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Application of Photo-Realism in Making Gamelan Kenong 3D Objects in Gamelan VR

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Abstract: In creating a simulated world, it is very necessary that the environment, objects, and experiences be similar to the original conditions in the real world. Simulation can be carried out using virtual reality technology, in which environments and objects can be created as desired. The creation of these three-dimensional objects can be achieved by taking into account the ten principles of photorealism to get realistic objects like those in the real world. In this research, objects from the Kenong gamelan will be created using the principles or characteristics of photorealism. In this study, an assessment of three-dimensional objects was made by distributing questionnaires in which the selected respondents gave a value of 1–5 for each photorealism characteristic of each object. It was found that the 3D objects that were previously made received a value above the average, which means that they meet the characteristics of photorealism. Data was also obtained indicating that realistic 3D objects are required in a simulation in order for the simulation to be felt more strongly or for the user to feel the feeling as closely as possible when playing gamelan. It is recommended to follow the principle of photorealism when creating 3D objects for simulation needs.

Keywords: Photo-Realism ● 3D Objects ● Virtual Reality ● Simulation ● Gamelan

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1. Introduction

Nowadays, technology has developed rapidly to assist humans in carrying out their tasks in various fields, such as education and the arts. In the fields of education and the arts, technology can be used as an information medium [1], [2]. One of these technologies is virtual reality, which is a technology that allows us to simulate in a virtual world and provides a multisensory environment and 3D objects that allow users to enter a computer-made simulated world [3]. Virtual reality has real-time visualization and interactive features in the virtual 3D world that are very similar to scenarios that exist in the real world [4].

Virtual reality is an immersive and interactive technology and is a new way of interacting with the environment that can even help understand new approaches in relation to reality [5], [6]. This VR technology can help people get to know gamelan musical instruments in an immersive manner that obscures the real world and the digital world or a simulated world so that they are able to experience direct interaction in a 3-dimensional virtual world [7]. The problem is that the immersive world can be less felt by the user if the objects in this world are less similar to those in the real world, thus reducing the user's desire to get deeper into the immersive world. Simulation, according to Law and Kleton, is "a collection of methods and applications for imitating or representing the behavior of a real system, which is usually done on a computer with certain software" [8]. With this understanding of simulation, simulations in gamelan games in the virtual world must also present or describe gamelan as it is in the real world.

Virtual reality technology is now starting to seep into our daily lives. Several studies, such as those in the fields of education, marketing, entertainment, and health care, have shown that the use of immersive technologies enhances the learning experience, encourages participation in collaborative activities, and enhances creativity and engagement [9]. Thus, it is known that immersive worlds have begun to be widely used in various fields.

Virtual reality is also often used for the creation and development of games and simulations. as was done by an immersive technology company that has created several VR, AR, and even MR products called Arutala. One of the simulations that has been created is ARULAB Excav VR, which is a simulation with realistic heavy equipment controls to assist and optimize excavator training with lower risks and lower costs but maximum results [10]. Arutala is also developing games and simulations to play gamelan virtually. This simulation aims to introduce and provide instruction for users to learn gamelan musical instruments.

While writing this journal, the author is doing an internship at Arutala to develop a VR gamelan application where later users can practice and play gamelan using VR. If the VR gamelan application that was made by Arutala previously had a modern and futuristic impression, in

the VR gamelan application that was developed by Arutala with UAJY and ISI, it was desired that the gamelan and the environment be as similar as possible to those in the real world, so a survey was conducted on the Gayam16 community and ISI to be able to see the original form of gamelan. The problem that will be examined in this study is the application of photo-realism to making 3D gamelan objects in VR. 3D objects in a good simulation have realistic values. Then how do we create a 3-dimensional object so that it is as similar as possible to what is in the real world? In order to create a 3D object that is as realistic as possible, the photo-realism method can be used, which is even used in the world of art and film.

