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Application of Marker-Based Tracking Augmented Reality of Human Digestive System for Elementary School

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Abstract— The digestive system in humans is one of the materials taught in biology subjects. Submission of material about the digestive system in humans is still through conventional media such as blackboards and pictures contained in biology books. While this material about the digestive system is difficult to see directly because most of it occurs in the body. Augmented Reality is a technique that combines two-dimensional and three-dimensional virtual differences into a real sphere. Augmented Reality can be one of the effective teaching materials in elementary schools because of the rapidly advancing technology.

Keywords— Augmented Reality, Book Media, Image-Based Tracking, Human Digestive System

I. INTRODUCTION

The food that humans eat cannot be directly absorbed and used by the human body but must be digested first by the digestive organs. There are two types of food digestion, namely mechanical digestion and chemical digestion. Mechanical digestion is a process that involves the digestive organs while chemical digestion is a process that involves the digestive glands. The process of digesting food occurs through the digestive tract which starts from the mouth, then goes to the esophagus, stomach, small intestine, and ends in the large intestine (Mauludin, Sukamto, & Muhardi, 2017).

The digestive system in humans is one of the materials taught in biology subjects. Submission of material about the digestive system in humans itself is still through conventional media such as blackboards and pictures contained in biology books. While this material about the digestive system is difficult to see directly because most of it occurs in the body. Even so, various technologies can be used as learning media that can display 3D objects, one of which is Augmented Reality technology. Augmented Reality is a technique that combines two-dimensional and three-dimensional virtual differences into a real sphere. Then, these virtual objects are projected in real-time directly through media in the form of markers or markers directed at the camera. By using this technology, students can see a real visualization of the human digestive system that is applied to an Android mobile device. Each object has a marker or image tracking book which is a great way to attach responsive content to physical objects or anchor your scene to a known location in a real-world environment. (Juannita & Adhi, 2017).

Augmented Reality is very suitable for use in education to improve curriculum standards. Because text, audio, video, and graphics can be overlayed to students in real-time so they can learn faster and better. With Augmented Reality, students can see simulations that exist on devices such as important history, parts and shapes of organs in the human body, geometric shapes and three-dimensional shapes, and many other examples. At a higher level of education, students can even learn about concepts from mathematics, geometry, and mechanical engineering. (Saputra, 2020).

Based on this background, the research entitled "Application of Marker Based Tracking Human Digestive System Augmented Reality in Elementary School Students". This research is expected to be an alternative learning medium to study the human digestive system so that it can increase students' interest and understanding of the material in the biology lesson. In this application, having a camera feature on our smartphone requires the euphoria SDK which is included in the framework for making AR where the data from our marker will be stored in the vuforia SDK database so that it can be integrated with unity.

Based on the description of the background of the problem above, the formulation of the problem proposed for this proposal is. How to create an interactive learning application about the human digestive system that attracts student learning using augmented reality. How to implement Image Marker Based Tracking. How are the respondents' test results on the application.

For this research to be directed and easy to discuss so that the research objectives will be achieved, the problem limits are as follows. The object used is an image. Applications use books as markers. This application displays objects in the form of 3D and descriptions. The development method used is a multimedia development method consisting of the concept, design, and distribution. The augmented reality method used is marker-based tracking or image-based tracking. The test method used is user acceptance testing.

The objectives of this research are as follows. Creating augmented reality-based learning aids with

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visualizations that match the learning material using a smartphone as a learning medium. Provide learning media facilities that display a description of human digestion with 3D animated image display. Creating learning media that can display the human digestive system so that students can easily learn the digestive organs and their explanations.

The expected results from the above objectives are. Students are increasingly interested in alternative teaching media. Students can find out what augmented reality is and how it works. Smartphones can be used as learning media regarding human digestive materials. Students can better understand the material provided.

