Digital Reconstruction and Virtual Roaming Technology of Tourism Landscape Art Based on CAD

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Abstract. In this article, the key technologies of digital reconstruction and virtual roaming of tourist landscape are deeply studied, including the acquisition of geometric shape, the reproduction of materials and colors, the rendering of 3D scenes, interactive operation and so on. Then, a digital reconstruction and virtual roaming system of tourist landscape based on Computer aided design (CAD) technology is proposed, which realizes the automatic reconstruction of landscape and the 3D browsing and experience of users. The results show that the digital reconstruction of tourism landscape and the virtual roaming system have good response speed and fluency. Moreover, the system has high reliability and stability, which can ensure the stability of long-term operation and massive data processing. In the user interface test, most users think that the interface is friendly, easy to use and easy to understand, and its user score is as high as 94%, which can meet the needs of users. It provides a new design method for designers, which enables them to design and plan the landscape in a digital environment and improve the design efficiency and accuracy. It is hoped that this research can provide theoretical support and practical guidance for the growth of related fields.

Keywords: Computer Aided Design; Tourism Landscape Art; Digital Reconstruction; 3D; Virtual Roaming Technology
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1 INTRODUCTION

With the growth of global tourism, the design and planning of tourism landscape has become more and more important. Bertocchi et al. [1] simulated the sustainable development scenario of Venice through a tourism carrying capacity model, aiming to provide reference for solving the problem of excessive tourism. Tourism carrying capacity refers to the maximum number of tourists that a region can receive within a certain period of time, while maintaining its resources, environment, social and economic development intact. The factors that affect the carrying capacity of tourism include multiple aspects such as natural environment, infrastructure, socio-economic factors, and cultural heritage. By establishing a tourism carrying capacity model, we can quantitatively analyze different influencing factors and formulate reasonable tourism development strategies. Tourism landscape not only provides tourists with opportunities to appreciate natural and cultural landscapes, but also brings local economic benefits. In the Lushan Cultural Landscape Heritage Site, high-precision mapping and protection of cultural heritage can be achieved through CAD technology. Cai et al. [2] can optimize the design of cultural heritage and propose more scientific protection plans through the parametric design function of CAD. CAD technology has also played an important role in the tourism development of Lushan Cultural Landscape Heritage Site. Firstly, through the virtual reality technology of CAD, realistic 3D scenes can be created, allowing tourists to more intuitively experience the beauty and cultural heritage of Mount Lushan. Secondly, through the visualization technology of CAD, tourists can have a clearer understanding of the historical background and artistic value of cultural heritage. In addition, through the collaborative design function of CAD, multidisciplinary collaboration can be achieved, improving the scientific and sustainable nature of tourism development. Moreover, tourism landscape art is an important part of tourism, and its design and planning are directly related to the experience and feelings of tourists. Empowerment algorithms, as an emerging technological means, provide more possibilities for architectural design and better auxiliary tools for novices in computational design. Chen et al. [3] explore how to use empowerment algorithms to assist in architectural design for beginners in computational design, from basic concepts to practical experience, to help readers gradually master this skill. Algorithms are the steps and rules for solving problems, and are the core of empowering algorithms. In architectural design, algorithms can help designers automate design tasks and improve work efficiency. Data structure is the foundation of algorithms, and a reasonable data structure can improve the efficiency of algorithms. In architectural design, data structures can help designers better organize and process design data. Code optimization can improve the running speed and efficiency of programs. In architectural design, code optimization can help designers better achieve their design intent. Traditionally, the design and planning of tourism landscape art mainly depends on the designer's experience and feeling, but this method often lacks scientificity and accuracy. Cherepashkov et al. [4] explore the related issues of training CAD target personnel in a virtual enterprise environment. The training of CAD target personnel in the virtual enterprise environment is an efficient and convenient training method, which can help enterprises quickly cultivate target personnel proficient in CAD software, improve design efficiency and innovation ability of enterprises. Through various training methods such as classroom teaching, practical operations, and enterprise internships, students' skill level, innovation ability, and team collaboration ability can be comprehensively improved. At the same time, through comprehensive training effectiveness evaluation, it is possible to timely understand the students' mastery level and training results, providing strong support for the development of enterprises. Therefore, the training of CAD target personnel in a virtual enterprise environment is of great significance and feasibility, and is worthy of active exploration and practice by enterprises. In order to solve this problem, CAD is gradually introduced into the design and planning of tourism landscape.

In the field of tourism landscape art, CAD can help designers to measure, model and render accurately, and improve design efficiency and accuracy. It provides strong support for landscape design and planning. With the rise of video streaming, computer-aided art design and production based on video streaming has become a new research hotspot. Guo and Li [5] discussed the relevant concepts, application advantages, and future development trends of computer-aided art design and production based on video streaming. Video streaming refers to continuous image and audio data transmitted over the internet. With the continuous progress of internet technology, video streaming has been widely applied in various fields, including online live streaming, video conferencing, online education, and so on. In the field of art design and production, video streaming technology provides artists with richer creative materials and expressive techniques. Video streaming technology can provide artists with more creative materials, such as obtaining specific images through video editing or obtaining the required color combinations through image processing. However, the application of existing CAD in the field of tourism landscape mainly focuses on the design stage, and the research on digital reconstruction and virtual roaming of landscape is relatively less. With the rapid development of digital technology and artificial intelligence, architectural conceptual design is gradually shifting from traditional manual design to automation and intelligence. The application of an algorithm framework to develop topology algorithms for architectural conceptual design aims to improve design efficiency, optimize design solutions, and provide more innovative possibilities for architects and designers. Lin [6] introduced relevant algorithms and their applications in architectural conceptual design. Topology algorithm is a fundamental algorithm for studying graph structure, used to describe the relationship between nodes and edges in a graph. In architectural conceptual design, topology algorithms can be used to analyze spatial structures, optimize design schemes, and more. Used to search for the best solution among existing design schemes. Common search algorithms include simulated annealing, ant colony optimization, etc. These algorithms can search for the optimal solution in the design solution space and improve design efficiency. These algorithms can present design solutions in the form of 3D models, improving the visual experience of designers. This makes it difficult for us to completely and accurately reproduce some complex tourism landscape art. Therefore, it is of great practical significance and theoretical value to study the digital reconstruction and virtual roaming technology of tourism landscape art based on CAD.