Three-dimensional assets are required in virtual reality technology as objects that interact with users. In the introduction of gamelan musical instruments through VR, it is necessary to have 3-dimensional objects that are as realistic as possible. This is done so that users can get to know this tool well even though they have never seen its original form. For example, if a person has never seen a gamelan in person and plays a VR gamelan application and the form of the gamelan does not match the original, then the person's first impression will be wrong about the actual form of the gamelan.

Making 3D objects is called "modeling" or "3D modeling," which is the process of making a three-dimensional representation of an object using special software. The purpose of this representation is to be able to convey the size, shape, and texture of objects. We can create 3D models from existing real objects as well as designs that have not been created in real life. If objects are to be used for simulation, the objects created must be similar to those in the real world [11]. This is because it is a representation of the real world, as previously mentioned.

An artist or artists is someone who usually creates 3D modeling. These artists use software to manipulate points in virtual space (vertices) to create meshes. The mesh itself is a collection of nodes that form an object. There are also many programs used to create 3D objects, one of which is Blender. A 3D object can be created automatically or manually by changing the shape of the mesh or manipulating the vertices.

Then how is a three-dimensional object created? Object creation usually begins by generating some initial forms, which are commonly called "primitives." These primitive shapes are like balls, cubes, or planes. This primitive form is just a raw shape or initial form to start modeling. Artists will make this basic shape, which will be manipulated using various modeling tools and changed in such a way that it becomes a more complex shape [11].

3D modeling is already used in various fields such as engineering, architecture, film, entertainment, games, and advertising. In the world of 3D film, this is used in making CGI, animation, and backgrounds. A famous example of using 3D modeling in movies can be seen in James Cameron's Avatar. The use of 3D objects helps viewers or VR users feel like they are in

the real world or in real-life situations. Based on research, it was also found that the use of 3D objects can improve the user experience [12].

We can use photorealism in a simulation world where the setting and objects must resemble the real world as closely as possible. In the world of painting, photo-realism is a style that demands the subject matter to be either real or already exist. The quantity of sightings generated by this method is very close to or on par with reality. According to Richard Estes, "photo-realism" refers to a painting that is based on a photograph. Because paintings can be improved with color, strokes, and texture by the artist's hands, the results of paintings based on photographs are typically better than the originals [13].

Over time, today's artists are not only people who can paint; digital art makers can also be called artists. Digital art is a work created with the help of or presented with digital technology. Making digital art usually uses software such as Adobe Illustrator, Corel Draw, and so on. Examples of today's digital art are vector art, WPAP, illustration art, 3D art, and many more. Therefore, 3D objects artists, when they create an object based on the real world, can use this photo-realism to create an object that looks real. However, photorealism was discovered long ago and has been used for a long time.

Photo-realism first appeared in the late 1960s, after Pop Art and Minimalism. Richard Estes, Chuck Close, and Ralph Goings were some of the first to attempt the precise replication of photographic imagery and were eventually considered the founders of the photo-realism movement. The term "photo-realism" was officially coined by Louis K. Meisel when it appeared in print as part of the 1970 Whitney Museum Catalog, "Twenty-two Realists." captured by cameras to create illusionist paintings, drawings, and other works of art. Artists typically project their photographs onto canvas to enable images to be captured with precision and accuracy [14].

In the past, artists used photographs as a reference to create their realistic paintings; it was the same as creating 3D objects with photo-realism. In making 3D objects in the Blender software, we can enter the original photo of the object to be made, then create a 3D object by following each curve of the object so that the shape will look very similar to the original object from our previous image. According to 3D artist Bill Fleming in his published book on photo-realism, photo-realism has a characteristic where the points are used to make an object look like the original object. The characteristics of photorealism are as follows [2]:

      a. Clutter and Chaos: where the resulting object is not perfect and has defects

      b. Personality and Expectation: Results that are as Expected

      c. Believability: It looks like real conditions.

d. Surface Texture: has a texture on the surface of the object

e. Specularity: has a level of reflection on an object

f. Dirt, dust, and rust: the object looks slightly dirty, dusty, or rusty.

g. Flaws, Scratches and Dings: Objects have several effects, such as being clawed, rubbed, or hit.

h. Beveled Edges: a side effect that isn't as stiff

i. Object Material depth: has a depth-level perspective

j. Radiosity: has a radiation effect.

