



Design and Manufacture of Game Props Based on PBR Process

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Abstract. This paper combs the workflow of the PBR, and explains its advantages, common maps, and advantages. Then, it describes the concept and classification of game prop design. Taking the firearms props in the game as a case, the implementation steps of the PBR workflow are standardized, and the standard PBR workflow is used to describe the production process of game props “Gun”.

Keywords: PBR · Game Props · Design · Gun

1 Introduction

Under the PBR process, the game prop model will be more in line with the physical rules, and the calculation of lighting will be more realistic. PBR is physics-based rendering, which can change the mapping method of traditional workflow and the information of mapping. This paper will sort out the concept of the PBR, analyze its advantages, sort out its mapping style, and describe the concept and classification of game props. The game prop “Gun” is taken as an example, and the 3D model of the game prop is made under the guidance of the standard PBR workflow.

2 PBR Workflow

2.1 What is PBR?

PBR is a physics-based rendering method, which can provide accurate coloring and render the real physical reaction of light on the surface of an object. It uses parameters measured from reality to accurately represent real-world materials. Compared with our original Phong or Blinn-Phong lighting algorithms, this rendering method looks more realistic on the whole. PBR process follows certain physical principles and norms and can be realized by different means. Generally, it is divided into Metal/Roughness workflow and Specular/Glossiness workflow.

2.2 What Are the Advantages of the PBR Workflow?

(1) Good artistic effect

In the traditional rendering workflow, diffuse map and specular map are generally used. These two maps are rough estimates of light and materials, and the artistic effect is not good. With the PBR method, scenes and models can be accurately expressed under all physical light conditions, scenes in real environments can be simulated, and realistic artistic effects can be obtained.

(2) High efficiency

The traditional mapping method is to draw the map in Photoshop, which requires the high painting skills of the producers, and it is time-consuming and laborious, inconvenient to modify, and inefficient. The method and algorithm of the PBR are based on the exact formula in physics. In the manufacturing process, only the basic properties of materials need to be adjusted to make personalized materials with high efficiency.

2.3 How Should Artists Use the PBR?

With the workflow of the PBR, the real physical properties of light can be accurately simulated by software. Instead of guessing and adjusting the test materials, artists can focus more on design and creativity.

Artists need to learn to use the PBR's production specifications. While making materials, first consider whether the materials are metal or nonmetal, and then follow different manufacturing specifications. It is an excellent conductor of metal heat and electricity, and the reflection value range of polished metal is high. Artists should also know the specific state of metal materials, such as whether they are painted, corroded, or covered with dust, oil, and other substances. Non-metals are poor electrical conductors. Compared with metals, they reflect less light and have an albedo color.

2.4 PBR Workflow Description

The workflow of the PBR is defined by a series of mapping channels, which are transmitted as maps to the coloring sampler of the PBR, thus presenting a realistic effect.

General maps are used to show the mapping effect of light and shadow parallax and displacement, and the data are placed on different maps.

(1) Normal

Normal maps can be used to simulate the details of a surface. The R, G, and B channels in the map correspond to the X, Y, and Z coordinates of the normal on the surface, respectively. It can be used to save the details of the high model and map to the low model. The normal map contains angle information but no height information. As shown in Fig. 1, they are normal maps.

(2) Ambient Occlusion

The ambient occlusion map depicts the effect of blocking the diffuse light around when an object intersects or approaches an object. It can enhance the layering and



Fig. 1. Normal maps

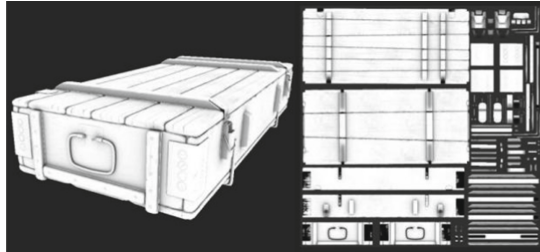


Fig. 2. Ambient Occlusion

realism of space, strengthen and improve the contrast between light and dark of the model, and enhance the artistry of the model. After adding an AO map to the model, the local details of the model, especially the dark shadows, will become more obvious. As shown in Fig. 2, it is an AO map.

(3) Height

The height map is usually used as a rendering displacement effect, showing the overall outline of the high model. It can be used as disparity mapping to add more obvious depth to the texture. Using a normal map and height map can ensure the same illumination and displacement, which can bring a more realistic effect than a traditional bump map.

