Restore Traditional Chinese Lanterns Based on Openscad and Threejs

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Abstract. With the continuous development of modern computer graphics technology, its scope of application is becoming increasingly broad. This also has a positive impact on the preservation of traditional culture, as modern modeling techniques can digitally recreate many traditional buildings and objects. This article aims to combine OpenSCAD and Three.js to reproduce traditional Chinese lanterns in a minimalist style and explore the integration of traditional culture and modern technology. Then build the website with Vue3(The Progressive JavaScript Framwork)+Vite+ElementPlus+Threejs to display the final result model, detailed code and model report. Finally, a random selection of interviewees was conducted to assess the overall model restoration, the compatibility of this style with traditional Chinese lanterns, and the quality of the scene rendering. The results indicate that the evaluation of the model quality and scene rendering is generally positive. However, there were some negative assessments regarding the level of restoration and scene quality, suggesting the need for further optimization and improvements.

Keywords: Modelling, Traditional Culture, Practical, Chinese Traditional Lantern.

1 Introduction

Nowadays, with the development of technology, 3D modeling and rendering are used in various fields. One of the uses is to shape some objects with cultural backgrounds. Many similar models can be found in various film, television, and game works. Restoring these buildings or objects with cultural background in the form of data is not only the protection of these cultures, but also a way to promote them, because visual presentation is the best way to display them [1].

This article will use minimalist style combined with openscad and Three.js to restore traditional Chinese lanterns on the Internet. Lanterns were invented during the Western Han Dynasty more than 1,800 years ago. They are traditional Chinese folk handicrafts and play an important role in China's long history. They represent the greatness and wealth of Chinese civilization [2]. This article will discuss whether minimalist style has a positive effect on cultural preservation based on the restored model.

2   Build a traditional Chinese lantern

The whole project is mainly divided into three parts, modeling, rendering and web page production. There are many different kinds of 3D modeling software available right now, including CAD(Computer-Aided Design) software, C4D(Cinema 4D), and 3DS Max [3]. Openscad is selected as the tool for modeling. Openscad is a tool mainly used to create CAD 3D models, Although Openscad is mostly used to build CAD 3D models, it is also capable of carefully reading script modeling files, which makes it more user-friendly for controlling the entire modeling process [4]. Therefore, it is very suitable for beginners to have a deeper understanding of the modeling process of the entire project. Then, threejs was chosen as the tool for rendering. Since it can render 3d animations and models in the browser for easy presentation. The construction of the website will also be based on threejs. This project is dedicated to modeling a traditional Chinese lantern. To make the whole scene not look monotonous and make the whole model more coordinated water and stars are added to the scene in a simplified way.

2.1   Modeling

- **Inspiration of lantern**

Using lanterns to create an atmosphere of celebration is essential. They are a type of folk cultural performance [5,6]. Due to different regional cultures and uses, there are many styles of lanterns. After discussion by the entire project team, it was decided to use the lantern in Fig.1 as the prototype.

Fig. 1. Chinese traditional lantern (Original)

The lantern in Fig.1 is the most commonly used lantern in Chinese festivals. It fits the theme of the project. Traditional Chinese lanterns. This style of lantern can be described as the most familiar style to the Chinese people. At the same time, this style is generally simple and suitable for Beginners modeling for the first time.

- **Draft of the lantern**

Before officially starting modeling, it is very important to draw a rough sketch of the lantern. Therefore, the team members first need to draw a rough sketch and mark the specific size, which is more conducive to the size planning during modeling. Fig.2 is the final sketch. From the Fig.2, not only the three views of the lantern are drawn, but also the dimensions of each part of the lantern are marked in detail, which will be of great help when modeling.
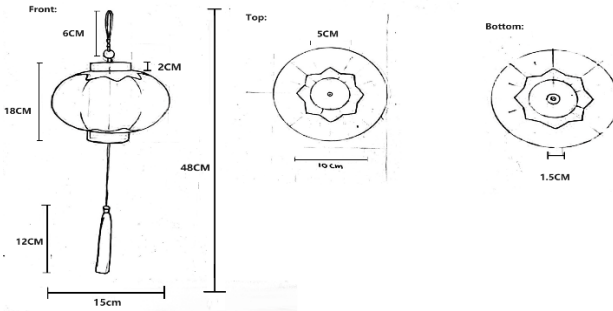

