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VIRTUAL REALITY BASED HUMAN DIGESTIVE SYSTEM APPLICATION ANDROID

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Abstract

The human digestive system is a system consisting of digestive organs that function to digest food in the human body. The lack of learning media that makes it easy to learn the material of the human digestive system becomes a separate obstacle for users so that research is carried out aimed at developing the learning media of the human digestive system more easily so that it can see the digestive system organs more clearly with virtual. This research uses the Research and Development (R&D) method with the ADDIE development model which consists of four stages namely analysis, design, evaluation and testing. This test is carried out with the appropriateness test conducted on the user testing respondents. The results of respondents' testing on the feasibility of the application of the human body's digestive system using questionnaire data from 40 respondents showed that "Strongly Disagree = 0%", "Disagree = 0.5%", "Neutral = 20.5%", "Agree = 93.5%", "Strongly Agree = 88%". With the application test results using the black box test (Black Box Test) all the menu functions in the application have been successful in accordance with their respective functions. The conclusion of this research is the application of virtual reality digestive system in the human body which is simulated in the digestion of food from the first entry to the exit has been successful as expected.

Keywords: Software, Virtual Reality, Digestive System Organs, Android, Cardboard.

INTRODUCTION

Learning media with virtual reality is media that can create a sense of interest in users to focus on learning and stimulate an active role in discovering and constructing their own knowledge in the learning process. The factors that cause or hinder the learning process are demands that are forced, boring, because you have to learn by reading lots of books, articles and so on. If this is ignored and not followed up on, it will have a negative impact on intellectual, emotional and personality development which is still in the operational phase. Therefore, we need to find a solution for how users can easily understand and be motivated in the teaching and learning process. To anticipate this, an application is needed that can provide comfort, convenience and interest in learning for users. So an application was created with the title "Android Based Virtual Reality Application for the Human Body Digestive System". The application will introduce the digestive organs of the human body with complete explanations and display animations of the digestive system in 3D.

One technology that can be used as a learning aid is virtual reality technology. Virtual reality technology allows someone to simulate an object whose visual appearance is similar to real world conditions. This technology is quite interesting because its appearance is created with the help of computer graphics such as a blender, so you can see that the objects in it look like they are real. Research was carried out in 2017 by Firman Setiawan Riyadi, A. Sumarudin, and Munengsih Sari Bunga with the title "Virtual reality application Introduction to the Indramayu state polytechnic campus based on Android". The results of this research are that virtual reality technology is able to provide real information and can interact directly with the environment and buildings on campus even though the appearance of the buildings and environment still looks low poly. By preparing a smartphone that supports or supports the Gyroscope sensor and preparing Google Cardboard or VRBox glasses, users can immediately use the 3D virtual reality application and can play it straight away.

Research conducted in 2017 by I Putu Astya Prayudha, AA Kt. Agung Cahyawan Wiranatha, I Made Sunia Raharja with the title "Virtual reality Application for Solar System Learning Media". The results of this research aim to make learning easier by adding visualization of the delivery of material related to the solar system. The application is designed to combine entertainment and knowledge for users to interact with a virtual environment and see the existence of planets along with information about planets in the solar system virtually. The application was developed by delivering learning in the form of text and voice to provide knowledge to users such as the distance of planets to the Sun, diameter, layers and contents of planets. Users agree that the Virtual Reality Application for Solar System Learning Media is effective in making learning related to the solar system easier, as evidenced by the results of the questionnaire, which is 60% for the value of agreeing on the content aspect.

A. Virtual Reality

Virtual reality (VR) was first named in 1989 in several magazines and newspapers by Jaron Lanier who was the founder of the VPL company. VR is a technology that uses computers and electronic technology to produce a realistic three-dimensional atmosphere so that users can experience it through sight, hearing, touch and to form a virtual world. VR technology is a kind of interface technology between humans and machines that can realistically simulate people as if they were in a natural environment including vision, hearing, movement and other actions. Not only can it clearly depict real environments, but VR also allows users to observe virtual environments and feel like they are there. Therefore, VR technology opens up new avenues for visualizing spatial information. This technology has three characteristics, namely immersion, interactivity and imagination.

B. 3D Blender

Blender is a development tool dedicated to computer modeling, animation and creation of 3D graphics, open source and cross-platform. Among the different graphic modelers, Blender is a free software that allows adding new scripts or elements, increasing the capacity and improving the program to work and behave as the programmer wishes.

