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Design and Development of Augmented Reality Applications for Human Anatomy Learning Mobile-Based

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ABSTRACT

Human body anatomy is a science that studies the structure of the human body. The anatomy of the human body is composed of cells, tissues, organs and organ systems. Organ systems are the parts that make up the human body. This system consists of various types of organs, which have special structures and functions. Each organ system depends on each other, both directly and indirectly. So far, students have studied body anatomy using books as reference material, making it difficult to explore real objects. Therefore, to make it easier for students to understand the complex anatomy of the body, especially the internal organs of the human body, an Android-based Augmented Reality Book application was developed as a learning media tool. This application makes it easier for students to understand the shape and space of human anatomy using a smartphone. Making this application uses Unity as an application editor, Blender is used to create three-dimensional models and Vuforia as image tracker software

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I. Introduction

The human body is composed of various parts, starting from the bones, which number up to 206 bones, as well as internal human organs such as the heart, lungs, brain and so on [1]. Human organs are parts of the body that are difficult to study because they have detailed structures. Currently, the media for studying human anatomy uses 2D (two-dimensional) images and also through other multimedia sources such as books, videos and teaching aids. Students have difficulty visualizing two-dimensional images into three dimensions to understand certain aspects of anatomy [2].

According to researchers, in studying human anatomy, students must rotate and move objects from various points of view in order to clearly understand the structure of human anatomy. Due to these limitations, Augmented Reality technology can provide three-dimensional visualization as well as animation in 360 degrees. According to the results of research reports on Augmented Reality in the field of education, it turns out that Augmented Reality can influence performance and encourage a person's motivation to learn because Augmented Reality presents graphic content that can be interacted with and looks more real [3].

Augmented Reality technology is suitable for implementation into learning tools because it has great potential to attract, inspire and motivate students. It is hoped that the use of this developed technology can create an attractive and interactive introduction media [4]. Augmented Reality is part of the Virtual Environment which has the advantage of combining two-dimensional or three-dimensional virtual objects by projecting these virtual objects into the real environment, thus allowing users to see images of virtual objects in three-dimensional form in the real world. Augmented Reality has become a pioneer in how to convey information because it combines text, images, videos, 3-dimensional models, which cannot be conveyed through books, or other 2-dimensional multimedia images such as videos and teaching aids. Augmented Reality is widely used in the fields of games, multimedia and image processing, as well as in the field of education [5]. The following are several examples of previous Augmented Reality research in the field of education ranging from early

childhood education to higher education, namely in the fields of health education [6], mathematics [7], biology [8], physics [9] and manufacturing [10].

The Augmented Reality Application Regarding Human Anatomy was developed based on Android using markers that have identified 3-dimensional human anatomical objects as well as information and other media from the human organs. The aim of this research is to design and develop a human anatomy learning application based on Augmented Reality (AR) technology that can be accessed via mobile devices. This application provides interactive learning media by utilizing 3D models of human body organs, making it easier to understand anatomical concepts visually. This research also aims to optimize the use of AR technology in the world of education as an innovative approach that is more attractive than traditional methods. By providing learning solutions that can be accessed anytime and anywhere, this research seeks to increase learning flexibility while offering a more efficient alternative to using Physical models of anatomy are expensive and difficult to reach. Overall, it is hoped that this research can encourage the adoption of modern technology in education, especially in the field of human anatomy, in order to enrich teaching and learning methods.

