Intelligent Design Mode and Simulation of Public Environment Ecology Based on 3D Digital Technology

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Abstract. In the research process of traditional public environment technology, there is an excessive dependence on digital virtual technology. The accuracy of the algorithms and models used in traditional environmental design systems is crucial to the performance of the system. If the algorithms or models are defective or inaccurate, it may lead to a large deviation between the design results and the actual situation. This paper uses the virtual reality and simulation technology in three-dimensional digital technology to simulate and predict the ecosystem in the public environment. Background: In the research process of traditional public environment technology, there is an excessive dependence on digital virtual technology. The accuracy of the algorithms and models used in traditional environmental design systems is crucial to the performance of the system. If the algorithms or models are defective or inaccurate, it may lead to a large deviation between the design results and the actual situation. Research Purpose: This paper uses the virtual reality and simulation technology in three-dimensional digital technology to simulate and predict the ecosystem in the public environment, so as to improve the quality and efficiency of the environment. This paper uses 3D VR tools to conduct virtual public landscape design modeling, and embeds the two-dimensional vector map into the two visual layers of terrain and image in the VR system. It is combined with the preliminary modeling of public landscape form to form a VR public environment landscape model. Through chaos synthesis technology, a chaotic model of virtual public landscape form is formed on the basis of three-dimensional public environment landscape modeling. Based on the virtual reality perspective, the evolution of public landscape efficiency is used to develop architectural design renderings of public landscape form. The test results show that the error of the three-dimensional model proposed in this paper is less than 8%, with high fidelity, quality and cost indicators, which is suitable for the use of public landscape art design profession.

Keywords. Digital technology; Public environment; Ecology; design

1. Introduction

3D VR art breaks the boundaries of public art design and relies on computer technology to develop the discipline of public art design [1]. In recent years, the development of public environment art design discipline depends on the application of digital virtual technology. However, due to the blind reliance on digital virtual...
technology [2], the major of public environmental art design lacks in-depth analysis and cannot fully analyze public environmental landscape and public landscape characteristics, resulting in low efficiency of public landscape art creation [3]. Due to the rapid development of China's urban public environment, the time required for public environment planning and construction must also be shortened [4]. Therefore, a rapid modeling method for three-dimensional landscape of public environment was invented [5]. This method is based on Google's Sketchup method, which not only greatly improves the effectiveness of 3D landscape models in public environments, but also reduces the cost.

- Application of 3D VR art in public environment art design
- In recent years, with the continuous development of virtual reality technology, the application of 3D VR art in public environmental art design has gradually attracted attention. This art form can create a unique virtual landscape, providing more possibilities for public environmental art design. Some scholars have studied the expression forms and characteristics of 3D VR art in public environment, and discussed how to combine this art form with public environment to create more attractive and interactive public space [6].

- Application of digital virtual technology in public environment art design
- The application of digital virtual technology in public environment art design has become a research hotspot. This technology can simulate and predict the visual effect of the public environment, the sense of space and the distribution of people, etc., to provide more reference for designers. Some scholars have studied the practical application of digital virtual technology and discussed how to improve the efficiency and accuracy of public environmental art design through this technology [7].

- The application of chaos generation method in public environmental art design
- Chaos generation method is a computer-generated method based on chaos theory that can create complex and unpredictable images and models. Some scholars have studied the application of chaos generation method in art design of public environment, and discussed how to combine this method with public environment to create more distinctive and innovative public space [8].

To sum up, this paper will take a new approach to the application of digital virtual information technology in the major of public environmental art design, and conduct an in-depth investigation on the application of public environmental landscape and public landscape form in the major of public environmental art design. On the basis of the 3D public environment landscape modeling based on Google Sketchup, the designer will use virtual reality technology and chaos generation method. In the process of experiencing public landscape, the chaotic formation and construction of public landscape images in virtual reality will be carried out by using virtual reality concepts. To enhance the intuitive experience of public environmental art design professionals.
2. 3D Modeling of Public Environments Using Google's Sketchup Method

The establishment of a 3D framework of the public environment is carried out using the Google Sketchup platform. Through this tool, the terrain and picture resources of the area modeled can be obtained. Then, the Google Sketchup tool is used to create a 3D framework of the public environment, forming a three-dimensional public environment landscape model, as shown in Figure 1.

![Flow chart for building landscape model.](image)

2.1. Vector Map Editing

The processing of the original scene first involves removing worthless images to maintain the blocky public landscape image required in digital virtual public environments or 3D scenes, such as rivers, forests, green spaces, streets, etc. To make the VR system is not affected by chaotic linearity and promote the quality of the 3D public environment framework, it is required to delete the disorderly overlapping connection classes, check the block public environment types, and determine the degree of closure of these block public environment types, as well as special situations where corner connections cannot be staggered.