II. LITERATURE REVIEW

A. Literature Study

Some of the literature used as a guide and reference in this Final Project, among others :

This research was conducted by Juannita and Bambang Prasetya Adhi from UNJ in 2017 entitled "Development of Human Digestive System Learning Media for Class 8 Junior High School with Android-Based Augmented Reality Features" this application has several advantages, not only displaying 3D objects of digestive system organs humans and videos on how the digestive system works with the Augmented Reality feature but also displays information on each digestive organ, an explanation of digestive enzymes, and an explanation of various digestive disorders, as well as markers for displaying 3D objects printed on clothing media so that students can immediately know the shape and location of each organ in the human body. This application is expected to make the human digestive system material easier to understand and more fun to learn and make it easier for teachers to teach the human digestive system material.

This research was conducted by Ani Siti Ranifa and Dadan Zaliludin from Majalengka University in 2020 entitled "Applications for Recognizing the Human Digestive Tract Using Android-Based Augmented Reality Technology" which will be designed to be adapted to support the health sector as information on the introduction of the digestive tract. Augmented Reality applications are made using the Unity software. With this application, it is hoped that it will be able to provide benefits in supporting health information regarding the human digestive tract in the Majalengka community.

This research was conducted by Tri Yuliono, Sarwanto and Peduk Rintayati from Sebelas Maret University Surakarta in 2018 entitled "The Effectiveness of Augmented Reality Learning Media on Mastery of the Human Digestive System Concept". The purpose of this research is to determine the effectiveness of learning using conventional learning media and learning media. Augmented Reality in Malaysia. The first result is that Augmented Reality learning media is more attractive to students than conventional learning media. Second, Augmented Reality learning media provides more understanding of the material to students than conventional learning media. The similarity with this research lies in the use of Augmented Reality media.

This research was conducted by Yuda Prasetyia Darma and Evri Ekadiansyah from the Potential Utama University in 2020 entitled "Android-Based Learning Media Applications for Recognizing Human Digestive Organs". and use teaching aids as learning aids. The learning process is directed to be carried out only during class hours and with current technological developments, learning media such as printed books are very inefficient. The problem found with the learning system using printed books is that sometimes students bring too many different books just to learn about one piece of information.

This research was conducted by Feby Zulham Adami and Cahyani Budihartanti from STIMIK Nusa Mandiri in 2016 entitled "Application of Augmented Reality Technology in Android-Based Digestive System Learning Media" in studying human organs are usually limited to print media such as books, at this time device users Smartphones have been widely used by various circles, where the use of smartphones can be widely used for various kinds such as calling, sending messages, browsing the internet, and others. With the existing technology in smartphones, it can also be used as a learning medium, so that it can be used anywhere and anytime, the development of smartphone hardware specifications at this time has been sufficient in the development of software that previously could be run on PC devices can be run on smartphone devices.

B. Theoretical Foundations

1. Human Digestive System

The human digestive system is a system that helps humans digest the food and drinks they consume into substances that are more easily digested by the body and various contents are taken in which are useful for internal organs and body parts as a whole. In another sense. The digestive system is the process of changing food and the absorption of food essence in the form of nutrients that the body needs with the help of enzymes that break down complex food molecules into simple ones so that they are easily digested by the body. (Nugroho, 2019). In Picture 1, food that enters the human body must undergo a long process before the food can become a source of energy for the body. The digestive process certainly cannot take place without the digestive organs commonly known as human digestive organs. These organs digest food through mechanical and chemical processes.

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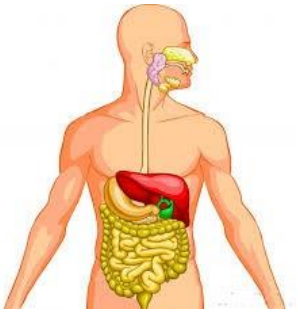
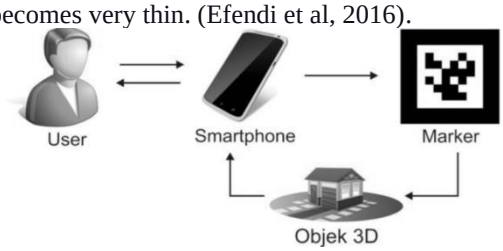


Picture 1. Human Digestive System

2. Augmented Reality

Augmented Reality (AR) is a term for an environment that combines the real world and the virtual world and is created by a computer so that the boundary between the two becomes very thin. (Efendi et al, 2016).