CAD variable geometry is a modeling method based on variable geometry, which can optimize design by changing the geometric parameters of the model. In this article, Lu et al. [7] utilized the principle of CAD variable geometry to optimize the linear leg design of a parallel manipulator. Specifically, we can adjust parameters such as link length and joint angle to improve the motion and operational performance of the robotic arm in the workspace. The workspace is the range of space that a robotic arm can reach during operation. For parallel manipulators, the size and shape of the workspace directly affect their operational performance and efficiency. Therefore, analyzing and optimizing the workspace is an important part of robotic arm design. Digital reconstruction refers to the process of transforming the real landscape into a digital model by using computer technology. Sustainable teaching aims to cultivate students' concept of sustainable development, enhance their environmental awareness and sense of social responsibility. In tourism education, the significance of sustainability teaching lies in helping students understand the impact of tourism on the environment, society, and economy, master the principles and methods of sustainable tourism, and cultivate professional talents who can promote the sustainable development of the tourism industry. With the development of the tourism industry, sustainability has become an important principle of its development. In order to cultivate tourism talents that meet the requirements of sustainable development, sustainable teaching in tourism education is particularly important. McGrath et al. [8] explored the purpose and significance of sustainable teaching in tourism education, and elaborated on the application and practice of sustainable teaching in tourism education through teaching simulation and case analysis. In sustainability teaching, some simulation scenarios related to the tourism industry can be designed, such as tourism planning, tourism activity organization, etc., so that students can experience and master the principles and methods of sustainable tourism in simulation practice. Virtual roaming is a process that allows users to browse and experience the landscape in a virtual environment through computer technology.

Digital reconstruction and virtual roaming technology can provide tourists with a more real and vivid landscape experience, and also provide designers with a new design means and methods. Mikeska et al. [9] can effectively evaluate students' CAD abilities by utilizing performance tasks in simulated environments. Performance tasks can truly reflect students' practical abilities, innovative spirit, and sustainable development awareness, while also examining their knowledge application ability and problem-solving ability. However, the difficulty and complexity of performance tasks are difficult to control, and evaluation criteria may be subjective, requiring a significant amount of time and effort for task design and evaluation. Therefore, future research can further explore how to optimize the design and evaluation methods of performance tasks to improve their reliability and effectiveness. In addition, further research can be conducted on the impact of different teaching methods on improving students' CAD abilities and their relationship with other abilities. During the task, students need to communicate and coordinate with simulated clients, partners, and other team members, as well as conduct research and analysis on the tourism market to develop innovative and sustainable tourism product development plans. However, there are still some problems in the existing digital reconstruction and virtual roaming technology. Sędzicki et al. [10] explored the application of computer-aided automated green design in sustainable development and the role of green BIM technology. Sustainable development refers to meeting the current human needs without compromising the ability of future generations to meet their needs. Computer assisted green design has broad application prospects in sustainable development. Firstly, computer-aided green design can optimize design schemes through simulation and analysis, improving the ecological benefits and landscape effects of green spaces. Secondly, computer-aided green design can help designers better consider issues such as energy utilization and water resource management, thereby achieving goals such as energy conservation, emission reduction, and efficient utilization of water resources in the design. Finally, computer-aided green design can achieve digitization and intelligence of design and management, facilitate subsequent maintenance and management, and reduce maintenance costs and difficulties. For example, it is difficult to guarantee the integrity and accuracy of digital reconstruction for complex tourist landscapes; Meanwhile, the interactivity and immersion of virtual roaming need to be further improved. Therefore, the purpose of this study is to develop a CAD-based digital reconstruction and virtual roaming system for tourism landscape. Its innovations are as follows:

(1) Using CAD and Virtual Reality (VR) technology synthetically, the digital reconstruction and virtual roaming of tourism landscape are realized. Compared with the traditional tourist landscape design method, this method is more scientific, accurate and efficient.

(2) The key technologies of digital reconstruction of tourism landscape are deeply studied, including the acquisition of geometric shapes, the reproduction of materials and colors, etc. Moreover, the key technologies of virtual roaming are also deeply studied, including 3D scene rendering and interactive operation. Based on this, a virtual roaming system of tourism landscape based on CAD is proposed, which realizes the automatic reconstruction of landscape and the user's 3D browsing and experience of landscape.

(3) The feasibility and effectiveness of the developed system are verified by experiments. The traditional design method and the performance of digital reconstruction and virtual roaming system are compared and analyzed, which proves that digital reconstruction and virtual roaming system have higher design efficiency and more accurate results.

(4) The results of this article can provide tourists with a more real and vivid landscape experience, enhance their understanding and feelings of tourism landscape, and improve the quality and efficiency of tourism. Moreover, it can also provide a new design means and method for designers to improve design efficiency and accuracy.

The research framework of this article is as follows:

Firstly, the research background and significance are introduced, and the importance of tourism landscape art in tourism industry and the application status of CAD in tourism landscape art design and planning are expounded.

Secondly, the key technologies of digital reconstruction and virtual roaming of tourism landscape are introduced, including geometric shape acquisition, material and color reproduction. A digital reconstruction and virtual roaming system of tourism landscape based on CAD is proposed, which includes the modules of landscape model building, texture mapping, illumination calculation and so on to realize the automatic reconstruction of landscape.

Then, the feasibility and effectiveness of the proposed method are verified by experiments, and the performance of traditional methods and digital reconstruction system is compared and analyzed. In addition, the typical tourist landscape is selected as a case, and its digital reconstruction and virtual roaming practice are applied and analyzed.

Finally, it summarizes the results and innovations of this article, and expounds the theoretical and practical significance of this research. Moreover, it points out the shortcomings and needs to be improved in the research, and puts forward the direction and prospect of future research.

