An Inter-Software Approach to Presenting Graphics-Related Digital Media

Hin Yeung Lam[1,*], Qingya Li[2]

[1]Paul G. Allen School of Computer Science and Engineering, University of Washington, Seattle, WA 98105, United States
[2]Maynooth School of Multimedia, Mobile & Web Development, Fuzhou University, Fuzhou, Fujian 350108, China

*Corresponding author: hlam3@uw.edu

Abstract. Modeling techniques are increasingly used in various industries, while the areas of model interpretability, automated modeling, and small-sample learning have received significant attention, contributing significantly to building a smarter and more efficient society. Meanwhile, virtual reality (VR) and augmented reality (AR) technologies combined with three-dimensional (3D) modeling, have made it easier and more affordable to go from a 3D model to the manufacturing of actual objects for applications in education, training, entertainment, and healthcare, revolutionizing areas such as prototyping, medical implants, and custom products. Based on the above background, the purpose of this paper is to illustrate the process of modeling a traditional Chinese lantern, and to evaluate the results and point out some problems. This paper describes the design and production process of a traditional Chinese lantern, including shape design, color combinations, and material rendering, and briefly creates a display screen for a relatively successful lantern modeling study, and presents the results to a group of randomly selected different users; the data collected suggests that the audience found the innovation aspect to be slightly lacking, but the overall modeling evaluation was good.

Keywords: 3D modeling; lantern; graphic-related

1 Introduction

The current state of research in the field of modeling shows rapid growth and diversity. The field of modeling experiments is rapidly evolving, spanning multiple fields, from science and engineering to culture and the arts. The rapid growth of this field is due in part to the rise of computer-aided design (CAD) technology, 3D printing, virtual reality, and augmented reality (VR/AR) [1, 2]. The advent of these tools has improved the accuracy and visualization of modeling experiments, providing unprecedented opportunities for innovation and research. Modeling experiments have permeated various fields such as product design, architecture, medicine, and entertainment, and have become a key driver of innovation and development.

B. H. Ahmad (ed.), *Proceedings of the 2023 International Conference on Data Science, Advanced Algorithm and Intelligent Computing (DAI 2023)*, Advances in Intelligent Systems Research 180,
https://doi.org/10.2991/978-94-6463-370-2_51

The field of modeling experiments has a wide and vibrant range of applications. In product design and manufacturing, digital modeling and virtual prototyping will accelerate innovation and reduce errors and costs. The medical and bioscience fields will benefit from modeling experiments to improve the accuracy of medical diagnosis and drug development. The architecture and urban planning professions can utilize this technology to create smarter, more sustainable buildings and cities. In education and training, virtual experiments and simulators will be powerful educational tools [3]. In entertainment and culture, virtual reality and augmented reality technologies will transform our entertainment experience while contributing to the preservation of cultural heritage. Environmental science will rely on modeling experiments to simulate climate change and ecosystem dynamics. Finally, aerospace and defense will continue to rely on modeling experiments for flight simulation, weapon system testing, and tactical planning. All in all, the field of modeling experiments has a wide range of promising applications and will continue to drive the advancement of technology and innovation in all areas to improve our quality of life, protect the environment, and advance society [4].

The main content of this article includes the shape of traditional Chinese lanterns, detail design, color and material rendering as well as simple audience experience and evaluation. The purpose of this paper is to understand and pass on the precious cultural heritage through Chinese traditional lantern modeling, documenting the design and production process of traditional lanterns to ensure that they are not forgotten by future generations. The value of this research lies in the fact that through digital modeling techniques, it is not only possible to reproduce the traditional art form, but also to provide inspiration for innovative design, incorporating modern aesthetic elements to create unique lantern works, and to promote the harmonious development of cultural heritage and innovation [4].

2 Graphics-Related Presentation Practice

This project is divided into four major steps: modeling, mapping, animation, and polishing (Fig.1). The modeling part includes the construction of the lantern itself and the addition of decorations; the mapping part includes the lantern itself, the addition of shadows, and the skybox as a background; the animation part is responsible for adding interactive animation options to some of the items in the scene; and the polishing part is responsible for further refining and beautifying both the modeling and the mapping.

