Virtual Reality Markerless Based on 3D for the Representation of Heart and Circulatory System

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Abstract ---The heart is the most important organ of the human body. The heart is the most important organ of the human body. But due to the lack of practice and knowledge of people about the mechanism of heat flow, many of the students do not understand how the heart works. Learning media that are directly related to the heart such as visual aids can only be found in certain places, so not everyone can know for sure how the heart shape apart from the video or reading media. With the development of technology today, thus encouraging the educational process to be more interesting and applicable in order to improve the quality of education and learning interests of learners. Virtual Reality learning media (VR) are a technique of displaying objects directly where users can interact directly with objects that have been prepared in a virtual space created. The development of an application that aims to show interactive 3D learning media using 3D animation and simulation of the circulation of blood and human heart as much as 3 parts. This is intended to facilitate users, especially for students and the public in recognizing the human circulatory system interactively.

Keyword--- Circulatory Heart; Simulation; Virtual Reality

1. Introduction

The heart's main function is to pump blood to the lungs for oxygenation and to the systemic circulation for oxygen and nutrient exchange. Looking at the heart from this 'mechanical' perspective, cardiac development must end with a fully functional pump. Heart development has to be exquisitely sensitive to the mechanics of pumping and blood circulation to ensure optimal cardiac performance; and to maximize the chances of the embryo surviving under different environments, it has to be adaptable to changes[1]. The cardiovascular system is a system that gives facilities a variety of transportation process, and to the substance of the cells of the body. This system consists of organs of locomotion called heart, and channel system consisting of arterial flow blood from the heart, and the veins which drain blood toward the heart. For many years, extended reality technologies have promised physicians the ability to move beyond 2-dimensional (2D) screens, allowing them to understand organ anatomy in 3-Dimensions (3D) noninvasively[2]. Learning from existing organs within the body more realistic by using AR, then doctors and experts will be able to make more informed decisions. Limitations the means as well as a vehicle to achieve these demands in a variety of educational establishments is a challenge to print high-quality graduates it is necessary for innovation and learning media markedly.

Exploration applications were mainly used for life sciences topics in out-of-class settings, using location-based AR, whereas simulation applications were used mainly for mathematics and physics instructional learning environments, carried out in in-class settings using either image-based or marker-based AR[3]. Current technological developments are supported by increasingly good and sophisticated graphic displays. To boost the growth of tourists, in the future there needs to be an empowerment, both human resources and improving the quality of modern technology facilities, namely Virtual Reality which refers to the concept that all objects can be explored like the original world, can walk in all directions, look at everything direction, rotate, and explore the surroundings[4]. One method of Augmented Reality that is now developing is the "Marker-less Virtual Reality" method, with this method the user can reduce the use of markers to display 3D objects that have been created. Marker-less trackers are likely to expand the applicability range being less intrusive and usually requiring minimum or zero setup effort of the final user[5]. Marker-less Virtual Reality possible every object or entire room can be used as an object. Marker-less in Virtual Reality is a technology that is more sophisticated than Virtual Reality or Virtual Reality that uses markers. Without a marker, the user can easily use a room without being bound to the markers that have been made on the application.

Based on the facts and the problems that exist in the conduct of the introduction of the circulatory system and

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heart of human most visual-based learning system where there are props that only exists on a particular space space are indeed based on learning of the heart such as hospitals or schools of medicine and science. In addition, other learning media is through internet video or text only, did not know how the interaction of the heart as well as the actual form. Therefore, with Virtual Reality technology is expected to be easier with can be used by all circles from both the medical students as well as the general public to find out about the heart. The aim of this research is to present information regarding the system of blood vessels and the heart with a more interactive media, feature Simulated 3D animations. This android-based application intended to simplify user to access it. A system built to take the picture that has been entered in the database which includes: Blood: Erythrocytes, Leukocytes, Platelets- Heart: the right Booth, booth left, right, left atrium - Blood vessels: the structure of blood vessels Systems that were built just removing the 3D images and messages in the form of writing as if the camera has captured the object The system is built using the technology of Virtual Reality The main device used are VR Box 1.00 and Controller.

