

Modular Technique of 3D Modeling and Procedural Texturing for 3D Game Environment Design of “Jurnal Pahlawan”

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Abstract: 3D game “Jurnal Pahlawan” (Hero’s Journal) is a game project based on the battle of Surabaya, Indonesia in November 1945 between Indonesian soldiers and British & British Indian troops. The purpose of this project is proposing a joyful learning media with history contents for youth through the game. The young users can interact with game system, which resemble to historical recount of the battle of Surabaya. The 3D digital visualization of the game world leads game players are be immersed to the game. This paper describes the process of designing the game environment, mainly historical building modeling and texturing. The research uses qualitative method such as battlefields observation, literature study and visual existing study. In addition, the assets design process uses modular technique in 3D building modeling and procedural texturing. Finally, the result of this design process gives opportunities for 3D designers to create game environment systematically. It means, in terms of 3D game environment, the repetition process of 3D assets production could be applied for making huge digital architectural in the game world easily.

1 INTRODUCTION

Many heroes from various places sacrificed their lives to fight for Indonesian independence. The battle of Surabaya on 10 November 1945 was one of the important historical events in preserving for independence. In the battle, many fighters from various groups together against allied forces (The Dutch - British Army) who trying to occupy the city of Surabaya (Sentosa, 2014). This battle event was later designated as a hero day, which could be interpreted as a true fight.

Discussing about history, mostly, some sources of Indonesia historiography obtained from literatures such as history book and textbook. On the other hand, the young Indonesians tend to not read history books (Rofalina, 2015). It is a potential problem that faced by young people to learn about history content. In spite of that, technology gives opportunity to integrate any knowledge so they ease to learn. Therefore, game as a new interactive media can be an alternative in disseminating this information.

The game is one of the fastest growing digital media and also very fashioned to the society at the moment. In addition, McGonigal (2011) added that

playing games could increase the positive emotions of the players. This sensation affected by the pleasure and satisfaction that are gained when accomplishing the games.

There are so many themes that can be incorporated into the games and historical content is one of them. Recently, there are lots of practices in combining game with history content that has been done and give positive feedbacks. Players can feel a direct visualization of the historical reconstruction which being displayed. As a result, the content is easier to understand due to the game appearance and can be linked directly to its historical events (Wainwright, 2014). Based on this, the game can be a supporting media in the delivery of historical material, especially the events of the battle of Surabaya in November 10, 1945.

This 3D game is named “Jurnal Pahlawan” (The Journal of Heroes). The name of this game was taken based on Indonesia Heroes' Day as a memorial to the battle of Surabaya.

1.1 3D Game

Three-dimensional game is a digital game that applies three-dimensional media, so the objects in

the game can be seen from various sides and interacted with them. Adam (2014) divides several types of perspectives displayed in three-dimensional games, namely:

- **Fixed 3D:** game that presents static three-dimensional backgrounds but is rendered in real-time. In this perspective, players cannot see objects freely.
- **First-Person:** game that makes player sees based on the perspective of the first person. Elias (2019) added that this type of game seems quite realistic because players like to look directly into the game. All interactions performed by the main character are seen through the eyes of the character.
- **Third-Person:** in this perspective the player acts as a third person and the player can see the characters played from various sides and move the character in various directions.

1.2 3D Environment

A three-dimensional environment is an environment made into three-dimensional forms. Meigs (2003) states that in the game, environment has functions to visualize the atmosphere, provide information of the time and location, and complement game play and support the stories. A game environment usually has seven basic elements, namely terrain, water, sky, sun, clouds, indoors and plants (Chopine, 2011).

Ahearn (2017) points out that designing environments on a large scale requires a long time, so it needs efficient techniques to develop the game. The modular technique can speed up the processing time of 3D assets modeling. Modular technique is a technique that repeats a simple asset and organizes into a single unit. In this process, modular techniques also require several other techniques that can give a little variation to the assets compilation, which are free-form and hybrids techniques (Ahearn, 2017). Free-form technique takes advantage of the player's perspective and rotation, so the assets seen slightly different. The hybrids technique provides other variations and details by combining non-modular assets into modular assets.

