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Computer-Aided Design AND APPLICATIONS

Utilizing Digital Art Virtual Reconstruction Technology in the Construction Industry for Modern Urban Landscape Sculpture Planning and Design

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Abstract. With the rapid development of urban construction, people pay great attention to the optimal design of municipal scenery statue. Modern municipal scenery statue is an important part of the urban environment and an important factor in building a modern and civilized city. While beautifying the environment, it improves everyone's aesthetic taste and artistic cultivation, and is an important element in improving the spiritual and cultural cultivation of citizens. municipal scenery statue is a sculpture standing in urban public places. In cities with high-rise buildings and crisscross roads, it can alleviate the congestion, congestion, rigidity and singleness caused by the concentration of buildings, and sometimes it can also play a role in increasing the balance on open venues. This paper proposes a modern municipal scenery statue planning and design scheme based on three-dimensional virtual reconstruction. Through the optimization design of municipal scenery statue, combined with image processing technology, the intelligent simulation control of municipal scenery statue is realized. Using three-dimensional imaging processing technology, the image processing of municipal scenery statue is carried out to improve the rationality of municipal scenery statue design. Finally, the simulation test analysis is carried out.This result fully shows that using GIS to establish a three-dimensional landscape sculpture planning system provides a feasible way, which undoubtedly has a very important significance and value for the standardization of landscape sculpture planning and design, the improvement of urban planning and design level, and the restoration of municipal scenery statue. municipal scenery statue design is an important platform for urban image display. Through the optimization design of municipal scenery statue, it is of great significance in promoting the basic and phased construction of the city to improve the living environment of the city.

Keywords:3D; Virtual; municipal scenery statue; digital art; Digitizing the Construction Industry
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1 INTRODUCTION

With the development of the times, the country is booming in urban construction, providing people with a large number of amenities such as living, working and living, and has made gratifying achievements. However, with the acceleration of construction, the quality of ecological environment has gradually declined or even deteriorated, the lack of characteristics of urban appearance, lack of cultural connotation and other problems have become increasingly obvious[12]. Therefore, how to create an urban atmosphere with connotation according to the city's own conditions, including economic, cultural, political, historical, natural and other factors, and how to fully display the city's personality style and improve the city's taste in the process of urban construction and development have become an important task in front of every city's decision-makers and builders, as well as urban planning, architectural design, artistic design Topics to be jointly discussed in the field of environmental landscape design and other disciplines[16]. municipal scenery statue is an important carrier of urban spirit and culture. In the historical process of its development, the city has left behind the basic things that it relies on to become a city. This kind of thing is the driving force for the existence and redevelopment of a city. Therefore, the sculpture art that reproduces this kind of thing becomes the personalized work of the city, which has great artistic shock[10]. However, modern society is an information society with highly developed industry. The acceleration of the pace of life has also led to great changes in people's aesthetic consciousness. As a unique category of sculpture art, municipal scenery statue, like architectural art, can embody the spiritual temperament of a city, and its creative concept is also updated with the changes of people's aesthetic consciousness, always aiming to meet people's aesthetic enjoyment[11].

With the progress of society and the development of science and technology, people's cognitive level has been greatly improved. At the same time, with the development of computer technology, geospatial information and its processing ability have also been greatly enriched and strengthened.[7] Therefore, people hope to use these rich geospatial information to study and grasp the spatial development law of the earth and society, so as to carry out virtual reproduction and macro-control.With the increasing frequency and diversification of human activities and the development of modern space technology, the acquisition, management and service of geographic information have become an important part of modern urban management[13]. Geographic information system technology has increasingly become one of the important means of modern urban management because of its powerful information management function[15]. In this context, GIS combines network technology, multimedia technology, virtual environment technology, intelligent technology, etc. to produce some new development directions, such as network GIS, 3DGIS, Open GIS, expert intelligent GIS, etc.[8]. In view of the advantages of 3D technology, this paper adopts GIS system, 3D modeling technology, database technology and secondary development technology in order to reduce the execution cost of the algorithm. Practice has proved that this combination can not only reduce the calculation time, but also improve the quality and efficiency of modern municipal scenery statue.