2. Related Work

Rapid development in the mobile computing arena has allowed extended reality technologies to achieve performance levels that remove longstanding barriers to medical adoption. Human body anatomy has become an important topic in Biology subject that must be understood since junior high school. Learning materials are mostly available in the form of book and anatomy mannequin (puppet), but it is still insufficient enough to help students in understanding human body anatomy. Concerning the difficulty of understanding this and the future development of AR, a web-based AR application is developed to support the human body anatomy learning[6]. The development of a prototype educational tablet application called Human Anatomy in Mobile-Augmented Reality (HuMAR) utilizing AR technology. This HuMAR application is currently implemented as a learning tool, designed to enhance learning and foster student motivation and to increase the learning outcomes in skeletal anatomy [7].

In Educational and Training Healthy field Interactive Anatomy-Augmented Virtual Simulation Training has module that use videos and skill demonstrations does not always allow for the interactive visualization of internal structures and anatomical landmarks that would assist the student learner in performing the skill in a way that they could practice in real time with feedback[8]. In order to improve the quality of knowledge of maternal health three-dimensional transvaginal ultrasound in combination with virtual reality (VR) which was developed to perform accurate and reliable visualization of the structure of the embryo and placenta with real depth perception. Technically, new biometry and volumetric measurement methods are possible to contribute to the embryonic and early placental health (*patho*) knowledge. Examples of these measurements are the length of complex structures such as the umbilical cord, vitelline duct, limbs and cerebellum or the overall volume of the embryo and brain cavity[9]. In addition to the physical health field, the press through VR- was also carried out to improve the ability of emotional and social adaptation for children with autism spectrum disorder (ASD) delivered with evaluation results. The research hypothesis states that children with ASD will improve them and social adaptation skills after training. More precisely, the skills and abilities of children Emotional recognition, expression and regulation, social interaction and adaptive skills are expected to be improved through this application. The research's prime priority focuses on expression and regulation, and social interaction, while our secondary results include emotional recognition and adaptive skills[10]. Developing simulation modules takes great effort from the developers, because the technical background of VR-based surgical simulators ranges widely (including computer graphics, physics, haptics, real-time simulation, and so on). VR can be considered to provide information regarding treatment of burn patients, who present themselves as Solutions and benefits for nursing care and multidisciplinary health team, and recent absence revision on the subject, database search of patient based conditions VR and effects in the care of burnt patients can provide information non-pharmacological complementary strategy in the context of scientific world literature[11]. VR and computer simulation refer to a human computer interface that facilitates highly interactive visualization and control of computer-generated 3D scenes and their related components with sufficient details and speed so as to evoke sensorial experience similar to that of real experience[12]. 3D AR is basically possible to support radiologists to find clear about anomalies such as micro distribution and thus a more accurate diagnosis process. Moreover, the progress of AR tourism can provide needs from a more complete diagnosis error with better care, reducing patients and producing lower costs[13].

Virtual reality (VR) surgery using Oculus Rift and Leap Motion devices is a multi-sensory, holistic surgical training experience. A multimedia combination including 360 videos, three-dimensional interaction, and stereoscopic videos in VR has been developed to enable trainees to experience a realistic surgery environment. The innovation allows trainees to interact with the individual components of the maxillofacial anatomy and apply surgical instruments while watching close-up stereoscopic three-dimensional videos of the surgery[14]. Simulators in otolaryngology mimic the variety of surgical techniques and environments present in this surgical

subspecialty. There is also a range of simulators including physical and virtual-reality simulators. Virtual-reality simulators allow the operator to interact with an environment that is generated by a computer[15].

3. Method

A. Requirement Analysis

1. Data collection

Data collection techniques are carried out with several techniques. Namely literature studies, observations and interviews. Where library studies are conducted to explore theories of articles, books, journals and other readings related to Virtual Reality. While observation is done by observing and recording and searching information about previous research so that it can be used as a reference and information. In the immediate implementation, an interview was conducted by one of the nursing faculty students at Universitas Muhammadiyah Sidoarjo were several questions were asked about the circulatory system in the human body.