2.2. Public environment texture and attribute data collection

The public scenes captured by dedicated digital cameras make the virtual public scenes of Google Sketchup system more realistic. By taking photos of the public environment, image data and public landscape layer data of the VR public environment can also be effectively obtained, and the public landscape photos taken can be encoded, managed, and archived. Resolve angle issues when capturing public landscape images through image editing programs. For ensuring the security of the VR public scene image, it must be selected according to the camera angle of the required public
environment. Using a small angle of view to capture a frontal image can overcome the situation where the camera cannot obtain all public environment images due to the influence of different occluding objects. Based on the similarity characteristics of ordinary external images in the public area, combined with the images obtained from all small angles of view, the overall public area image texture can be obtained.

2.3. Preliminary 3D model of public environment

To improve the authenticity of the initial 3D model in a virtual public environment, it is usually necessary to use texture maps on the initial model. Texture mapping generally includes the following content: one is to use texture pasting on the initial data after Photoshop processing based on the actual materials collected; There is also a situation where the actual texture collected is used locally as a map, and there are also cases where the texture set in the software system is used as a map. The Google Sketchup platform comes with a built-in texture map and material editor [8], which is convenient and concise to apply. However, only a few places use actual texture maps, and in other places, the texture map built-in in the software system will be used, resulting in a more realistic overall effect. Therefore, it is more commonly used in the second scenario.

2.4. Construction of three-dimensional public environment landscape

Embed the obtained 2D vector maps onto the terrain and image visual layers within the 3D VR tools, adjust the data to match the information, and then integrate the created or completed 3D preliminary modeling of the public environment and other auxiliary 3D public landscape modeling into the VR modeling of the public environment. The VR modeling of these public environments should be stored, and the stored VR modeling of the public environment should be uniformly embedded into the Google Sketchup platform. Finally, the specific location points for the 3D landscape modeling of the public environment should be determined through a 2D vector map. After the 3D landscape model of the public area is established, it can be viewed by sending a message to the modeling area of Google Earth on the 3D VR system.

3. Construction of VR Public Environment Form

3.1. Virtual reality view

According to the simulation of three-dimensional public environment landscape, public landscape art design is based on the construction of VR public landscape modeling. It understands the public landscape modeling from the physical perspective of objective existence and the cultural perspective of people's artistic aesthetics, thereby transforming the views of art, aesthetics, and science and technology. Figure 2 is a virtual reality view.
The process of VR chaotic modeling is based on modeling the 3D public environment view, beginning from the local characteristics of the public environment, and modeling from the lowest level to the top level of the entire public environment. In this way, Dutch physicist Lorenz carried out surveying and mapping of meteorological change information, and embedded the picture after surveying and mapping in the moon phase space map. The original disordered data points formed a double helix map. There was no intersection between the image and the orbit, and its movement was never stopped. Chaotic thinking model has a efficiency of rebuilding of initial condition, and has the parameters of feeling random and objective order. The definition of VR refers to the establishment of public environmental forms through the perception of human participation in the experience of public situations, and the chaotic characteristics of its process are more prominent.

3.2. Research Methods and Procedures

This study aims to design an intelligent public environment ecological model based on three-dimensional digital technology, and evaluate its effectiveness through simulation research, exploring its potential and feasibility in practical applications.

Step 1: Collect relevant public environmental ecological data, such as meteorological data, land use data, etc. Construct corresponding scene models using 3D digital technology.

Step 2: Based on the collected data, design a public environmental ecological model and optimize it. Considering the visualization effect and simulation accuracy of the model, physical simulation based methods can be used for model design and optimization.

Step 3: Use 3D digital technology to construct a simulation environment scene, simulating different public environmental conditions and intervention measures.

Step 4: Conduct statistical analysis and visualization of simulation results, evaluate the effectiveness of different public environment intervention measures, and find the best solution.
Step 5: Compare and verify the simulation results with actual scenarios, discuss the accuracy and reliability of the model, and explore its application potential and limitations.

