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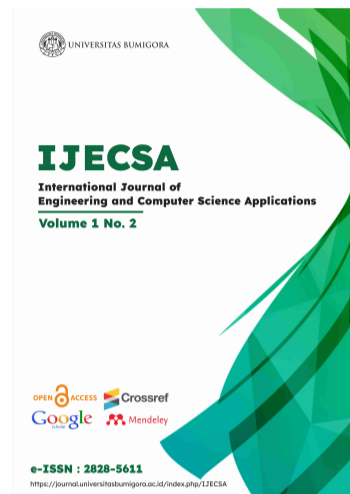
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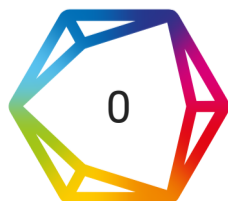
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Visualization of Gastric Acid Reflux Using Mobile-Based Augmented Reality

Ahmat Adil[1*], Bambang Krismono Triwijoyo[2], Miftahul Madani[3],
L Riyandi Damar J[4]

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Abstract— **Interactive information media has many benefits in the process of conveying information, one of which is by visualizing objects in real time. Socialization activities at the Rensing Health Center in conveying information on gastric diseases still do not use visual aids as a medium for delivering counseling. Therefore, this study aims to develop information media in the form of an android application by utilizing Augmented reality (AR) technology to show the stomach acid process in real time which is visualized in the form of 3D animation. The method used in application development is Multimedia Development Life Cycle (MDLC). Where this method consists of 6 (six) stages of development, namely concept, design, Material Collecting, Assembly, testing and distribution. The results of this study are a visualization application of gastric acid reflux using mobile-based augmented reality built using Unity 2017.3.1f1 and the Vuforia Software Development Kit (SDK), with several stages of the process, namely entering the database and all assets into unity, lighting, creating a user interface, scripting and finally build the application to the android platform Based on the results of application trials that have been carried out at the Rensing Health Center, it shows that mobile-based augmented reality has succeeded in assisting officers in visualizing gastric acid reflux. The satisfaction of health officers in using the application can be seen from the results of the questionnaire to the respondents, where the results of the questionnaire 32% stated strongly agree, 59% agreed, 6% disagreed and 2% disagreed.**

Keywords : **Augmented Reality, Media Information, Gastric Acid Reflux ,3D Animation**

I. INTRODUCTION

The stomach is one of the organs of the mechanism of digestion of food in humans, known in the medical world as the ventriculus, located on the lower left of the diaphragm where food is temporarily stored. The stomach produces enzymes and amino acids, whereas the enzymes produced by the stomach are pepsin and renin[1]. Stomach The stomach is a J-shaped organ located in the left upper quadrant of the abdomen or abdomen. The upper edge is connected directly to the esophagus which is under the diaphragm. The lower border of the gastric organ located to the right of the midline fuses with the duodenum. The size of the stomach varies, depending on the volume of food present[2]. The stomach organ plays an important role in storing and digesting both food and drinks that enter the human body, so it is very important to maintain it.

The stomach wall also produces mucus which serves to moisten food and protect the stomach[3]. At both ends of the stomach there is a sphincter (sphincter) which regulates the entry or exit of food in the stomach. At the end of the stomach adjacent to the esophagus there is also a sphincter (sphincter) that keeps food in the stomach, where the sphincter (sphincter) tends to be closed and opens only when food enters the stomach or when vomiting. The sphincter located at the end of the stomach adjacent to the small intestine is called the pyloric sphincter (pyloric sphincter). The stomach has an indentation called the major curvature on the left and the minor curvature on the right. There is a cardial incisor which is the beginning of the major curvature and an angular incisor which indicates the presence of pars pylorica on the minor curvature[4].

The development of smartphone technology is used by some people to create a learning media based on Augmented Reality (AR)[5]. Users only need supporting objects such as Android smartphones, markers, and AR supporting applications. In everyday life, AR has started to dominate the world market . Several studies have used AR to visualize an object, such as facial emotion pattern recognition, 3D foot phantom, smart home control, information systems on smart buildings, battery bank information media, and M-Commerce[6] .