Picture 2. How Augmented Reality Works

In picture 2 mobile Augmented Reality is one of the emerging technologies that have great pedagogical potential. The ability to combine the virtual and real worlds has given birth to new possibilities in improving the quality of teaching and learning activities. The effectiveness of AR can be further extended when combined with other types of technology such as mobile devices. (Nincarean, 2013).

Augmented Reality can even be used by kindergartens. Usually, children will be bored if they only see animals that are depicted in two dimensions. But with Augmented Reality, children can see simulations of shapes, sounds, habitats, movements, and even interactions between animals. For example, they can see the three-dimensional shape of 3 frogs. When we enter the mosquito marker, a three-dimensional shape of the mosquito will appear. Then there will be an interaction between the frog and the mosquito, the frog will move closer to the mosquito, then the frog will eat the mosquito. (Saputra, 2020).

3. Markers (Image-Based Tracking)

Marker-based tracking is one of the methods of augmented reality. Marker-based tracking is a black and white square illustration with a thick black border and a white background. The computer will recognize the position and orientation of the marker and create a 3D virtual world, namely, points (0,0,0) and three axes, namely X, Y, Z. By using marker based tracking, identification of patterns to identify the target image is easier and the process is faster. In one condition, the problem that often arises is that the marker cannot be detected due to several things such as distance and angle of inclination. The distance and angle of inclination of the marker with the camera is very influential in identifying markers.

Picture 3. Marker Example

In picture 3 this marker is usually a black and white square illustration with a bold black border and a white background. Through a position that is faced with a computer or smartphone camera, the computer or smartphone will carry out the process of creating a two-dimensional or three-dimensional virtual world. (Mufida & Harun, 2018).

The parts of the digestive tract in humans and their functions and what is in them. Human digestion goes through 2 processes, namely.

Mechanically the process of digesting food by chewing and pressing until it becomes like porridge.

Chemically the process of digesting food using enzymes that will break the bonds of complex compounds in the food. These enzymes are needed because when they are still in the form of whole foods, the compounds in them are still in the form of complex molecules, or macromolecules consisting of fats, carbohydrates, proteins, and nucleic acids. To be able to process various kinds of these compounds, our digestive system consists of various organs whose function is to carry out mechanical and chemical decomposition. Among them are the Mouth, Esophagus, Stomach, Small Intestine, Large Intestine to Anus. Here's an explanation of the human digestive organs.

Mouth in figure 4 the mouth is the digestive system that will carry out the earliest digestion process. Inside the mouth, there are teeth and tongue that will crush food mechanically. At the same time, the enzymes in our saliva produced by the salivary glands begin to break down.

Picture 4. Mouth

polymer chains in food. After the chewed food is fine enough, there is an urge to swallow the food. This

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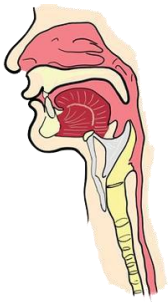
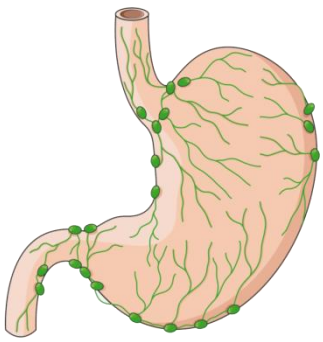
swallowing process is the second stage of the digestive process, namely propulsion. In the propulsion process, food that has been mechanically disintegrated in the mouth is pushed deeper into the digestive tract.

Esophagus When swallowing food, peristaltic movements are carried out unconsciously by the muscles of the digestive tract. In peristalsis, the muscles of the digestive tract move alternately to push food to its next destination in the digestive tract.