2.5 What Are the Advantages of the PBR Standard Over the Traditional Standard?

The workflow of the PBR is to achieve a more realistic physical rendering effect in the virtual world. According to the reflection property of light, the rendering material is calculated to simulate the real effect. Through this set of processes, we can achieve good results.

The PBR standard uses a unified coloring scheme, which makes the final effect the same under different rendering tools. All kinds of material parameters of the PBR standard are relatively uniform, which can optimize the workflow.

Traditional standards are based on maps, including normal maps, hand-painted highlight maps, and hand-painted diffuse maps. There is no uniform standard, and different people will have completely different results when making different materials.

3 Game Props Design

3.1 Definition of the Game Props

Game props are important elements in games, and the design of game props plays an important role in game design. The design of game props should be highly artistic and creative to attract players.[1].

3.2 Classification of the Game Props

(1) Still-life props

Still-life props refer to the props that play a decorative role in the game and play a role in setting off and stating the background of the game. Including characters' hats, decorations, treasure chests, task cards, letters, keys, magic medicine bottles, etc. As shown in Fig. 3, they are still-life props.

(2) Equipment props

Equipment props generally include firearms, knives, blunt objects, swords and shields, scepters, helmets, armor, etc. The setting of weapons needs to be designed according to different game categories and different styles. As shown in Fig. 4, they are weapons props.

(3) Vehicle props

Vehicle props are divided into land vehicles, air vehicles, and water vehicles. Land vehicles include war horses and chariots. Aerial vehicles include airplanes, space-ships, sci-fi space vehicles, etc. Water carriers include ancient ships, modern ships, magic-style ships, etc. As shown in Fig. 5, they are vehicle props. [2].



Fig. 3. Still-life props



Fig. 4. Weapons props



Fig. 5. Vehicle props

4 Making a Game Prop Model

Making game prop models based on the PBR workflow needs to follow certain rules. According to the sequence, the production steps can be divided into making the middle model, making the high model, making the low model, splitting UV, baking texture map, drawing texture map, rendering output, etc. The middle model, high model, low model, and split UV are completed in Maya. Baking maps and drawing materials are completed in substance painter. The rendering is completed in Marmoset Toolbag. Here, take the game prop “Gun” as an example to show the production process in detail. [3].

4.1 Making the Middle Model of the Game Prop

The model is mainly used to shape the large model, and the model’s wiring is made as quadrilateral as possible, which is convenient for edge locking operation in the high model stage. The model does not make small chamfer edges or lock edges. There is no limit to the number of model faces in the model. As shown in Fig. 6, it is the middle model of the game prop “Gun”.

4.2 Making the High Model of the Game Prop

A high model means that the model has many faces and details, and there is no limit to the number of faces when making a high model. Later, the details on the high model will be baked onto the low model with few faces by baking operation. The principles that should be followed in making high models include: (1) The edges of hard surface models need to be locked on three sides to finalize the model. (2) Soften all edges of the high model. The purpose of edge softening is to control the vertex normals of the model. Polygons will show a soft appearance when rendered. (3) To make the float, if you want to make small nails, small holes, grooves, and other shapes on a complete large model, you need to modify the wiring of the model, and the operation is extremely complicated. Generally, such a model will be made into a floating sheet independent of the large model. All models are made of Blinn materials, and it can be seen visually that the floating sheet is well integrated with the main model. As shown in Fig. 7, it is the high model of the game prop “Gun”.

4.3 Making the Low Model of the Game Prop

A low model refers to the small number of faces in the model, and the rules to be followed in making low models include: (1) Minimizing the number of faces in the model and

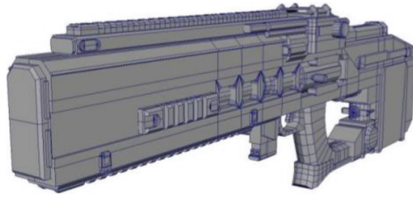


Fig. 6. The middle model



Fig. 7. The high model

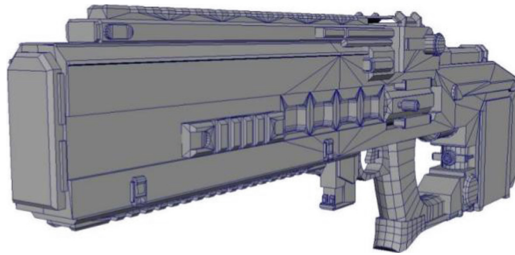


Fig. 8. The low model

deleting the invisible clamping faces. (2) Delete the points and lines that don't support the model. (3) All the faces on the model can't be larger than four sides but can be three sides or four sides. As shown in Fig. 8, it is the low model of the game prop "Gun".

