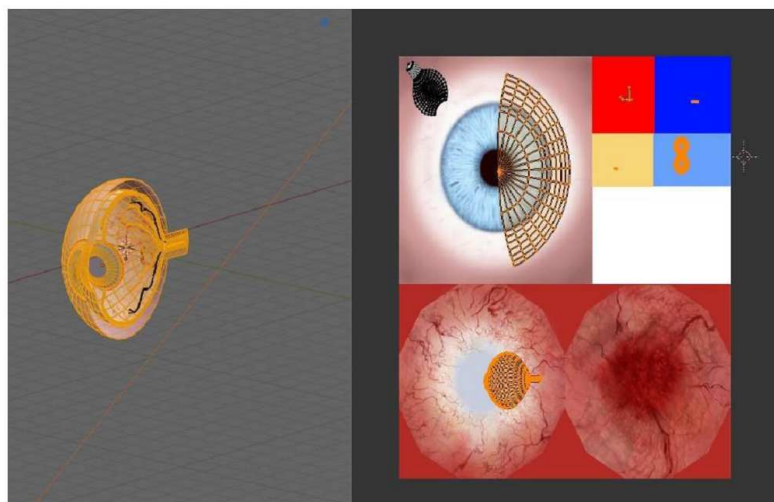

FIGURE 4. Results of unwrap on the object of the eye

3.2.2. *Animation making.* The process of making animation aims to simulate the movement of light towards the eye object. 3D animation of light movement created using Blender. In addition, animation is also made to recognize the parts of the eye using Unity, where first the names of the eye parts are created using Photoshop and saved in PNG format, then importing it into unity. To create an eye light animation using a plane, by

changing the shape of the plane object whose shape is a box into a triangle, then give the armature or bone to the object, and then join it with the armature or bone. After the object and armature have been combined, then enter the animation stage by clicking the automatic keyframe to start recording objects from small to large scales.

The next step is to import the light animation that has been made in the blender into the Unity application with a blender format so that it is easy to adjust the position of the light on the eye object that has been made first. The results can be seen in Figure 5. The process of adjusting the position of the eye light on the eye object that has been created using the Blender application requires an animator to control the animation.
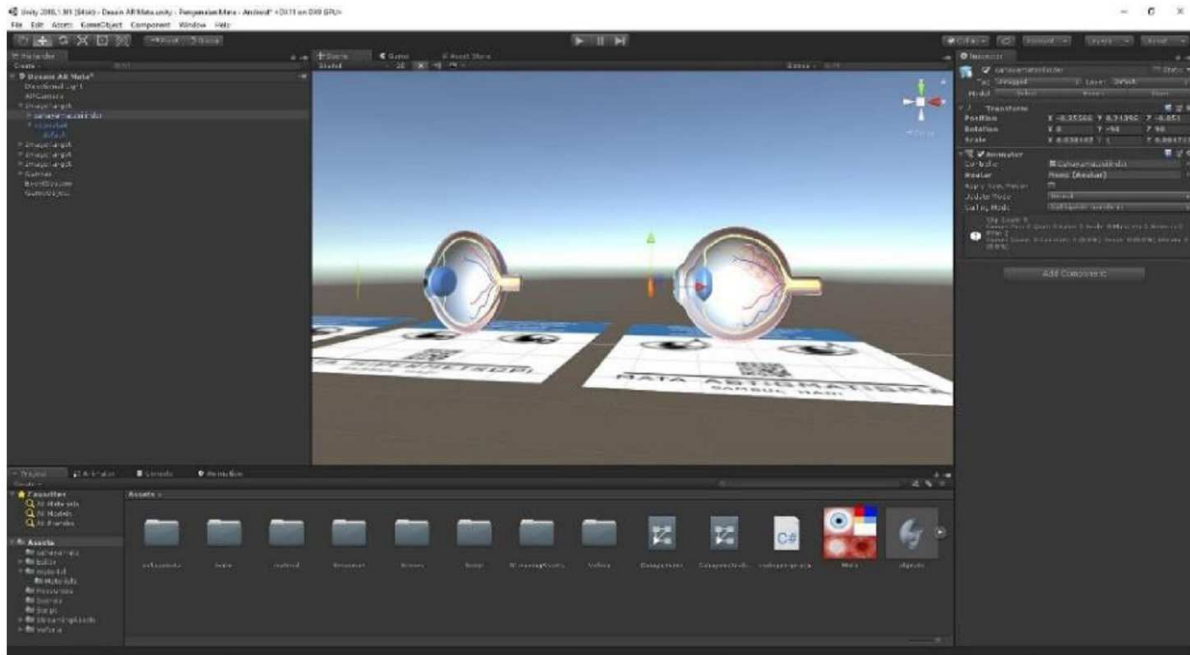

FIGURE 5. Adjustment of eye light position on eye objects

3.2.3. *Making AR Marker.* AR Marker is created using marker generator from the page https://barcode.tec-it.com. Markers will be used as a database or will be scanned by the AR Eye Recognition application. Next is designing stickers with Coreldraw software for a catalog that contains information on human visual objects with several eye diseases. Figure 6 shows some markers for human visual objects.

