Research on Digital Reconstruction and Virtual Reality Display Technology of Ancient Architecture Based on AIGC

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ABSTRACT
As an important carrier of history and culture, ancient architecture is facing the damage crisis caused by natural erosion and human factors, and the traditional protection and inheritance methods are limited. Although digital technology has been applied, there are still challenges in high-precision reconstruction and immersive experience. This article focuses on the research of digital reconstruction and virtual reality display technology of ancient buildings based on generative artificial intelligence, aiming at opening up a new path for this field and having far-reaching significance. Firstly, this article analyzes the ancient architectural theory, the principle of generative artificial intelligence technology and the technical basis of virtual reality display. On this basis, the technical path of digital reconstruction is discussed. Artificial intelligence is used to generate the missing model and detail processing mechanism, and a scientific reconstruction effect evaluation system is constructed to ensure the reconstruction quality. Then, the realization strategy of virtual reality presentation is studied, including virtual scene construction and interactive mode design. This study is expected to provide effective technical support and theoretical guidance for the protection and inheritance of ancient architecture. This will help to dig deep into the cultural connotation and enhance the sense of national cultural identity.

Keywords: *Generative artificial intelligence, Ancient architecture, Digital reconstruction, Virtual reality display, Cultural heritage*

1. INTRODUCTION

As an important carrier of history and culture, ancient architecture bears the social features, craft wisdom and humanistic spirit of the past [1]. However, years of erosion, natural disasters and human factors have caused many ancient buildings to face the crisis of destruction or even disappearance [2]. Effective protection and inheritance of ancient architecture has become a key problem to be solved urgently in the field of cultural heritage [3]. With the rapid development of information technology, digital technology has opened up a new path for the protection and inheritance of ancient buildings. Rebuilding and displaying ancient buildings by digital means can not only preserve their information permanently, but also present the charm of ancient buildings to the public in a more vivid and intuitive way [4]. Among many digital technologies, AIGC has brought new opportunities for the digital reconstruction of ancient buildings with its powerful generation ability [5]. Virtual reality technology can create an immersive experience environment, making the audience feel the unique charm of ancient architecture as if they were there.

The research on digital reconstruction and virtual reality display technology of ancient buildings based on AIGC has far-reaching significance and value [6]. From a cultural point of view, it helps to dig deep into the historical and cultural connotation behind ancient architecture and inherit and carry forward excellent traditional culture [7]. With the help of digital reconstruction and virtual reality display, we can break through the time and space restrictions, let more people contact and understand the ancient architectural culture, and enhance the national cultural identity and pride. Technically, this research can promote the

application and innovation of AIGC and virtual reality technology in the field of cultural heritage protection, and promote the integration and development of interdisciplinary fields [8].

Although some achievements have been made in the digital protection of ancient buildings, there are still many challenges in realizing high-precision digital reconstruction with AIGC and creating immersive experience with virtual reality technology. The purpose of this study is to explore the digital reconstruction method of ancient buildings based on AIGC and the application strategy of virtual reality display technology.

2. DIGITAL RECONSTRUCTION OF ANCIENT BUILDINGS BASED ON AIGC

2.1 Data Acquisition and Preprocessing

Data acquisition is the basic work of digital reconstruction of ancient buildings. In view of ancient architecture, it is necessary to comprehensively use various technical means to obtain comprehensive and accurate data. On-the-spot measurement can accurately obtain the geometric size information of buildings with the help of laser scanning technology; Photogrammetry records the texture details of the building by shooting its appearance from multiple angles [9]. At the same time, it is also indispensable to collect historical documents, drawings and other materials, which can provide important clues for missing parts of buildings or areas that are difficult to measure on the spot.

The collected data are often complicated and disorderly, so it needs to be preprocessed. The first is data cleaning to remove noise data caused by measurement errors, equipment interference and other factors. Then the data format is converted to make it suitable for subsequent analysis and processing. Figure 1 shows different data acquisition methods and their corresponding preprocessing operations.