Landscape sculpture is a form of sculpture based on public landscape, which is set up in the outdoor public environment, can arouse people's visual and spiritual beauty, and coordinate with the surrounding environment. Landscape sculpture is also known as "public sculpture" and "environmental sculpture". Compared with municipal scenery statue, it pays more attention to the integration of sculpture and environment. Its function is to create scenery and meet the needs of viewing and decoration[4]. Municipal scenery statue has rich forms of expression, a wide range of themes, and a variety of production materials. Excellent landscape sculpture works can vividly show the background of urban humanities and history, inherit the breath, style and historical culture of the city, increase the thickness of urban landscape, enrich the level of urban public space, and increase the spiritual enjoyment of urban residents. Excellent municipal scenery statue can even become a city's landmark. Therefore, the planning and design of municipal scenery statue is

particularly important, which provides a guarantee for the city to establish a reasonable and excellent landscape sculpture. This paper establishes a visual feature reconstruction model of modern municipal scenery statue planning, extracts the fuzzy feature quantity of landscape sculpture, and then achieves virtual visualization. Its innovation lies in:

Through the combination of various cartographic analysis software and GIS, the three-dimensional data of municipal scenery statue can be obtained to realize the visualization of three-dimensional landscape.

This paper studies the planning and design of modern municipal scenery statue. The framework is as follows:

The first chapter is the introduction. This part mainly expounds the research background and significance of modern municipal scenery statue planning and design optimization, and puts forward the research purpose, method and innovation of this paper. The second chapter mainly summarizes the relevant literature, summarizes its advantages and disadvantages, and puts forward the research ideas of this paper. The third chapter is the method part, which focuses on the combination of three-dimensional virtual technology, the use of GIS and three-dimensional imaging technology to construct a modern municipal scenery statue planning and design method. The fourth chapter is the experimental analysis. In this part, experimental verification is carried out on the data set to analyze the performance of the model. Chapter five, conclusion and outlook. This part mainly reviews the main contents and results of this study, summarizes the research conclusions and points out the direction of further research.

2 RELATED WORK

Municipal scenery statue is an important carrier of urban spirit and culture. In the historical process of its development, the city has left behind the basic things that it relies on to become a city. This kind of thing is the driving force for the existence and redevelopment of a city. Therefore, the sculpture art that reproduces this kind of thing becomes the personalized work of the city, which has great artistic shock. C curr ó et al. Proposed that municipal scenery statue is like a bridge connecting realistic beauty and ideal beauty. Through its image sensitive spatial modeling power, it inspires people's national pride and the spirit of striving hard. Make people cultivate temperament and firm faith in the aesthetic process. It can be said that a city's attention to municipal scenery statue can reflect the level of spiritual civilization development of the city. municipal scenery statue is not only a formal creation and design, but also a medium of cultural transmission, which is more meaningful to convey local and contemporary cultural characteristics. It shows certain characteristics of the times, interweaves politics, economy and culture, and integrates national emotion and pursuit to present artistic works[6]. Camas D and others further said that the planning and design of municipal scenery statue should start with mining the content with historical value and unique style in the regional culture, and focus on the content closely related to people's spiritual life, such as cultural history and art, as well as the regional culture, customs and folk customs in the tourism environment. At the spatial level, the research focuses on how to achieve the perfect combination of municipal scenery statue and spatial environment[3]. Seitzman N and others believe that municipal scenery statue is gradually integrated into urban public space, appropriate to public life, and has spiritual communication and resonance with the public, which has become an important part of urban landscape. This art form is an important conductor between people and nature, and between people, so as to shorten the distance between the two and add luster and vitality to the city[20]. Chytas D, Chronopoulos e, salmas m initiated the research field of urban image. He emphasized people's actual perception and feeling of the city. In view of the loss of urban space, he proposed five elements of urban image that play a role in people's psychological feelings: region, boundary, path, node and marker, forming a set of fixed structural tools for studying urban image[5]. The research results of