By making 3D objects with photo-realism so that they are as similar as possible, it is hoped that the VR Gamelan Application can make it easy for users to recognize gamelan in detail according to what is in the real world. Photo-realism is also an important factor in interactive emotional scenarios where it enhances the feeling of being present in a real space and is perceived as more visually appealing [15].

2. Methods

The research method used in this study can be seen in Figure 1 below:
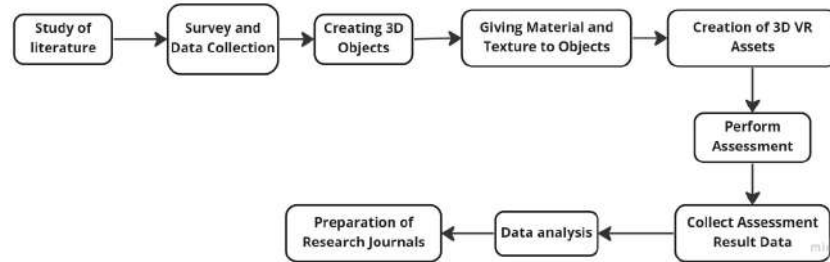

Figure 1: Research Stage

Based on the chart above, there are several stages carried out in this study:

1. Study of Literature

   At this stage, reading and understanding of previously existing related papers will be carried out. Researchers will also look for information relevant to the problem under study, including collecting, reading, will also look for information relevant to the problem under study, including collecting, reading, recording, and processing research material.

2. Survey and Data Collection

The steps taken at this stage are conducting surveys and collecting data in the form of visits to Gayam 16 and ISI, and then taking data in the form of photos of gamelans, beaters, and rancakan to be used as 3D objects. The kenong in Figure 2a is one of the Javanese gamelan musical instruments and is played by being beaten. It is a voice actor for harmony or chords and functions for the singer to define the boundaries of the gatra and set the rhythm. Then the Rancankan in Figure 2b is a place to put the gamelan, which is usually made of wood and has carvings on its body. Meanwhile, the gamelan beater shown in Figure 2c is a tool used to beat the gamelan so that it can be heard, also known as Tabuh. The shape of the gamelan beater varies depending on the type of gamelan being hit.
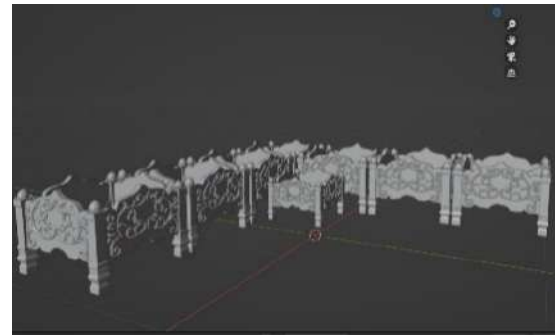

(a) Kenong   (b) Rancakan   (c) Gamelan Beater

Figure 2: Kenong, Rancakan and Gamelan Beater

3. Creating 3D Objects

At this stage, 3D objects are made from gamelan kenong, rancakan, and beaters. Making objects is done by paying attention to the characteristics of photorealism and looking at photos that have been taken before. Making this 3D object is done using the Blender application. Here is a photo of 3D objects made using the Blender application. The results of the creation of 3D objects in the Blender application can be seen in Figure 3 below.
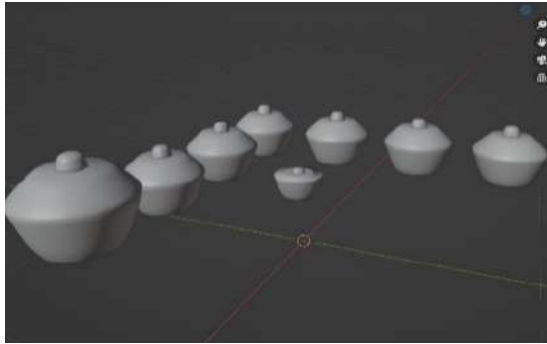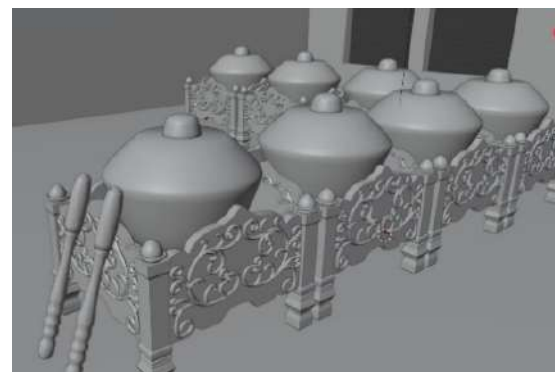
(a) Kenong in Blender