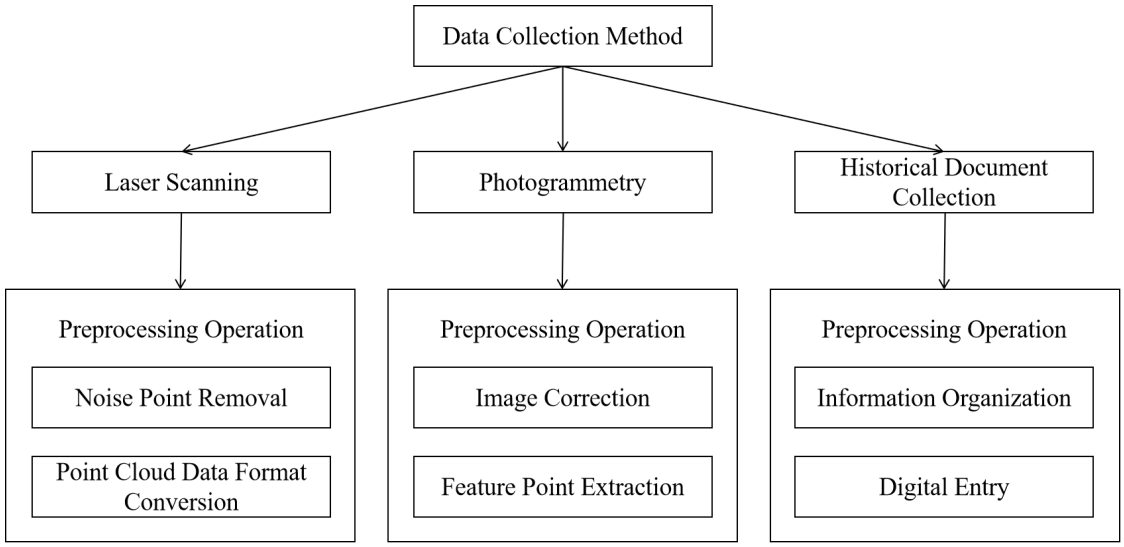


Figure 1 Data acquisition and preprocessing mode

2.2 Application of AIGC in Digital Reconstruction

It is an important application to use AIGC to generate the model of the missing part of ancient buildings. Taking an ancient temple damaged by war as an example, AIGC can generate a missing part model that is consistent with the original architectural style based on the knowledge and algorithm it has learned by analyzing the data of existing building parts and studying historical materials and inputting relevant text descriptions. AIGC can also assist in the fine processing of ancient architectural details. The details of ancient architecture such as carving and painting are rich and exquisite, but it is difficult to accurately restore them in the process of digital reconstruction. By learning a large number of detailed data of ancient buildings, AIGC can intelligently generate detailed textures in line with historical styles, making the reconstructed model more vivid and real.

2.3 Reconstruction Effect Evaluation

In order to ensure the quality of digital reconstruction of ancient buildings based on AIGC, it is very important to establish a scientific and reasonable evaluation index system for reconstruction effect. The evaluation indexes mainly cover geometric accuracy, texture authenticity and style consistency. The geometric accuracy is measured by comparing the error between the reconstructed model and the field measurement data. The authenticity of texture is judged according to the similarity between reconstructed texture and historical image and field residual texture. The consistency of style is evaluated by expert evaluation and comparison with the same type of ancient architectural style. If the geometric accuracy error is controlled within a certain range, the texture similarity reaches a high standard and the style is consistent with historical data, it shows that the reconstruction effect is good.