In addition to these implementations, AR is starting to be used as a learning tool in the field of education. For example, ARca is a book that provides additional facilities with the AR program. Other AR-based research is the AR-based water cycle learning method and the AR-based coordinate system case learning system[7]. Other studies that use AR to support the learning system of human organs include using a monitor as a visualization and a keyboard to select the options provided and applying AR to study eye anatomy. Based on the studies above, in this paper, a mobile-based visualization application that focuses on gastric acid reflux is created[8].

With the application of Visualization of human gastric acid that carries AR technology, the Rensing Health Center can understand problems related to gastric acid, so that it can make it easier for health workers to convey information to patients. What's more, an increasingly advanced era will continue to require humans to follow its

development from day to day. By utilizing this application, Puskesmas officers and the community can more easily access the information needed.

This study aims to produce an application of Gastric Acid Reflux Visualization using Mobile-Based Augmented Reality, as a media to help Puskesmas, in visualizing gastric acid reflux. In addition, the resulting application is used as a medium for describing gastric acid for Rensing Health Center officers in disseminating information about gastric disease to patients. As a community health center, the Puskesmas works to facilitate the community in providing information related to public health. One of the diseases that often get complaints from the public (patients) is acid reflux disease, so that the Puskesmas staff is obliged to explain various things related to this stomach acid disease by visualizing using Augmented Reality based on Mobile.

There is a similar research that has been done previously related to the application of Android-based Augmented Reality for gastric acid disease is a research by Fony Ferliana Widianingrum et al with the title Application of Android-Based Augmented Reality for Learning Human Gastric Organs. This study focuses more on the use of Augmented Reality as a learning tool in the field of education. This research gains understanding of students learning about the digestive organs of the stomach, and can make it easier for teachers to convey information to their students. In addition, by utilizing this application, it can make it easier for students to access the required information on gastric acid disease[1].

II. MATERIALS AND METHODS

2.1. MATERIALS
a. Stomach Desease
Gastric organs that cannot work normally can cause several diseases such as the following [2].

1) Gastroesophageal Reflux Disease (*Gerd*)
   (Gastroesophageal Reflux Disease) which stands for GERD or gastric acid reflux, is a condition that occurs when stomach acid experiences back up into the esophagus. This causes the sufferer to feel nauseous, vomit, and even feel hot in the chest (heartburn). When stomach acid rises to the esophagus or esophagus, the corrosive acid content will irritate and burn the surface layer of the esophagus, causing a burning feeling in the chest (heartburn) so that the inside of the neck and even the throat and mouth can feel sour because of it 4). The cause of GERD is generally due to interference with the valve (sphincter) at the bottom of the esophagus. Under normal conditions, the sphincter valve will be closed tightly to hold the stomach contents from rising back up. However, when the valve is weak, the stomach contents will more easily go up into the esophagus [4].
   Causes of GERD
   Between the esophagus and the stomach is a sphincter, a ring of circular muscle that can tighten (close) and relax (open). When swallowing food, the sphincter muscles will relax so that food and liquid can flow into the stomach and when finished, the valve will close again so that food does not go back up 2). When the sphincter valve weakens or relaxes abnormally, acid and gastric contents will flow back into the esophagus. As a result, patients will feel heartburn to nausea, which if it continues, stomach acid can irritate the lining of the esophagus and cause inflammation (esophagitis). Over time, the lining of the esophagus can be damaged and lead to dangerous complications, ranging from bleeding, narrowing of the esophagus, or Barrett's esophagus (a precancerous condition) [1]. Figure 1.1 below shows the condition of the stomach in an injured state.
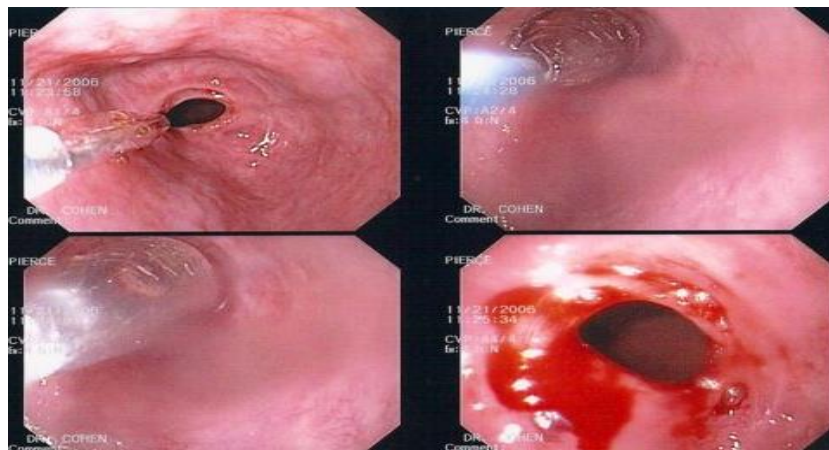