(b) Rancakan in Blender

(c) Gamelan Beater in Blender

(d) Kenong Set in Blender

Figure 3: 3D Objects in Blender

4. Giving Material and Texture to Objects

   After making a 3D object and already having the appropriate shape, material, and texture, those will be given according to the original object as in the photo. Material serves to provide the appropriate color and texture, which provide detail or texture on the object's skin surface.

5. Creation of 3D VR Assets

   At this stage, the objects that have been created and have material and texture will be moved into Unity and arranged to later be used as assets to create virtual reality applications. All objects will be arranged according to the original Kenong gamelan arrangement in the real world. The kenong will be placed on top of the rancakan, or the

place where the gamelan is placed, which has previously been made into a 3D object in a blender. Figure 4 shows how the kenong sets are arranged.
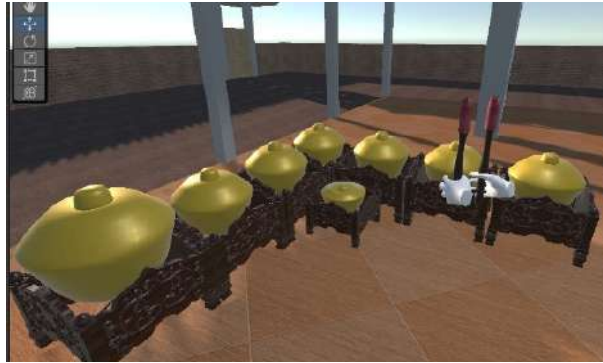

Figure 4: Kenong Set Arrangement

Apart from incorporating gamelan into Unity, the environment that will be used as a place to play later is also included. In Figure 5, the playing environment, the gamelan is placed in an environmental asset in the form of a pavilion, which has been downloaded from the internet. This pavilion environment was chosen because it was felt to be the most suitable environment for playing gamelan. Based on a visit to Gayam 16, this pavilion environment is the most similar to that of Gayam 16, which has a large enough area to be suitable for playing gamelan.

Figure 5: Play Environment

Then in Figure 6, for materials and textures, 3D objects that have been moved into Unity have been given the same texture and material. The carvings, as well as the rancakan or

locations where the gamelan is placed, have a texture and material similar to wood, with a few strokes similar to real wood texture. On the bat section, the texture and material of the cloth section have a texture like thread wrapped around the bat. Kenong also has a material like bronze and has a little bit of dust attached to it.
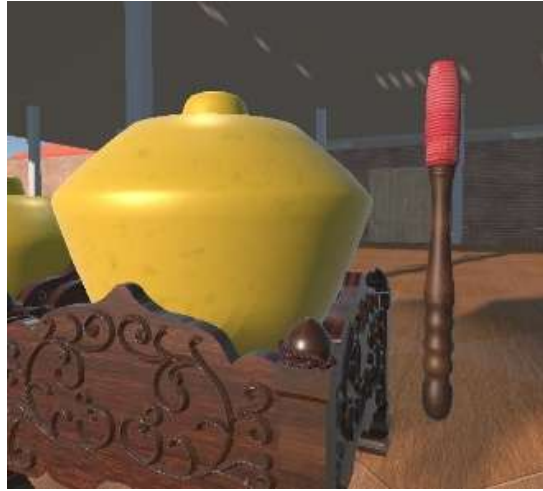