3. REALIZATION OF VIRTUAL REALITY DISPLAY IN ANCIENT ARCHITECTURE

3.1 Real Scene Construction

Building a virtual scene based on digital reconstruction model is the primary task of virtual reality display of ancient architecture. First of all, it is necessary to optimize the ancient architectural model that has been digitally reconstructed to meet the operational requirements of the virtual reality environment. This includes simplifying the number of polygons in the model, reducing the rendering load of the model and ensuring the smooth operation of the scene without affecting the appearance and details of the building. At the same time, the model is endowed with accurate and exquisite materials and textures, so that it can truly present the texture of ancient architecture, such as the warmth of wooden structure and the simplicity of masonry.

The setting of elements such as environment, light and shadow in the scene is also extremely critical. The environment of ancient architecture is very important for its overall atmosphere. According to historical data and field investigation, the surrounding environment matched with ancient buildings is constructed. Figure 2 shows the common virtual scene environment element settings of different types of ancient buildings.

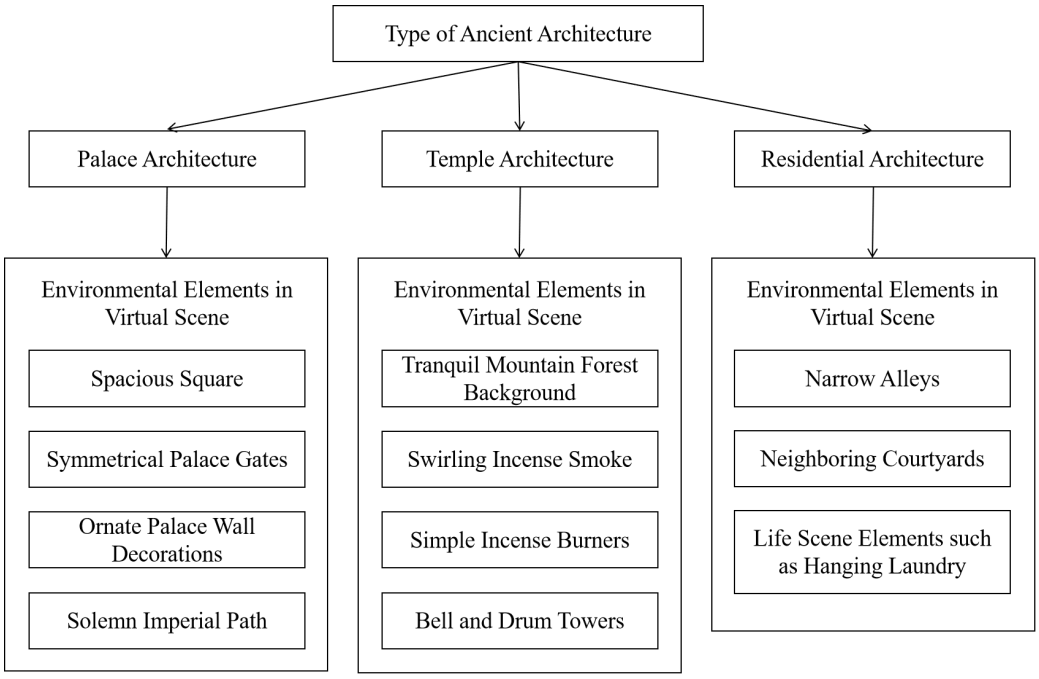


Figure 2 Environmental elements of virtual scene in ancient architecture

Light and shadow effect is an important means to create a realistic scene. By simulating natural lighting in different time periods, ancient buildings show different visual effects under different light and shadow. At the same time, it is necessary to reasonably arrange artificial light sources, such as palace lanterns in palaces and candlelight in temples, to add a sense of atmosphere to the scene.

3.2 Interaction Design

The design of interaction between users and ancient buildings in virtual reality environment can greatly enhance the depth and interest of user experience. First, users should have the ability to browse freely, and can walk freely, turn around, go up and down stairs in the virtual scene through handles or body movements, and observe all angles and details of ancient buildings in an all-round way. Secondly, the information interaction function is added. When the user is close to a specific building component or area, the system will automatically pop up relevant introduction information, including the historical background, structural characteristics and cultural implications of the building, so that the user can increase his knowledge while watching.