II. Method

A. Working Principles of Augmented Reality (AR)

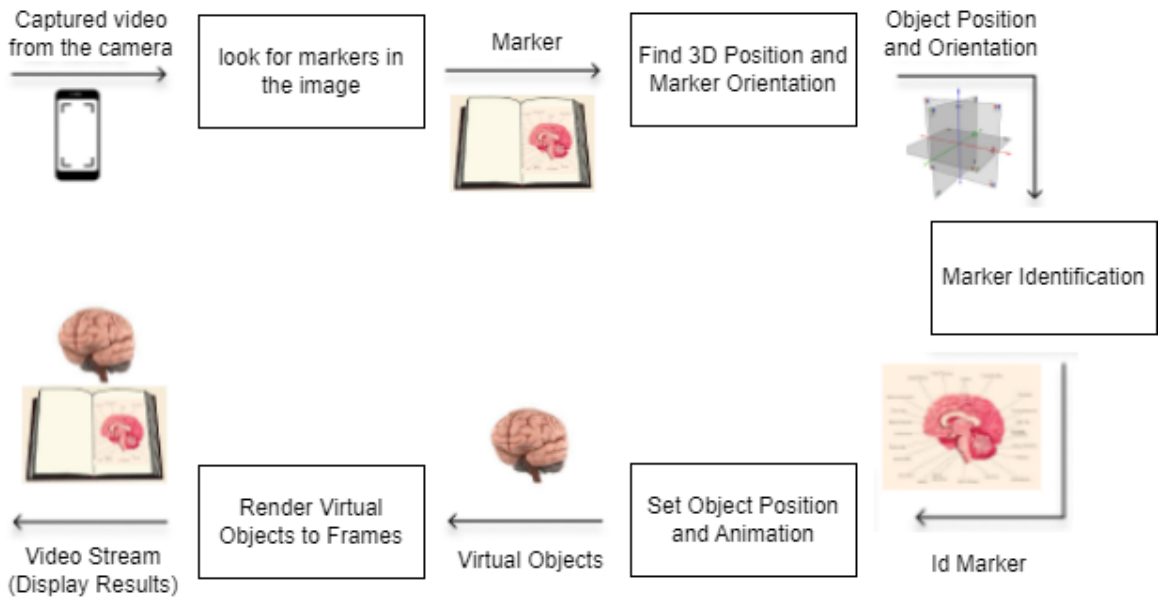


Fig 1. Working principle of Augmented Reality human anatomy.

The working principle of Augmented Reality is as follows:

1) The system starts by capturing real-time video from the user's mobile device camera. The camera functions as a tool to detect the environment and markers.
2) After the video is captured, the system will scan the image (frame) to look for markers. Markers are visual patterns (for example, images or QR codes) that serve as references for the system to display virtual objects.
3) If a marker is found, the system will process the marker for use in the next step.
4) The system identifies the position and orientation of the marker in 3D space. This step is important for determining the viewing angle and layout of the virtual objects to be displayed to match the camera perspective.
5) Markers that have been detected are further processed to identify their special IDs or attributes. This identification is used to determine which virtual objects to render.

6) After the marker is recognized, the system determines the position of the virtual object according to the marker. Additionally, object animations (if any) are also set to provide an interactive experience.
7) Virtual objects, such as 3D models of human anatomical organs, are created based on identified marker data. This object represents the learning material that you want to convey to the user.
8) The system renders (combines) virtual objects into video frames so that the objects look as if they are in the real world, following the scanned markers.
9) The final result is displayed on the user's mobile device screen in the form of streaming video. Users can view virtual objects, such as 3D models of anatomical organs, that appear and follow markers in real-time.

B. Main Menu Flowchart

In the main menu there are 4 buttons, namely the start button to carry out AR functions, the help button to display information on how to use AR, the about button to display developer information and the application exit button. The AR camera will search for markers then identify the markers that are read and those that have been stored in the database, the system identifies the markers. If the marker is valid, the application displays a 3D Object View, namely a 3D model that corresponds to the marker (for example human body organs). If the marker is invalid, the user is asked to try again, where the marker search process is repeated.