Fig. 2. Draft (Original)

- **The body of lantern**

According to the lantern style in Fig.1, it can be seen that the body of the lantern needs an oval shell. At the same time, in order to ensure the function of the lantern itself, that is, the lighting function, it is necessary to hollow out a hollow in the lantern for placing the light source [7]. In openscad, the above requirements can be achieved by subtracting a sphere with a radius of 10 from a sphere with a radius of 9.9 by differential operation. As shown in Fig.3, the main body of the lantern is completed.
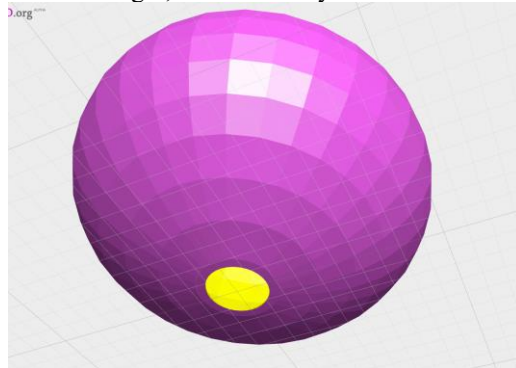

Fig. 3. Lantern body (Original)

- **Decorations**

The lantern in Fig.1 is decorated with a circle of golden flowers on the top and bottom. In order to ensure the overall minimalist style, redundant details were discarded in modeling, and the golden flower decoration was restored in a minimalist style [8].

Therefore, after a series of simplifications, the golden flower in Fig.2 was drawn. One thing to understand is that because this modeling is all-code production, complex models cannot be called directly. Therefore, it is necessary to use the intersection operation to combine multiple cubes together to form a octagon, then use the scale operation to control the proportion of model, and finally use the difference operation to delete the redundant part in the middle.

Fig. 4. Golden flower (Original)

The key model change node shown in Fig. 4, which can be clearly See how the golden flower decoration is done with the above operations. In addition to the golden flower decoration, a small decoration is also needed to be installed on the top of the lantern, and the bottom of the rope ring is shown in Fig. 5.
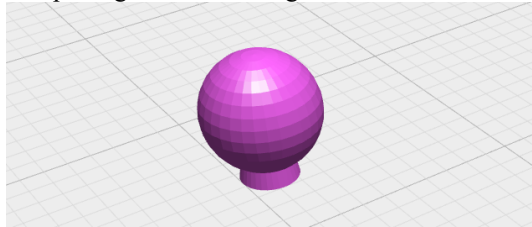

Fig. 5. Small decoration (Original)

- **Metal ring**

It can be found that there is a metal ring on the upper and lower sides of the lantern in Fig. 1 to fix the entire lantern, which is also restored in Fig. 2. Using the code to restore the metal ring in openscad also requires the difference operation. The specific operation is to subtract a cylinder with a radius of 4.5 and a height of 3 from a cylinder with a radius of 3.5 and a height of 0.8. Fig. 6 is the finished product.
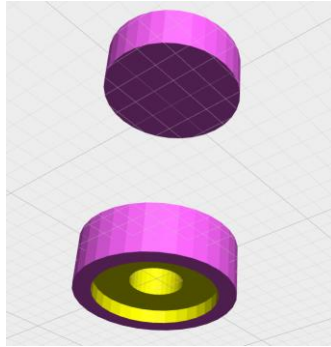
Fig. 6. metal ring (Original)