In order to realize these interactive functions, a series of technical development and optimization measures are needed. In terms of hardware, it is ensured that the virtual reality device can accurately capture the user's actions and instructions, reduce the delay and improve the real-time interaction. On the software level, efficient interactive logic code is written to make the interactive operation smoother and more natural. For example, by optimizing the collision detection algorithm, users can avoid unreasonable phenomena such as walking through walls; using voice recognition technology, users can obtain information or perform specific operations through voice instructions.

3.3 Application Case and Prospect

Take the famous ancient palace as an example (Figure 3). Through virtual reality technology, users seem to be in the ancient palace through time and space. Walking in the long corridor of the palace, you can clearly see the exquisite paintings on the beams; when you step into the main hall, you can feel the majesty of imperial power. This immersive experience attracted a large number of tourists and cultural lovers, and played a positive role in the spread of ancient architectural culture.

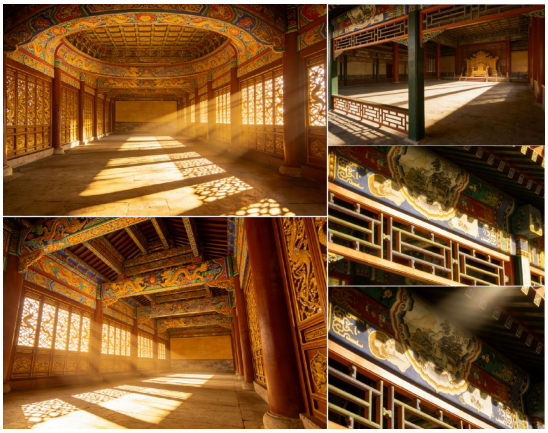


Figure 3 Exhibition of ancient palaces

Looking forward to the future, with the continuous development of virtual reality technology, the virtual reality display of ancient buildings will be applied in more fields. On the one hand, in the field of education, it can become a vivid teaching tool to help students learn ancient architectural knowledge more intuitively. On the other hand, with the lightweight and popularization of hardware equipment, the virtual reality experience of ancient architecture is expected to enter thousands of households, further expanding the influence of ancient architectural culture.

4. CONCLUSION

As a treasure of history and culture, ancient architecture bears the heavy memory of human civilization. However, in reality, they are constantly threatened by natural and human factors, so it is urgent to protect and inherit ancient architectural culture. Based on AIGC and virtual reality technology, this article provides a new perspective for the protection and inheritance of ancient architecture. In the aspect of digital reconstruction, through systematic data collection and preprocessing, combined with the powerful generation ability of AIGC technology, the effective generation of the missing part model of ancient architecture is realized. Verified by the scientific evaluation index system of reconstruction effect, this method can achieve high geometric accuracy, texture authenticity and style consistency.

In the exhibition of virtual reality, a highly realistic virtual scene was successfully constructed, and the environment and light and shadow elements were reasonably set to create an atmosphere suitable for ancient architecture. Well-designed interaction greatly enhances the user experience, so

that the audience can not only immerse themselves in the charm of ancient architecture.

The digital reconstruction and virtual reality presentation technology for ancient architecture based on AIGC has achieved significant results, addressing certain challenges in the preservation and transmission of ancient architectural heritage. However, there is still room for improvement, and as related technologies continue to advance, its application is expected to expand into more fields. For instance, further optimizing AIGC algorithms can enhance the automation and intelligence of digital reconstruction, while integrating more advanced hardware devices can create more immersive and interactive virtual reality experiences. With ongoing research, this technology will inject new vitality into the preservation and transmission of ancient architecture, allowing the culture of ancient architecture to shine even more brilliantly in the new era.

ACKNOWLEDGEMENTS

A major phased achievement of the 2023 Educational Teaching Reform Research Project of Liaoning Communication University-“Research on the Path and Practice of Integrating Excellent Traditional Chinese Culture into Ideological and Political Education in Curriculum”

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