Chopine (2011) in his study describes that 3D objects in games certainly have a low number of polygons. This low-polygon has limitation of the assets' form, which the assets are looked rough. To overcome this boundary, the 3D artist can apply normal maps to increase the detail of the 3D objects. The normal maps function as a texture that creates the impression of depth and can be applied with procedural techniques. The procedural texture is texture repetition techniques with same pattern as

seamless edges, consequently they can be replicated on other assets (Chopine, 2011).

1.3 Dutch Colonial Architecture in Indonesia

The Dutch colonial architecture built in Indonesia belongs to the category of modern architecture. However, Sumalyo (1995) explains that these architectures are unique because there are adaptation of two cultures between modern architectural culture, which brought by the Dutch and traditional Indonesian culture. In the urban planning, the Dutch had their own characteristic of built magnificent buildings in the downtown. In addition to the distinctive features of the city structure, the Dutch also had a buildings characteristic that they erected which was adapted to the climate in Indonesia. The adjustment optimized lighting and air circulation as construction elements of the interior of the building.

1.4 The Battle of Surabaya in 1945

Ricklefs (2008) emphasizes that the battle of Surabaya was the biggest battle that occurred in Indonesia after Indonesian Independence Day. The main cause of this battle was the arrival of allies (The Dutch - British Army) who aimed to evacuate prisoners of the previous war. However, the arrival of these allies coincided with the speech of Sutomo (Bung Tomo). This circumstance led tempestuous condition in Surabaya at that moment.

Actually, the allied forces and the Indonesian side had a cease-fire agreement, however fighting broke out again as a result of the murder of Brigadier General A.W.S Mallaby. Theorina (2007) wrote that in its movement, the allies attacked the Surabaya region from the north, which was the coast and then moved to the south by deploying the navy, army and air forces. Ricklefs (2008) adds information that during this battle, allied forces successfully controlled more than half of the city of Surabaya, consequently Indonesian forces retreated to other areas.

2 METHODOLOGY

There are several methods in design process in collecting some supporting data. These data will be the basis for creating the environment concept. Then the next process is brainstorming & mind mapping which is useful for determining the focus in this design. After passing the two processes above, the

next thing to do is to set the environment concept. This is related to the location and object that will exist in that environment.

2.1 Data Research

At this stage, the authors conduct literature studies and interviews, which employ to explore the material and techniques needed in the design process. In addition, we also conducting former battlefield observations in the city of Surabaya and also compared several existing works. The aim of existing study is getting an overview and also visual references. The battlefield observation used for 3D environment conceptualization.

2.2 Brainstorming & Mind Mapping

According to the phenomenon and obtained data, the focus set for asset visual is a Dutch colonial building with a specific location, namely Jembatan Merah area. The reason for the establishment of this location is because there is much iconic architecture from the Netherlands. The designer set the colonial buildings that would be developed were Internatio building and Cerutu building. In addition to the visual focus, the author also determined the PC platform as a platform for playing games. Furthermore, the PC also used for separating building asset and produced supporting game properties.

2.3 Environment Conceptualization

The concept of environment is made to adjust the theme; therefore the environment will be described as the place where the battle of Surabaya was took place. The visual theme of the game environment is realist visual style. It is a challenge to reconstruct the battle of Surabaya in realist visual theme.



Figure 1: Visual Reference of Jembatan Merah Area. (https://upload.wikimedia.org/wikipedia/commons/d/de/COLLECTIE_TR_OPENMUSEUM_De_Roode_Brug_en_de_Handelstraat_in_Soerabaja_T_Mnr_60028087.jpg)



Figure 2: Visual Reference of Internatio Building. (<https://i.pinimg.com/564x/61/57/48/615748537aa1e2d91f126e1fc81758ac.jpg/>)

There are many differences according to the ties of time and battlefield. To overcome this challenge, the researcher looks for some historical photographs as references to get approximate visualization of the battle time, for examples as shown in Figure 1 and Figure 2.