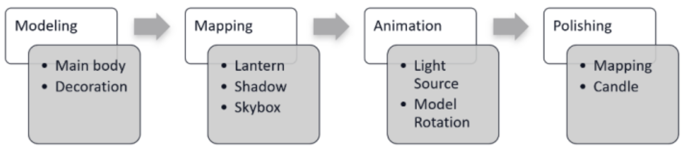

Fig.1 Implementation flow chart (Original)

2.1 Modeling

Our entire modeling journey was accomplished through the utilization of a software tool called OpenSCAD [5]. With this software, we crafted a digital representation of a classic Chinese lantern. Because of the way OpenSCAD works, we opted to use a technique involving either merging or breaking apart different shapes to construct our model. This approach allowed us to build the lantern in three main steps, namely forming the main body, designing the decorative fringes, and refining the finer details.

To begin, we laid the foundation for our lantern's structure in the software. This involved creating the basic shape, much like building with blocks, to establish the core structure of the lantern. This core structure was then extended to accommodate the lantern's characteristic fringes that contribute to its traditional appearance. Finally, we focused on enhancing the intricate elements that make the lantern visually captivating, ensuring our digital model was both authentic and detailed.

2.2 The main body of lantern

The process started with cubes to create the lantern's central part (Fig.2), forming a rectangular box shape [6]. For clarity in later stages, the structure was painted gray, aiding in distinguishing components during work. Next, attention turned to a key design element – the frames and grilles around the lantern. These patterns, made of intersecting lines, were placed at each corner, providing decorative elegance.

To simplify this stage, the method starts by designing the pattern within a single corner. We completed the grid-like window design in a single corner by adding multiple elongated rectangles, and then used a mirroring technique to delicately replicate the pattern in the remaining corners, copying one side to the other. This meticulous process provided a sturdy foundation for the lantern, ensuring not only a strong base but also intricate detailing. This strategic approach to development promotes a harmonious blend of structural integrity and visual appeal, making the lantern not only functional but also aesthetically appealing.

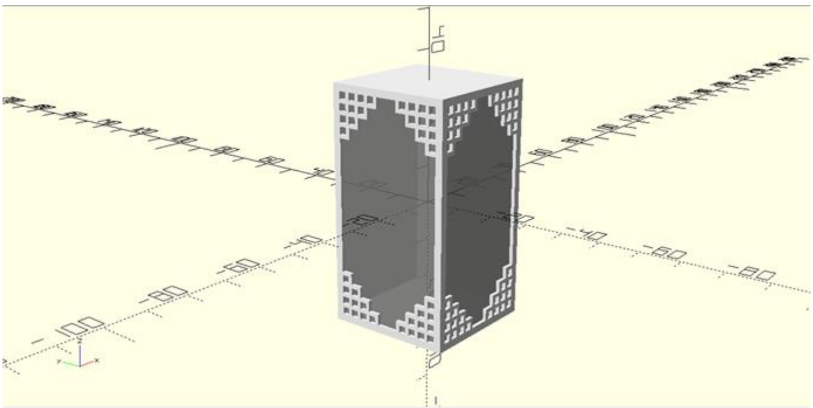

Fig. 2 The designed main body of lantern (Original)

2.3 The tassels of lantern

In the subsequent phase, the process advanced to incorporating more intricate components into the lantern's construction, inclusive of the upper sections and the appended hanging tassels (Fig.3). The methodology employed to achieve this augmentation shall now be delineated. Commencing with the uppermost segment, a novel cube was introduced, accompanied by calibrated modifications in both form and placement. Positioned atop the lantern's structure, this addition endowed the lantern with a distinctive visual profile while seamlessly integrating it with the framework. Progressing to the tassel, an ornamental aspect that gracefully suspends, a conventional motif characteristic of traditional Chinese lanterns was harnessed. This motif encompassed a series of spherical heads, akin to petite balls, adorning the tassel's suspension. Further enhancing this aesthetic, a pivotal element – the silk thread – was thoughtfully integrated, an essential constituent to emulating the suspended appearance intrinsic to a tassel. The pursuit of achieving a tassel characterized by delicacy and finesse was facilitated through the utilization of a "for" loop technique. This iterative approach enabled the creation of numerous slender and tubular formations, collectively harmonizing to shape the tassel, achieving a more realistic effect. To ensure a seamless visual transition and refine the lantern's overall presentation, the integration of a rectangular block, akin to a diminutive cube, was meticulously executed atop the tassel. This addition facilitated a graceful linkage between the tassel and the primary lantern structure, further enhancing the overall aesthetic cohesion.

