

Research on digital restoration and restoration methods of ancient buildings Based on PBR material technology-- Taking Shenyang Shifo Temple Pagoda as an Example

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Abstract: This thesis studies "the digital restoration and restoration method of ancient buildings based on PBR material technology". Based on physical principles, PBR material technology presents real light and shadow effects and materials. Taking the Stone Buddha Temple Pagoda as an example, through data collection, modeling, texture reconstruction, and the application of PBR material technology, the digital restoration of ancient buildings is realized. The evaluation of the restoration effect shows that digital restoration enhances the authenticity and sustainability of the restoration effect of ancient buildings, and brings new possibilities for the protection of cultural heritage. However, the application of PBR material technology needs to fully consider the characteristics of building materials and environmental conditions. This study promotes new ideas and methods for the protection of ancient buildings, and continues to promote innovation in the protection of ancient buildings.

Keywords: PBR-based material technology, ancient buildings, digital restoration, protection and inheritance, data collection and processing

1. Introduction

1.1 Research background and purpose

As a precious heritage of human civilization, ancient buildings carry rich historical and cultural connotations. However, due to the passage of time and the erosion of natural forces, many ancient buildings are facing varying degrees of damage and decay. In order to protect and inherit these precious cultural heritages, restoration and conservation work has become crucial. In recent years, digital restoration technology has gradually attracted attention due to its unique advantages. This article aims to explore the significance and challenges of digital restoration for ancient buildings.

1.2 History and value of Stone Buddha Temple Pagoda

As an important Buddhist building in northern China, the Stone Buddha Temple Pagoda has a long history and profound cultural value. It was built in Shijiazhai, Shuangzhou City, in the tenth year of Xianyong in the Liao Dynasty (1074 A.D.), with a history of more than 900 years. There is a temple near it called "Jingjuyuan", which is now renamed Stone Buddha Temple, so the Stone Buddha Temple Pagoda is also called "Jingjuyuan Relic Pagoda". In May 1982, the city's cultural relics workers excavated the underground palace of the ancient pagoda. The pagoda is of great significance to the study of several city sites discovered under Qixing Mountain and the history, religion, and culture of the Qixing Mountain area in the Liao Dynasty.

1.3 Significance and challenges of digital restoration

As an emerging restoration method, digital restoration has many advantages that traditional restoration methods cannot match. First of all, digital restoration can avoid further damage to ancient buildings through non-contact data collection. Secondly, digital restoration uses advanced computer technology and three-dimensional modeling technology to accurately restore the original appearance of ancient buildings and provide a reference for restoration plans. In addition, digital restoration has

the characteristics of strong visualization and interaction, which can allow the public to better understand and appreciate the value of ancient buildings. [1] However, digital restoration also faces some challenges. First of all, the complexity and diversity of ancient buildings require sufficient professional knowledge and technical support for digital restoration. Secondly, technical difficulties in lighting, texture reconstruction, etc. may be encountered during data collection and processing. In addition, digital restoration needs to take full account of historical and cultural factors to maintain the authenticity and credibility of restoration results.

To sum up, digital restoration is of great significance to the restoration and protection of ancient buildings. Through digital restoration, accurate restoration and protection of ancient buildings can be achieved, allowing people to better appreciate and inherit historical culture. However, digital restoration also needs to face technical and cultural challenges, and needs to be further researched and explored. Through this research, we will explore the application of digital restoration in the restoration of Stone Buddha Temple Pagoda, and provide useful reference and reference for the restoration of ancient buildings.

2. Digital restoration method and process

2.1 Data collection and processing

The first step in digital restoration is data acquisition. Various technologies, such as laser scanning, photogrammetry, and drone aerial photography, can be used in the acquisition process to obtain accurate three-dimensional data of ancient buildings. From these data, information such as the geometry, details and texture of the building can be obtained. The collected data needs to be combed and reprocessed to improve the accuracy and rationality of the data. This includes rectification, fusion and texture mapping of images, etc. The goal of data processing is to generate high-quality, consistent and usable digital models that provide a reliable basis for subsequent restoration work.