- **Lantern cord**

The rope in the middle of the lantern is used to carry the lantern and attach the tassels. To restore a real lantern, there needs to be a loop at one end of the rope of the lantern, and the lantern tassel below should be the lantern grass hanging in reality, but in order to keep the overall minimalist style of the lantern consistent. In the end, the lantern plant was replaced by a cylinder. There are similar designs in real life, but they are relatively rare. The corresponding model has been shown in Fig.7.
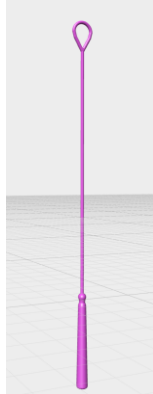

Fig. 7. String and tassels (Original)

In order to achieve the style of the rope circle in Fig. 7, rotate_extrude is used to make a half-coil effect, and then the rope and tassel can be simply spliced with cylinders and spheres.

- **Final result**

After combining all the above components together, a model of a traditional Chinese lantern is completed as shown in Fig.8. It can be seen that it is almost the same as the sketch, because the model drawn by the sketch has been followed during the modeling

process. This is also a very important function of the sketch, which is to give the designer a clear idea and restore the lantern step by step.
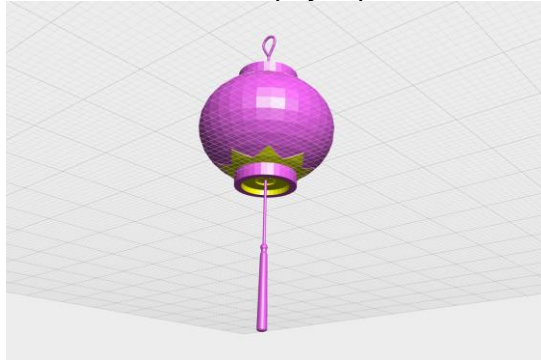

Fig. 8. Final model (Original)

2.2   Rendering

Three.js was chosen as the renderer, because three.js can display the whole project on the browser, which means that anyone can directly access this project without any threshold. At the same time, three.js contains many material libraries for use, including various materials, models, prefabricated scenes and so on. These will be of great help to the rendering model because there is no need to download additional libraries or materials by yourself.

- **Import Model**

The default file format of Openscad is stl file. One drawback of this file format is that it only contains vertex and surface data, which means that textures cannot be directly referenced to the entire model in Three.js. The solution was to split the full lantern model into smaller models, import them into Three.js, and apply textures to each smaller part individually [9]. It can be roughly divided into metal textures, cloth textures, rope textures, and lantern textures. The Fig. 9 is the initial appearance of the stl file after it is imported into three.js.
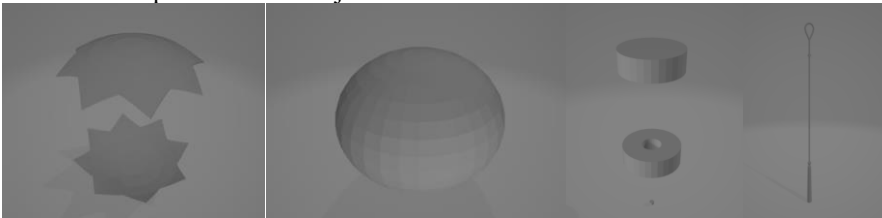

Fig. 9. Original model (Original)

- **Material application**

Because the stl file has no uv information, many errors occurred when adding tex-
tures, so the whole model can only be rendered with the material that comes with
three.js. At the same time, in order to maintain the unity of the overall rendering style,
after a large number of material tests, the final Choose THREE.MeshPhysicalMaterial
as the material of each part [10].

The Fig. 10 is the final surface effect. The built-in SphereGeometry of Threejs is
used, and MeshPhysicalMaterial is also selected to test displacementMap, roughness-
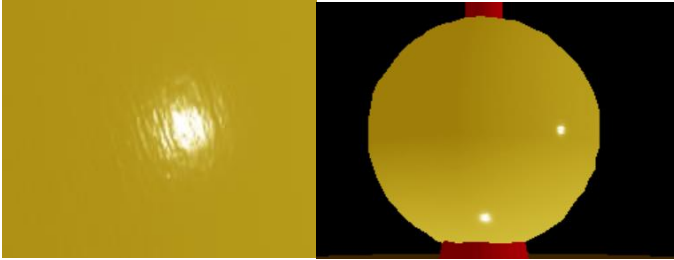Map, metalnessMap and normalMap, and the effect shown in the Fig. is obtained.