Since the area around Jembatan Merah was an urban area, there will be many buildings in that location in the game world visualization. For the map topology, the author follows a photo from the Surabaya tram map in the 1940s (Figure 3).

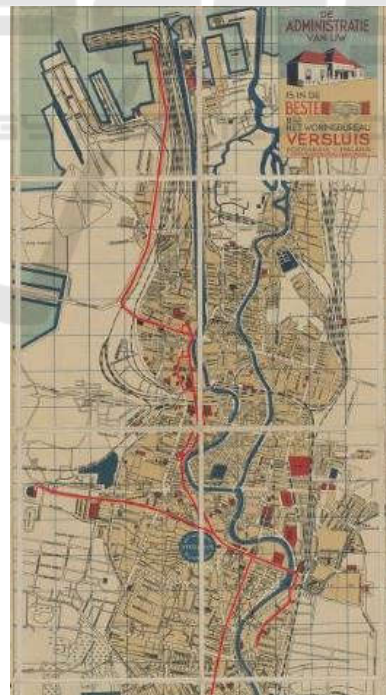


Figure 3: Surabaya’s Tram Map in 1945. (http://picsr.com/photos/bad_boy_4_life/interesting/page29?nsid=58256433@N07)

Figure 4 shows the process of designing the 3D environment in the “Jurnal Pahlawan” game.

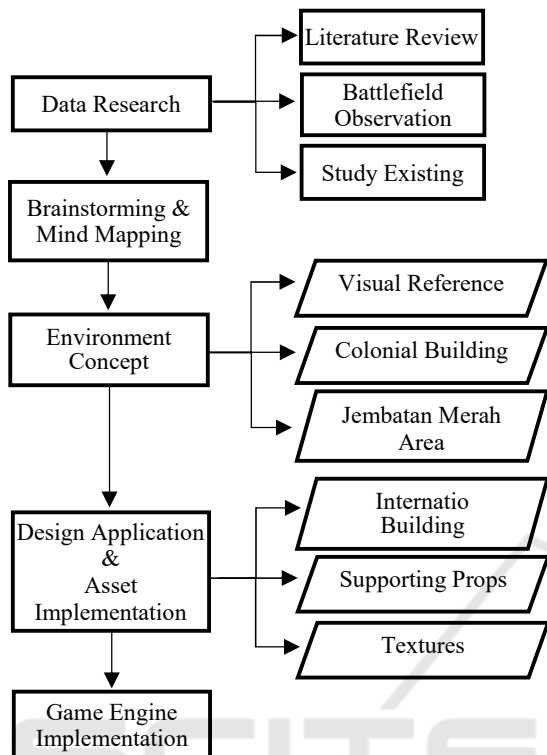


Figure 4: Design Process Scheme.



Figure 6: Sketch of the Urban Atmosphere.



Figure 7: Sketch of the Jembatan Merah Atmosphere.

2.4 Sketches

2.4.1 Environment

The designer sketches the topology for the Jembatan Merah area (Figure 5), which is adjusted by reference from the tram map (Figure 3). Figure 6 and Figure 7 illustrate the atmosphere of the battlefield.



Figure 5: Sketch of the Jembatan Merah Area Topology.



Figure 8: Sketch of the Cerutu Building.

2.4.2 Buildings and Props

Basically, houses that designed for residents have the same shapes, so the buildings for housing will be made by adjusting the sketch of the Jembatan Merah topology. The sketch of colonial buildings drew based on visual references, as shown in Figure 8 and Figure 9.



Figure 9: Sketch of the Internatio Building.