2 RELATED WORK

Shi et al. [11] used POI and cellular automata methods to simulate the tourism land in regional tourism planning. By analyzing POI data, understand the needs and behavioral characteristics of tourists, and guide the planning of tourism land. Utilize cellular automata to simulate the dynamic changes and evolution process of tourism land, and obtain optimization plans and suggestions for tourism land planning. These methods can provide important references and support for regional tourism planning. Determine the rules and evolution mechanisms of cellular automata based on the characteristics of tourism land and simulation needs. Divide tourism land into different cells, each representing a specific plot or area. Initialize cellular automata based on initial conditions, with each cell having its initial state and attributes. Choosing materials with high reflectivity and good insulation performance can reduce the absorption of solar radiation and indoor temperature fluctuations. Showkatbakhsh et al. [12] use materials such as coated glass and reflective coatings to design gaps and vents on the building's exterior, regulate indoor and outdoor heat exchange, and reduce energy consumption. For example, using air pressure difference for natural ventilation. Using vertical greening or roof greening design techniques on the building surface can increase the green coverage of the building and also regulate indoor and outdoor temperatures. The design technique of using a double skin layer can form an air interlayer between the two skin layers, playing a role in insulation and insulation. At the same time, this space can also be used for ventilation. Through an intelligent control system, the state of the building surface can be automatically adjusted according to changes in the indoor and outdoor environment, such as automatically adjusting the opening and closing degree of the louvers, adjusting the operating parameters of the air conditioning system, etc. This can achieve a more energy-efficient and comfortable indoor environment. By embedding a heat energy collection and storage system in the skin material, excess heat energy can be collected during the day and stored for use at night. This can achieve energy self-sufficiency and reduce dependence on external energy. Shpak et al. [13] revealed the interaction between external factors and their actual impact on the utilization of regional tourism potential by simulating their impact on the utilization level of regional tourism potential. However, this study still has certain limitations, such as the accuracy of model parameters and the selection of actual cases. Future research can further optimize models and parameters, while expanding the sample range and increasing the number of cases to improve the reliability and universality of the study. Through simulation and analysis, we found that external factors such as policies and regulations, economic development, social culture, and technological progress have a significant impact on the level of regional tourism potential utilization. Among them, the impact of policies and regulations is the most prominent, as they directly and indirectly affect the development and utilization of regional tourism potential. Economic development and socio-cultural factors influence the utilization of regional tourism potential by changing consumer demand and market environment.

Song and Jing [14] analyzed the application prospects of integrated software technology in landscape planning and design. CAD SketchUp can help designers better simulate the natural environment in ecological planning, and by constructing three-dimensional models, conduct detailed analysis of vegetation, terrain, and hydrology to develop more reasonable ecological restoration and protection plans. At the same time, the image processing function of PS can be used to create pre-ecological construction renderings and comparison images, more intuitively displaying the effect of the design scheme. In urban planning, CAD SketchUp can be used to establish urban models, simulate and analyze urban spatial layout, public facility distribution, and transportation network. PS can be used to create renderings and promotional materials for urban planning, improving the rationality and feasibility of urban planning. With the increasing attention paid to the quality of living environment, plant landscape design has become an indispensable part of people's lives. However, plant landscape design often requires a large amount of capital investment, so how to reduce design costs while ensuring design quality has become an urgent problem to be solved. The emergence of computer-aided collaborative design systems provides strong support for low-cost plant landscape design. Xu and Wang [15] analyzed the color effects of low-cost plant landscape design in computer-aided collaborative design systems. In plant landscape design, color effect is one of the important factors that affect the design effect. Reasonable color matching can make plant landscapes more beautiful and harmonious, while also enhancing the visual impact of the landscape and enhancing its ornamental value. In low-cost plant landscape design, color effects also play an extremely important role. Through reasonable color matching, designers can minimize design costs while ensuring design quality. With the advancement of technology and the widespread application of computer-aided design, three-dimensional computer-aided simulation has become an important tool in the field of interior design.

Through 3D simulation technology, designers can comprehensively evaluate and optimize design schemes in a virtual environment, thereby improving design quality and efficiency. Yang [16] explored how to use 3D computer-aided simulation for interior design optimization teaching, and introduced relevant cases and methods. 3D computer-aided simulation is a technology that utilizes computer technology to generate realistic 3D images and scenes. In interior design, 3D simulation technology can help designers perform the following tasks in a virtual environment. By adjusting the position and size of furniture, partitions, and other elements in the virtual environment, optimize the spatial layout and improve space utilization. Select appropriate materials and colors based on actual needs, and observe their effects in actual environments through simulation technology. Zhang and Deng [17] used an actual landscape design project as an example to illustrate. This project is the design of a city park, where the designer utilizes CAD software for scheme design, 3D modeling, material and color application, as well as rendering and animation production. Firstly, the designer creates a 3D model of the park in CAD based on the planning needs and terrain conditions of the park. Then, simulate the real landscape effect by assigning different materials and colors. For example, using different material parameters to simulate different types of vegetation and ground materials; Simulate the lighting effect and color changes of water bodies at different time periods by adjusting color parameters. Finally, utilize the rendering and animation production functions of CAD to generate realistic renderings and animated videos. These images and videos are not only used to showcase the effectiveness of landscape design schemes, but can also be used for virtual roaming and interactive experiences. This allows customers and reviewers to have a more intuitive understanding of the characteristics and effectiveness of the design scheme. Zhao [18] has utilized BIM technology to establish refined models for specialties such as architecture, structure, and mechatronics. This model reflects in detail the geometric information, material properties, and layout and operation status of the electromechanical system of the building. Energy consumption analysis was conducted through the BIM model. The analysis results indicate that winter heating and summer air conditioning are the main sources of energy consumption for buildings. In response to this issue, the designer added insulation measures to the building plan and considered using renewable energy sources such as ground source heat pumps to reduce energy consumption. Through simulation and analysis, the designer found that the southwest direction of the building is the best ventilation and lighting direction. Therefore, skylights and vents have been added to the architectural design to achieve maximum utilization of natural ventilation and lighting. At the same time, the exterior design of the building was optimized to reduce areas with poor convection. Zhao [19] analyzed that improving model accuracy can better express the details and features of landscape design. In 3D CAD, model accuracy can be improved through techniques such as fine modeling and the use of high-precision rendering. Reasonably adjusting the level of detail can balance the relationship between model complexity and rendering efficiency. By optimizing the level of detail, the model can maintain accuracy without becoming too complex and rendering difficult. In order to achieve the purpose of communication, effect display, and engineering quantity calculation in landscape design, frequent data exchange is required. By utilizing the data exchange function of 3D CAD, model data can be easily imported into other software or exported as external files, improving work efficiency.

Through the study of previous literature, this article puts forward a technical system of digital reconstruction and virtual roaming of tourism landscape based on CAD technology, and develops a digital reconstruction and virtual roaming system of tourism landscape, which provides a new method and means for the design and planning of tourism landscape art. Moreover, this study will also provide tourists with a more real and vivid landscape experience, enhance their understanding and feelings of tourism landscape, and improve the quality of tourism.

3 OVERVIEW OF DIGITAL RECONSTRUCTION AND VIRTUAL ROAMING TECHNOLOGY OF TOURISM LANDSCAPE ART

3.1 The Concept and Technology of Digital Reconstruction of Tourism Landscape Art

Digital reconstruction of tourism landscape art refers to the digital modeling, texture mapping, lighting calculation and other processing of tourism landscape by computer technology, so as to obtain a realistic digital model. This digital model can be saved, displayed and virtually roamed in the computer, and it can also provide more accurate design reference for designers.