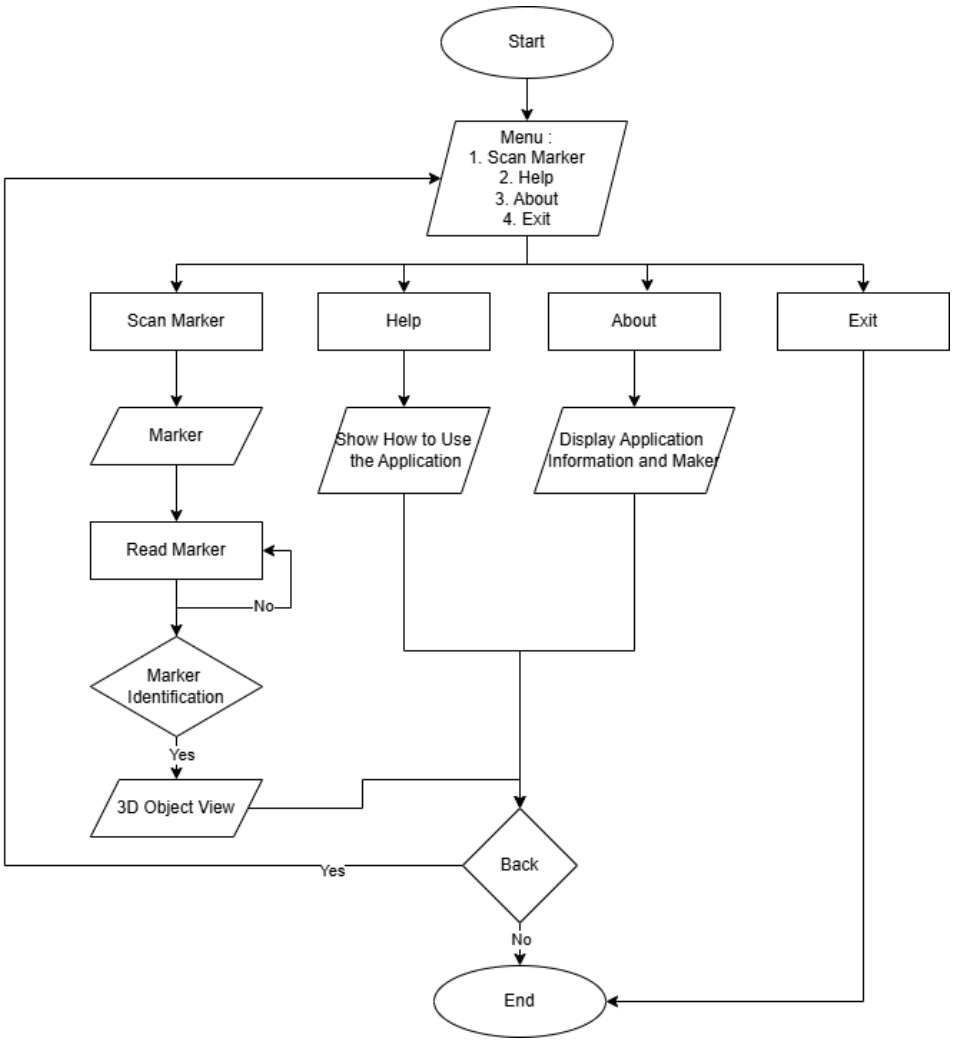
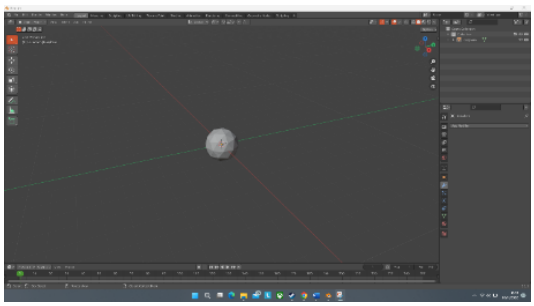


Fig 2. Main Menu Flowchart

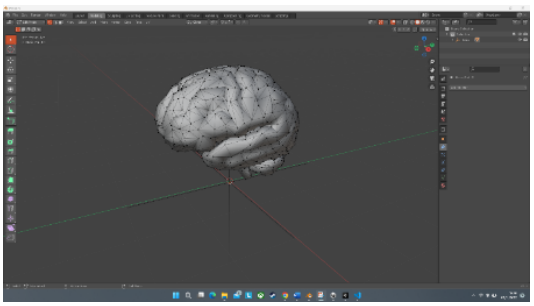
C. Creation of 3D Human Organ Objects

Making human organ objects using Blender software. In the blender application there are various features used, including:

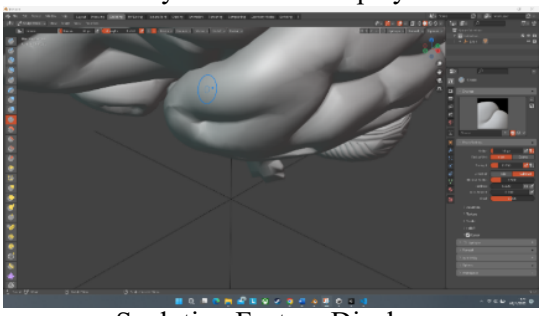
1. Layout is the main feature in Blender which functions to enter default objects which can then be manipulated using the Modifier menu.
2. Modeling functions to change the vertex (corner), edge (edge) and face (side) of the object.
3. Sculpting functions to manipulate objects by sculpting objects with the tools provided such as Draw to create objects, Clay to add object structures, Smooth to smooth object structures and other features.
4. Texture Paint functions to color and create texture on objects to make them look more real.



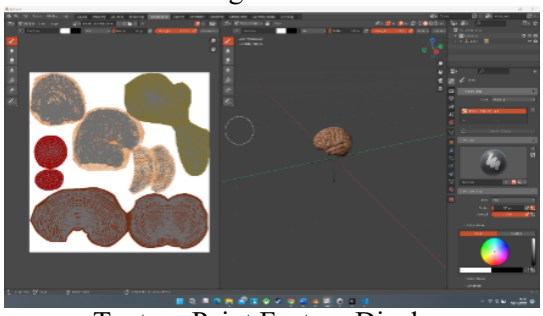
Layout Feature Display



Modeling Feature View



Sculpting Feature Display



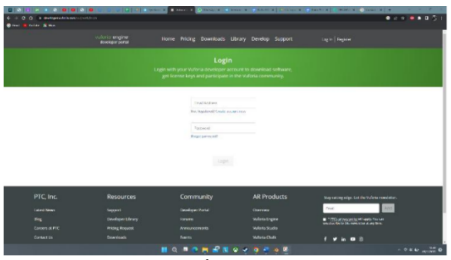
Texture Paint Feature Display

Fig 3. Creation of 3D Human Organ Objects

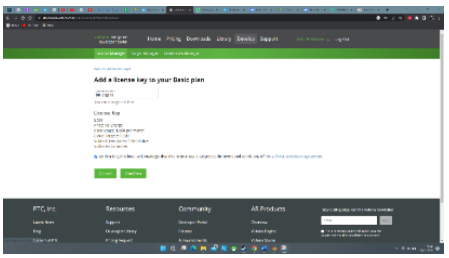
D. Making Markers

A marker is an image that has a certain pattern as a marker that makes a 3D object appear on the cellphone screen. Making markers using the Vuforia Engine which is integrated with the Unity application. The ways to make markers include:

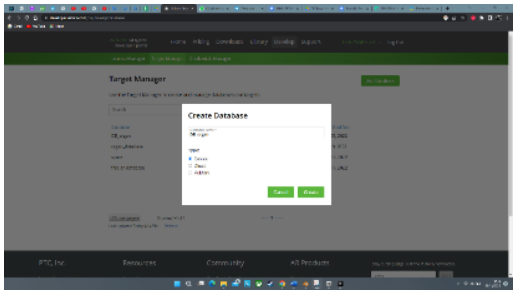
1. Log in to the Vuforia website page.
2. Create a License Key which functions to activate the license from Vuforia so that it can be used.
3. Create a marker database.
4. Upload an image as a marker. The image has been scanned from the book.
5. Download the marker database and then import it into Unity.



Login Page



Display the License Key page.



Database Creation View

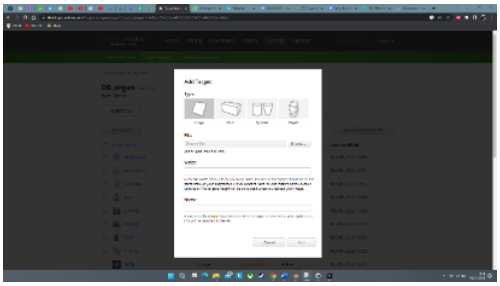
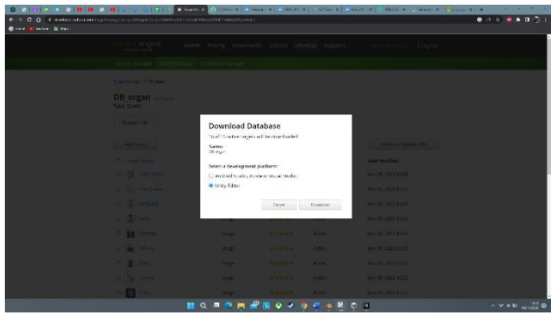


Image Upload View



Download Database.

