Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based

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Abstract. The quality of the education can be improve with the use of learning media. Learning media can be used as the development of teaching methods with conventional techniques into teaching methods using information technology. One of them is the learning media with utilization of virtual reality technology in the field education, especially in science lesson. Human circulatory system is one of science lesson which is considered difficult by student. This is because the subject matter have the microscopic organ and process that can not be seen directly. The use of learning media with virtual reality based can increase students curiosity about what is being learned. Application of learning media based on virtual reality called “Bloodyou” is a learning media application about the human circulatory system is equipped with 2D animated content 360 degrees, visualization of organs in 3D and simulation of the circulatory process. The creation of 2D and 3D assets is done using Luther’s multimedia software development method. Testing on making 3D and 2D asset is done by Likert scale calculation on each answer. From the test results obtained the average value of answers that show the results strongly agree with the results of the making of 2D and 3D assets that exist in the application of interactive learning media of the human blood circulation system based on virtual reality.

1. Introduction

The use of learning media is growing along with the development of technology. One of them is virtual reality-based learning media, where virtual reality is a technology that presents the visual experience that is displayed on the computer screen or through a stereokoptic viewer such as Google Cardboard glasses. Based on the results of interviews conducted with teachers of Biology class 8, the human circulatory system is a material that is difficult to understand by students. Difficulties caused by the concepts in the material of the human blood system are abstract, including microscopic objects and organs and processes that can not be seen directly by the students. This causes the material difficult to understand if it is only conveyed through with words, because the processes that occur in it are difficult to observe. In addition, many terms referring to the drawing make the teacher have to explain in detail, but because the teaching-learning activities are limited, much of the material must be understood by the students themselves. The process of learning is done only to use lecture techniques and see the object of supporting images only through the book. It is necessary to improve the quality of teachers' recruitment by utilizing the development of information technology in the form of learning media [9]. Utilization of virtual reality technology in the field of education, especially in the field of science can motivate students' desire to learn. This instructional media application will present an interesting visualization to increase user interest in understanding the content of the material from making this interactive learning media [11]. So it takes the asset object 3D and 2D to support the
manufacture of interactive learning media using virtual reality technology. Making this asset will produce an object image that resembles the original object in terms of shape, so that the object will look visible and can help users in understanding the learning materials contained in the application [12].

2. Literature Review

2.1 Interactive Learning Media

According to Gagne Briggs, learning media includes tools that are physically used to convey the content of teaching materials, which include books, tape recorders, cassettes, video cameras, films, slides, photographs, graphics, television and computers. Sadiman (2008) explains that instructional media is anything that can be used to transmit messages from the sender to the recipient of the message. From both definitions, it can be concluded that the learning medium is an intermediary that is used to distribute information content of teaching materials from the sender of the message to the recipient of the message [6]. Interactive learning media is a combination of learning media by combining multimedia elements. Interactive learning media utilize computers to combine text, graphics, audio, moving images (video and animation) into a single entity with links and appropriate tools that enable multimedia users to navigate, interact and communicate [8].

2.2 2D Object

Graphic objects 2 Dimensions or 2D are formed on the dimensions of length and width in one flat plane, so there is only length and width only in the absence of thick dimensions. The 2-dimensional plane can be illustrated with X and Y axes or the two-dimensional axis coordinate cartes. 2-dimensional object consists of 2 types, namely bitmap and vector [1].

a. Bitmap Image

A bitmap image is a graphical object consisting of pixels. Each pixel or bits in the object contained the color information to be displayed. Bitmap has a fixed resolution and can not be enlarged because it will eliminate the sharpness of the resolution. Bitmap has several types of file extensions: JPEG, TIFF, GIF, PICT, BMP, etc. The drawback of a bitmap image is the size of the image when it is changed. The effect of this bitmap image is to cause the image to be broken or less detailed when printed at a lower resolution. In other words, the nature of the Resolution Dependent raster image causes the low resolution image difficult to change to be high resolution. Conversely, high resolution images are easy and safe to convert to low resolution.

b. Vector Image

The vector image is a collection of several lines and curves. Vector images represent the development of a bitmap (digital) graphics system. Vector type images are not slammed on the number of pixel constituents, because the vector display is composed of lines so that the display will look clear when done magnification (zoom). The use of certain coordinate points and formulas can create various forms of graphics such as circles, triangles, squares and polygons. The use of vector graphics will be more efficient in terms of file volume, but in terms of use the processor will take a lot of memory.