2.2 Modeling and texture reconstruction

Modeling is an important step in digital restoration. Based on the collected data, 3D modeling software can be used for modeling work. The goal of modeling is to restore the original shape and details of ancient buildings, as well as the restoration of damaged parts. Depending on the specific situation, different modeling methods can be selected, such as manual modeling, automatic modeling and semi-automatic modeling. During the modeling process, it is necessary to carry out detailed texture reconstruction work according to the structural characteristics and cultural background of the building. By mapping the captured texture information onto the modeled surface, a more realistic appearance can be achieved. Texture reconstruction can use image processing and texture mapping techniques to make the restored ancient buildings have the original color, texture and details. PBR material technology is an important means of texture reconstruction.

2.3 Practical application of PBR material in restoration

As an important part of digital restoration, PBR material (Physically Based Rendering) technology has shown excellent results in practical applications. Based on physical principles, PBR materials simulate the interaction between light and materials, making restored ancient buildings more visually realistic and realistic.[2]

In the process of digital restoration, PBR material technology can be applied in many aspects, including the lighting effect of the material surface, the color and texture of the material, and the overall integration of the restored part and the original building.

First of all, PBR materials can accurately simulate the lighting effects of different material surfaces. For example, for an ancient building with a stone structure, the PBR material can realize the real texture of the stone surface under different lighting conditions according to the light reflection and scattering characteristics of the wood. This makes the restored ancient buildings present natural light and shadow effects under different time and light, which enhances the realism of the restoration effect.

Secondly, PBR material technology has played an important role in restoring the color and texture of ancient buildings. With accurate color maps and texture mapping, PBR materials can restore the original appearance of ancient buildings. This includes the precise restoration of painted patterns, carved details, and the colors and textures of building materials, so that the restored ancient building is visually seamless with the original building.

Finally, PBR material technology can realize the overall integration of the restored part and the original building. In digital restoration, it may be necessary to supplement or reconstruct parts of ancient buildings. By applying PBR materials, the restored part can match the material and color of the original building, maintaining the overall consistency and harmony. This makes the restored ancient buildings not only restore the original appearance in details, but also present a more complete and unified visual effect as a whole.

In general, the practical application of PBR material technology provides higher accuracy and authenticity for the digital restoration of ancient buildings. By simulating the interaction of light and materials, PBR materials make the restored ancient buildings visually closer to the original state. However, the application of PBR materials also needs to fully consider the characteristics of building materials and environmental conditions to ensure the accuracy of the restoration effect and restore the historical value of ancient buildings. With the continuous development of technology, PBR material technology will continue to bring more innovation and progress to the digital restoration of ancient buildings.

3. Restoration process and effect evaluation

3.1 Steps and strategies of the restoration process

The process of digital restoration of ancient buildings can be divided into several key steps. First, a detailed survey and assessment of the historic building is required to understand its condition of damage and restoration needs. Then, formulate repair strategies and plans, and determine the scope and goals of repair. Restoration strategies can combine the historical value and cultural background of the Stone Buddha Temple Pagoda, while considering the structural safety and material protection of the building. The next step is the restoration implementation stage, through digital modeling and texture reconstruction, the ancient buildings are restored and restored. During the repair process, it is necessary to carry out structural reinforcement, reconstruction of missing parts and repair of damaged parts according to the actual situation. Material selection and technical application during restoration also take into account compatibility and durability with the original material.

3.2 Practical application of PBR material in restoration

PBR material technology has important application value in the restoration of ancient buildings. [3] Through the application of PBR material, the visual consistency between the restored ancient building and the surrounding environment can be achieved. The PBR material can accurately simulate the reflection, refraction and lighting effects of building materials, so that the restoration part and the original building materials can be seamlessly blended visually.