Like other 3D modeling editor software (3DSMax, Maya, etc.), basically Blender also has similar features. Some basic features for 3D modeling editors include:

1) Modeling is a process of forming a model that you want to create. Modeling is the initial stage of a series of processes for creating 3D images or animations.
2) Material and Texturing is the stage of providing texture and material properties to the modeling object that has been created. Material and texturing processes play an important role in making a 3D object look real.
3) Lighting is the stage of providing light for 3D objects that have been created. By providing lighting, the 3D objects that have been created will look more real and realistic.
4) Camera, Blender uses the camera to provide a camera view of 3D objects. The camera itself can be animated.
5) Environment and Effect is the process of providing background and additional effects that will beautify the 3D appearance created. A work in the form of a 3D image or 3D animation will be more beautiful and interesting if it has a background and effects.
6) Particles is a feature in Blender that functions to create various kinds of random and numerous additional effects, for example making rain, snow, shards, and the like.
7) Animation, every object component, element, texture and effect in the scene can be animated.

Rendering is the final calculation process of the entire process in creating a 3D image or animation. Rendering will calculate all material elements, lighting, effects, and others so that it will produce an output image or animation.[6]

C. Unity 3D

Unity is a software designed to create or develop 3-dimensional programs. The main functions provided by Unity usually include a renderer engine which is useful for rendering 2D or 3D graphics, a physics engine to make 3D objects act like real objects (affected by gravity, collisions), sound, scripts, animations, artificial intelligence (AI), networking, streaming, memory management, threading, and animated graphics. There are many engines designed to create games for various platforms such as video consoles and desktop systems such as Microsoft Windows, Linux, and Mac OS.

Unity was created using the C++ programming language, Unity 3D supports other programming languages such as JavaScript, C#, and Boo, Unity is similar to other engines such as Blender, Virtools, as for the advantages of Unity, Unity can be operated on the Windows and Mac Os platforms and can produces programs for Windows, Mac, Linux, iPad, iPhone, Google Android and also browsers. The ease of using Unity in building a program includes:

1) There are many and complete tutorials, both in the Unity 3D Manual Book, from the internet or from forums that discuss Unity 3D, so that even beginners can quickly master it.
2) There are many complete game projects, and free assets that can be used freely, either to study or use for our own projects, and are free to be used for sale or not for sale (as long as development is still using Unity 3D).
3) Unity 3D has a GUI interface that is easy to understand and very user friendly, with a large collection of ready-to-use assets and scripts, making it very easy for beginners to learn. Programming languages that UNITY accepts are JAVA SCRIPT, CS SCRIPT (C#) & BOO SCRIPT. The obj file format is the most effective format for exporting to Unity, namely the . FBX as animation.[7]

A. Android Studio

Android is a Linux-based operating system designed for touch-screen mobile devices such as smartphones and tablet computers. Android was originally developed by Android, Inc., with financial support from Google, which purchased it in 2005. The operating system was officially released in 2007, along with the founding of the Open Handset Alliance, a consortium of hardware, software, and technology companies. and telecommunications aiming to advance open standards for mobile devices. The first Android phone went on sale in October 2008.

B. Google VR SDK

The Google Cardboard software development kit (SDK) is available for the Android and iOS operating systems. The VR SDK allows developers to include VR content in websites and instant applications. Google provides 3 (three) SDKs for Cardboard application development. The three SDKs include a Java-based Android operating system package.

METHOD

This research was conducted using several software system feasibility testing methods, namely:

1. Alpha or black box testing is a testing method that focuses on the functional requirements of the application. Black box testing is carried out with a focus on the expected output results of the system being tested, whether it can run as expected or not.
2. The Likert Scale Method is a psychometric scale method that is commonly used in questionnaires and is the scale most widely used in research in the form of surveys. The scale is named after Rensis Likert, who published a report explaining its use. When responding to questions on a Likert scale, respondents determine their level of agreement with a statement by choosing one of the available options. Usually five scale options are provided using the following weights:
    a) Foranswer A states, Very muchGood given a weight of 5.
    b) For answer B stating, Good, a weight of 4 is given.

c) For answer C, it is enough to give a weight of 3.
d) For answer D stating, Less is given a weight of 2.
e) For answer E stating, Very Poor, a weight of 1 is given.