Siegrist m, ung C Y and zank m are highly operational. The successful application of the five elements in the city can help people form a clear direction, a high sense of identity and a distinctive urban image[21].Through the three-dimensional reconstruction of the urban landscape, a large-scale urban virtual three-dimensional environment is constructed. People can browse the real city as a whole or locally in a dynamic interactive way. Because the three-dimensional landscape is more in line with people's cognitive habits, it is more conducive to the transmission and sharing of information. Andras L and others focused on the study of the landscape model for the purpose of building a real real environment, and constructed a quite realistic urban landscape model[1]. Bruniaux, Pascal and Zeng have conducted in-depth research on 3D city models and developed a 3D city model system called Tobago. In order to solve the problem of 3D modeling, they have specially developed a system called cybercitymodeler, which allows users to model interactive 3D objects[2]. In recent years, with the rise of "digital city" construction, 3D reconstruction of urban landscape has gradually become a research hotspot, and the research direction is also mainly focused on the establishment of 3D model of urban landscape. Based on the principles and classification of landscape model expression in urban 3D GIS, Rong y, Zhang T, Zheng y proposed a batch 3D model construction method of symbol matching and triangulation for abstract point, line and area objects[19]. Genesis L G, Juliet g, Stephen s proposed to realize the rapid reconstruction of urban 3D landscape by establishing the urban 3D landscape model base[9].

3 METHODOLOGY

3.1 Use 3D Laser Scanning Image to Collect the Characteristics of Municipal Scenery Statue

In order to carry out the three-dimensional virtual reality design of urban landscape and improve the rationality of urban landscape design, image acquisition is carried out through the three-dimensional virtual reality technology of urban landscape, the visual displacement and road feature information of urban landscape image are constructed, and the information feature distribution of scene state information acquisition of urban landscape is obtained as follows:

$$M(x,y)=m(x,y)+d(x,y) \tag{1}$$

Where, $m(x,y)$ represents the integer level parallax function of 3D laser scanning of buildings and road facilities, and $d(x,y)$ represents the parallax function of 3D virtual reality imaging of urban landscape. The three-dimensional laser three-dimensional scanning imaging technologyis used to draw the rendering volume of urban landscape virtual reality imaging, the edge contour of urban landscape virtual reality imaging is detected by surface grid detection method, the three-dimensional laser scanning image of urban landscape is segmented in the laser transmission space, and the three-dimensional statistical analysis of urban landscape three-dimensional laser scanning image is carried out by Monte Carlo method, 3D laser scanning dynamic laser virtual image output of urban landscape is：

$$I(x)=J(x)t(x)+A(1-t(x)) \tag{2}$$

Among them, A is the pixel value of urban landscape 3D laser scanning dynamic imaging in x directions, $t(x)$ is the corresponding statistical characteristics of urban landscape 3D laser scanning dynamic imaging, and $J(x)t(x)$ is the adaptive distribution function of urban landscape 3D laser scanning. Then the surface grid detection method is used to detect the edge contour of urban landscape virtual reality imaging, and the three-dimensional laser scanning process is shown in Figure 1.

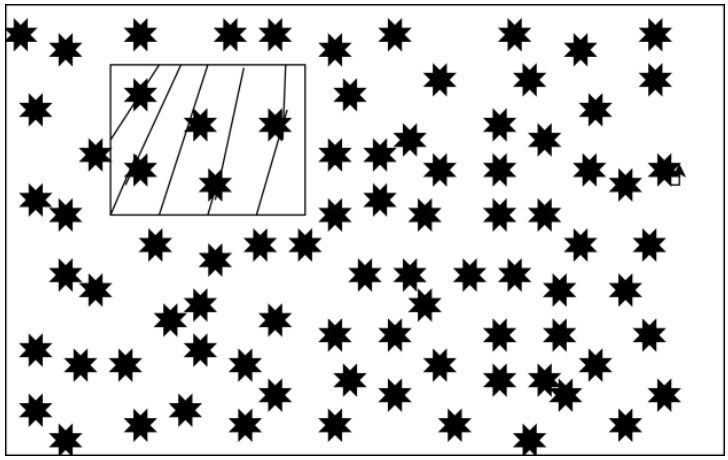

Figure 1: Regional Distribution of 3D Laser Scanning Area of Municipal Scenery Statue.