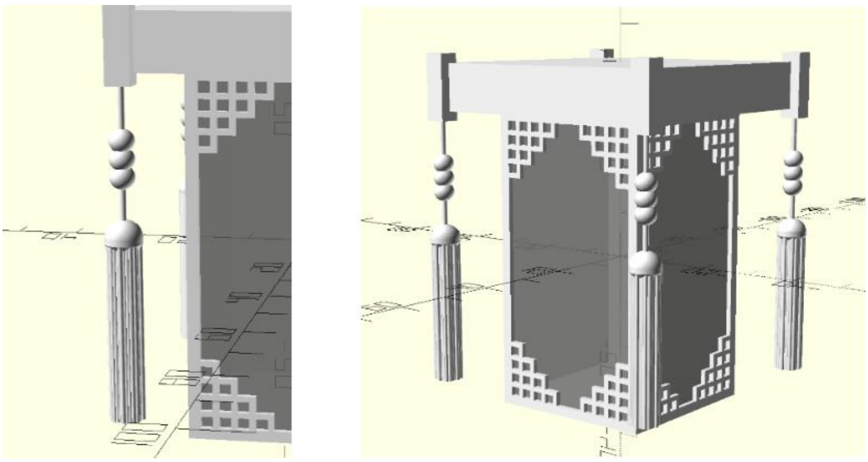

Fig. 3 The single tassel (Left), top and all tassels (Right) (Original)

2.4 More Decoration Incorporated

Concluding the process within the final phase of modeling, intricate elements were subsequently incorporated into the composition, encompassing the elaborate base, the ornate upper adornment, and the handle (Fig.4). To enhance the foundation's aesthetic intricacy and stability, other designs of lantern were referred, the tassels were added [7].

Turning attention towards the apex, the uppermost section was meticulously designed to encompass circular and elongated strip formations, ingeniously serving as the connecting medium for the handles. This design approach added an element of visual continuity while ensuring functional convenience.

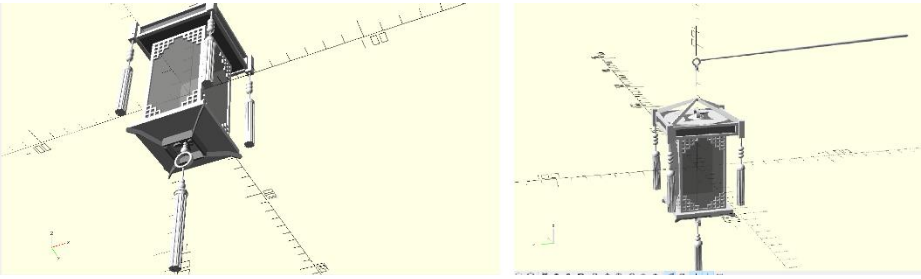

Fig.4 More decorations (Original)

3 Applying Materials

3.1 Implementing Mesh Phong Material

After the modeling of the Chinese lantern, we focused on applying materials on it, such as texturing and shading. The first phase was the implementation of Mesh Phong Material [8]. Using Three.js, we were able to create a new Mesh Phong Material object to infuse the model with satisfying effects by invoking Three.js built-in constructor [9]. This material provides properties - color, specular, map, etc.- for this model to define how it will respond to light.

3.2 About Mapping

The next phase is texturing the lantern. Through the Phong material, it is simple to use normal mapping for the texture of models. Normal mapping excels in most mappings because it has many advantages. In order to evenly distribute sample rates across all points and orientations on the surface, texture stretch (small texture distances mapped onto large surface distances) is minimized. To produce precise textured mesh approximations, it also minimizes texture deviation ("slippage" error based on parametric correspondence) [10].