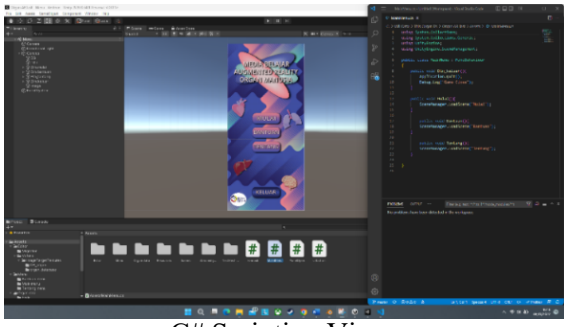
Fig 4. Making Markers

E. UI and application creation

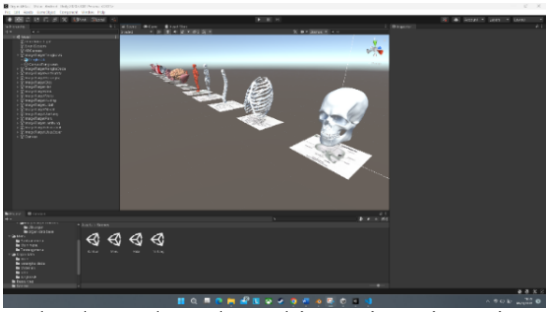
Application creation using Unity Engine. The steps are as follows:

1. Application UI settings that can be adjusted in both position and size.
2. Creating scripts for buttons and others using the C# programming language.
3. Insert the object that was created in Blender into Unity and adjust it to the marker that was imported from Vuforia.
4. Build the application

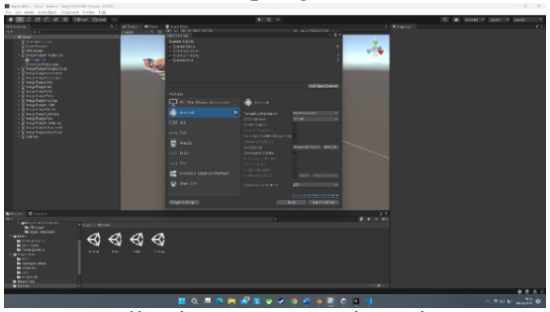
UI Creation View



C# Scripting View



Blender and Marker Object Views in Unity



Application APK Creation View.

Fig 5. UI and Application Creation

F. Marker

The markers used in this research refer to the book Introduction to Human Anatomy and Physiology, authored by Ardhina Nugrahaeni, S.Tr.Keb, 2020 [1] . There are sixteen (16) objects made in the markers, namely:

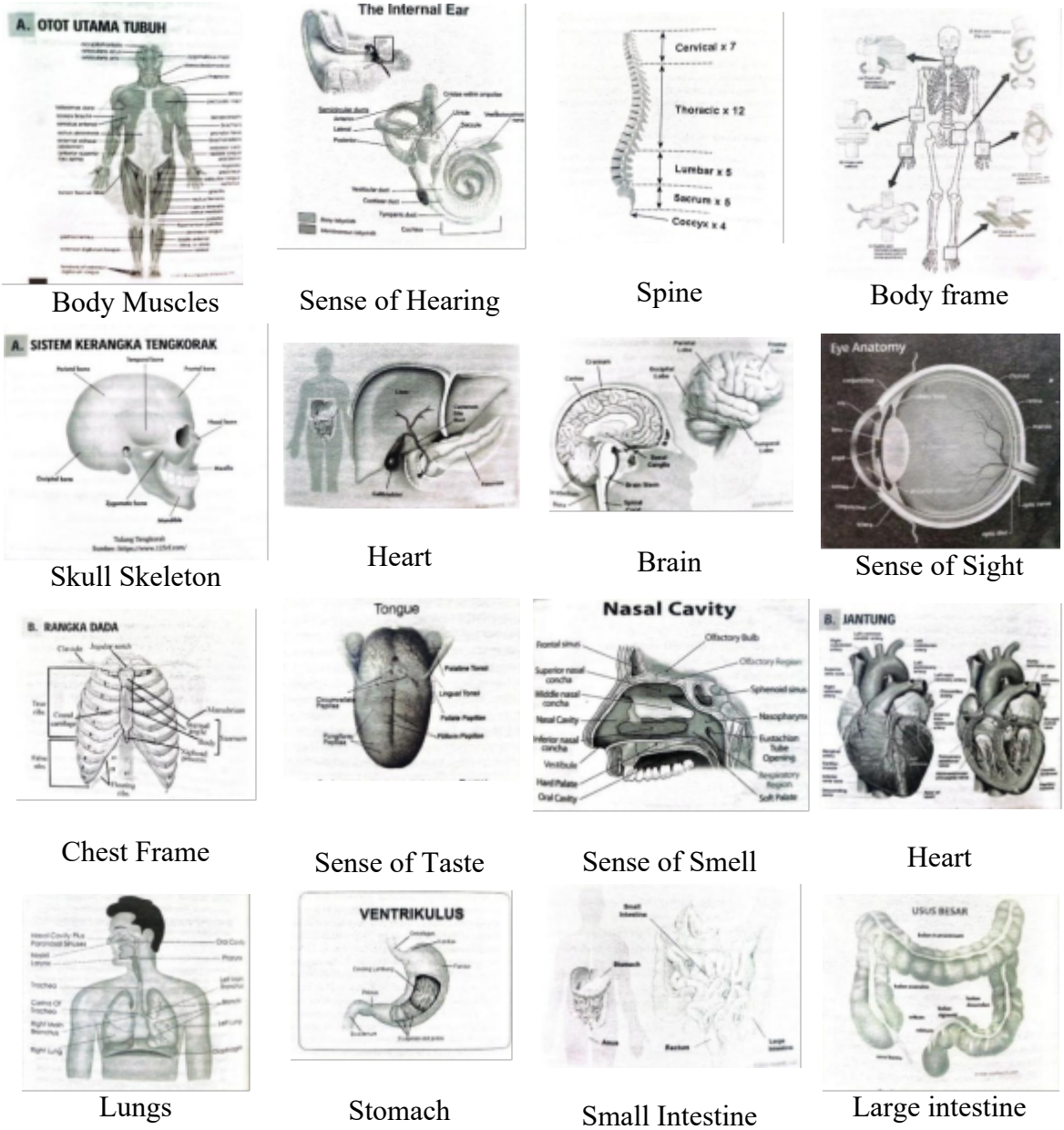


Fig 6. Marker

III. Results and Discussion

A. Main Menu Display

Figure 7 shows the interface of the Human Organs Augmented Reality Learning Media application which consists of several main menus and supporting features. In the Main Menu display, there are four main navigation buttons, namely Start, Help, About, Exit. The Help page contains a guide to using the app, including steps such as pressing the "Start" button to activate AR, pointing the camera at a marker to reveal a 3D object, and using the explain button to get more information about an object. The main feature of the application is seen in the Augmented Reality (AR) display, where a 3D model of human anatomy is displayed visually over the detected markers. The display also

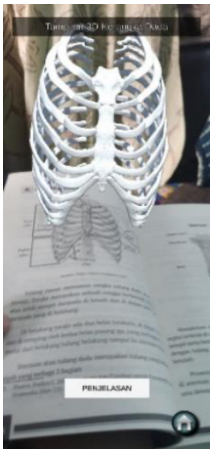
includes detailed explanatory text about the organs displayed, and an "Explanation" button provides access to more specific information.