Digital modeling is the basis of digital reconstruction of tourism landscape art. Using CAD software, designers can build digital models by drawing geometric figures and using plug-ins. Among them, terrain modeling is one of the key points of digital reconstruction of tourism landscape art. Terrain modeling usually adopts GIS technology, and Digital elevation model (DEM) is established by obtaining terrain data. Texture mapping is one of the key technologies for digital reconstruction of tourism landscape art. By mapping the photographed image or map to the surface of the digital model, the details and realism of the digital model can be increased. Texture mapping technology includes texture coordinates, texture filtering, texture compression and so on. Lighting calculation is one of the important links in the digital reconstruction of tourism landscape art. By simulating the shadow, reflection, refraction and other effects of light irradiation on objects, the visual effect of digital models can be increased. Illumination computing technology includes global illumination, local illumination, direct illumination and so on.

3.2 Principle and Application of Virtual Roaming Technology

Virtual roaming technology is one of the research hotspots in the field of computer graphics and computer vision in recent years, and its application in the field of tourism landscape art is also increasingly extensive. The principle of virtual roaming technology is to construct a virtual 3D environment by using computer graphics and computer vision technology, and control the movement and position of virtual characters or objects through input devices (such as mouse, keyboard, touch screen, etc.). In the field of tourism landscape art, virtual roaming technology is usually combined with digital reconstruction technology to transform the tourism landscape into a realistic digital model, and on this basis, users can browse and experience freely.

(1) Design and planning of tourism landscape art.

Virtual roaming technology is widely used in the design and planning of tourism landscape art. Designers can simulate the real scene of tourist landscape in the computer through virtual roaming technology, and design, layout and plan the landscape. Moreover, designers can also evaluate and optimize the design scheme by observing and experiencing the landscape effect in virtual roaming.

(2) Exhibition and publicity of tourism landscape art.

Virtual roaming technology can provide a brand-new way for the exhibition and publicity of tourism landscape art. By applying virtual roaming technology to the publicity and display of tourist landscape, visitors can have a comprehensive understanding and experience of tourist landscape before visiting. Moreover, virtual roaming technology can also provide more vivid and three-dimensional visual effects for the propaganda and promotion of tourist landscapes.

(3) Protection and inheritance of tourism landscape art.

Virtual roaming technology can provide an effective means for the protection and inheritance of tourism landscape art. By transforming the tourist landscape into a realistic digital model and realizing virtual roaming, the tourist landscape can be fully recorded and protected. Moreover, virtual roaming technology can also provide new ideas and methods for the inheritance and growth of tourism landscape art.

4 DIGITAL RECONSTRUCTION AND VIRTUAL ROAMING SYSTEM OF TOURISM LANDSCAPE BASED ON CAD TECHNOLOGY

4.1 Key Technologies of Digital Reconstruction of Tourism Landscape

The key technologies of digital reconstruction of tourism landscape in this article include geometric shape acquisition, material and color reproduction, etc. (1) Geometrical form acquisition: Geometrical form acquisition is the basis of digital reconstruction of tourism landscape. It involves terrain modeling, building modeling, landscape element modeling and other methods. Among them, terrain modeling: using GIS technology, DEM is established by obtaining terrain data to express the ups and downs and morphological characteristics of terrain. Architectural modeling: by taking photos of buildings or using laser scanning and other technologies, 3D data of buildings are obtained, and then digital models of buildings are established by using these data. Modeling of landscape elements: Using 3D modeling software, such as SketchUp, 3ds Max, etc., the digital models of landscape elements, such as plants, rocks and water bodies, are established according to the designer's scheme. (2) Material and color reproduction: Material and color reproduction is one of the important links in the digital reconstruction of tourism landscape, which involves techniques such as texture mapping and illumination calculation. Among them, texture mapping: by mapping the shot image or map to the surface of the digital model, the details and realism of the digital model are increased. For tourism landscape, it is needed to shoot and deal with different materials and textures, such as the external walls of buildings, the materials on the ground and the leaves of plants. Illumination calculation: By simulating the shadow, reflection, refraction and other effects produced by light irradiation on an object, the visual effect of the digital model is increased. This needs to be realized by using lighting model and computational rendering technology.

In the process of digital reconstruction of tourism landscape, it is also needed to consider the historical culture, natural scenery and other factors of scenic spots in order to achieve a more realistic and vivid digital reconstruction effect. Moreover, in order to improve the quality of digital reconstruction, this article also combines some automatic modeling software and image processing software.

4.2 Digital Reconstruction of Tourism Landscape and Design of Virtual Roaming System

The establishment of landscape model is the basis of digital reconstruction of tourism landscape. Based on CAD technology, the landscape model can be established through the following steps: ⊖ Geometric shape acquisition: Geometrical shape data of tourist landscape, including terrain, buildings, plants and other elements, can be obtained by using 3D scanning technology. This article uses GIS technology (DEM) to obtain terrain data, and then imports it into CAD software. In the software, according to DEM data, the terrain 3D model is constructed by using surface modeling technology. In order to improve the accuracy and realism of the model, details are processed, such as adding mountain shadows and expressing terrain textures. For building modeling, this article obtains 3D data of buildings by taking photos of buildings or using laser scanning technology. Then use these data to build a digital model of the building in CAD software. In addition, in the process of modeling, this article also considers the structure, material, color and other factors of the building to increase the details and realism of the model. Plants are one of the important elements in tourism landscape, so they need to be represented in scene modeling. In this article, plants are created by using the plant library or custom model of CAD software. In the process of modeling, the shape, color and growth law of plants are considered to increase the details and realism of the model. ⊜ 3D model construction: According to the obtained geometric data, the 3D model is constructed by using CAD software. Different modeling methods and techniques are needed for different landscape elements. In order to simplify the calculation, the straight line is set to be parallel to the corresponding edge of the minimum area circumscribed rectangle, and then the straight line is divided into $1+\Delta t u_t \ y'$. The sum of the square error of the segment and the straight line in the original polygon is:

$$P_{t+\Delta t} = p_t + \Delta t p_t u_t(y) \tag{1}$$

$$P_{t+\Delta t} = p_t \; 1+\Delta tu_t(y) \; + p_t \; 1+\Delta tu_t(y') \tag{2}$$

$P_{t+\Delta t}$ finds the first partial derivative of y. When the first partial derivative is 0, the error is the smallest, so:

$$s_{t+\Delta t}(y) = \frac{p_{t+\Delta t}}{P_{t+\Delta t}} = \frac{p_t + \Delta tp_t(y)}{p_t \; 1+\Delta tu_t(y) \; + p_t \; 1+\Delta tu_t(y')} \tag{3}$$

$$s_{t+\Delta t}(y) = \frac{p_{t+\Delta t}}{P_{t+\Delta t}} = \frac{s_t(y) \; 1+\Delta tu_t(y)}{s_t(y) \; 1+\Delta tu_t(y) \; + s_t(y') \; 1+\Delta tu_t(y')} \tag{4}$$

The fitting straight line equation of this segment is obtained as follows:

$$s_{t+\Delta t}(y) - s_t(y) = s_t(y)\frac{\Delta tu_t(y) - \Delta t\bar{u}_t^p}{1+\Delta tu_t} \tag{5}$$

⊛ Texture mapping and material processing: Texture mapping and material processing are performed on the 3D model to increase the detail and realism of the model. This requires shooting and processing different landscape elements, such as the external wall of the building, the material of the ground and the leaves of plants. ④ Illumination calculation and rendering: The 3D model is calculated and rendered by using illumination model and rendering technology to increase the visual effect of the model. This needs to consider the direction and intensity of the light source, as well as the reflection and refraction characteristics of the material.