2.3 3D Object

3-dimensional object (3D) is an object or space that has a long, wide and high that has a shape. 3D is not only used in math and physics, but in the field of graphics, art, animation, computers and others. 3D concept shows an object or space has three geometric dimensions consisting of depth, width and height. The term 3D is also used to denote representations in computer graphics (digital), by removing stereoscopic images or other images in aid, and even simple stereo effects that construct a 2D effect (in the perspective projection, shading calculations). The 3D characteristic refers to three spatial dimensions, that 3D shows a Cartesian X, Y, and Z coordinate points. The use of this 3D term can be
used in many fields and is often associated with other things such as additional qualitative specifications (eg three-dimensional graphics, 3D videos, 3D movies, 3D glasses, 3D sound) [2].

2.4 Human Circulatory System

The circulatory system in humans is a closed and double circulatory system. Blood circulation is closed, meaning that blood flows or circulates through the blood vessels in the human body. Duplicate blood circulation means in a single circulation, blood through the heart twice. (Team Abdi Guru, 2016). The circulatory system in humans is divided into two parts. Because of these two circulatory systems, the circulatory system in humans is called the double circulatory system. Human blood circulation through the blood vessels so that the human blood circulation is called closed blood circulation [7].

2.5 Blender

Blender is one of the software used to create multimedia content, especially 3D or 3 Dimensions. Blender is an open source software, where we can freely modify the source code for personal and commercial purposes, as long as it does not violate the GNU General Public License used Blender. Blender is available for a variety of system operations such as Linux, Mac, and Windows. So the files created using Blender versions of Linux will not change when opened in Blender versions of Mac or Windows. Blender Status is Open Source, making Blender can be developed by anyone, so this software update is much faster than other similar software. Blender has a more complete feature of other 3D software, such as Video Editing feature, Game Engine, Node Compositing, Sculpting [2].

2.6 Adobe Illustrator

Adobe Illustrator is one of the most widely used software by graphic designers around the world. Adobe illustrator has the ability to create a variety of interesting and unique creations. This software can also be used for a variety of graphic media, such as creating a site interface, vector-based three-dimensional creation, creating advertisements, promotional media (brochures, posters) and so forth [10].

2.7 User Interface Design

User Interface Design or UID aims to design an effective interface for software systems. Effective in terms of ready for use and results according to user requirements. Users often assess the application or system of its user interface, not from its function. Poor user interface causes the user to make a fatal error. Therefore, there is an evaluation process conducted on the design results. The principles in designing the user interface are as follows [13].

a. User Familiarity
   In creating a user interface, use terms, concepts and user habits instead of computers. Examples in office systems use the terms letters, documents, folders instead of directories, files, identifiers.

b. Consistency
   The consistency in operation and the term of the whole system is therefore not confusing. Like the layout of the menu in the open office similar to the menu layout in MS office.

c. Minimal Surprise
   The operation may be suspected to be a process based on the commands provided.

d. Recoverability
   Recoverability is a confirmation of destructive actions and availability of cancellation facilities (undo)

e. User Guidance
   Online manual system, help caption menu on special icon available.
f. **User Diversity**

   Interaction facilities for different types of users are provided. For example, the size of the letter can be enlarged.

### 3. Model Luther

Luther (1994) defines multimedia software development steps in 6 stages: concept, design, collecting materials, assembly, testing, and distribution. Each stage is not necessarily sequential, but can be done in parallel with the planning stages (concept and design) [3].

#### 3.1 Concept

The concept or concept stage is the stage to determine the purpose of the application, who the program user (audience identification), the type of application (presentation, interactive, etc.), and general things. The basic rules for the design stage are also set and determined at this stage, such as style, application size, platform to use, and more. The output of this stage is a narrative report document to reveal the purpose of the project to be achieved.

#### 3.2 Design

Design is the stage of making a specification about the architecture, style, appearance, and material needs for programming. The specifications are made in detail so that the next steps, the collecting and assembly materials can be done without the need to take new decisions, simply by using the decisions that have been determined at this stage. However, in practice, project work in the early stages will often experience additional material or subtraction of parts of the application, or other changes. The design stage usually uses storyboards to describe the description of each scene, by listing all the multimedia objects and links to other scenes and flowcharts to describe the flow from one scene to another.

#### 3.3 Material Collecting

**Material collecting** is the stage of collecting materials that match the needs done. Such materials include clip art images, photographs, animations, audio, video and others are obtained for free or by ordering to others in accordance with the design that has been made. This stage can be done in parallel with the assembly stage. However, in some cases, the collecting material stage and assembly stage will be done linearly and not parallel.