The Likert scale explains that first the ideal score or criteria is determined. The ideal score is a score determined with the assumption that each respondent to each question gives an answer with the highest score, then the total score of the research results is divided by the ideal score. It can be concluded that the questionnaire is calculated using a Likert scale to see the level of agreement from respondents using the following formula:

$$P = \frac{\text{Research Results Score}}{\text{ideal score}} \; x\; 100\% \quad \ldots\ldots (1.1)$$

Information :

P (percentage number) = Ideal score: highest score for each aspect x number of respondents x number of questions per aspect.

After the data is transformed, the rating scale calculation can be done. Next, they are classified into five categories using a scale as in Figure 1

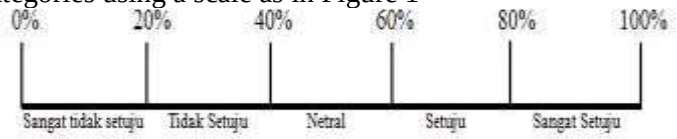

Figure 1 Five Categories using a Likert Scale

A. Use Case Diagrams

A use case diagram is a description of the functionality of a system that can be accessed by users. Users can access the entire menu, namely Viewing
3 dimensions of the human digestive system, view animations, view application explanations and view creator profiles.

The purpose of a Use Case is to map system requirements, represent user interactions with the system, to find out needs outside the system. The Use Case diagram used for the Human Digestive System Virtual Reality Application can be seen in Figure 2.

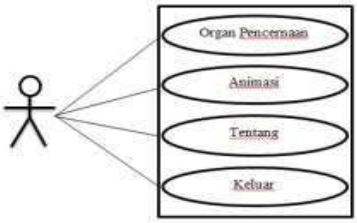

Figure 2 Use Case Diagram

B. System planning

At this stage, a system design process is carried out which aims to explain the system that will be created. System design is a stage carried out after the research materials have been obtained.

a) Making 3D Objects of Human Digestive Organs

This digestive system application will display 3D objects of each digestive organ. The creation of 3D objects can be seen in Figure 3.

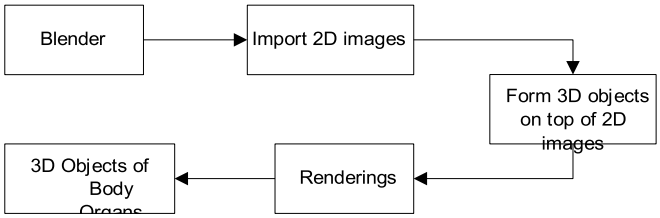

Figure 3 Block diagram for creating 3D objects for human digestive organs

In the initial stage, the researcher opened the Blender application, then entered a 2D image of the organ into the working screen in Blender, then formed a 3D organ object on top of the 2D image, after the whole organ was formed then rendered and displayed the results of the 3D Digestive Organ object

b) Transform Object Design

In designing transform objects, coding will be added to control 3D objects so they can be moved. The design block can be seen in Figure 4 below.

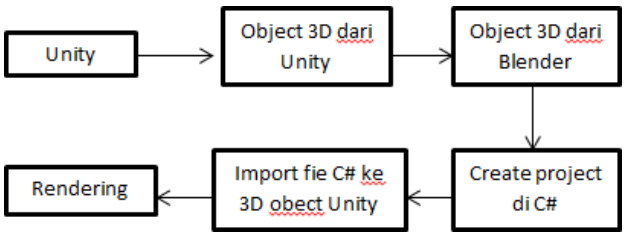

Figure 4 Block Diagram of Transform Object

In the initial stage, the researcher opened the Unity application, then added a 3D object from Unity to the hierarchy, then imported the 3D object from Blender and inserted it into the 3D object from Unity, then created a project in Visual Studio to enter coding so that the 3D object could be rotated.

c) Application Creation

In making the system, several software are needed such as Blender, Visual Studio and Unity. The system creation block can be seen in Figure 5.