Virtual roaming system is the key to realize users' 3D browsing and experience of landscape. Based on CAD technology, a virtual roaming system can be constructed, which includes scene modeling, lighting calculation, interactive operation and other modules. ⊖ Scene modeling: using CAD software to build a 3D model of virtual scene, including terrain, buildings, plants and other elements. Moreover, lighting effects in the scene and the creation of environmental atmosphere need to be considered in the scene modeling. In this article, the illumination model and rendering technology are used to calculate and render the 3D model to produce realistic lighting effects. Moreover, the factors such as the direction and intensity of the light source, as well as the reflection and refraction characteristics of the material are considered. By adjusting the position and properties of the light source, different lighting effects can be generated, such as sunlight and moonlight illumination. In order to make the virtual scene more realistic and create a suitable environment atmosphere, this includes the treatment of sky, clouds, lighting and other factors. In this article, the rendering function of CAD software is used to calculate and render the global illumination of the scene to produce realistic visual effects. Moreover, by adding background music, wind and other sound effects to enhance the feeling of environmental atmosphere.

Sparse coding technology uses a set called "dictionary" to represent signals or images sparsely. This dictionary usually contains atoms with higher dimensions than the original signal or image, so it is called "over-complete". In sparse coding, signals or images are usually represented as a linear combination of atoms in the dictionary, but only a few atoms (sparse coefficients) are used. This representation is sparse and redundant. Sparsity means that a signal or an image is represented by only a few atoms in the dictionary, while redundancy means that the quantity of atoms in the dictionary exceeds the dimension of the signal or image. As shown in Figure 1.

In practice, the following three constraints can be used to solve the sparse representation problem:

$$\min_{\alpha} \left\| D\alpha - X \right\|_2^2 \quad s.t \left\| \alpha \right\|_0 \le L \tag{6}$$

$$\min_{\alpha} \left\| \alpha \right\|_0^2 \quad s.t \left\| D\alpha - X \right\|_2^2 \le \xi^2 \tag{7}$$

$$\min_{\alpha} \; \left\| D\alpha - X \right\|_2^2 + \gamma \left\| \alpha \right\|_0^2 \tag{8}$$

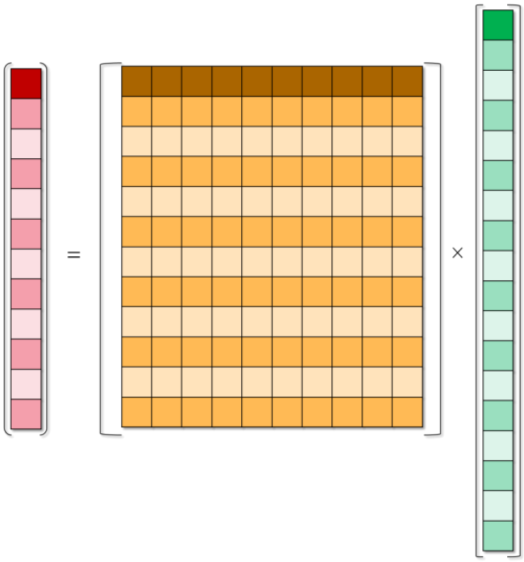

Figure 1: Sparse representation model of image signal.

Among them, the constraint condition of formula (6) is sparsity L; The constraint condition of formula (7) is to solve the residual of the signal; The constraint conditions in the case of Formula (8) comprehensively consider sparsity L and signal residual. The complexity of 3D landscape image components is used to express the diversity of landscape elements:

$$F = CR \times TY \tag{9}$$

In the formula, CR represents the quantity of main colors of the landscape, and TY represents the quantity of types of the landscape. The dimension of the average score of landscape architecture is calculated as follows:

$$FD_b = \frac{1}{n}\sum_{i=1}^{n} 21n\left(\frac{P_{bi}}{4}\right) / \ln S_{bi} \tag{10}$$

Where P_{bi} represents the perimeter of the i bottom area of the landscape building. In this article, a fineness function $D\ O,d,m$ is established to describe the fineness of objects:

$$D = \begin{cases} 0 & d > d_0 \\ D\ O,d,m & d \le d_0 \end{cases} \tag{11}$$

Among them, O is the identification of the object, d is the distance of the object from the viewpoint, and m is the importance weight of the object.

⊜ Lighting calculation and rendering: Lighting calculation and rendering are carried out in the virtual scene to produce realistic visual effects. This requires the use of lighting model and rendering technology, taking into account the position, direction and color of light source, as well as the reflection and refraction characteristics of materials. ⊛ Interactive operation: Interactive operation between users and virtual scenes is realized through user input devices. This includes the user's operations such as moving, rotating the visual angle, changing the light source, etc., as well as the operation and interaction of objects in the scene. In this article, in order to enable users to interact with the virtual scene, interactive elements are added to the scene modeling. This includes the operation and interaction of objects in the scene, the setting of roaming paths and so on. In this article, interactive tools of CAD software, such as selection, scaling and rotation, are used to support users' operations, and hot keys or menu bars are set to quickly perform common operations. ④ Virtual roaming: users can browse and experience freely in the virtual scene through virtual roaming technology. This can be achieved by setting the roaming path, limiting the user's moving range, etc., and also includes the operation and interaction of objects in the scene.

4.3 System Implementation and Application

The digital reconstruction and virtual roaming system of tourism landscape based on CAD can realize the design, planning, display and experience of tourism landscape. The following are some application examples:

Tourism landscape design: Designers can use this system to design and plan tourism landscape, and evaluate and optimize the design scheme through 3D model and virtual roaming technology.