The pixel value of the laser 3D scanning image corresponds to the two-dimensional coordinate system, and the arithmetic mean value of the sub sample of the attenuation coefficient X of the laser light intensity is used as the approximate solution of the pixel sequence K of the urban landscape virtual reality design:

$$\overline{x_T} = \frac{1}{T}\sum_{i=1}^{T} x_i \tag{3}$$

Where: $x_1, x_2, x_3, \ldots, x_T$ is the three-dimensional resampling feature sequence of urban landscape of X, T is the time interval of laser point scanning, $V(g)$ is the bounded variation of continuous function g on region $R=[0,1]$, and for T points $x_1, x_2, x_3, \ldots, x_T \in R$ of edge pixel points, the edge contour point distribution of urban landscape three-dimensional laser scanning image composed of several thread blocks meets:

$$P\left(\left|\overline{x_T} - K\right| < \frac{\lambda_x \sigma}{\sqrt{N}} \approx \frac{2}{\sqrt{2\pi}} \int_0^{\lambda_x} e^{-\frac{1}{2}t^2} dt = 1 - x\right. \tag{4}$$

According to the central pixel of laser three-dimensional scanning imaging, the three-dimensional structure of urban landscape design is dynamically reconstructed, and the multi wavelet scale segmentation technology is used for image virtual reconstruction and filtering, so as to improve the rationality of urban landscape design.

Using AutoCAD, 3dsmax, creator and SketchUp software combined with ArcGIS software, the three-dimensional landscape is reconstructed in ArcScene. At the same time, three-dimensional modeling technology, database technology and secondary development technology are used for simple auxiliary design of urban planning, with the focus on the research of three-dimensional landscape reconstruction of auxiliary planning and the secondary development of ArcScene. See Figure 2 for the flow chart of complex 3D model establishment.

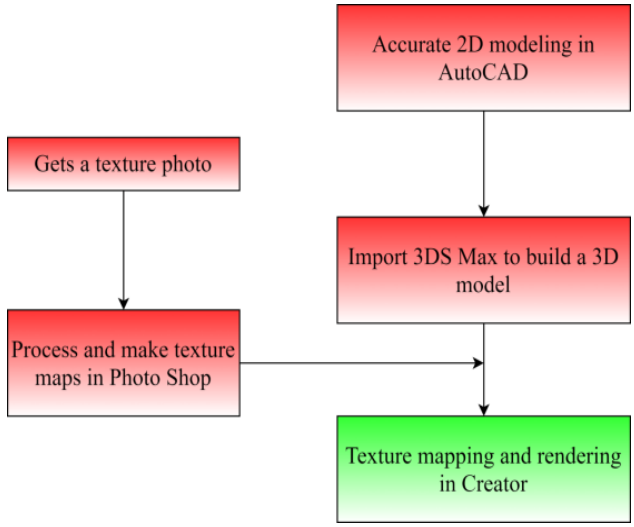

Figure 2: Technical Process of 3D Software Modelling.

According to the central pixel of laser three-dimensional scanning imaging, the three-dimensional structure of urban landscape design is dynamically reorganized, and the virtual reality design of urban landscape is carried out on the basis of image virtual reconstruction and filtering processing using multi wavelet scale segmentation technology. This paper proposes an urban landscape design technology based on frame reorganization and texture mappingof three-dimensional laser scanning.

The error order of laser 3D scanning imaging light attenuation is $O(T^{\frac{1}{2}})$. Assuming that the coordinate value of laser 3D scanning sampling is expressed as $\{(zK, ak)\}$, there is an Inequality:

$$\left|\frac{1}{T}\sum_{i=1}^{T} g(x_i) - \int_0^1 g(t)dt\right| \le V(g)D_T^* \tag{5}$$