Figure 6: Material dan Texture

6. Perform Assessment

The method used in writing this journal is a quantitative method. The quantitative method is a method that relies on the collection of quantitative data in the form of numerical data that is collected objectively and systematically [16]. The monetary data to be collected in this study is through surveys. Respondents will be asked to assess the 3D objects that have been made by looking at the characteristics of photorealism. The survey scores were very bad/not at all suitable (1 point), bad/not suitable (2 points), sufficient (3 points), good/appropriate (4 points), and very good/very suitable (5 points).

The sampling method that will be used in this study is purposive sampling. Purposive sampling is a type of non-probability sample in which the sample is chosen because it is considered appropriate for the research being conducted and can provide the information needed based on experience, interest or knowledge [17]. In this study, the sample chosen was made up of people who had tried the VR Gamelan application or had seen gamelan in person. Then, to calculate the minimum number of samples, the Slovin formula will be used. The Slovin formula is a formula that is frequently used in studies to determine sample size using the formula:

$$n = \frac{N}{1 + Ne^2} \tag{1}$$

Total Population: 37 (N)

Margin of Error: 5%/0.05 (e)

Population: Students who have used the VR Gamelan application or who have seen gamelan in person.

Therefore, if we use the Slovin formula, it can be calculated as follows:

$$n = \frac{N}{1 + Ne^2}$$
$$n = \frac{37}{1 + 37(0.05)^2}$$
$$n = \frac{37}{1 + 37(0.0025)}$$
$$n = \frac{37}{1 + 0.0925}$$
$$n = \frac{37}{1.0925}$$
$$n = 33.867$$

So, the number of respondents needed is then set to 34.

The questions that will be asked later in the questionnaire are as follows, but we will first explain briefly what the characteristics of photo-realism are.

Give a score (1-5) to whether the 3D gamelan beater object conforms to photo-realistic characteristics! (An image of the beater can be seen in Figure 7)

Figure 7: Object Comparison

a. Rate it from 1 to 5 on Clutter and Chaos!

b. Rate it from 1 to 5 on Personality and Expectation!

c. Rate it from 1 to 5 on Believability!

d. Rate it from 1 to 5 on Surface Texture!

e. Rate it from 1 to 5 on Specularity!

f. Rate it from 1 to 5 on Dirt, dust, and rust!

g. Rate it from 1 to 5 on Flaws, Scratches and Dings!

h. Rate it from 1 to 5 on Beveled Edges!

i. Rate it from 1 to 5 on Object Material depth!

j. Rate it from 1 to 5 on Radiosity!

The same assessment is carried out for other objects, namely gamelan Kenong and Rancakan, or places to put Kenong.

7. Collect Assessment Result Data
   Collecting data from the assessment results is a step taken to collect data that has been generated from the assessment and will be analyzed.

8. Data analysis
   At this stage, the author analyzes the data that has been collected previously, and the data will be assessed to determine whether it can be used or not as a result of the research later because the data used will affect the final results of the research.

3.   Results and Discussion

3.1.   Results

A survey of 34 people was used to collect data for this study. Respondents were asked to provide a value for each 3D object that had been created using photorealism by looking at the characteristics of photorealism. Respondents are individuals who have witnessed gamelan and used gamelan applications. In this study, the Kedaireka Arutala apprentices were involved. The values taken in the questionnaire are in the form of numbers 1–5, namely, very bad/not at all suitable (1), bad/not suitable (2), sufficient (3), good/appropriate (4), and very good/very suitable (5). The three 3D objects to be evaluated are the kenong beater, the carving, rancakan or placement of the kenong, and the kenong itself. From the results of the survey that has been conducted, the following data has been obtained and can be seen in Table 1 below.