Picture 5. Esophagus

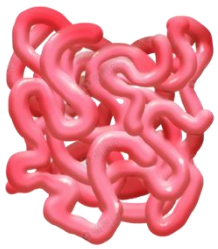
In Picture 5 on peristalsis, the muscles of the digestive tract move alternately to push food to its next destination in the digestive tract. Stomach Food that has been sufficiently destroyed by the digestive process will turn into a kind of porridge called Kim / chyme and go to the stomach. Talking about the stomach, you must have often heard of stomach acid. Food will be chemically digested into a simpler form. The stomach is the most elastic part of the entire digestive tract and can hold 2-4 liters of food. The process of digestion of food is not only accommodated and waiting for gastric acid to work but is also ground and destroyed by the actively moving stomach wall. The stomach wall is made of a structure similar to the rest of the digestive tract plus some modifications found only in the stomach. Similar to other digestive tracts, the stomach wall consists of four main layers, namely the mucosal, submucosal, muscularis externa, and serosa layers.



Picture 6. Stomach

In Picture 6 the stomach the muscular layer is thicker. There is an additional layer of smooth muscle that helps the stomach wall to actively grind and crush food that enters the stomach.

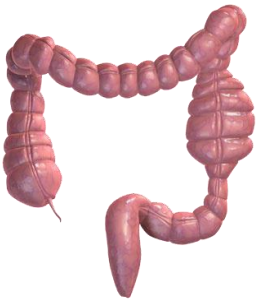
Small intestine Although very good at breaking down food substances, the stomach cannot absorb these substances.



Picture 7. Small intestine

In Figure 7, this is where the role of the small intestine is ready to absorb these foods so that they are ready to be used in the body's cells.

Large intestine In the large intestine, there is the absorption of water and the decomposition of food waste. The large intestine itself consists of three main parts, namely the colon, rectum, and anus. Its size is much shorter than the small intestine, which is about 1.5 meters, but the diameter is twice as large. When it enters the large intestine, most of the nutrients that can be absorbed by the body are absorbed by the small intestine. The main function of the large intestine is to absorb the remaining water in the feces and store the feces until it is ready to leave our bodies. Actually in the large intestine also still occurs the digestive process.



Picture 8. Large intestine

In picture 8 in the large intestine, digestion is not carried out by enzymes but is carried out by bacteria that live in the large intestine. These bacteria will digest the chyme parts that the body cannot digest using thousands of enzymes that they can make themselves. . This process will produce important vitamins and fatty acids that can still be absorbed by your colon. In addition, these bacteria also produce gases such as carbon dioxide, methane, hydrogen sulfide, and mercaptans.

Anus food that has been processed must be discarded so that it does not accumulate in the body. Therefore, the anus becomes the last organ to help dispose of food waste or defecation. That is the process of digestion in our body. the small intestine, large intestine, and anus.

III. Research Methods

A. Research Procedure

The multimedia development methodology consists of six stages, namely concept (conception), design (design), material collection (material collection), assembly

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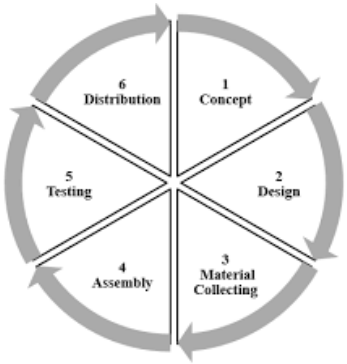
(manufacture), testing (testing), and distribution (distribution). These six stages do not have to be sequential in practice, the stages can swap positions. Even so, the concept stage should be the first thing to do.