4. Experimental simulation testing and analysis

This study used the Google Sketchup platform as the primary tool for constructing 3D models of public environments. Google Sketchup is a widely used design software in architecture, urban planning, engineering and other fields. Its powerful 3D modeling capabilities and convenient data extraction abilities allow us to quickly construct 3D models of public environments. Firstly, we used the terrain and image data provided by Google Earth to extract and process through the Google Sketchup platform. This data included elevation information, terrain features, building shapes and structures, providing important basic information for our 3D modeling. During the data extraction process, we employed a variety of techniques and algorithms, including image processing, pattern recognition, machine learning, to conduct in-depth analysis and processing of the terrain and image data. This processing included steps such as data cleaning, image enhancement, feature extraction to obtain more accurate and reliable data. Next, we used the 3D modeling capabilities of the Google Sketchup platform to model the processed data. The platform provides a wealth of modeling tools and functions, including line drawing, surface creation, shape adjustment, allowing us to quickly construct 3D models of public environments. During the modeling process, we employed a variety of techniques and methods, including geometric modeling, texture mapping, lighting rendering, to obtain more realistic and detailed models. At the same time, we also utilized the animation functions of the Google Sketchup platform to dynamically display and interact with the model, allowing us to more deeply understand the features and issues of public environments.

Figure 3 is a three-dimensional rendering of the public landscape of a certain urban park drawn in this article. From the rendering, it can be represented that the public landscape design model is real, reasonable, and has considerable artistic value.

Figure 3. Three-dimensional rendering of the public landscape.
In order to highlight the advantages of this scheme, the design model of reference [5] and [8] are selected as the comparison test objects, with the goal of measuring the deviation of the national park 3D model. The error comparison test of the three schemes are shown in Figure 4.

![Figure 4. Error comparison results of different design models.](image)

The error of the ground 3D model of the experimental park using our design mode is less than 3.3%; The deviation of the 3D model for the high-altitude GIS three-dimensional modeling method is about 3.5% to 5.1%; The 3D model deviation of digital photography 3D model technology exceeds 3.1%. This indicates that the 3D model deviation of the technology in this article is low and has high accuracy, creating a good information environment for establishing a model of VR public environment art design. To demonstrate that the technology presented in this article can greatly promote the realism and efficiency of the art design profession in experimental park public spaces, and reduce design costs, based on relevant technical data, the effectiveness of the art design profession in three ways and the effectiveness of Zbrush 3D model software are analyzed, as shown in Table 1.

<table>
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<th>Design pattern of this article</th>
<th>Form</th>
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<th>Efficiency</th>
<th>Cost</th>
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Table 1. Performance of different public environment design models
From Table 1 it can be concluded that the average fidelity of the design experiment and public environment art in this article is 88.3%, the average improvement in design quality compared to other design model is 35.8%, and the average decrease in design cost compared to Zbrush 3D modeling software is 43.5%. Moreover, the design quality improvement and cost savings of the two experimental models compared to other 3D model software in the usage environment are both lower than our design model. This indicates that the technology presented in this article can significantly promote the fidelity and quality of public landscape art design majors, thereby significantly reducing the production costs of art design majors.

5. Summary and outlook

This article aims to improve the sustainability and adaptability of the public environment through intelligent design and simulation, in order to meet the growing needs of people.

1) We have conducted comprehensive research on the application of three-dimensional digital technology in public environment design. This innovative technology offers a novel perspective that allows for a more intuitive and realistic observation and understanding of the public environment. It facilitates accurate simulation of real-world scenarios, enabling us to predict potential changes and impacts. By integrating digital technology into public environment design, we can gain deeper insights into the interaction between the environment and people, thereby incorporating these factors into our designs to create a more humane and sustainable public environment.

2) We propose an ecological intelligent design model for public environments that combines principles from environmental ecology with the concept of intelligent design. The aim is to optimize the ecosystem of public spaces, fostering harmonious coexistence between nature and humans. Leveraging intelligent design algorithms alongside three-dimensional digital technology, we can simulate and optimize various aspects of the public environment such as spatial planning, resource allocation, and environmental management. This holistic approach ensures that the needs of the community are met while maximizing sustainability and adaptability.
3) Through simulation research, we have validated the effectiveness of our proposed ecological intelligent design model for public environments. Specifically selecting a representative scenario within a public space setting, we employed 3D digital technology along with intelligent design algorithms for simulation purposes followed by optimization analysis. The results demonstrate that our proposed design patterns effectively enhance both ecosystem quality and user experience within these settings. Furthermore, this flexible approach exhibits adaptability across diverse scenarios and contexts allowing adjustments or optimizations based on specific circumstances.

In summary, this study conducted research on the intelligent design mode and simulation of public environment ecology based on three-dimensional digital technology. We propose an innovative design pattern and demonstrate its effectiveness and adaptability through simulation experiments. This is of great significance for improving the sustainability and adaptability of the public environment, and improving people's quality of life. Future research can further explore the application of this design pattern in a wider and diverse public environment, and delve into its impact and effectiveness.

References