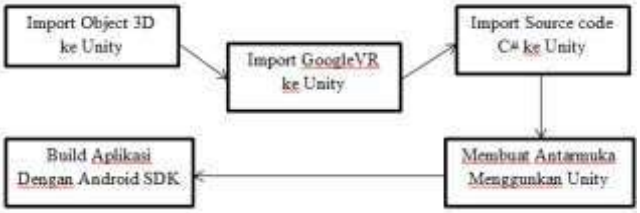

Figure 5 Block Diagram of Application Creation

In the initial stage, researchers imported 3D objects from Blender files into Unity, then imported GoogleVR SDK and Source Code into Unity, then created an interface using Unity, then ran the application with the Android SDK.

RESULTS AND DISCUSSION

A. System Test Results

After the application design is complete, the next stage is testing the application which aims to determine the level of success of the system when the device selects a button on one of the organs in the human body. Before testing, the application that has been built in *.apk form is first installed on the Android smartphone. After the installation process is complete, an icon will appear in the Android menu as in Figure 6.

Figure 6 Application Icon

Next, the application will be tested by trying to see the results of the display or application interface that has been designed. Starting from the Main Menu page display, 3D Organ page display for selecting organs, 3D Animation page display, About page display and exit page display.

a. Main Page Display

On the main page there are 4 buttons that users can select. The button options include: Digestive Organs, Animation, About and Exit. The following display of the main menu page can be seen in Figure 7.

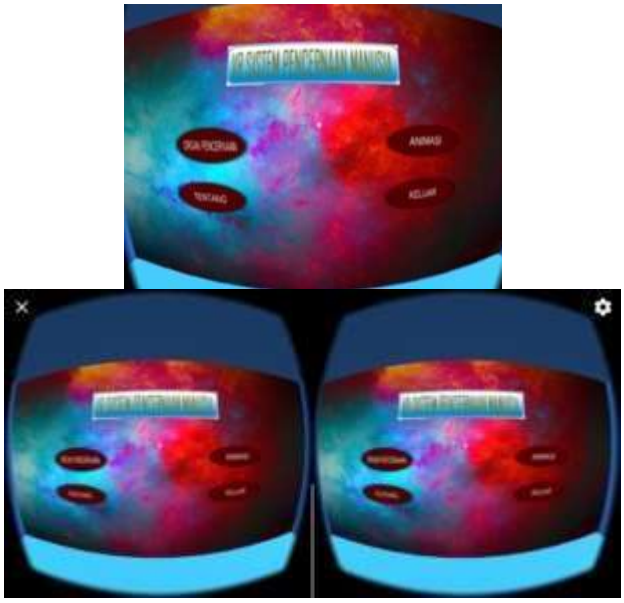

Figure 7 Main Menu Page

Figure 7 is the result of the main page display which contains the main buttons to make it easier for users to go to other pages. On the main page there are 4 main buttons with different functions, namely:

1. Digestive Organs
   The digestive organs show what organs are included in the digestive system, along with an explanation of each part of the organ.
2. Animation
   Animation displays an animation of the digestive system in the form of a 3D animated video.
3. About
   The About button displays about the application and about the application creator profile.
4. Go out
   The exit button is to exit the application.

b. Digestive Organs Page View

On the organs page there are 4 screens, namely stomach, mouth - esophagus, small intestine, large intestine - anus which can be seen along with an explanation of each organ, and a back button option. The following page design for the digestive organs can be seen in Figure 8.

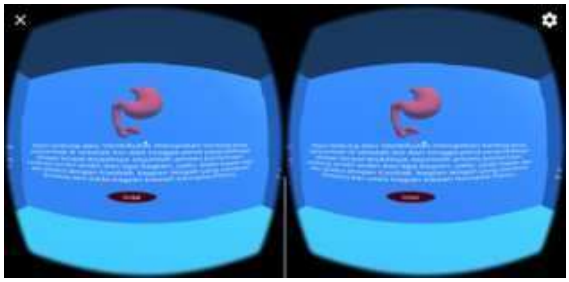

Figure 8 Page 3D Digestive Organs

Figure 8 is the result of the Digestive Organs page display which contains 4 views, namely: Mouth - Esophagus, Stomach, Small Intestine, and Large Intestine - Anus, along with an explanation of the organs in each view.

c. Animated Page Display

The Animation page is used to display animated videos of the digestive system and Back to the Main Menu. The animated page display can be seen in Figure 9.