FIGURE 6. Markers results created from the online barcode generator

3.2.4. *Creating an interface of mobile augmented reality.* At this stage an augmented reality mobile interface is built by adding scripting, using MonoDevelop which is the default application from Unity for editing and adding scripts. In this scripting process, the writer makes use several scripts that already exist in the standard assets of the Internet that can be used in making application interfaces. Finally, it is the process of building

an application to Android using Unity, by changing the required settings, namely the minimum supported Android system, application name, package name, and application icon. The format to be generated is APK for android applications. The build process is carried out by entering all the scenes that have been created, then determining the Android platform as the target destination and selecting a location where the build results are saved. Figure 7 shows some of the results of the mobile augmented reality model for learning the structure of human vision.
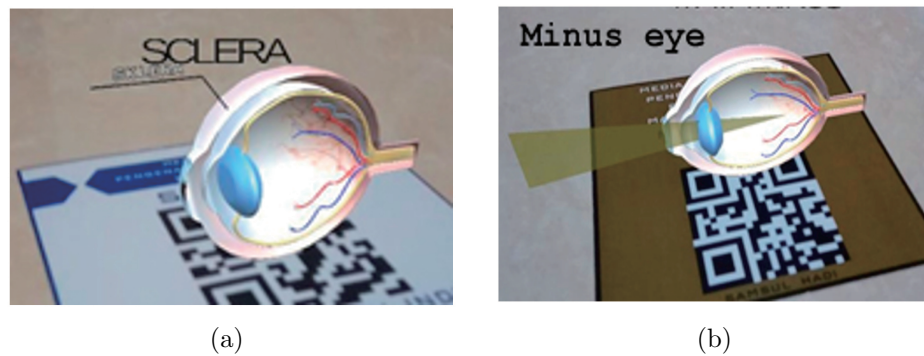

(a)   (b)

FIGURE 7. The scan results of the mobile augmented reality: (a) Sclera Eye; (b) Minus eye

3.3. **Testing.** The results of the mobile augmented reality application model for learning the structure of human vision were then tested on 37 students and 2 teachers as respondents. After the respondent has finished trying the model, then they fill out a questionnaire consisting of six questions. The questionnaire that has been filled in is then calculated of the percentage of user acceptance using Equation (1). Table 1 shows a list of questions on the results of the user acceptance questionnaire. The answer is on a scale of 5, where 1 = very bad, 2 = not good, 3 = good enough, 4 = good, and 5 = very good.

Based on the results of the questionnaire in Table 1, the percentage of user acceptance using Equation (1) is as follows: the percentage of very good answers is 47.86%, the percentage of good answers is 37.18%, the percentage of fairly good answers is 14.53%,

TABLE 1. The results of the user acceptance questionnaire

No	Question	Number of answers				
		1	2	3	4	5
1	Is the interface design of this application interesting to use?	0	0	5	17	17
2	Is the content design of this application interesting?	0	0	2	21	16
3	Can this application provide understanding and insight into the structure of human vision?	0	0	4	11	24
4	Do the models and animations in the application support understand the structure of human vision?	0	1	9	14	15
5	Is the application user friendly?	0	0	7	20	12
6	Can this application be used as an alternative for the media to help the learning process of the structure of human vision?	0	0	7	4	28
	Total	**0**	**1**	**34**	**87**	**112**

the percentage of unfavorable answers is 0.43%, and the very bad answer is 0%. From these data, it can be seen that the results of user acceptance who answered very well and well were 85.04%; in general, it can be concluded that the model is acceptable.

4. **Conclusion.** This study aims to build a 3D interactive multimedia model using cellular-based augmented reality for learning the structure of human vision. The model was built using the MDLC methodology and tested on 39 respondents, where the test results showed most respondents or 85.04%, so it can be concluded that the model can support and be useful for users to provide an overview of the structure of the human eye. Our future work is to apply MAR and 3D technology to visualizing the anatomy of human internal organs, such as the lungs, liver, and kidneys, both normal and abnormal caused by disease for learning purposes.

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