Tourism landscape display: Through this system, the tourism landscape can be displayed in 3D, providing more real and vivid visual experience for tourists. Moreover, it can also be used for publicity and promotion of tourist attractions.

Tourism landscape experience: Through this system, users can experience the scenery and atmosphere of tourism landscape at home, and feel the artistic charm and cultural connotation of tourism landscape. Moreover, it can also be used in remote tourism and online education.

5 RESEARCH RESULTS OF DIGITAL RECONSTRUCTION AND VIRTUAL ROAMING TECHNOLOGY OF TOURISM LANDSCAPE ART

5.1 Comparative Experimental Results and Analysis

In the previous section, based on CAD technology, the digital reconstruction and virtual roaming system of tourism landscape was developed. After developing the digital reconstruction and virtual roaming system of tourism landscape, it is needed to test and optimize the system. This section tests and optimizes the developed system to improve the stability and performance of the system.

Firstly, the function test is carried out to test whether the system meets the design requirements, including whether the functions of each module are normal and whether the data input and output are correct. Functional testing is an important link to ensure that the digital reconstruction of tourism landscape and virtual roaming system meet the design requirements. As shown in Table 1, the results of digital reconstruction of tourism landscape and virtual roaming system are shown in detail:

Test item	*Test content*	*Test result*
Terrain modeling module	Test whether terrain modeling module can build terrain 3D model according to DEM.	Success
Building modeling module	Test whether the building modeling module can accurately establish the building digital model according to the photos or data of the building.	Success
Texture mapping module	Test whether the texture mapping module can correctly map the texture to the 3D model, and increase the detail and realism of the model.	Success
Illumination calculation and rendering module	Test whether the lighting calculation and rendering module can produce realistic lighting effects and ambient atmosphere.	Success
Interactive operation module	Test whether the interactive operation module can support users to roam and operate freely in the virtual scene.	Success

Data input and output module	Test whether the data input and output module can correctly read and parse various data formats, and export the 3D model to a common file format, etc.	Success
System stability	Test the stability of the system during long-term operation and large-scale data processing, and whether there is memory leakage or not.	Success
System performance	Test the response time, rendering speed and other performance indicators of the system, as well as the performance on different hardware platforms and browsers.	Success
Safety test	Test the security of the system, such as data encryption, user rights management, etc., to ensure that the system is not affected by security problems such as hacker attacks and data leakage.	Success
User interface testing	Test whether the user interface of the system is friendly and easy to use, and whether there are bugs and defects.	Success

Table 1: Digital reconstruction of tourism landscape and test results of virtual roaming system.

Then this article carries out performance testing: testing the performance indicators of the system, such as response time, rendering speed, stability and so on. In order to test the performance, this section adopts the following experimental settings: high-performance computer, Intel Core i7-8700K processor, 16GB memory and NVIDIA GeForce GTX 1080 Ti graphics card. Tourism landscape digital reconstruction and virtual roaming system applications, operating system for Windows 10. Test with large terrain data set and building data set. Perform multiple roaming operations and record the response time of the system, including initial loading time, roaming operation time, etc. The response time of the system is shown in Figure 2.

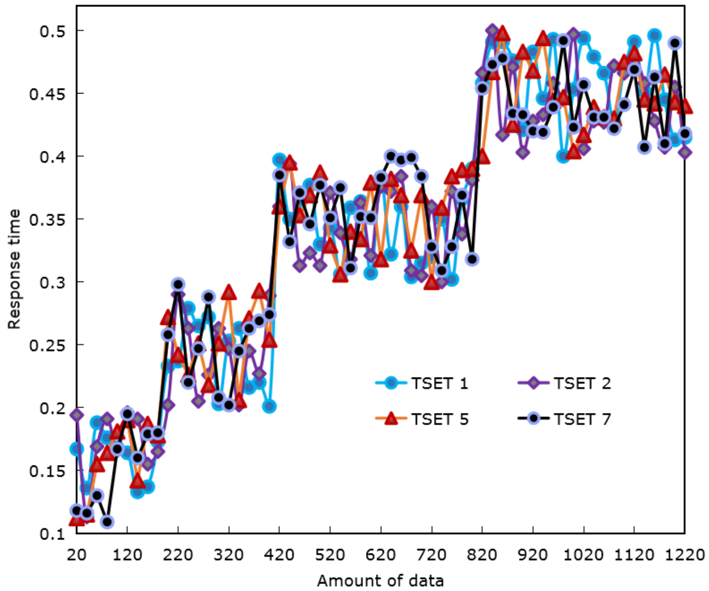

Figure 2: Response time of the system.

The experimental results in Figure 2 show that the response time of the system increases with the increase of data volume. When loading large terrain and building data sets, the initial loading time of the system is long, but the roaming operation time is relatively short. With the increase of data, the response time of the system gradually increases, but it is generally within an acceptable range. The performance of the digital reconstruction and virtual roaming system of tourism landscape is good. When dealing with large data sets, the initial loading time of the system is long, but the fluency and response speed of roaming operation are fast. This shows that the system still has good performance when dealing with a large quantity of data. The rendering speed of the system is shown in Figure 3.

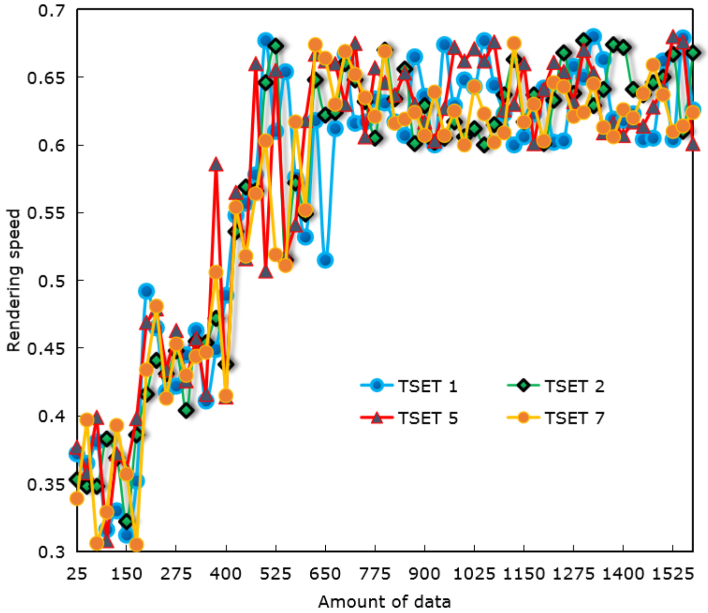

Figure 3: Rendering speed of the system.