Figure 1.1 Injured stomach[2]

2) Mag; This condition occurs because there is injury or inflammation in the stomach caused by excessive amounts of hydrochloric acid (HCl).
3) Stomach Cancer; In contrast to ulcers, gastric cancer is caused by excessive or even uncontrolled growth of gastric cells. Stomach cancer can also occur due to genetic factors.

b. Augmented reality

Augmented reality (AR) is a technology that combines 2-dimensional or 3-dimensional objects into a 3-dimensional (real time) and then projects these objects into real time [9]. Another definition of Augmented reality is that an object can appear in a real environment, either in a 2-dimensional or 3-dimensional object. Augmented reality can also represent descriptive words from someone who wants to explain an object by displaying the object being discussed in real time [10]. Virtual objects display information that cannot be received by users with their own senses, this makes Augmented reality referred to as a tool to help the user's perception and interaction with the real world. The information displayed by virtual objects helps users carry out activities in the real world.

Some of the applications needed to support AR creation are as follows: [11].
1) Blender: Blender is a software used to create 3D designs, which can be downloaded for free through the official website.
2) Vuforia: Vuforia is a plugin from the Unity 3D software, which is used to create AR applications [12], and requires some basic 3D model object components. In Vuforia there are two develop, namely License Manager and Target Manager, which are made so that users get a license key that is useful for supporting the database in making applications and a Target Manager which is made to enter the marker database to be created.
3) Unity: Unity is a game engine that can create 2D or 3D games[13]. The main advantage of Unity is that it can be downloaded for free and contains an asset store or equipment that can be used immediately. Assets available include the form of characters and scripts.

c. Marker

Marker is a marker to bring up a 2-dimensional or 3-dimensional object that will be detected by the computer. Marker detection by a computer is done by counting the number of images on the marker which is commonly called image processing. There are 2 types of markers that are used to date, namely static markers and abstract markers [14]. Static markers are markers that are in the form of a square or rectangular pattern and are black and white. While abstract markers or what can be called markerlees are markers in the form of complex patterns in the form of writing, images, or a 3-dimensional object. The marker is usually a square black and white illustration with a bold 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 3 axes, namely X, Y, and Z. Marker Based Tracking has long been developed since the 1980s and in the early 1990s began developed for the use of Augmented reality[15].

d. Markerless

With this method, users no longer need to use a marker to display digital elements. Currently, markerles are being developed by large companies, by making Augmented reality applications for various markerless tracking techniques as their mainstay technology [9]. The various techniques that can be used by using Markeless Tracking in Augmented reality are as follows:
1. Face Tracking; is a Markerless Augmented reality that uses a developed algorithm, so that computers can recognize human faces in general by recognizing the position of the eyes, nose, and mouth of humans, then will ignore other objects in the vicinity such as trees, houses and other objects.
2. 3D Object Tracking; In contrast to face tracking which only recognizes human faces in general, 3D object tracking techniques can recognize all forms of objects that are around such as motorbikes, cars, tables, televisions, buildings and others.
3. Motion Tracking; This technique can capture motion or motion tracking which has begun to be used extensively to produce films that simulate body movements.
4. GPS Based Tracking; GPS Based Tracking techniques are currently gaining popularity and are widely developed in smartphone applications (iPhone and Android). By utilizing the GPS and compass features in the smartphone, the application will take data from the GPS and compass and then display it in the form of the direction we want in real terms, there are even some applications that display it in 3D.

e. Mobile Application

A mobile application is an application that allows us to carry out mobility using equipment such as PDAs, cell phones or cellphones. By using a mobile application, we can easily perform various activities ranging from entertainment, selling, shopping, doing office work, browsing and so on. A mobile application can be defined as a product of a mobile computing system, i.e. a computing system that can be easily moved physically and whose computing capabilities can be used while they are being moved[16].