Fig 6. Main Menu Display

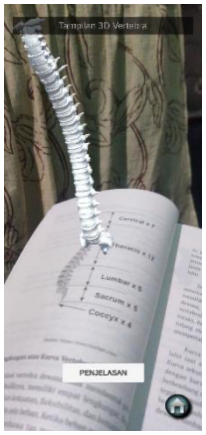
B. Display of 3D Objects

The following is an AR view of the camera with objects. Along with a brief explanation of the organ being viewed.

Skull Skeleton
Page. 1

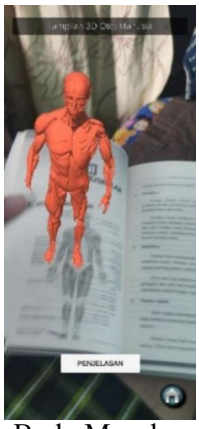


Chest Frame
Page. 6

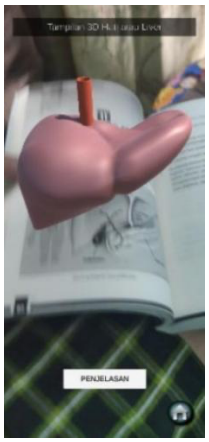


Spine
Page. 10

Body frame
Page. 62

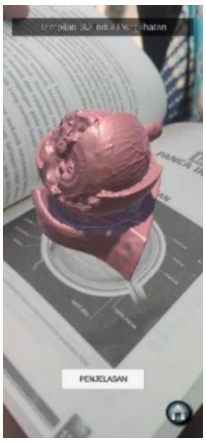


Body Muscles
Page. 66



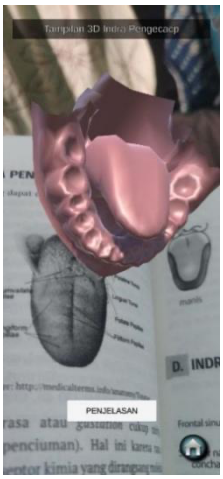
Heart
Page. 80

Brain
Page. 115



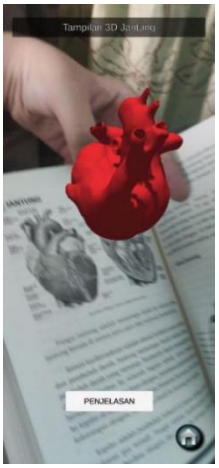
Sense of Sight
Page. 135

Sense of Hearing
Page. 136

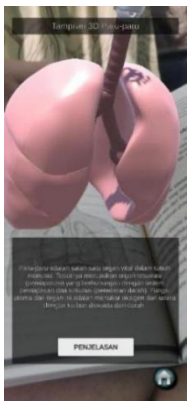


Sense of Taste
Page. 140

The sense of smell
Page. 141

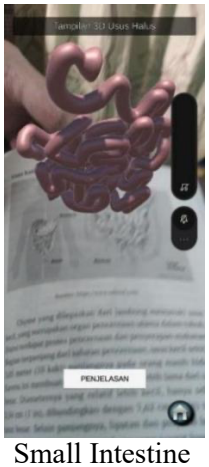


Heart
Page 184

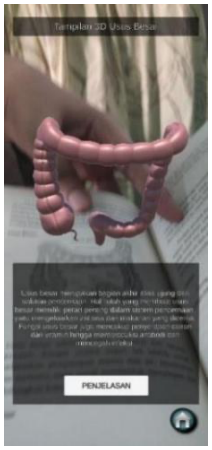


Lungs
Page. 198

Stomach
Page. 214



Small Intestine
Page. 215



Colon
Page. 216

IV. Conclusion

After carrying out the planning and testing stages, it can be concluded:

a) By utilizing Augmented Reality techniques, it makes it easier for students to obtain clear information about human anatomy
b) The use of Augmented Reality technology in this application goes according to design, namely it can display 3D human anatomical objects. And can display information in text form.
c) It is suggested that for further research, Gamification features can be added, namely Integrating game elements such as interactive quizzes, learning challenges, or achievements to increase user engagement and Multi-User features, namely Developing AR-based collaboration features, where several users can interact with the same model simultaneously to group learning.

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