Fig. 10. Material (Original)

- **Light source addition**

After the overall material of the lantern is completed, a very critical part needs to be
considered, which is the light-emitting function of the lantern. Of course, as a lantern it
has the ability to shine. This is also relatively easy to achieve, just add a point light to
the lantern. However, after adding the point light, the lantern does not emit light directly
because the transparency of the lantern material is not set. After setting the opacity to
4, the lantern successfully lights up. The Fig. 11 shows the changes of the lantern before
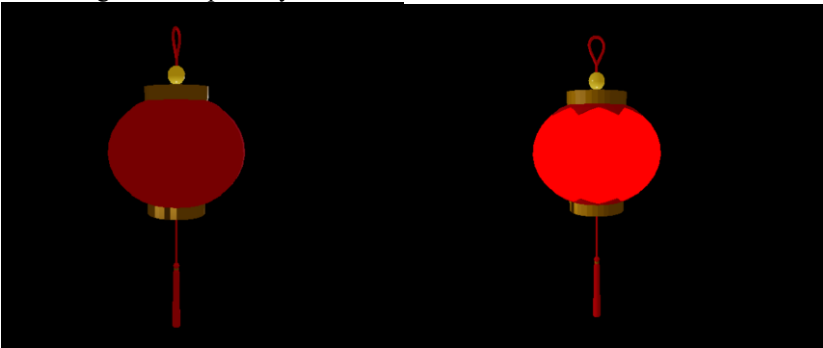and after setting the transparency.

Fig. 11. The lantern was successfully lit (Original)

- **Background**

If there is only one lantern in the whole scene, it will be too monotonous. The best
way is to add a background. In order to highlight the characteristics of the lantern, that
is, the glow at night, the overall background is determined to be glowing at night, and

the interaction between the reflection of the water and the light source can also highlight the glow of the lantern. To sum up, the overall scene is set on the water at night. To add water surface in three.js, the water objects in its own jsm library can be used, which comes with water physics effects and corresponding water maps. Directly introduce it into the scene and set the corresponding parameters to achieve the effect of adding the water surface to the scene.

After implementing the water in the scene, it is time to implement the stars in the night sky. There are so many ways to implement the stars in the night sky, in order to interact with the water surface, adding sprite particles to the scene was finally chosen as the way to implement the stars. To add stars, it is definitely not enough to add only one sprite particle, but if you add them one by one, the amount of code that needs to be written will be terrible. Therefore, a for loop is needed, use the for loop to add a sprite particle at random coordinates, loop 200 times, you can achieve the effect of adding 200 sprite particles in the scene. Then set all sprite particles to white and a simple star is done.

As shown in the Fig. 12, after adding water and stars to the scene, the water can reflect the stars in the sky to form an interaction, and at the same time make the overall background more realistic and fuller of artistic conception.
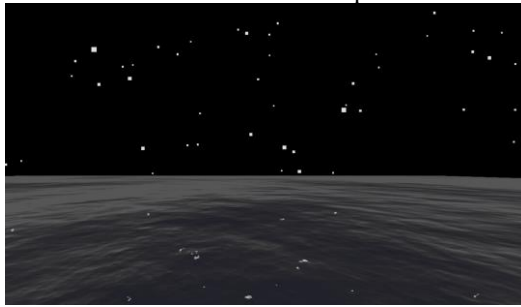

Fig. 12. Background (Original)

After completing the overall background, it is only necessary to add the lantern to the scene and the final result is completed (Fig. 13).