The application used will be built on a mobile-based basis that operates on the Android operating system, where Android is a mobile device on an operating system for Linux-based cellular phones, and is one of the most widely used mobile-based operating systems or operating systems today[17]. Through the mobile application, users can also access a number of important information using a smartphone that is connected to the internet service. The main advantage of the mobile application is that it makes it easy for users to get information portable without using a PC or netbook and its use in obtaining up-to-date information is fulfilled without being hindered by the time and place of where mobile device users are and whose area can be reached by internet communication networks. on a website can be done through a mobile application using the user's mobile device[18].

In its development, the mobile application has been integrated with features found on mobile devices, such as GPS, Compass, accelometer etc. This integration allows for the role of mobile applications in performing certain complex tasks, namely tracking the user's whereabouts, showing directions or navigation, displaying location routes or maps in digital form.

2.2. METHODS

The development method used in this research is the Multimedia Development Life Cycle (MDLC) method which consists of concept, design, collecting material, assembly, testing and distribution [19].
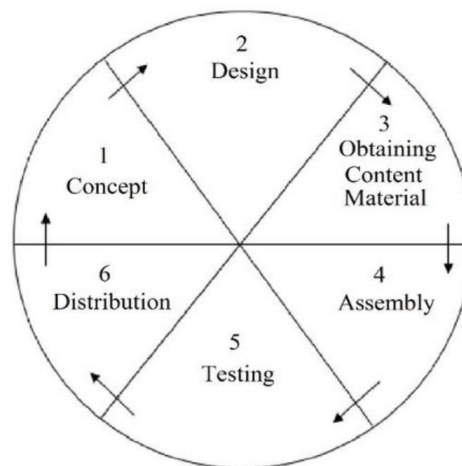

Figure 2.1. MDLC [19]

a. Concept

The concept is the initial stage where the research objective is determined by the purpose of designing a visual gastric reflux application using augmented reality, which is interactive, and will be applied to an Android-based smartphone. Included in this concept stage are user identities, research locations and data collection methods.

b. Design

The next stage is the design of the display pattern and content of the application which is the basis for making the application which includes:
1) Information Content; The content contained in the gastric acid reflux visualization application using mobile-based Augmented reality is application content that displays visually the process of gastric acid reflux or GERD in 3 Dimensional form. Information content also uses augmented reality accompanied by voice explanations and information based on data and facts obtained from the Rensing Health Center as well as journal books and other references.
2) Production Plan; In the production design stage in accordance with what has been described in the concept stage (user identification), this application is intended for Puskesmas, in order to make it easier for prospective users (Users) to get markers and access the application. This application uses Google Drive as a media for storing markers which later will provide a marker download button to direct users to the marker download link. after the marker is successfully downloaded, the user can print or use other media such as a second smartphone as a marker storage so that it is easy to scan.

c. Material Collecting

Material Collecting stage, collecting materials that are suitable for application needs such as textures, icons, audio, and others via the internet or personal documentation from the author.
The following are the materials that the author has managed to collect where these materials will be used in the assembly process.
1) 3D objects, needed in designing a visualization application for gastric acid reflux made using Blender

software. The required 3D objects can be seen in table 2.1
2) Marker, a marker that has been stored in the Vuforia database that will be used to be scanned by the application. An example of a marker can be seen in Figure 2.1
3) Audio, which will be used in the design of this application as table 2.2

Table 2.1 Required 3D objects

No	3D Object
1	Head and Body
2	Mouth
3	Esophagus
4	Stomach
5	Stomach acid
6	Food

Table 2.2. Audio

No	Audio
1	Click Button
2	Animation Explanation

Figure 2.2 Marker

d. Assembly

After all the required materials have been collected, it will then enter the assembly stage, namely making all objects based on concepts that have been previously designed and will be implemented into the application. The following are the details of the stages of making the Visual gastric acid reflux application:
1. The first stage is the creation of 3-dimensional objects, animations and other materials that have been previously designed at the Material Collecting stage.
2. The second stage is to include the assets that have been designed into the Unity software. Unity used must have the Android SDK (Software Development Kit), JDK (Java Deplovment Kit) and Vuforia SDK installed.
3. Furthermore, making the scene in accordance with the designed concept, after that each object will have a function with coding made using the C# Programming Language using the default software from Unity, namely Monodevelop.
4. After the scene creation and coding stages are complete, the next step is debugging testing to see if the results of the coding that have been made have errors or not, if there are no errors then the components that have been made can be run in unity.