Table 1: Table of 3D Object Assessment Results

No	Object	Clutter and Chaos	Personality and Expectation	Believability	Surface Texture	Specularity	Dirt, dust, and rust	Flaws, Scratches and Dings	Beveled Edges	Object Material depth	Radiosity	Average value
1	Gamelan beater	4,3	4,5	4,5	4,4	4,3	3,7	3,6	4,2	4,2	3,9	**4,16**
2	Engraving and Rancakan	4	4,2	4,1	4,2	4,1	3,5	3,5	4	4,2	4,1	**3,99**
3	Kenong	3,5	3,7	3,6	3,8	3,7	3,4	3,2	3,7	3,8	3,8	**3,62**

From the results of the survey conducted, it was found that there is no average value for each object that is lower than 3. This means that the value obtained is above average or sufficient, and it also proves that the object that has been made has followed the 10 photo principles of realism. The value of each point above is the result of the average value collected from 34 respondents.

Table 2: Table Average Rating 10 Principles of Photorealism

Principles	Mean
Clutter and Chaos	3,9
Personality and Expectation	4,1
Believability	4
Surface Texture	4,1
Specularity	4
Dirt, dust, and rust	3,5
Flaws, Scratches and Dings	3,4
Beveled Edges	3,9
Object Material depth	4
Radiosity	3,9

Table 2 shows the average rating of the 10 photorealism principles. All the average rating results obtained are more than 3, which means that every principle of photorealism has received a good rating.

3.1.1. Gamelan Beating Object Assessment Results

From the results table above, it can be seen that the average value of the 3D gamlean beater object has the highest value of 4.16; this means that the 3D gamlean beater object has the most similar appearance to the original gamlean beater object in the real world. The highest

score obtained by gamelan beater an object is personality, expectation, and believability, where gamelan beater an object looks real. While the lowest values are flaws, catches, and dings because the gamelan beater object looks too smooth and has no strokes

3.1.2. Results of the Assessment of Engraving and Rancakan

Rancakan and carving objects get an average value of 3.99. The average value, which almost touches 4, proves that this object also fulfills the photo-realism characteristics. The lowest value obtained for rancakan and carving objects is "dirt," "dust," "rust," and "flaws," "scatches," and "dings," which means that the object looks less dirty and has fewer streaks or scratches on its surface.

3.1.3. Kenong Assessment Results

Even though the Kenong object gets a lower rating than other objects, the value obtained is 3.62, which is still above the average. This object gets an average value of 3 because the color of the gamelan is too yellow so that the dirty spots or rust spots are less obvious. The kenong material used also lacks reflection, so the basic material looks like iron and not bronze. Then, for the bottom diameter of the kenong, it is still a little less wide than it should be.

3.1.4. Results Question: "Do you pay attention to the level of realistic similarity of objects in a simulation?"

In the questionnaire, there are also questions to find out whether the respondent pays attention to the level of realistic or object similarity in a simulation. The result is that 34 out of 34 respondents pay attention to the degree of similarity of objects when carrying out the simulation. A pie chart for question 1 can be seen in Figure 8.
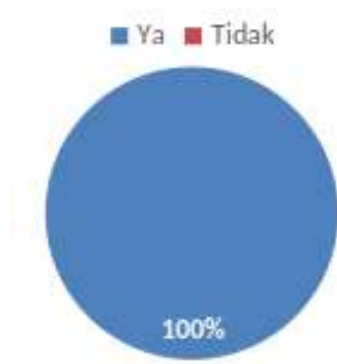

Figure 8: Pie Chart Question 1

3.1.5. Results Question: "Does realistic objects help you feel the simulation becomes more real?"

This question is asked to find out whether realistic objects can help respondents feel more immersed in the simulation. And 30 out of 34 respondents indicated that they thought the simulation would be more realistic if the object had a high realistic level. A pie chart for question 2 can be seen in Figure 9.
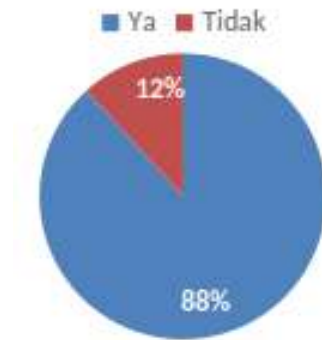