4.4 Splitting the UV of the Game Prop

The principles that should be followed in UV splitting include: (1) UV cuts should be as few as possible. (2) Place the incision in an inconspicuous position as far as possible. (3) The edges with an included angle of 90 or less than 90 should be disconnected as far as possible. (4) In the production of game props, share UV as much as possible. (5) Straighten the UV rays that can be straightened as far as possible. As shown in Fig. 9, it is the UV of the game prop "Gun" after splitting.

4.5 Baking Maps for the Game Props

A baking map is to project the details of the high model onto the low model so that a model with thousands of faces can reflect the details of millions of high models, which

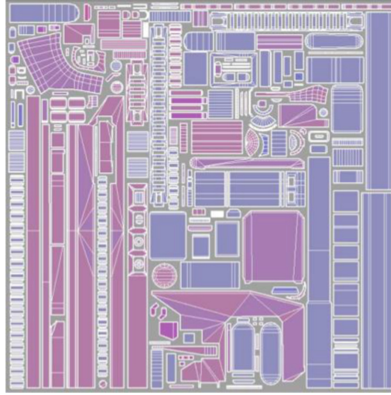


Fig. 9. The UV

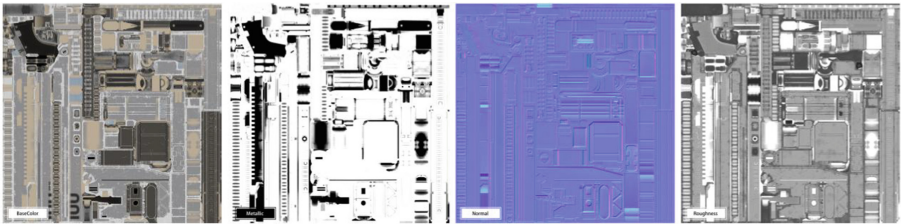


Fig. 10. The maps

can show the rich effect of the high model on the low model. This case adopts the workflow of M/R in PBR workflow. As shown in Fig. 10, they are the Base Color map, Metallic map, Normal map, and Roughness map.

4.6 Drawing Material Maps for the Game Props

Using Substance Painter to draw material maps for game props. Substance Painter software has a layer function similar to Photoshop and has a wealth of smart shader built-in. Adjust the parameters of the shader to change the appearance of the map, and get the desired appearance of the game props. As shown in Fig. 11, they are the material maps.

4.7 Rendering Output

Marmoset Toolbag is a complete set of 3D real-time rendering preview, animation, and baking maps. It is an indispensable tool for game artists. It is widely used in the development and display of game art. Marmoset Toolbag runs fast and can provide an efficient workflow. It can provide high-quality renderings in real-time. As shown in Fig. 12, it shows the final appearance.[4].



Fig. 11. The material maps



Fig. 12. The final appearance

5 Conclusion

This paper combs the application of the PBR production process in the design and production of game props. It explains the concept of the PBR workflow and compares the advantages of the PBR standards with traditional standards. It describes the workflow of the PBR and commonly used maps. It describes the concept and classification of game props. Taking the game prop “Gun” as an example, it describes the detailed process of making game props using the PBR workflow. This paper standardizes the operation steps of using the PBR workflow to make game prop models.

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References

1. Yao Di (2015) Research on the Application of Chinese Elements in Virtual Game Props Design. Hubei University of Technology, Hubei.
2. Zhang Kai, Ma Xiaoling, Guo Lihuai (2017) Game Props Design. Ocean Press, Beijing.

3. Zhou Yanpeng (2020) The Realization of Digital Design from Sketching to AR Presentation. In: 2020 International Conference on Intelligent Design (ICID). Xi'an. pp. 38–41.
4. Zhou Yanpeng, Zhang Zhiyong (2021) Case Study of Next-Generation 3D Model Based on PBR Process. Tsinghua University Press, Beijing.

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