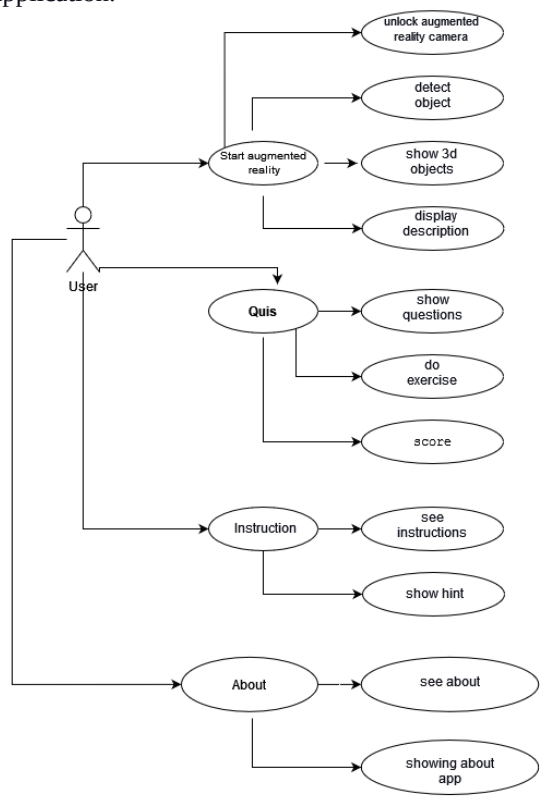


Picture 9. Multimedia Development Stage

1. Concept
   The concept stage is the stage to determine the goals and who the program users are (audience identification). The purpose and end-users of the program affect the nuances of multimedia as a reflection of the identity of the organization that wants information to reach the end-user. User characteristics including user abilities also need to be considered because they can affect the design.
2. Design
   Design is the stage of making specifications regarding the program architecture, style, appearance, and material requirements or materials for the program. The specifications are made as detailed as possible so that at the next stage, namely collecting and assembly materials, new decision-makers are no longer needed, just use the decisions that have been determined at this stage. However, in practice, project work in the early stages will often experience the addition of materials or reduction of application parts, or other changes
3. Collecting Materials
   Material Collecting is the stage of collecting materials according to the needs being worked on. These materials include clip art images, photos, animations, videos, audio, and others that can be obtained free of charge or by ordering to other parties according to the design. This stage can be done in parallel with the assembly stage. However, in some cases, the collecting material stage and the assembly stage will be carried out linearly and not in parallel.
4. Assembly
   The Assembly stage is the stage of making all multimedia objects or materials. Application development is based on the design stage, such as storyboards, flowcharts, and navigation structures.
5. Testing
   The Testing stage is carried out after completing the assembly stage by running the application or program and seeing whether there are errors or not. The first stage at this stage is called the alpha testing stage (alpha test) whose testing is carried out by the maker or the maker's environment. After passing alpha testing, beta testing involving end use will be carried out. When beta testing the method used is the User Acceptance Testing (UAT) method. UAT is a testing process carried out by the user with the output of a test result document that can be used as evidence that the software has been received and has met the requested requirements.
6. Distribution
   At this stage, the application will be stored in storage media. If the storage media is not sufficient to accommodate the application, compression of the application will be made. This stage can also be called the evaluation stage for the development of finished products so that they become better. The results of this evaluation can be used as input for the concept stage of the next product.

B. Concept

1. Use case
   In Picture 10 about use cases. Use Case is a model for the behavior (behavior) of the information system to be made. Use case describes an interaction between one or more actors and the information system that will be created. Roughly speaking, use cases are used to find out what functions are in an information system and who has the right to use those functions (S. & Salahuddin, 2013). In the application system, there are several main menus including the AR start menu, quiz menu, instructions menu, and menu about the human digestive system augmented reality application.



Picture 10. Use Case

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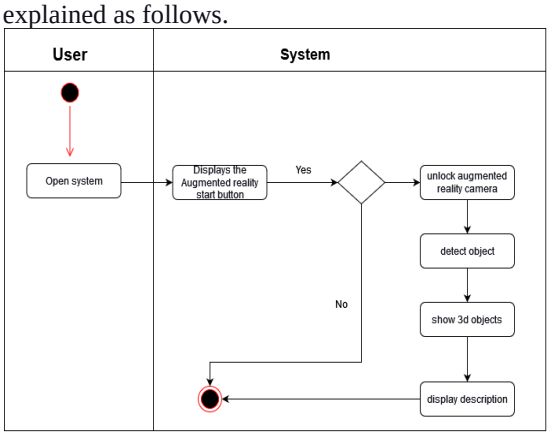
Knowing that the user starts using the application with the initial menu display, namely the AR start menu, quiz menu, instructions menu, and about the menu. AR start menu when the user scans the marker it will display a 3d human digestive system object in the application there will be a button displaying a description. The quiz menu contains displaying questions and answers as well as scores. The instructions menu contains a guide to using the application. The about menu contains the application or application maker profile.