Figure 9: Pie Chart Question 2

3.1.6. Results Question: "Do you think realistic objects are important in gamelan game simulations?"

The question of whether realistic objects are important in gamelan playing simulations is asked in order to determine whether realistic objects are important in gamelan playing simulations. The result is that 32 out of 34 respondents feel that realistic objects are important or needed when simulating gamelan playing. A pie chart for question 3 can be seen in Figure 10.
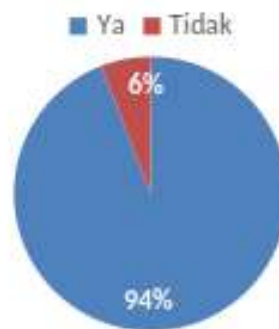

Figure 10: Pie Chart Question 3

3.2. Discussion

3.2.1. Discussion of Clutter and Chaos Assessment

Clutter and chaos, or irregularity, is a characteristic in which existing objects look imperfect and have slight defects. The objects that have been made can be seen in the ropes in "Rancakan," where the ropes are a little convoluted and not straight. The carvings on the rancakan also look a bit stiff.

3.2.2. Discussion of Personality and Expectations Assessment

Personality and expectation ratings are influenced by the individual's perspective and state of mind. For example, respondent A feels that kenong is a light golden color, and another respondent feels that kenong is a darker gold. However, the value obtained in this study proves that the object made has met the expectations of the respondents.

3.2.3. Discussion of Believability Assessment

Believability is the degree to which objects appear to exist in real life. An object cannot be considered photorealistic if it cannot be believed that it looks like the real thing. Objects that have been made get a good value, which indicates the object can be trusted or looks original.

3.2.4. Discussion of Surface Texture Assessment

Objects that meet the characteristics of "surface texture" have a texture on their surface. This texture is in the form of smooth, rough, smooth, and other textures. Surface texture is visible and can be felt. This surface texture can be seen in the string wrapped around the gamelan beater, which looks wavy, so it looks like it has a non-smooth surface.

3.2.5. Discussion of Specularity Assessment

Specularity is the level of reflection of an object. Specularity is the reflection of the light source. Specularity can be seen on the surface of the gamelan and the rancakan, where it reflects a little light.

3.2.6. Discussion of Dirt, dust, and rust Assessment

Dirt, dust, and rust are characteristics whereby an object has an effect such as a dirty spot, dust, or slight rust. It can be seen in the kenong gamelan object, which has a little stain.

3.2.7. Discussion of Flaws, scratches, dings Assessment

What is meant by flaws, scratches, dings are effects such as being clawed, rubbed, or as if they had been hit. The object may look slightly dented or have small scratches.

3.2.8.   Discussion of Beveled edge Assessment

Objects that meet the characteristics of a beveled edge are those whose sides are not rigid, have an appropriate slope, and are obtuse.

3.2.9.   Discussion of Object Material Depth Assessment

Objects that fill materials Depth objects are objects that have depth levels. An example is the carving that appears to be embossed on the body of the rancakan.

3.2.10.   Discussion of Radiosity Assessment

Radiosity is a characteristic possessed by an object when the object experiences light reflection. Light from the original source hits an object, and the light is reflected back.

4.   Conclusions

From the results that have been obtained from the survey that has been conducted, the researcher can draw several conclusions in the study "Application of Photo-Realism in Making 3D Gamelan Kenong Objects in Gamelan VR." The following conclusions can be drawn:

1. The objects that have been created fulfill all aspects of photorealism and get good grades.

2. The researcher realizes that the simulation can be felt better or can bring the user deeper into the world of the simulation if the objects in this simulation have a high level of realisticness, so that the user gets a picture as similar as possible to real conditions.

3. The researcher realizes that the user pays attention to existing objects when simulating in the virtual world.

4. Researchers realize that there are many aspects that must be considered to create an object that looks realistic.

5. The researcher realizes that there are still deficiencies in creating 3D objects in this study, so there are still some photorealistic characteristics that are not fully maximized.

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