Props are illustrated according to the objects in the old photos references in 1945, some games’ visual references, and also adopted from the properties of existing animation movies (Figure 10).

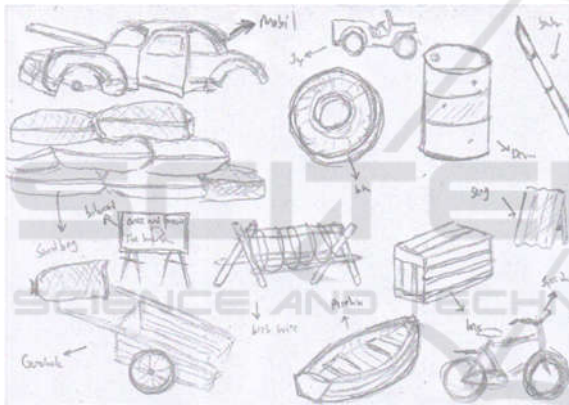


Figure 10: Sketch of the Props.

3 DESIGN APPLICATIONS

In this process, the author implements a sketch that has been designed into the process of three-dimensional modeling and texturing.

3.1 Environment Asset

In this stage, the designer did a layout blocking based on the sketch of topology maps as shown in Figure 11. The purpose of this layout blocking is to determine the structure of the building and the density of the location.

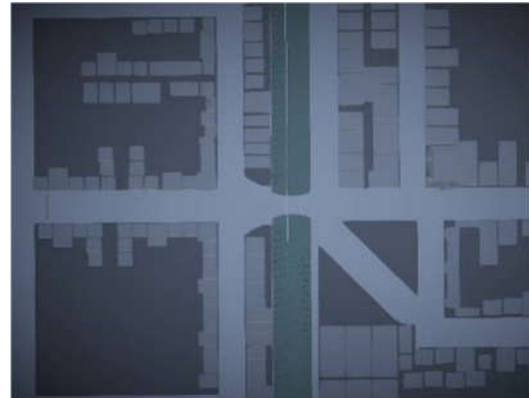


Figure 11: Blocking Level of Jembatan Merah.

The next steps are 3D architectural modeling, 3D game properties modeling, and textures making.

3.1.1 Building

The 3D modeling implementation of the building, the scale of each part of the building for housing is determined by character height. In addition, the designer also breaks down each part of the building as needed (Figure 12). The Internatio building (Figure 13) and the Cerutu building (Figure 14) get a special treatment for modular parts. This special handling of the 3D modeling process due to broad modular section and more detail of those buildings.

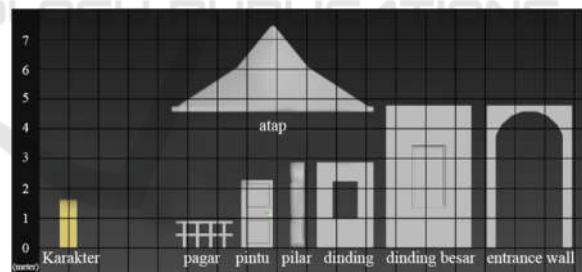


Figure 12: Modular Section and Building Scale.



Figure 13: Modular Section on Internatio Building.



Figure 14: Modular Section on Cerutu Building.

After the modeling process, the designer made UV map template by adjusting the 3D model using material features of the 3D modeling software. The 3D model unwrapping process (as shown in Figure 15) was needed for preparation of texturing implementation using procedural texture technique. The result of this unwrap process must have proportionally same measures (length - width) with the texture dimension. This procedure is important to ensure the texture look fit to the 3D asset and visually not stretch.