Fig. 13. Final Result (Original)

After completing all the scene layouts, in order to display the scene, a camera is needed to surround the entire scene. Using the OrbitControls function can achieve the function of rotating the camera around a certain point.

2.3   Website building

After studying the official website layout of three.js, a design similar to it has been choosed, because this design is simple and clear enough. In the construction of the website, Vue3+Vite+ElementPlus+Threejs was chosen, so that users can understand the specific design of the website through the menu on the left. The Fig. 14 is the final product of the website.
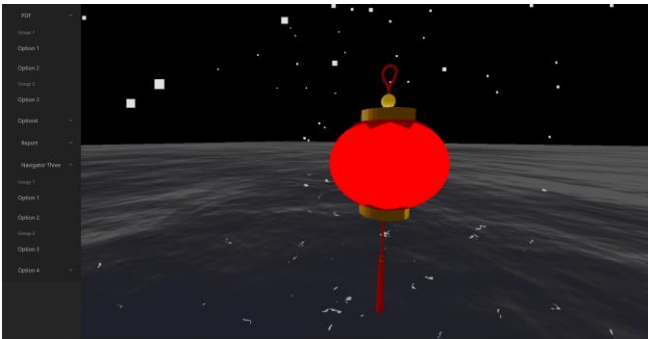

Fig. 14. Website (Original)

3   Results and Analysis

After going through the above process, anyone can see this model on the website. From the website, It can be found that there are several different options on the left menu, namely the final product, the rendered code, the lantern report and the ppt for presentation. This site will allow anyone who consults it to have a detailed look at the overall process of lantern making and rendering if needed. At the same time, anyone can drag the lantern freely on the website, also can observe the lantern from multiple angles to get more details as shown in Fig. 15.
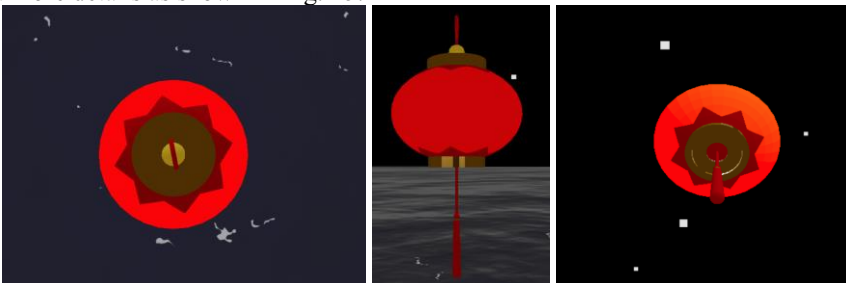

Fig. 15. Details of lantern (Original)

Now, this website and the original source of inspiration, Fig.1, will be sent to 10 random people and asked to rate them from five aspects: restoration, modeling quality, rendering quality, scene quality, and style suitability, with 0 being the lowest. 10 is the highest score, and the Table 1 shows each person's rating and the final average score.

Table 1. Scoring Result (0-10 points)

Grader	Restoration	Modeling quality	Rendering quality	Scene quality	Style suitability
1	4	8	9	2	3
2	3	7	8	3	5
3	5	9	10	4	9
4	2	6	6	2	2
5	2	7	9	3	9
6	3	9	9	4	10
7	1	6	7	1	1
8	5	9	8	6	4
9	6	7	9	3	5
10	8	10	10	7	10
Average score	3.9	7.8	8.2	3.5	5.8

The overall evaluation of the modeling quality and rendering quality is generally positive, but there have been more negative assessments regarding the degree of restoration and scene quality. The majority of feedback has focused on the substantial differences between the modeled lantern and the actual original image, with many details missing. Furthermore, concerns have been raised regarding the empty background, unrealistic stars, and the presence of sprite particles obstructing the camera's view. These areas are considered to be areas in need of improvement.

It is worth noting that the evaluation of style adaptation has elicited somewhat polarized responses, which can be attributed to subjective perspectives. Supporters of the simplistic style argue that it effectively captures the essence of traditional Chinese lanterns and successfully restores their appearance. On the other hand, critics argue that this style lacks intricate details and fails to convey the cultural atmosphere and charm associated with traditional Chinese lanterns.