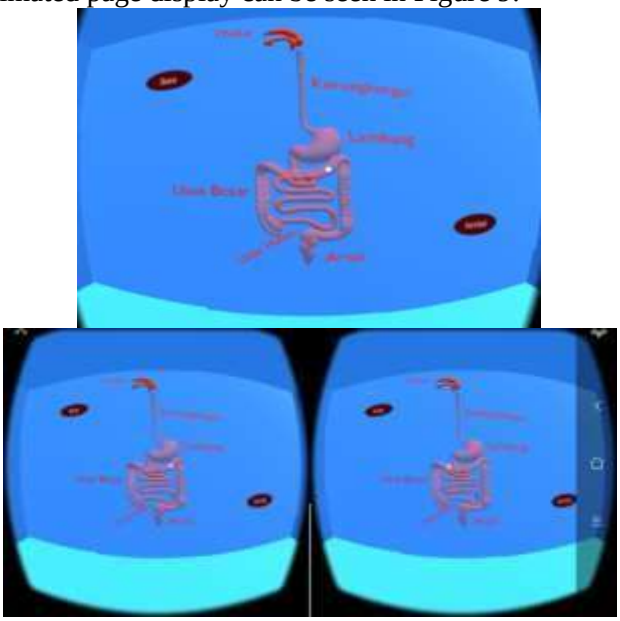

Figure 9 Animation Page

Figure 9 is the result of an animation or video page display that shows the process of digestion of food from when it first enters the mouth until it exits to the anus.

d. About Application Page View

The about page is used to display

page namely the page about the application. The page display can be seen in Figure 10.

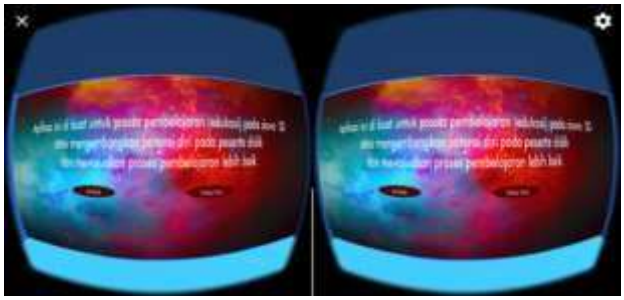

Figure 10 About Application Page

Figure 10 is the result of the about page display which contains about the application and about the application maker. This page can be seen by selecting the about button on the main page.

e. About Me Page Views

The about page is used to display pages, namely profile pages. The page display can be seen in Figure 11.

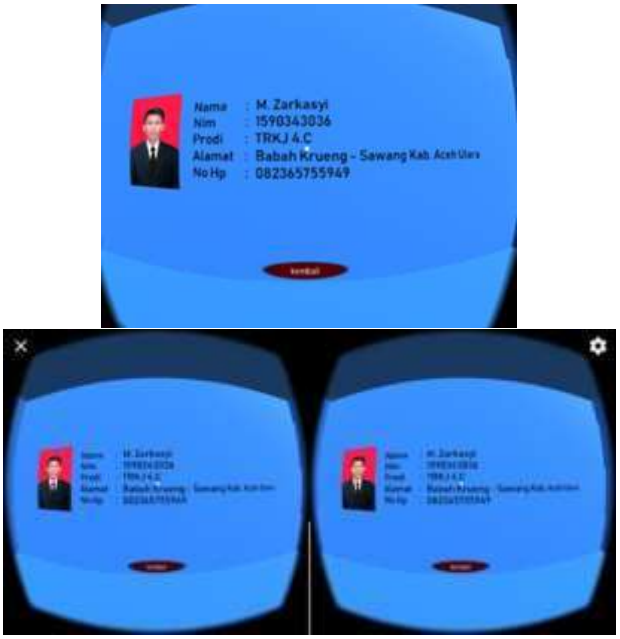

Figure 11 About Me Page

Figure 11 is the result of a page display about the application maker. This page contains the biodata of the human digestive system VR application creator. Can be seen by selecting the about me button on the app's about page.

B. Testing Using Questionnaires

At this stage, an application feasibility test will be carried out by obtaining data from users. Testing was carried out on 40 users to use the application that had been created by the researcher and fill in the questionnaire sheet that had been prepared. Data from user responses can be seen in table I.