When texturing, we integrated the normal map directly into the Mesh Phong Material constructor. This step was pivotal in transforming the single-colored modeling prototype into a realistic lantern. However, we faced a challenge that we were not able to do direct coloring or mapping of the entire lantern. That is, it was not applicable to separate this lantern and map it separately in Three.js. Thus, we had to separate it to several *.stl files - for example, main cube, top cube, tassels, and the handle - before importing to

Three.js, and map them accordingly. After the mapping, the lantern is close to being a finished product after the mapping (Fig.5).

Fig.5 Chinese lantern with texture (Original)

3.3 Adding Shadow

In order to provide realism to this lantern, shadows are indispensable. For adding shadows, we needed to enable the shadow map of renderer, create a plane to receive the shadow, and enable the cast-shadow feature of both the light and the model. After the plane was created, we applied a checkerboard texture with repetition to fill the whole plane using the texture loader method of Three.js (Fig.6).

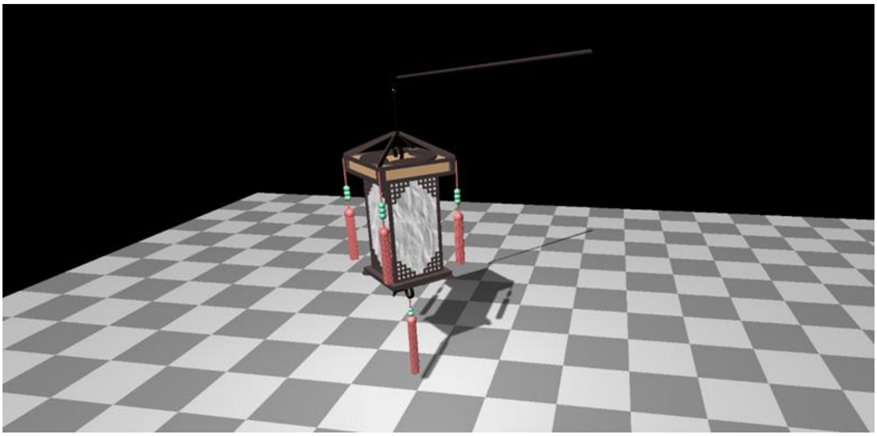

Fig.6 Checkerboard plane and shadow of lantern (Original)

3.4 Cube Mapping and Skybox

To further enhance the overall aesthetics of the product, we turned our attention to Cube Mapping because it creates an illusion of a 3D environment by creating a giant box and projecting six given images correspondingly onto the six faces of the box. The skybox surrounds the entire scene to simulate a 3D background. Under this environment, this lantern and the whole project appeared more vivid and realistic (Fig.7).

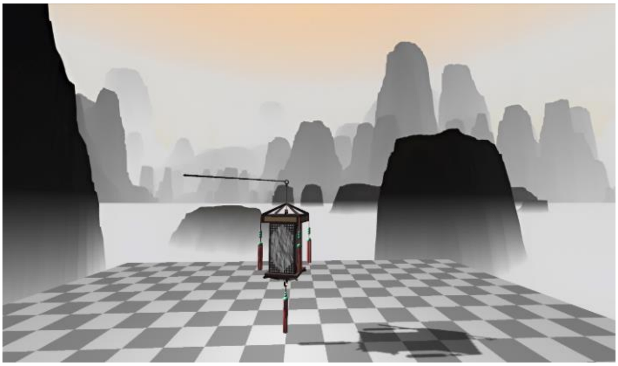

Fig.7 Skybox as background (Original)

4 Animation

4.1 Light Source

As the final step of the project, the animation not only enhances the user's ability to manipulate the model itself, but also facilitates the user's ability to view the model in a variety of lighting environments and from a variety of perspectives. The first adjustable is the light source. It affects the surface illumination of the lantern, its shadow shapes, and the overall ambient brightness conditions. We created a button to control the movement of the light source, making it travel at a constant speed in the distance. Th e little yellow cube above the lantern is the source of light (Fig.8).