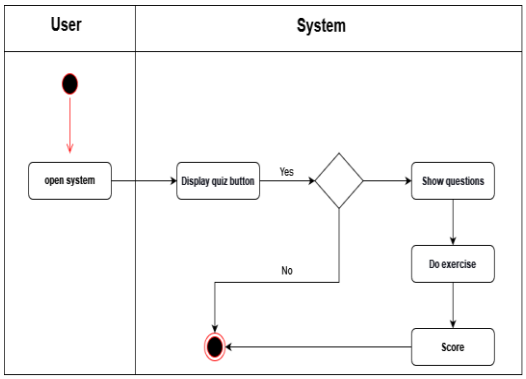
2. Activity Diagram Start Augmented Reality
According to Hendini in (Ayu & Permatasari, 2018) Activity Diagram (Activity Diagram) describes the workflow (workflow) or activities of a system or business process. From picture 11, this augmented reality activity diagram about the application workflow with augmented reality technology can be explained as follows.



Picture 11. Activity Diagram Start Augmented Reality

On the start menu, the user can directly enter image tracking and then enter image detection, when entering image detection it will display 3d objects and display descriptions.

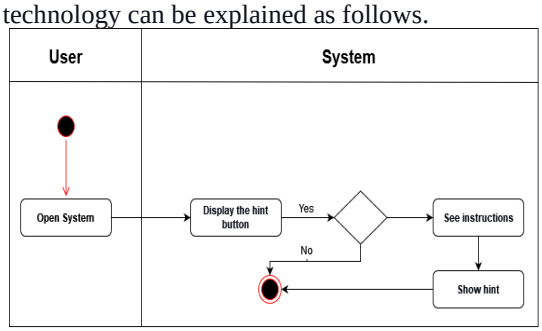
3. Activity Diagram Quiz
From picture 12 quiz activity diagrams about application workflows with augmented reality technology can be explained as follows.



Picture 12. Activity Diagram Quiz

In the quiz menu above, the user enters to start then enters the exercise and questions will be displayed, then after doing the quiz the score will immediately come out from the quiz question.

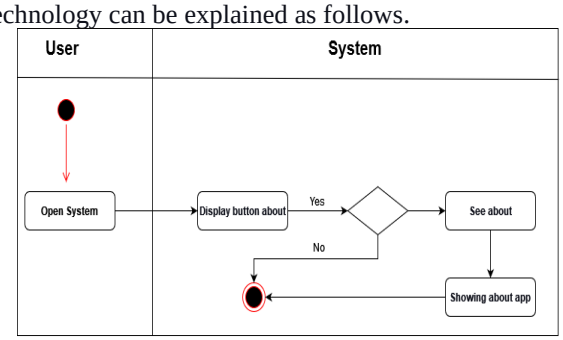
4. Activity Diagram Instructions
From picture 13 the activity diagram of this guide on the application workflow with augmented reality technology can be explained as follows.



Picture 13. Activity Diagram Instructions

In the instructions menu, the user can enter first and then see the instructions and will be directly on the instructions display then there are explained instructions for use of this application.

5. Activity Diagram About
From picture 14 the activity diagram about the application workflow with augmented reality technology can be explained as follows.

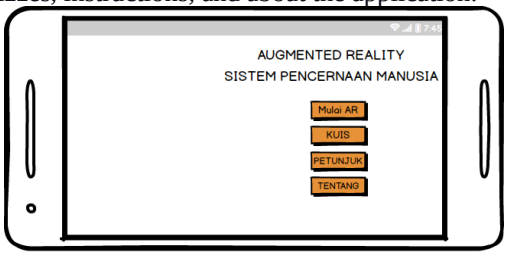


Picture 14. Activity Diagram About

E. Design

The following is a mockup display of the user interface and prototype design of an augmented reality application.