e. Testing

This stage will conduct testing with the aim of ensuring that the application that has been made will run the right process and produce the appropriate output based on the concept that has been designed and then find out if there are errors that may exist in the application. Based on the research method used by the author, namely MDLC (Multimedia Development Life Cycle), there are two testing methods that will be carried out on applications that have been made, namely by application makers and prospective application users by means of Alpha Testing and Beta Testing. The application testing phase will be carried out on Android smartphones with minimum operating system specifications, namely Android 5.0 (Lollipop) version.

f. Distribution

After the application has been confirmed according to its functionality and no errors are found, then the application is ready to be distributed. At this distribution stage, it will be done to save the application into a storage media such as a hard drive, flash drive, smartphone or distribute it by uploading it to the Playstore. In this case, save the application by uploading the application to Google Drive storage media.

Distribution is done so that users can get, install and use the application as a medium of information. The conditions that must be met by prospective users are that the smartphone device owned by the user must have an android version 5.0 (Lollipop) and above, then have a camera and RAM that supports it. If you meet the requirements, you can download the application and install it on the device.

This section will discuss the contents of the gastric acid reflux visualization application using Augmented reality which has been completed and is ready to use.

3.1. Implementation

In the main menu design there is the title of the application, namely "AR Visual stomach acid". In this main menu there are five buttons, the first is the AR Camera button whose function is to navigate to the Augmented reality camera menu, the second is the Info button which contains information about stomach acid and a button to display the discussion text, the third button is about the application whose function is to explain the purpose the application is made and the fourth is the download marker button and the fifth is the Exit button which functions to exit the application. While the background used in the main menu is the title of the application with several icons of the stomach organ. The following view of the Main Menu can be seen in the image 3.1 below.
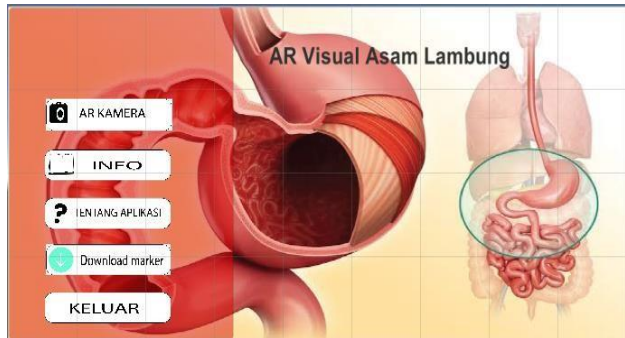

Figure 3.1 Main Menu Display

Animation Making

The next stage is the process of making animation that aims to move 3D objects where with the animation, it is hoped that application users, especially Puskesmas employees, get an idea of how the process of gastric acid occurs in humans. Making the animation can be done using Blender software. The animation movement starts from food in humans moving through the mouth, esophagus, and stomach. Animation of the movement of food through the digestive organs of food in humans is moved by changes in location, scale and rotation. Starting from the food will enter the mouth and go through the process of mastication to become smooth, then (mechanical digestion) is passed into the stomach little by little through the esophagus. Animation of objects from the mouth through the esophagus to the stomach is moved by changing the location and scale of the object. After being in the stomach, a chemical digestion process will be carried out and will describe what happens in the stomach related to the enzymes in the stomach. The food will be in the stomach for approximately 3 or 4 hours, in this animation the object is only in the stomach for a few moments so that the duration of the animation is not too long.

Before starting the animation creation process, change the screens (workspace layouts) to animation, with the screens position above the workspace, after the animation is selected, the workspace layout will change. If you are already on screens animation, a dope sheet will appear and the workspace width will adjust to the dope sheet feature.
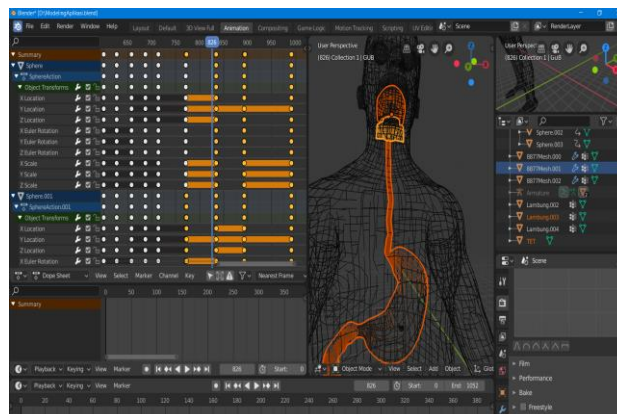