#### 3.4 Assembly

The assembly stage is the stage of making all objects or multimedia materials. Application creation is based on the design stage, such as storyboard, flow chart, and / or navigation structure.

#### 3.5 Testing

Testing stage is done after completion of the assembly stage by running the application or program to see if there is any error or not. The first stage is the alpha test phase (alpha test) whose testing is performed by the manufacturer or the manufacturer's own environment. After escaping from alpha testing, beta testing is done by involving end users or audiences.

#### 3.6 Distribution

At this stage, the application will be stored in a storage medium. If the storage media is not sufficient to accommodate the application, compression of the application will be performed. This stage is also called the evaluation stage for the development of ready-made products to become better. Evaluation results can be used as input for the concept stage of the next product.
4. Design and Implementation

4.1 Design of Virtual Reality Application

Making interactive learning media about the human circulatory system based on virtual reality requires a good planning and mature. This planning will give an overview of the application that will be generated. The better the planning is made, it will minimize the occurrence of errors in the end result of the application. One of them is planning on making object asset 3D and 2D as content of instructional media application. The methodology used in making these assets is Luther's methodology which consists of six stages. The first three stages of concept, design, and collecting materials will explain the design part of the application program.

4.1.1 Concept of Virtual Reality Application

Application of interactive learning media of human circulation system based on virtual reality is an application made as a learning media for students of Class 8 SMP / Mts about human circulatory system. This application uses a simulation concept that gives the sensation as if it is in the circulatory system and passes through the parts to be traversed by when the blood drains. In addition, this application also presents 2D animated video with a scope of 360 degrees as an introduction to the story of the application program. Virtual reality application for interactive learning media of the human circulatory system displays human organs such as heart and lungs in 3D. This application also presents features about diseases related to the human circulatory system. This feature is presented in a simulated form so that users will know the difference of the circulatory system in normal work and in a state of abnormality.

4.1.2 Design of Virtual Reality Application Asset

The design of virtual reality applications is included in the second stage of the Luther method. At this stage the storyboard is made of application and design sketches for logos, user interfaces, character sketches and 2D backgrounds based on animated illustrations & 3D modelboard modeling based on shapes in the human circulatory system.

a. Storyboard of Application
   Storyboard application is made to facilitate the process of making asset required for the user interface on the application.

b. 2D Asset Design
   2D asset design is made to facilitate the creation of characters and backgrounds that will be used for the creation of 2D animation.

4.1.3 Material Collecting Aplikasi Virtual Reality

Material collecting is the third stage of Luther's method of collecting materials for the process of making the assets to be worked on. Such materials include photo or image research from organs such as heart, lungs, visualization of circulatory system, red blood cell shape, white blood cell, oxygen, carbon dioxide and sickle cell reference for 3D modeling of related objects.

4.2 Realisasi Pembuatan Asset 2D

There is the description and realization of 2D asst for virtual reality applications.

4.2.1 Application Logo

In making an interactive learning media, generally the logo created by using the title of the learning media. Making the logo “BloodYou” is begun by making a storyboard design or sketches that will be in the application on learning media. Designing for logos using the Adobe Illustrator CC 2015 software. The technique used to create the basis of a logo is to manipulate the elliptical shape of the
Ellips Tool by adding some point required by using the Add Anchor Pen Tool. In this application logo added stylize outer glow effect so it will get the end result of logo creation as in the following picture.

4.2.2 Making of User Interface

In making the design of the user interface, the image needed to be the background on the interactive learning media. Making the User interface begins with a storyboard or sketch of objects to be created. The sketches that have been made are imported with the art size of 640x360 pixels. Making buttons for main menu using rectangle tool, horizontal type tool and insert background image with reduced opacity

![Button Interface](image)

**Figure 1. Button Interface**

4.2.3 Making of Character and Background

In the creation of animated characters, the vector image type is used to prevent blur or pixilation during penganimasian. Designs that have been made will be digitized. Digitalization in question is to do the process of tracing and coloring digitally in the manual image. Create a new layer above the imported image to perform tracing. The tracing technique is done by using Pen Tool or digital pencil. To color the tracing results use the fill color and outline color menu located in Control Panel.

4.3 3D Object Implementation

After designing the design and reference collection for 3D assets for the interactive learning virtual circulation system based on virtual reality is complete, the next stage of the realization will be done. This stage of realization is the Assembly stage of Luther's methodology.