Although there has been some negative feedback, these opinions offer valuable guidance for refinement. Enhancements are needed in terms of accurately reproducing the actual original image, restoring missing details, and elevating the realism of the scene. The exploration of diverse styles should also be pursued, while striking a balance between simplicity and adequately representing the cultural ambiance intrinsic to traditional Chinese lanterns. Additionally, careful attention should be given to the background and particle effects, ensuring they are rendered in a more realistic and seamless manner.

4   Conclusion

Based on the research and survey conducted in this study, we utilized modern computer graphics technology in combination with OpenSCAD and Three.js to attempt reproducing traditional Chinese lanterns in a minimalist style, while exploring the integration of traditional culture and modern technology. By gathering opinions and viewpoints from interviewed individuals, the following conclusions have been drawn.

Firstly, the minimalist style does not completely align with the reproduction of traditional Chinese lanterns. While the minimalist style can express the form and general characteristics of the lanterns in a clear and concise manner, it falls short in fully capturing the intricate details and patterns. During the simplification process, the texture of the lanterns' paper, intricate carvings, and delicate decorations are often overlooked or simplified, resulting in a lack of high-fidelity restoration.

Secondly, further improvement is required in the overall quality of scene rendering. Currently, the integration of background elements and particle effects related to the lanterns is inadequate, lacking realism and intricacy. This compromises the realism and presentation of the overall scene, making it difficult for audiences to immerse themselves.

In conclusion, it can be determined that when reproducing traditional Chinese lanterns, the minimalist style poses certain challenges, primarily in terms of low-fidelity restoration and the need for enhancement in the overall quality of scene rendering. To better preserve and showcase traditional culture, it is necessary to strive for a better balance during research and development, emphasizing both the distinctive features and aesthetic appeal of traditional Chinese lanterns, while leveraging the advantages of modern computer graphics technology to achieve a closer representation of the lanterns' details and atmosphere. Lastly, it is recommended to intensify research and knowledge acquisition pertaining to traditional culture, aiming to enhance the accuracy of model restoration and the authenticity of scene rendering. By combining professional modeling techniques and visual art design, we can explore more effective approaches to reproduce lanterns, further driving the organic fusion of traditional culture and modern technology, and presenting more captivating and immersive works to audiences.

References

1. Zhu Hongyang. Virtual world construction and visual presentation in animation and game design. Toy World, 2023(04):79-81.
2. Xiao Yajing. Research on the Communication of Lantern Culture in Film and Television Works. Southeast Communication, 2015(07): 60-62.
3. Ge Tian. Application of editable polygons in three-dimensional game scene modeling—taking Xieshan architecture as an example. Modern Information Technology, 2022, 6(09):107-109+113.
4. About OpenSCAD,https://openscad.org/about.html
5. Tao Zhang.Study on the Lantern Culture of the Hakka Ancestral Land Ninghua.Proceedings of the 3rd International Conference on Judicial, Administrative and Humanitarian Problems

of State Structures and Economic Subjects. 10.2991/jahp-18.2018.2. 2352-5398. August 2018.

6. Mark L .Artificial Intelligence for Games. Series in Interactive 3D Technology.Computer Journal, 2007(3):371-371..

7. Ganguly R , Reddy D R , Venkataraman R ,et al.Review on foreground artificial intelligence in games.International Journal of Engineering & Technology, 2018, 7(2.8):453.

8. Millington I F J .Artificial Intelligence for Games.Artificial Intelligence for Games, 2009, 15(2):196–211.

9. Yannakakis G N, Togelius J .Artificial Intelligence and Games[M]. 2018.

10. Yachun,Zhou,Mingquan, Rapid three-dimensional scene modeling by sketch retrieval and auto-arrangement. Journal of Visual Languages & Computing. 2008, 14(1):97-117.