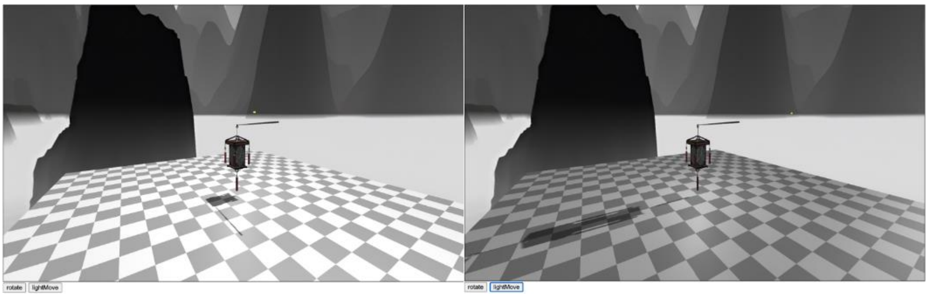

Fig.8 Moving light source (Original)

4.2 Rotation of the Model

Another adjustable is the lantern itself. It is able to rotate about its center axis. We created a button to make it rotate or stop. This is a frequently used strategy because rotating the model highlights its details, textures, and surfaces that might not be as visible in a single static view. Specifically, the light source stays in the same direction to the lantern, so the rotation showcases how the lantern's reflected light changes in real time depending on the angle of illumination (Fig.9).

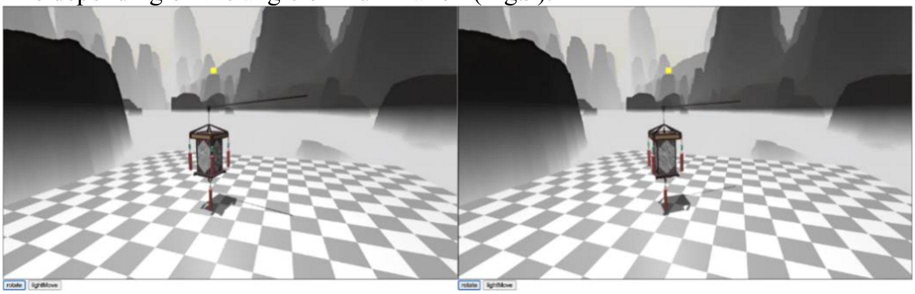

Fig.9 Rotation of the lantern (Original)

5 Polishing

After completing all the tasks, we found ourselves not entirely content with our model mapping; it had the potential for greater intricacy, leveraging capabilities beyond those inherent to three.js. This included the possibility of using Blender for a more refined mapping process. Upon completing our preparatory steps, we recognized that exporting it from Blender to three.js and subsequently animating it posed considerable challenges, especially given the file type we were currently employing. Consequently, we opted to retain the enhanced model within Blender and present it as a separate entity.

5.1 Replacing the Enclosure

The nature of crepe paper material doesn't lend itself to significant reflectivity and restoration of the real appearance of the lantern. Therefore, we opted for yarn as a more suitable choice to convey the characteristics of Chinese culture (Fig.10).

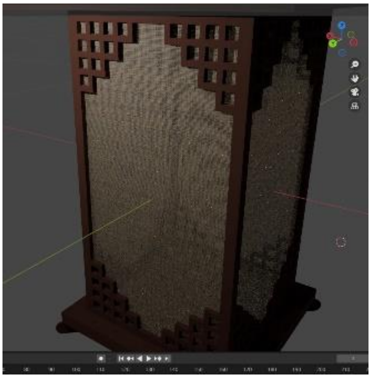

Fig.10 Lantern with yarn enclosure (Original)

On top of the crepe paper, we folded a beautiful Chinese painting that surrounds the four sides, which not only enhances the aesthetics, but also makes each of the four sides different and enhances the diversity (Fig.11).