TABLE I
QUESTIONNAIRE TESTING RESULTS

No	Question	Mark				
		SQS	QS	N	S	SS
1	The application is easy to operate, what do you think?			5	23	12
2	The application can be easily learned, what do you think?			3	20	17
3	Appearance/menuin the application it is easy to recognize, what do you think?		1	5	19	15
4	What about the information provided by the application that is easy to understand?			5	21	14
5	Function*menu*according to the desired goals, what do you think?			3	17	20
6	This application suits your needs, what do you think?			6	19	15
7	The application is comfortable to use, what do you think? The			2	22	16
8	application has an attractive appearance, what do you think?			5	18	22
9	Overall, is the use of this application satisfactory?			4	15	21
10	The application is useful for users, what do you think?			3	13	24

Table II will show the results of responses from 40 users to the question "The application is easy to operate, what do you think?" and the value will then be calculated using the Likert scale formula.

TABLE II
RESPONDENT TEST RESULTS QUESTION 1

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	-	-
3	Neutral	3	5	15
4	Agree	4	23	92
5	Strongly agree	5	12	60
	Amount		40	167

Based on the data in table II it can be calculated based on equation 1.1 below.

$$P = \frac{167}{40\ x\ 5}\ x\ 100\% = 83{,}5\ \%$$

Based on these calculations, a percentage result of 83.5% was obtained, so it can be concluded that users strongly agree with the ease of operation of this application.

Table III will show the results of responses from 40 users to the question "The application can be easily learned, what do you think?" whose value will then be calculated using the Likert scale formula.

TABLE III
RESPONDENT TEST RESULTS QUESTION 2

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	-	-
3	Neutral	3	3	9
4	Agree	4	20	80
5	Strongly agree	5	17	85
	Amount		40	174

Based on the data in table III it can be calculated based on equation 1.1 below.

$$P = \frac{174}{\frac{40}{5}\ x}\ x\ 100\% = 87\ \%$$

Based on these calculations, the percentage result was 87%, so it can be concluded that

Table IV will show the results of responses from 40 users to the question. The menu display in the application is easy to recognize, what do you think?" The value will then be calculated using the Likert scale formula.

TABLE IV
RESPONDENT TEST RESULTS QUESTION 3

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	1	2
3	Neutral	3	5	15
4	Agree	4	19	76
5	Strongly agree	5	15	75
	Amount		40	168

Based on the data in table IV it can be calculated based on r equation 1.1 below.

$$P = \frac{168}{40\ x\ 5}\ x\ 100\% = 84\ \%$$

Based on these calculations, a percentage result of 84% was obtained, so it can be concluded that users strongly agree with the easy-to-recognize appearance of the application menu.

Table V will show the results of responses from 40 users to the question "Is the information provided by the application easy to understand?" "Is the information provided by the application easy to understand?" The value will then be calculated using the Likert scale formula.

TABLE V
RESPONDENT TEST RESULTS QUESTION 4

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	-	-
3	Neutral	3	5	15
4	Agree	4	21	84
5	Strongly agree	5	14	70
	Amount		40	169

Based on the data in table V, it can be calculated based on equation 1.1 below.

$$P = \frac{169}{40\ x\ 5}\ x\ 100\% = 84{,}5\ \%$$

Based on these calculations, a percentage result of 84.5% was obtained, so it can be concluded that users strongly agree with the ease of understanding the information provided by the application.

Table VI will show the results of responses from 40 users to the question "The menu function is in accordance with the desired goal, what do you think?" whose value will then be calculated using the Likert scale formula.

TABLE VI
RESPONDENT TEST RESULTS QUESTION 5

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	-	-
3	Neutral	3	3	9
4	Agree	4	17	68
5	Strongly agree	5	20	100
	Amount		100	177

Based on the data in table VI it can be calculated based on equation 1.1 below.

$$P = \frac{177}{40\ x\ 5}\ x\ 100\% = 88{,}5\ \%$$

Based on these calculations, a percentage result of 88.5% was obtained, so it can be concluded that users strongly agree with the function of this application menu according to their needs.

Table VII will show the results of responses from 40 users to the question: "This application meets your needs, what do you think?" whose value will then be calculated using the Likert scale formula.