2. Requirement Analysis

A system that will be built based on Android. In its application will be made a marker media in which there are several markers with a predetermined pattern where each marker will be identified its coordinates and will display 3D objects. The objects that will be displayed are objects of the human body and heart and each marker displays the 3D animation heart object according to the database that has been stored. This stage also analyzes user requirements, hardware specifications and software needed for making the application.

B. Implementation and Configuration

1. Create a 3D object / Modeling

The creation of human circulatory system objects in 3D is made using Blender 3D software. At this stage, will be created 3-dimensional objects in the Human Body blood circulation system, namely Heart, Blood circulation, and blood. The object that has been made is given a material in the form of color or texture that is good and resembles the actual object. So that when the application is run the application is better and interesting after coloring the object, the object is given an animation that matches the movement of the original object. So that the simulation in the application will be more real. Export the created object using the fbx converter plugin. so the file is ready to be imported into the Unity Engine.

2. Configuration

The 3-dimensional objects that have been created in the previous stage will be processed or configured to become the desired application. This process is made using Unity 5.6.5f1 software. In this configuration using GoogleVR as an asset for SDK virtual reality to run as virtual reality. GoogleVR can be downloaded on the available Asset Store. Configuration is also followed by making a Scene that will be displayed in the application. These views include:

1) Splash Screen
2) Tutorial App
3) Main Menu
4) Heart Menu
5) Blood vessel menu
6) Blood menu
7) Simulation Menu

In the last stage, build APK is done so the application can run on Android.

4. Result

Applications that have been created in the form of files. APK in your copy into the Android smartphone, which is then installed on a smartphone Android APK so it can run VR360. Following is the display of the application install process. Next the splash screen will appear as early application will run. In the main menu there are 5 menus that will direct to each scene, namely the heart, blood, blood vessels, simulation, about the app. In each scene will explain each of the uses, functions and display the moving 3D models. Following is the display of the menu of the heart scene. Description about animation the 3D animation in figure 3 -10.From the results of the experiment shows this application can be run and how it looks on Android smartphone resolution 720 x 1280 px. If resolution is not 1280 x 720 px then the look of the application does not comply could be larger or smaller, as shown in table 1-3. From the experiment results comparison application load time on each of the Android smartphone is the process of distinguishing load VR and objects that can be affected by the number of applications installed as well as the existence of the gyroscope feature on Smartphones.

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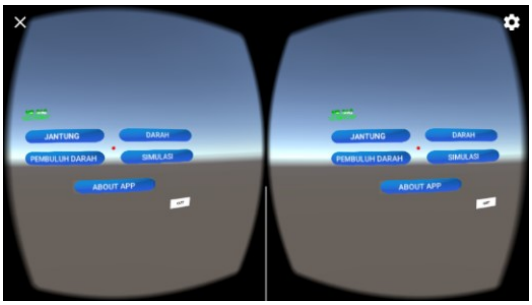