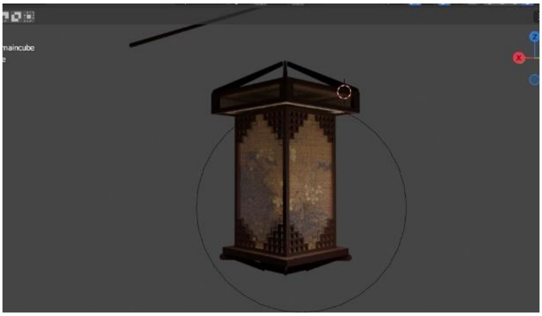

Fig.11 Lantern enclosed with Chinese painting (Original)

5.2 Candle and Other Textures

It's natural that a lantern would require a candle to serve its fundamental purpose. Accordingly, we integrated a candle within the lantern, utilizing its flame as the primary internal light source. Furthermore, we substituted the plastic-like material previously used for the beads and rings with a more metallic-like substance (Fig.12).

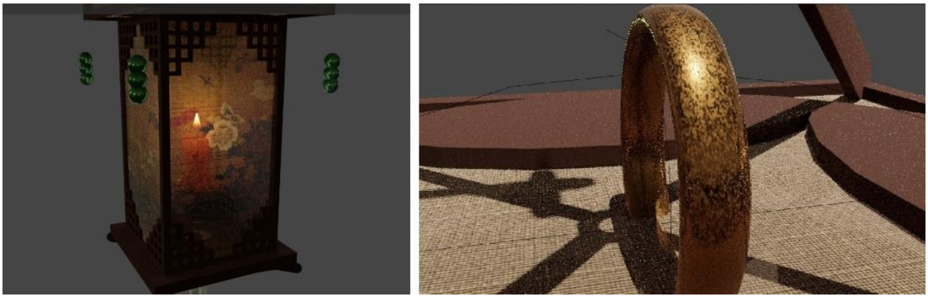

Fig.12 Candle inside the lantern with metal beads (Left) and rings (Right) (Original)

5.3 Improvement of the Model

The original fringe design for this lantern comprised a sphere and numerous elongated cylinders, yet we found this design to impart a rather rigid appearance. Consequently, we opted for a plusher and smoother fringe model from the repository. Additionally, we made subtle enhancements to the mapping of the lantern's main body, incorporating wood grain patterns to enhance the authenticity of its wooden texture (Fig.13 and Fig.14).

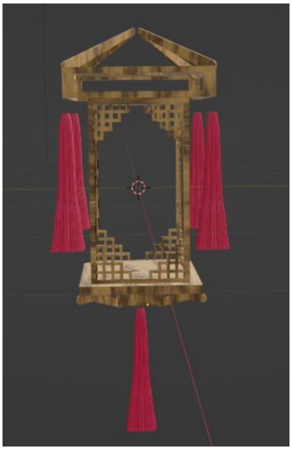

Fig.13 Enhanced fringe and main body texture (Original)

Fig.14 Final result (Original)

6 Results and Discussion

In an attempt to obtain a relatively objective assessment of the degree of completion and excellence of all aspects of our project, and to gain inspiration for improvements to be made to the product, the overall product was presented to 10 randomly selected people who completed ratings on five aspects of the work. All the ratings are presented in the following table, and the average rating of each aspect will be calculated and presented (Table 1).

- **"Modeling Quality"** measures how detailed the lantern model itself is and its interpretation of the concept of lanterns.
- **"Rendering Quality"** showcases the details and aesthetic quality of the mapping and rendering of the lantern.
- **"Innovation"** represents the degree of novelty of the work itself, i.e. the degree of extension of the whole project that goes beyond the lantern itself.
- **"Style Integration"** indicates the overall finish of the work (including modeling and rendering) and its interpretation of the concept of lanterns.
- **"illumination"** demonstrates the function of the lantern itself in a relatively dark environment.

Table 1. The assessment result (0-10 point)

Person	Model Quality	Rendering Quality	Innovation	Style Integration	Illuminance
A	9	8	6	8	9
B	9	7	7	10	10
C	8	8	5	8	9

D	7	6	6	9	7
E	7	9	6	7	8
F	8	10	7	10	9
G	9	8	8	8	9
H	8	9	6	8	8
I	8	10	7	10	7
J	7	7	7	9	7
Average	8.0	8.2	6.7	8.7	8.3

In terms of evaluations, modeling, rendering, and illuminance received more positive feedback overall. Style Integration achieved the highest rating among the five aspects, whereas Innovation obtained the lowest score.