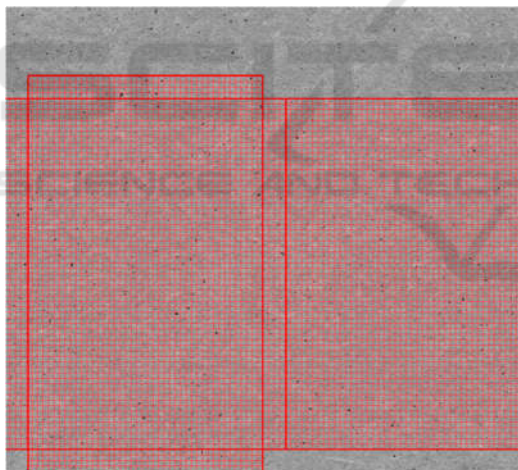


Figure 15: Unwrap on Modular Walls.

3.1.2 Game Properties

In this game, properties are made in various types (Figure 16). These properties were designed to provide variations and triggers of the interactions with players. For instance, the property could be used as a protector when shooting the enemies (Figure 17). Since the property assets are non-modular 3D model, the property assets were made a lot and varied, so they can be visualized more distinction.



Figure 16: Game Properties Asset.



Figure 17: Game Properties Asset as Protector.

3.1.3 Textures

Procedural textures are made into several types to give variation to buildings as shown in Figure 18. In addition, each texture is made into seamless edge. So it does not cause cuts effect when be implemented to the 3D asset. It means, the texture has simultaneous visualization when it is repeated to the tiled assets.



Figure 18: Texture Set for Modular Assets.

This procedural texture can be applied to any modular assets. On the other hand, texture that is not implement the procedural technique can only be executed on certain objects, which have been fitted to its texture.

Some textures, especially wall textures were designed to match the theme by using a slightly more faded color and also there is the effect of cracks or broken walls to give the impression of historical of the battle. This texture can only be applied to modular assets with good unwrap as explained in the previous point (Figure 15). In the game engine software (Unity 3D), first step, the designer made a material that is main texture components such as diffuse/ base color before this texture was used. This function is making the color giver (Figure 19) and also normal map whose providing detail and depth effect (Figure 20). Some additional textures such as roughness, metallic and height can also be added to furnish more detail of the material. When this material preparation has been completed, the next step is assigning the textures material to modular assets.



Figure 19: Base Color of Concrete.



Figure 20: Normal Map of Concrete.

3.2 Game Engine Implementation

Modular assets that have been completed were then set into the 3D game engine. Next, the procedural texture was applied to modular assets and arranged using a free-form technique that utilizes position changes and rotations on objects precisely (Figure 21). If arranged correctly, the results will be obtained as in Figure 22, Figure 23 and Figure 24.

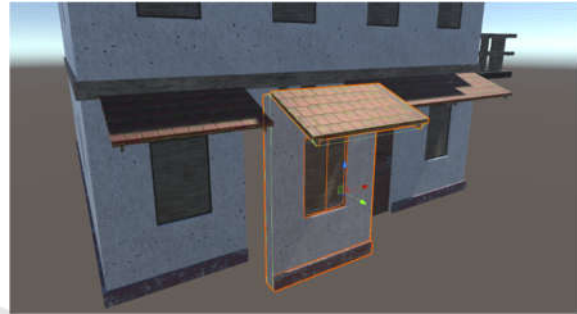


Figure 21: Modular Asset Preparation.



Figure 22: Modular Asset for House.



Figure 23: 3D Asset of Internatio Building.



Figure 24: 3D Asset of Cerutu Building.

After completing the construction of several buildings, the last step is utilizing the results of the layout blocking that has been previously done by replacing the marker boxes with building assets and properties, so they become a whole environment, as shown in Figure 25.



Figure 25: The Visualization of Jembatan Merah Environment.

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4 CONCLUSIONS

According to the results of this study of 3D game development, we can conclude that the implementation of modular techniques on 3D modeling and procedural texture potentially has positive influence in designing large-scale game environments. Both of these techniques are able to accelerate the process of working on assets, especially in buildings that are scattered in the huge game environment.

The recommendation for next study is doing research for an implementation possibility of modular technique for organics modeling of game assets, such as plants & trees and other non-angular objects.