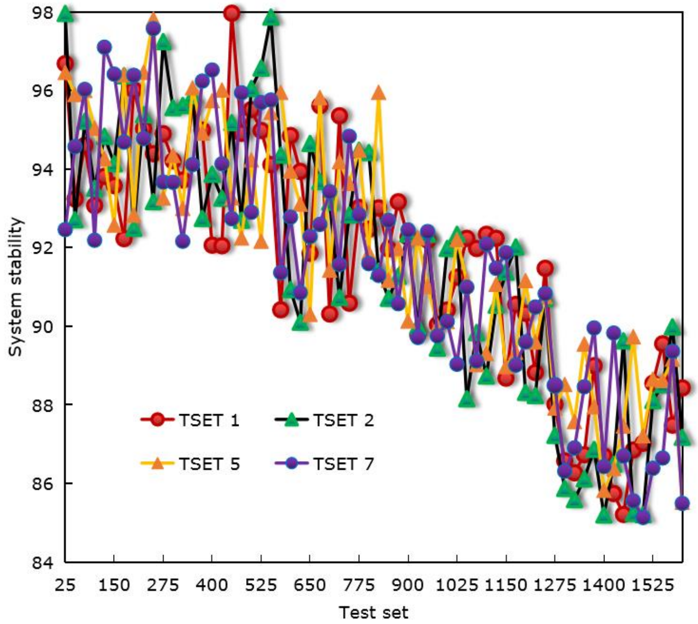

Figure 4: Stability of the system.

The experimental results in Figure 3 show that the rendering speed of the system slows down with the increase of data volume. When dealing with small data sets, the rendering speed of the system is fast, but with the increase of data volume, the rendering time is gradually extended. Especially when dealing with large data sets, the rendering speed of the system is obviously slowed down. This shows that the digital reconstruction of tourism landscape and the rendering speed of virtual roaming system are greatly affected by the amount of data. With the increase of data volume, the rendering speed of the system gradually slows down. This is because the calculation and rendering operations needed by the system when processing a large amount of data are more complicated and time-consuming. The stability of the system is shown in Figure 4. The experimental results in Figure 4 show that the system has no problems such as crash or memory leakage during long-term operation and large-scale data processing. When dealing with large data sets, the response time of the system may be extended, but the system can still run stably. Generally speaking, the stability of the digital reconstruction and virtual roaming system of tourism landscape is good, and the stability of the system are guaranteed.

Let's test the user interface to see if the user interface of the system is friendly, easy to use and easy to understand, as shown in Figure 5.

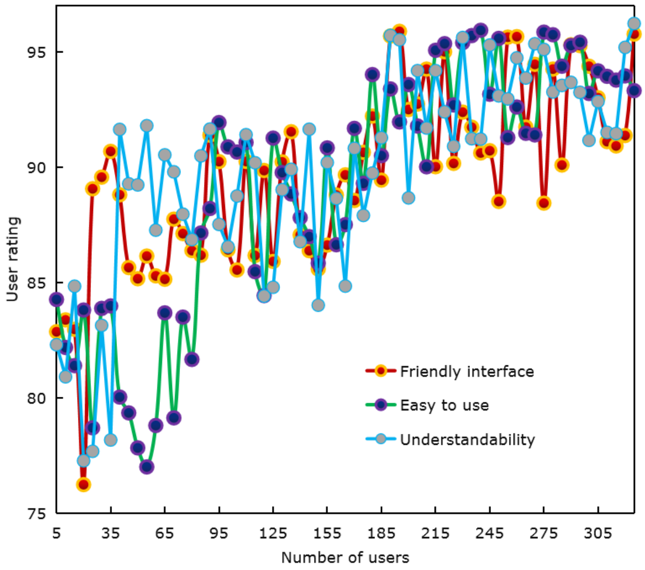

Figure 5: User interface testing.

As can be seen from the experimental results in Figure 5, in the user interface test, most users think that the interface is friendly, easy to use and easy to understand, and its user score is as high as 94%. Through the system performance test and analysis results in this section, the following conclusions can be drawn:

⊖ The digital reconstruction of tourism landscape and the virtual roaming system have good response speed and fluency. ⊜ The rendering speed of the system is greatly affected by the amount of data. When dealing with small data sets, the rendering speed of the system is fast, but with the increase of data volume, the rendering time is gradually extended. Therefore, in order to improve the performance of the system, we can consider adopting more efficient rendering algorithm or optimizing data processing flow. ⊛ The stability of the system is good, which can meet the needs of users. During long-term operation and large-scale data processing, the system has no problems such as crash or memory leakage. Therefore, the system has high reliability and stability, which can ensure the stability of long-term operation and massive data processing.

5.2 Visual Display of Research Results

This section chooses a representative tourist landscape-the ancient Jiangnan water town as the experimental object. The tourist landscape is famous for its developed water system and unique ancient town style, and has rich historical and cultural connotations. In order to better display this tourist landscape, this section has carried out digital reconstruction and virtual roaming. In the data collection stage, high-precision surveying and mapping instruments and photographic equipment are used to collect comprehensive data on key elements such as topography, architecture and texture of the water town. These data include terrain data, building structure data, texture data and so on, which provide a basis for subsequent digital reconstruction. After data collection, the digital reconstruction and virtual roaming system of tourist landscape is used to process and digitally reconstruct the collected data. The system can quickly convert the processed data into 3D models and generate realistic virtual landscapes.

Firstly, the collected terrain data is processed and converted into a format that can be recognized by the system. Then, using the terrain modeling function of the system, the terrain data is transformed into a 3D terrain model. Next, the building structure data and texture data are used to digitally reconstruct the building. The system provides rich texture mapping function, which can restore the appearance and details of the building finely. After the digital reconstruction is completed, this section carries out a virtual roaming experiment. Figure 6 shows the visualization effect of Jiangnan water town scene using traditional design methods. As shown in Figure 7, the visualization effect of this system for Jiangnan water town scene is shown.