Concerning the model, we crafted a relatively intricate lantern frame. It has aesthetic and design lace frames on all four corners of the main frame, imbuing the entire structure with a heightened sense of intricacy. Additionally, it incorporates decorative beads and tassels that not only enhance its beauty and complexity but also introduce a certain visual fluidity to the model itself. These refinements in details have contributed to a relatively high rating of 8.0 in the 'Model' metric. However, there is room for further improvement by diversifying the individual decorations, as the identical tassels on the lantern's sides and bottom could potentially induce a degree of aesthetic fatigue.

Similarly, the rendering exhibits greater intricacy, showcasing the beads and rings with a metallic texture, while the encircling material is composed of yarn, reflecting Chinese cultural aesthetics. Furthermore, it's worth noting that all the beads and tassels maintain uniformity in terms of material and color, which, while contributing to the overall visual coherence, could introduce a slight sense of repetitiveness. However, what truly sets our rendering apart is the diversity in imagery adorning the four sides of our lantern. This very factor explains the close alignment of the first two ratings, with the rendering score holding a slight edge.

The rating for the innovation aspect, consistent with our expectations, turned out to be the lowest among the five categories. We held the belief that our project featured an aesthetically pleasing model, and our strategic utilization of a skybox background successfully heightened its realism. However, upon closer examination, we identified that our project's focus on faithfully reproducing a traditional Chinese lantern inadvertently led to the lack of innovative elements. Therefore, potential avenues for improvement encompass introducing non-Chinese elements to diversify the design, as well as exploring more shapes for the beads and tassels, among other possibilities.

Integration style was awarded the highest rating thanks to its successful fusion of traditional design elements and modern modeling techniques to create a piece that combines classical flavor with modern aesthetics. The modeling demonstrates respect for traditional lantern shapes and presents the classic structure of the lantern by using basic geometric shapes such as cubes. At the same time, by flexibly using the characteristic elements of lanterns, such as borders, patterns and paper windows, the modeling successfully gives the modeling work a unique cultural character. However, traditional Chinese lanterns usually have specific functions, such as blocking light and placing candlesticks. In the process of designing, some practical functions may be neglected due to the lack of practical application cases, resulting in the design losing the practicality of the lantern itself.

The modeling has incorporated modern lighting elements while retaining the appearance and morphological features of traditional lanterns. Candle lighting is set up inside the lantern, and then through the paper windows printed with beautiful patterns, unique light and shadow effects can be created, enhancing the visual appeal of the lanterns, and viewers are presented with a brand-new visual experience. The modeling also considers the balanced lighting of all parts of the lantern. This helps to avoid uneven light and darkness and excessive shadows and ensures the consistency of the overall lighting effect. However, in practice, the use of candles as a light source, although aesthetically pleasing, inevitably has the problem of longevity and safety risks, and is easily affected by environmental changes. In the process of future improvement, we will be committed to creating a safer and more beautiful lighting system.

Overall, the project demonstrates a commendable level of accomplishment with satisfactory refinement and aesthetics. While certain details have significantly improved the presentation and reproduction of the concept of lanterns, the project could benefit from more innovative elements.

7 Conclusion

In this project, we have successfully taken the study of lantern styling deep into the complex realm of coding, modeling, and rendering. With advanced algorithmic techniques and a meticulous colorization process, we have developed a more comprehensive understanding of the various factors affecting lantern illumination, structural integrity, and aesthetic appeal. The developed lantern model combines simulation-driven optimization and artistic considerations to increase its visual and structural plausibility and fascination, while ensuring their stability and luminous efficiency. This research takes steps towards the field of architecture and lighting design with the goal of merging traditional craftsmanship with modern technology. In order to create more innovative and culturally resonant lantern structures, it is hoped that this work will continue to inspire new approaches to architectural design that respect heritage while embracing the potential of contemporary technology.

Authors Contribution

All the authors contributed equally, and their names were listed in alphabetical order.

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