Figure 3.2. Stomach acid visual animation

Marker Creation

Markers are markers that make objects appear on the marker display on the user's device camera. At this stage, the author uses Adobe Illustrator CC 2019 software. This marker will be used as a database for the application and then the marker uses images of objects of the human digestive system taken from several references on the internet that are modified in such a way as to have a unique pattern. Markers that have a unique pattern will be easily detected by the user's device so that the object will appear strongly above the marker.
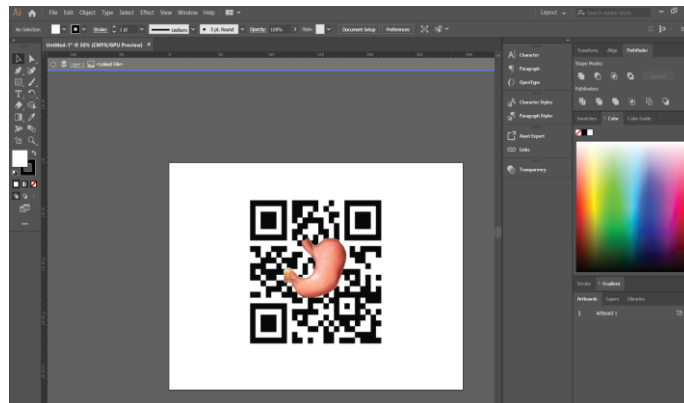

Figure 3.3. Marker Design using Adobe Illustrator

After the marker has been created, then upload the marker to the Vuforia website which will be used as an AR application database. In Vuforia itself there is a rating feature, which is to find out how much sensitivity the marker has made to display objects, the higher the rating obtained by the uploaded maker, the faster the camera in the application will read or detect the marker to display objects. From the markers for the database that have been created in this study, after being uploaded, they get a 5 star rating, which means that the markers are very good for displaying objects and being used as application databases.

Android Application

The process of building applications to android, is the last step in the assembly stage. In this application, a testing stage will be carried out before entering the distribution stage. Before doing the application build process, select the player settings menu to change some of the necessary settings such as setting the minimum supported android system, application name, package name, application icon and much more. The format that will be generated when the application build process is complete is APK which is the format for the android operating system.

After doing some settings, then enter all the scenes that have been created into the build settings, then determine the destination platform that will be used, namely Android, then select the build and choose where to store the results of the application build.
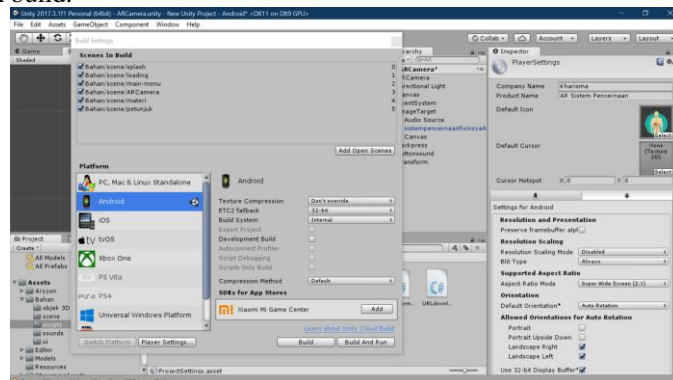

Figure 3.4. Application Build Form

3.2. Test result

The testing phase aims to ensure that the application that has been made will run according to the right process and produce the appropriate output based on the concept that has been designed, as well as find out if there are errors that may exist in the application. There are two methods of testing that will be carried out on applications that have been made, first by application makers and secondly by prospective application users by means of Alpha Testing and Beta Testing. The application testing phase will be carried out on an Android smartphone with a minimum specification of the Android 5.0 (Lollipop) operating system.

a. Alpha Testing

Alpha testing is a test that is carried out by finding out whether there are errors or not in a system that focuses on the functional requirements of the software being built. This test uses blackbox testing that focuses on the functionality requirements of the system being built. The test results can be seen in the application test table below:

Table 3.1 Program Test Results

No	Scenario	Expected results	Test results
1.	Open the app	Enter the splash screen view	In accordance
2.	*Splash screen.*	*Loading can run and go to the Main Menu page.*	In accordance
3.	Pressing the Start AR tombol button.	Opens the camera on the user's smartphone.	In accordance
4.	Pressing the Info button	Go to the Info page about the stomach	In accordance
5.	Pressing button About app	Go to the app's about page	In accordance
6.	Press the download marker button	Go to the marker download page	In accordance
7	Press Exit Button	Exit the app	In accordance

Table 3.2 AR Play Menu Test Results

No	Scenario	Expected results	Test results
1.	Push the button Start AR.	Activate the user's smartphone camera.	In accordance
2.	*Stomach system marker scan*	Can scan markers and display animated 3D objects.	In accordance
3.	Press the Back button.	Back to Main Menu page.	In accordance
4	Pressing the zoom button.	3D objects can approach and move away.	In accordance
5	Pressing the Start AR tombol button.	Activate the user's smartphone camera.	In accordance

Tabel 3.3 Hasil Uji Menu Download Marker

No	Scenario	Expected results	Test results
1.	Pressing the Download Marker button.	Link to the Google Drive website page.	In accordance
2.	Press the Back button.	Back to Main Menu page.	In accordance

b. Beta Testing

Beta testing is a test that is carried out with the aim of knowing how far the quality of the system in the application that has been built, whether it has met expectations or not. For this reason, in Beta testing, research is carried out on respondents or application users by collecting data using questionnaires or questionnaires. This process is a decision that a digital product or application is suitable for use by users. Digital products at this stage are also still in the testing category to eliminate potential damage to a digital product.

Table 3.4. Beta Test Results

No	Question	Evaluation 4	3	2	1
1	Can the application be easily operated by the user?	15	4	1	
2	Is the menu contained in the application complete enough?	2	17	1	
3	Can this application add insight into stomach acid?	1	18	1	
4	Is the content and animation in this application enough to give an idea of how the process of stomach acid occurs?	11	5	2	2
5	Is the application suitable enough to be used as a tool in the process of understanding stomach acid?		20		
6	Is the application content design interactive enough?	10	7	3	
Total		**39**	**71**	**8**	**2**

Based on the data from the questionnaire, it is possible to calculate the percentage of each answer. To calculate the percentage amount can be done with the following formula :

$$Y = \frac{\sum jr}{q \, x \, p} \; x \; 100\% \tag{1}$$

Information:

Σ = Number of respondents' answers q = Number of questions

p = Number of respondents Y = Percentage value

The results of the percentage calculation for each answer are as follows:

1. Strongly Agree $\qquad Y = \frac{\sum jr}{q \, x \, p} \, x \, 100\%; \qquad Y = \frac{39}{6 \, x \, 20} \, x \, 100\% \; = 32\%$ **(2)**

2. Agree $\qquad Y = \frac{\sum jr}{q \, x \, p} \, x \, 100\%; \qquad Y = \frac{70}{6 \, x \, 20} \, x \, 100\% \; = 59\%$ **(3)**

3. Disagree $\qquad Y = \frac{\sum jr}{q \, x \, p} \, x \, 100\%; \qquad Y = \frac{7}{6 \, x \, 20} \, x \, 100\% \; = 6\%$ **(4)**

4. Don't agree $\qquad Y = \frac{\sum jr}{q \, x \, p} \, x \, 100\%; \qquad Y = \frac{2}{6 \, x \, 20} \, x \, 100\% \; = 2\%$ **(5)**

IV. CONCLUSION

From the results of the research that has been done, it is concluded that the application of information media for visualization of gastric acid reflux by utilizing augmented reality technology from the stage of collecting reference materials in the form of videos, to implementation in the form of 3D modeling, was successfully carried out and became a reference in making gastric acid reflux animation using Blender. Furthermore, the applications that have been built can be run on Android-based smartphone devices. Based on the results of testing with puskesmas officers and the general public and also through questions related to interface design, animated content, through questionnaires, the conclusion is that the application is quite good. This can be seen from the results of the tests that have been carried out by researchers on the percentage of test results, where the results of the questionnaire 32% stated strongly agree, 59% agreed, 6% stated less agree and 2% disagreed. So the application of visualization of gastric acid reflux using mobile-based Augmented reality is feasible to be used as a visual medium for gastric acid reflux.

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