TABLE VII
RESPONDENT TEST RESULTS QUESTION 6

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	-	-
3	Neutral	3	6	18
4	Agree	4	19	76
5	Strongly agree	5	15	75
	Amount		100	169

Based on the data in table VII it can be calculated based on the following equation 1.1.

$$P = \frac{169}{40\ x\ 5}\ x\ 100\% = 84{,}5\ \%$$

Based on these calculations, a percentage result of 84.5% was obtained, so it can be concluded that users strongly agree with the suitability of this application's needs.

Table VIII will show the results of responses from 40 users to the question: "The application is comfortable to use, what do you think?" The value will then be calculated using the Likert scale formula.

TABLE VIII
RESPONDENT TEST RESULTS QUESTION 7

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	-	-
3	Neutral	3	2	6
4	Agree	4	22	88
5	Strongly agree	5	16	80
	Amount		100	174

Based on the data in table VIII it can be calculated based on equation 1.1 below.

$$P = \frac{174}{40\ x\ 5}\ x\ 100\% = 87\ \%$$

Based on these calculations, a percentage result of 87% was obtained, so it can be concluded that users strongly agree with the convenience of this application.

Table IX will show the results of responses from 40 users to the question: "The application has an attractive appearance, what do you think?" The value will then be calculated using the Likert scale formula.

TABLE IX
RESPONDENT TEST RESULTS QUESTION 8

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	-	-
3	Neutral	3	5	15
4	Agree	4	18	72
5	Strongly agree	5	12	60
	Amount		40	147

Based on the data in table IX it can be calculated based on the following equation 1.1.

$$P = \frac{147}{40\ x\ 5}\ x\ 100\% = 73{,}5\ \%$$

Based on these calculations, a percentage result of 73.5% was obtained, so it can be concluded that users strongly agree with the appearance of this application.

Table

TABLE X
RESPONDENT TEST RESULTS QUESTION 9

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	-	-
3	Neutral	3	4	12
4	Agree	4	15	60
5	Strongly agree	5	21	105
	Amount		40	177

Based on the data in table X it can be calculated based on the following formula.

$$P = \frac{177}{40\ x\ 5}\ x\ 100\% = 88{,}5\ \%$$

Based on these calculations, a percentage result of 88.5% was obtained, so it can be concluded that users strongly agree with satisfaction with this application.

Table

TABLE XI
RESPONDENT TEST RESULTS QUESTION 10

No	Information	Score	Respondent	Respondent Score
1	Strongly Disagree	1	-	-
2	Don't agree	2	-	-
3	Neutral	3	3	9
4	Agree	4	13	52
5	Strongly agree	5	24	120
	Amount		40	181

Based on the data in table XI it can be calculated based on equation 1.1 below.

$$P = \frac{181}{40\ x\ 5}\ x\ 100\% = 90{,}5\ \%$$

Based on these calculations, a percentage result of 90.5% was obtained, so it can be concluded that users strongly agree with the benefits of this application.

C. Application Button Function Testing

At this stage a series of tests will be carried out on the button functionality of the application. The test was carried out on a smartphone mounted on cardboard and connected to a remote controller. Testing is carried out by running the application, then seeing whether the results match the requirement specifications. It can be seen in table XII.

TABLE XII
APPLICATION BUTTON TESTING

Name Knob	Form Testing	Specification Need	Results Testing
VROrganPencernaan.apk	Open Application	An icon appears Unity then go into main page	Succeed
Organ Digestion	Push Organ button Digestion	Show page digestive organs	Succeed
Animation	Push knob	Show page Animation	Succeed
About Application	Push about button application	Show page About the app	Succeed
About me	Push about button I	Show page About me	Succeed
Return	Push knob return	Show page return	Succeed
Exit	Push exit button	Exit the application	Succeed

Based on table XII, button testing or testing using Black boxon the applicationVirtual realitybased human digestive systemAndroidIt can be concluded that the test states that all functions run well and as expected.

CLOSING

After conducting research and discussion regarding the Android-based virtual reality application of the digestive system in the human body, the following conclusions were drawn:

The virtual reality application of the digestive system in the human body which simulates the digestion of food from first entry to exit has been successful as expected.

Based on respondents' responses to the feasibility of applying the human body's digestive system using questionnaire data from 40 respondents, it shows that Strongly Disagree = 0%, "Disagree = 0.5%", "Neutral = 20.5%", "Agree = 93.5%", "Strongly Agree = 88%". With the results of application testing using the black box test, all menu functions in the application have been successful in accordance with their respective functions.

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