4.3.1 Human Object Modeling

The basic design of the human form in 2D form that has been collected in collecting material is used as the basic reference or blueprint in the manufacture of human objects in 3D. The technique used is the technique of using basic objects such as cube, plane, sphere or cylinder. The first part that is made is part of the body by manipulating the base object of the cube so as to form like the body on the basic design design. Techniques used in manipulation are common techniques such as translate, scaling, rotate, extrude, mirror, loop cut and slide and merge. Loop cut and slide is a technique used to provide edge on the surface of 3D objects. The mirror technique is used to create a symmetrical 3D object between the right and left objects. When the object is modified then the opposite position of the object will be modified simultaneously. This technique helps to create 3D objects that have symmetrical parts like the human body as in the picture.
4.3.2 Material for Human Object Model

To apply the material for objects in human modeling look transparent, check the box transparency set alpha and Fresnel options. To get a transparent result on the object, change the alpha in the transparency menu to 0.162 and Fresnel to 2.100, so that will get the results as in the picture.

5. Conclusions

Based on the work of thesis entitled "Making 3D and 2D Object Assets for Interactive Learning Media" Human Circulatory System "Virtual Reality Based" can be concluded that:

1. This research succeeded in making user interface design application, character creation, 2D animation background and 3D object modeling for interactive learning media application of human circulation system based on virtual reality.
2. Based on alpha testing results, showing valid results in asset creation for virtual reality applications, except for 3D objects that will be used for simulation show invalid results when inserted in Unity, but immediately made improvements.
3. Based on the results of beta testing, obtained an average answer value of 121. This value proves that respondents strongly agree with the results of the making of 2D and 3D assets in the application of interactive learning media of the human circulatory system based on virtual reality.

References

[1] Anonymous, 2018. NANOPDF. [Online] Available at: https://nanopdf.com/download/animasi-objek-2-dimensi-animasi-objek-2-dimensi-terdiri-dari_pdf [Accessed 19 Maret 2018].
[2] Ardhianto, E., Hadikurniawati, W. & Winarno, E., 2012. Augmented Reality Objek 3 Dimensi dengan Perangkat Artoolkit dan Blender. Jurnal Teknologi Informasi DINAMIK Volume 17, pp. 107-117.
[3] Binanto, I., 2010. Multimedia Digital Dasar Teori dan Pengembangannya. Yogyakarta: Penerbit ANDI.
[4] Desstya, A., 2014. Kedudukan dan Aplikasi Pendidikan Sains di Sekolah Dasar. Profesi Pendidikan Dasar, pp. 193-200.
[5] Gunawan, D. L., Liliana & Satiabudhi, G., 2016. Pembuatan Kebun Binatang Virtual untuk Pembelajaran Mengenai Binatang Liar. Jurnal INFRA.
[6] Juannita & Adhi, B. P., 2017. Pengembangan media pembelajaran sistem pencernaan manusia kelas 8 SMP dengan fitur augmented reality berbasis android. Jurnal pinter volume 1, pp. 54-59.
[7] Kwarrie, Y. N. P., Liliana & radion, K., 2015. Media Interaktif Pembelajaran Sistem Peredaran Darah Manusia.

[8] Miskowati, M., 2012. Pembangunan media pembelajaran geografi untuk siswa kelas VIII Sekolah Menengah Pertama Negeri 1 Karangpandan Berbasis Multimedia Interaktif. *Jurnal Sentra Penelitian Engineering dan Edukasi Volume 4 No 4*, pp. 34-39.

[9] Permna, M., Johar, D. & Bunyamin, 2014. Pengembangan Media Pembelajaran Interaktif Ilmu Pengetahuan Alam (IPA) Berbasis Multimedia. *Jurnal Algoritma*, p. 3.

[10] Rustandi, I., 2006. *Buku Latihan Membuat Desain Grafik Kreatif dengan Adobe Illustrator*. Jakarta: PT Elex Media Komputindo.

[11] Sahulata, R. A., Wahyudi, A., Givens, B. & Akri, M., 2016. Aplikasi Virtual Reality Pengenalan Kerangka Tubuh Manusia Berbasis Android. *Cogito Smart Journal*, pp. 204-215.

[12] Suprapto, 2016. Peningkatan Kualitas Pendidikan Melalui Media Pembelajaran Menggunakan Teknologi Informasi di Sekolah. *Jurnal Ekonomi dan Pendidikan*, pp. 34-41.

[13] Suteja, B. R. & Harjoko, A., 2008. Perancangan User Interface E-Learning Berbasis Web. *Seminar Nasional Informatika*, p. 36.