1. Application start menu
In picture 15 is the initial view when entering the application or the main menu, where there are several menu options, including starting Augmented Reality, quizzes, instructions, and about the application.



Picture 15. Application start menu

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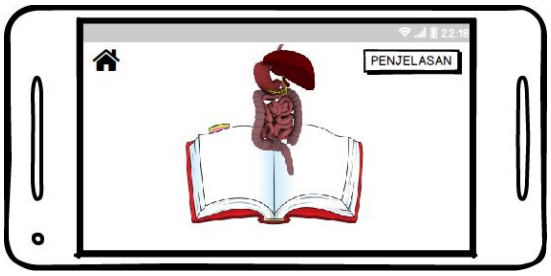
2. Augmented Reality Start Menu
   In picture 16 the Augmented Reality start menu is a place where 3D objects are displayed, on this menu Augmented Reality technology is used, when the user starts this menu, the application immediately opens the camera so that the user points the camera at the available marker or book, in the Augmented Reality start menu there are features -other features such as an explanation menu to provide information about the human digestive system one by one.

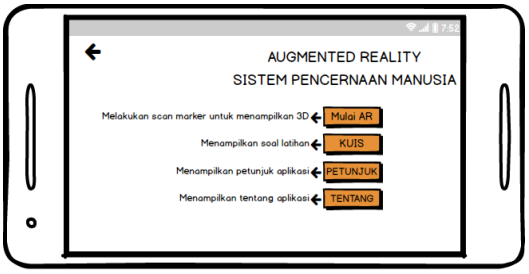


Picture 16. Augmented Reality start menu

3. Quiz Menu
   In picture 17 the display of this Quiz Menu provides questions as a game to the user, several questions will appear, there are several features, namely: answers and scores. The purpose of the quiz menu is only to answer the questions you want to answer, there are no additional features when answering questions, and the application feature will display the score for the correct answer. The score will return when the user closes the quiz menu.

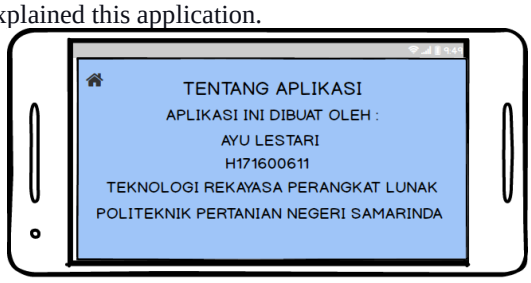
Picture 17. Quiz Menu

4. Hint Menu
   In picture 18 there are no additional features in the Instructions Menu, only the back feature, the function of the back button is to return to the main menu, in this Instructions Menu, the user will be explained this application, an explanation of the features on each menu.



Picture 18. Hint Menu

5. Menu About Application
   In picture 19 there are no additional features in the About Application Menu, only the back feature, the function of the back button is to return to the main menu, in the About Application Menu, the user will be explained this application.



Picture 19. Menu About Application

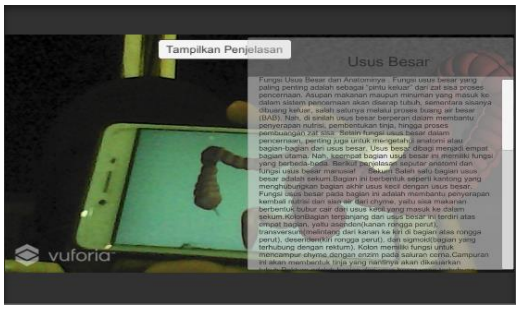
IV. Results And Discussion

The results of the augmented reality application for the human digestive system for elementary school students are as follows:

1. Homepage
   In picture 20 the initial page is a menu display that has buttons such as Augmented Reality start menu, quizzes, instructions, and about applications. Can be seen in picture 20.

Picture 20. menu display

2. Augmented reality start view
   In picture 21 the Augmented Reality start menu display is a place where 3D objects are displayed, on this menu Augmented Reality technology is used, when the user starts this menu, the application immediately opens the camera so that the user points the camera at an available marker or book, in the Augmented Reality start menu there are other features such as an explanation menu to provide information about the human digestive system one by one .