In practical applications, it is necessary to select appropriate PBR material parameters according to the material properties and environmental conditions of ancient buildings. By adjusting parameters such as albedo, roughness, and metalness, you can precisely control the appearance and material effect of the restored part. At the same time, adjustments are made based on lighting conditions to ensure that the repaired part presents a real light reflection effect under different lighting conditions.

3.3 Evaluation and analysis of restoration effect

For digitally restored ancient buildings, the evaluation and analysis of the restoration effect is very important. Evaluation can be done in a variety of ways, including visual inspection, evaluation by professionals, and feedback from the public.

First of all, the restored ancient buildings can be visually inspected to compare the changes and effects before and after restoration. Particular attention was paid to the consistency of the restored part with the original building, material effects and detail accuracy. At the same time, professionals can be invited to evaluate the restored ancient buildings. They can assess the quality of the restoration, the application of techniques and the choice of materials based on their expertise and experience. In addition, public feedback is also an important reference for evaluating restoration effects. The public can evaluate the appearance, touch and cultural value of the restored ancient buildings through visits and interactive experiences. Through comprehensive evaluation and analysis, the restoration effect can be evaluated quantitatively and qualitatively. This helps improve restoration methods and techniques, and increases the effectiveness and sustainability of digital restoration.

To summarize the above, the digital restoration of ancient buildings is a complex and challenging task. Through reasonable steps and strategies, combined with the application of PBR material technology, the precise restoration and protection of ancient buildings such as Shifo Temple Pagoda can be realized. The evaluation and analysis of restoration effect is an important part of continuous improvement to ensure the quality and sustainability of restoration work.

4. Conclusion and Outlook

4.1 Summary of research work and review of results

This paper discusses the application of virtual reality technology and PBR material technology in the restoration of ancient buildings by studying the digital restoration of Shifosi Pagoda. Through the steps of data acquisition and processing, modeling and texture reconstruction, and the application of PBR material technology, the Stone Buddha Temple Pagoda has been successfully restored and protected. At the same time, the restoration process and restoration effect were evaluated and analyzed to verify the effectiveness and feasibility of digital restoration.

4.2 Limitations and improvement directions of digital restoration

Although digital restoration has achieved remarkable results in the conservation of ancient buildings, there are still some limitations and challenges. First of all, digital restoration requires advanced technical equipment and professional support, which may be difficult for regions or institutions with limited resources. Secondly, digital restoration needs to comprehensively consider multiple factors such as technology, culture and environment, so as to avoid excessive changes and loss of original cultural values. Therefore, the direction of improvement in the future includes the popularization and optimization of technical equipment, as well as the strengthening of cultural protection principles in the restoration process.

4.3 Prospects and suggestions for digital restoration of ancient buildings in the future

Looking into the future, the digital restoration of ancient buildings will continue to develop and play a greater role. First of all, we should continue to promote the innovation and application of digital technology to improve the accuracy and efficiency of the restoration process. For example, combining technologies such as artificial intelligence and deep learning to further improve the accuracy of modeling and texture reconstruction to achieve a higher level of digital restoration. Secondly, strengthen international cooperation and exchanges, and jointly promote the research and practice of digital restoration of ancient buildings. The restoration of ancient buildings in different regions and cultural backgrounds faces different challenges and needs. Through cooperation, experience and technology can be shared to improve the quality and effect of restoration work. In addition, public participation and promotion of cultural education should be strengthened. Through virtual exhibitions, online interactions and educational activities, more people can understand and experience the charm and value of ancient buildings, and enhance awareness and participation in the protection of cultural heritage.

To sum up, digital restoration of ancient buildings is a research field with great significance and broad prospects. Through continuous innovation and improvement, digital restoration technology will provide more possibilities for the protection and inheritance of ancient buildings. Future research and practice should focus on the development and application of technology, strengthen international cooperation and cultural education, and jointly promote the development of digital restoration of ancient buildings, so as to leave a more complete and precious cultural heritage for future generations.

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