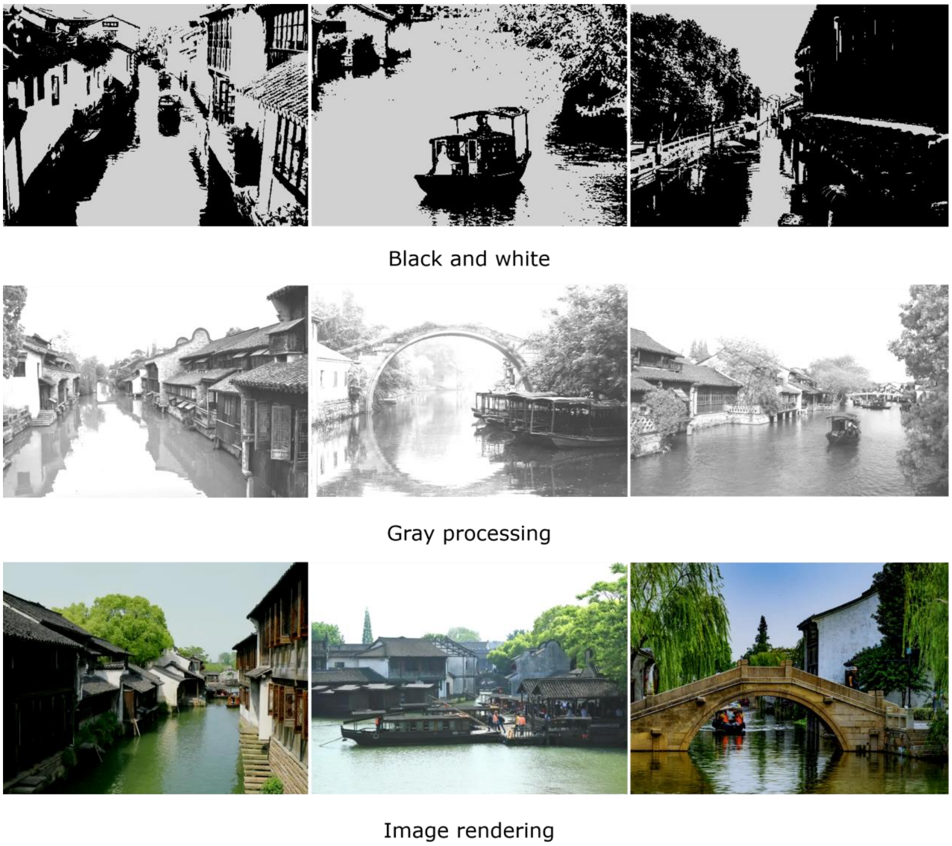

Figure 6: Visualization effect of traditional design methods.

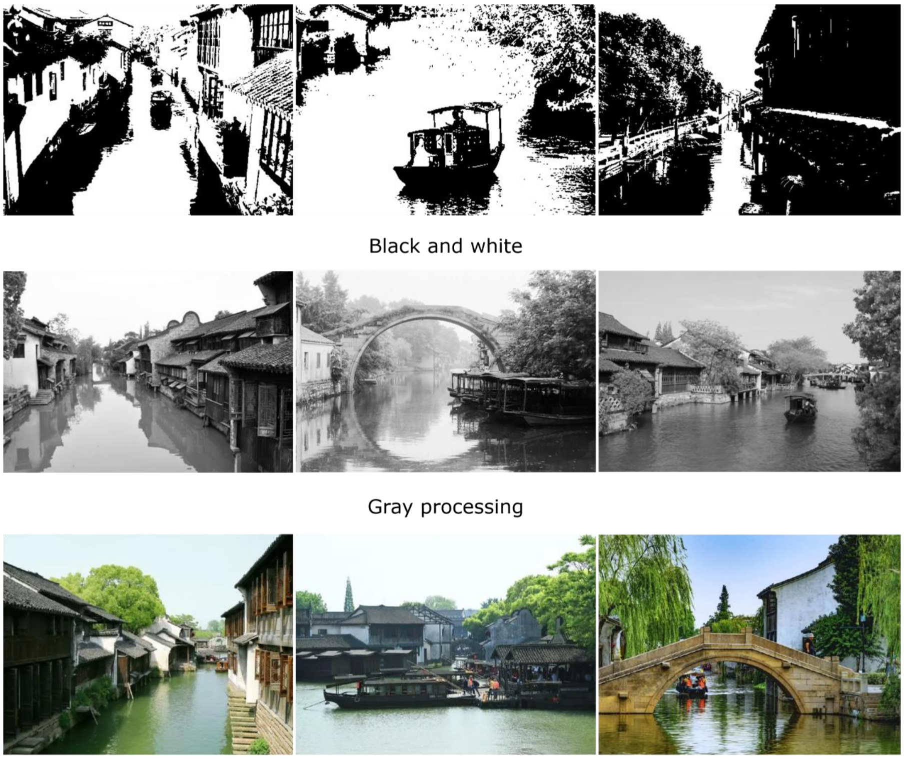

Figure 7: The visualization effect of this system on the scene of Jiangnan water town.

It can be seen that the scene of Jiangnan water town generated by this system shown in Figure 7 has obvious advantages in image clarity compared with the scene generated by the traditional design method shown in Figure 6. In the image generated by this system, the details and textures of the water town are richer and the colors are fuller, which makes the scene more realistic and vivid. In terms of scene restoration degree, although both methods can better present the basic characteristics of water towns in the south of the Yangtze River, the system in this article has more advantages in detail processing and creating environmental atmosphere. In Figure 7, we can see that the bridges, houses, trees and other elements in the water town are more refined, and the light and shadow processing and color matching are more natural, making the scene more realistic and immersive.

6 CONCLUSIONS

This article puts forward a technical system of digital reconstruction and virtual roaming of tourist landscape based on CAD. And developed a digital reconstruction and virtual roaming system of tourism landscape. The system has the following functions: digital reconstruction of tourism landscape, including accurate acquisition and reproduction of information such as landscape geometry, material and color; Realize the virtual roaming of the landscape, so that users can browse and experience the landscape in 3D online; It provides a new design method for designers, so that they can design and plan the landscape in a digital environment and improve the design efficiency and accuracy.

From the results of system performance test, it can be concluded that the digital reconstruction and virtual roaming system of tourism landscape still has good performance and stability when dealing with large data sets. The response speed and fluency of the system are good. Moreover, the system has high reliability and stability, which can ensure the stability of long-term operation and massive data processing. In the user interface test, most users think that the interface is friendly, easy to use and easy to understand, and its user score is as high as 94%, which can meet the needs of users. In addition, this article selects a typical tourist landscape as a case, and makes practical application and analysis on its digital reconstruction and virtual roaming. It is concluded that digital reconstruction technology can realistically restore the details and features of tourism landscape, so that users can deeply experience and understand the history and culture of tourism landscape in virtual environment. Moreover, the virtual roaming technology breaks the limitation of time and space, so that users can observe and experience the style, history and culture of tourist landscape anytime and anywhere. The overall simulation results prove that the digital reconstruction and virtual roaming system has higher design efficiency and more accurate results, and at the same time, it shows that the tourism landscape virtual roaming system based on CAD has superior performance. It provides a new design method for designers, which enables them to design and plan the landscape in a digital environment and improve the design efficiency and accuracy.

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