Picture 21. Augmented Reality Start View

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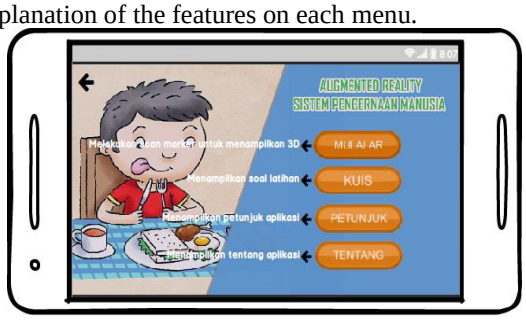
3. Quiz menu display
   In picture 22, this quiz menu display provides questions as a game to the user, several questions will appear, there are several features, namely: answer choices and scores. The purpose of the quiz menu is only to answer the question you want to answer and the application feature will display the score for the correct answer. The score will return when the user closes the quiz menu.

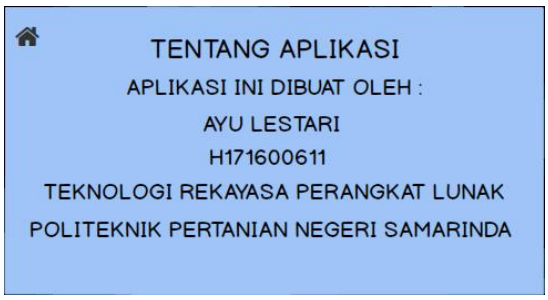
Picture 22. Quiz Menu Display

4. Hint Menu Display
   In picture 23 the instructions menu display there are no additional features in the instructions menu, only the back feature, the function of the back button is to return to the main menu, in this Instructions Menu, the user will be explained this application, an explanation of the features on each menu.



Picture 23. Hint Menu Display

5. Menu display about the application
   In picture 24 the menu display about the application has no additional features, only the back feature, the function of the back button is to return to the main menu, on the menu about this application, the user will be explained this application.



Picture 24. Menu Display About The Application

6. User Acceptance Test (UAT)
   This test is done by giving questionnaires to people as user samples. To draw conclusions based on the results obtained from the questionnaire, several assessment standards were held to determine whether the application was well received by the user or not. Table 2 shows the testing results.

Table 2. UAT Test Results

#	Question	Response					Number of Respondents
		VA	A	N	D	VD	
1.	Is this AR application of the human digestive system interesting	1	0	9	11	11	32
2.	Does this application increase your interest in learning	1	1	4	19	7	32
3.	Is the menu on the application sufficient	1	0	10	14	7	32
4.	Is this application easy to understand	1	0	4	20	7	32
5.	Is this application easy to use	1	1	5	19	6	32
6.	Does the application run properly according to its function	1	0	4	18	9	32
7.	Can the application run properly	1	0	5	18	8	32
8.	Are the application features working properly?	1	0	5	21	5	32
9.	Is the application display attractive	1	1	8	16	6	32
10.	Is this application useful for users	1	0	5	16	10	32
TOTAL		10	3	59	172	76	320

Based on the results in Table 2, it is known that this application can run well. The application can be used and accepted by the school at SDN 002 Harapan Baru Samarinda. The value obtained from user-accepted testing from the student's point of view is with the following details.

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Very Disagree (SD) : 10
Disagree (D) : 3
Neutral (N) : 0
Agree (A) : 172
Very Agree (VA) : 152

After getting the results obtained from the questionnaire, the following calculation results are obtained:

Test result $= \frac{(-3x0)+(-2x0)+(-1x17)+(1x187)+(2x96)}{32x10x10} \times 100\%$

Test result $= \frac{301}{3.200} \times 100\%$

Test result = 94%

V. CONCLUSION

After designing and building an augmented reality application for the human digestive system, the following conclusions can be drawn, with the creation of an augmented reality application for the human digestive system at this elementary school, which can attract students and increase student interest in learning more.

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