Figure 1. Display result of Main Menu scene

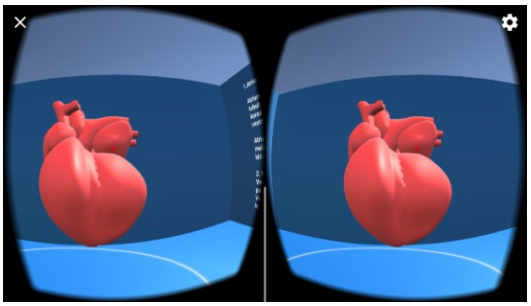

Figure 2. Display of Animation Heart 3D Menu

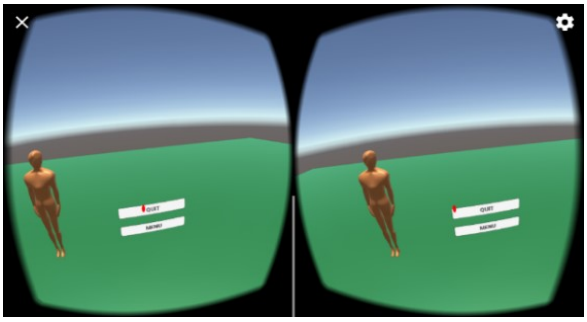

Figure 3 Display result of simulation scene

Figure 4. Display result of simulation scene

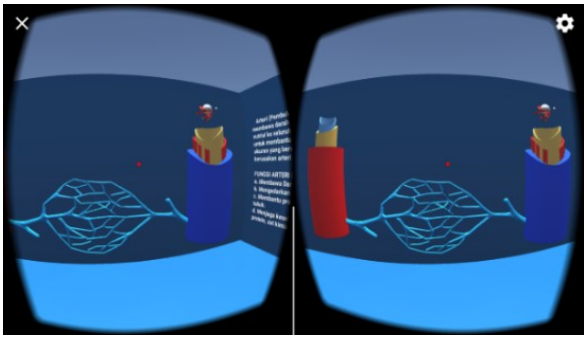

Figure 5. Display result of blood vessels 3D animation

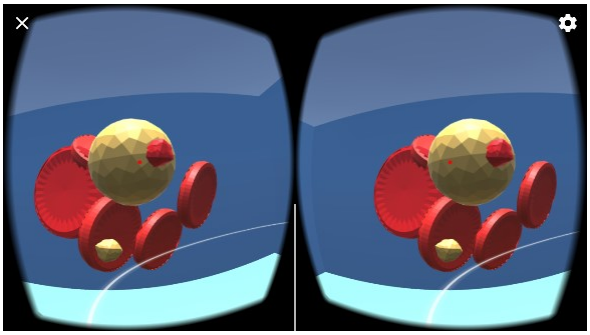

Figure 6. Display result of 3D blood animation menu

Table 1. Comparison of Android Smartphone Spesifications

Phone Specification	PHONE I	PHONE II	PHONE III	PHONE IV
Brand	Xiaomi Redmi 5	Oppo A37	Samsung 5a	Infinix x551
Android Version	Nougat 7.1	Lollipop 5.1	Lollipop 6.1	Lollipop 5.1
Processor	Quad Core 1.0 GHz	Quad Core 1.2 GHz	Quad Core 1.3 GHz	Quad Core 1.3 GHz
Resolution	720 x 1280 px	720 x 1280 px	720 x 1280 px	720 x 1280 px
Running display	Yes match	Yes match	Yes Match	No No Match

Table 2. Comparison of Time Load Applications on Android Smartphone

PHONE Specification	PHONE I	PHONE II	PHONE III	PHONE IV
Load splash screen	3 sec	3 sec	3 sec	-
Load Main Menu	10 sec	12 sec	13 sec	-
Load Heart	7 sec	8 sec	12 sec	-
Load blood vessels	3 sec	4 sec	3 sec	-
Load Blood	4 sec	5 sec	5 sec	-
Load Tutorial	3 sec	3 sec	3 sec	-

Load Simulation	12 sec	13 sec	14 sec	-

Table 3 Trial results display of 3D objects on Android smartphone

PHONE Object 3D	PHONE I	PHONE II	PHONE III	PHONE IV
Heart	v	v	v	-
Blood	v	v	v	-
Blood Vessels	v	v	v	-
Simulation	v	v	v	-

5. Conclusion

The result of the development of Virtual Reality Markerless 3D human circulatory system is an application called VR360 Human circulatory system. This application was developed using 3D Simulation with Unity3D as the game engine, where the user can view 3D objects and animation. The object is created using the program blender, with some of the 3D animation is controllable by the user. There are features of this application is the user interaction against objects that can display that object information. From the results of the experiment to display 3D objects generate that from 3D objects the circulatory system and heart there is Android smartphone that cannot be smoothly using this application. This is because the large number of applications that are installed as well as the processor and the android version used.

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