Among them, D_T^* refers to the central pixel deviation of virtual reconstruction of urban landscape in T neighborhoods. Carry out laser ray volume rendering of urban landscape 3D laser scanning

urban landscape virtual reality design, count the number of points in the model, and get the volume of urban landscape virtual reality design grid model, which can be expressed as:

$$V_{abj} = V_{box} \times \frac{P_{in}}{P_{all}} \tag{6}$$

Among them, V_{abj} is the final measurement of the volume of the 3D urban landscape virtual reality design model, P_{in} is the number of points in the model, and P_{all} is the number of all points in the volume rendering of urban landscape design. The data point trajectory flow of 3D virtual reality design to obtain high-precision output VR urban landscape is:

$$Data\_term(x, y, d(x, y)) = -\frac{[\sigma_d u, \bar{u}]\varphi_{x_0}}{\left\|\tau_d u\right\|_{\varphi_{x_0}} \left\|\bar{u}\right\|_{\varphi_{x_0}}} \tag{7}$$

Where, $\tau_d u = u(x - m(x, y) - d(x, y), y)$, image attribute feature $m(x, y)$ represents the distance of spatial building distribution; $[.,.]_{\varphi_{x_0}}$ represents the measurement error of urban landscape design centered on x_0 points; $\|.\|_{\varphi_{x_0}}$ represents the normalized normof VR reconstruction virtual imaging centered on x_0.

3.2 Virtual Three-Dimensional Visualization, Decomposition of Landscape Sculpture with Graphics, and Optimization of Design

The basic content of urban 3D landscape reconstruction is 3D landscape modeling and visualization[19]. The content of 3D landscape modeling mainly includes terrain modeling and feature modeling. In the process of modeling, not all models should be expressed realistically, but should be comprehensively selected and simplified according to different needs. On the other hand, building a large-scale 3D scene will inevitably produce contradictions between the 3D visualization effect and the amount of data, which will eventually affect the rendering efficiency of the 3D scene. Terrain surface reconstruction is actually DEM surface reconstruction or DEM surface generation. When DEM surface modeling is completed, the elevation of any point on the model can be obtained from DEM surface. For the digital description of terrain model, scholars at home and abroad have done a lot of research, among which there are two representative categories: one is based on Irregular Triangulation modeling; One is rule-based grid modeling. The two methods have their own advantages and disadvantages, as shown in Table 1:

Modeli ngmet hod	*Advantage*	*Shortc oming*	*Scopeofapplication*

IrregularTriangulation(TIN)	*1. Thetinmodelcandynamicallyadjustthenumberofdatapointscontainedaccordingtotheroughnessoftheterrainsurfaceortheintensityofchanges;Whentheterrainisflat,thetinmodelcontainsfewerdatapoints,andviceversa. 2.Itisconvenienttoexpresstopographicfeaturessuchasstructurallinesandfaultlines.*	*1.Datastorageandoperationarecomplex. 2.Datastorageandoperationarecomplex.*	*TinmodelisexpressingpackageTerrainwithalargenumberofcharacteristiclines(faultlines,structurallines)ismoreaccurateandreasonable.*
Regulargrid	*1. Thedatastructureissimpleandeasytoconstructanetwork. 2. Smallamountofdatastorage. 3. Analysisandcalculationareconvenient. 4.Themodelingmethodisdirect.*	*1.Storagedataredundancy. 2.Dataredundancyinflatareas Serious.*	*CommonlyusedtodealwithflatcoverageGlobalnumberofslowregionsAccordingto,butforterrainshapeGroundwithrelativelybrokenstateArea,specialplacesarerequiredManage(addfeaturepointsLineorincreaseddensity).*

Table 1: Comparison of Modeling Methods Between Irregular Triangulation and Regular Grid.

The process of building digital elevation model based on ArcGIS is shown in Figure 3.

Specific operation process:

1. Vectorization of contour data. The vectorization of contour data is generally to vectorize the paper topographic map, but because the paper topographic map is prone to deformation due to environmental conditions, it should be corrected before vectorization.

2. Repair the data based on CAD software. In the process of vectorization, some data errors will inevitably appear, so it is necessary to repair the data errors with the help of CAD software, improve the relevant attribute information, and establish the data required by the correct DEM.

3. Data format conversion. Use the conversiontools tool in arctoolbox to convert AutoCAD data into ArcGIS supported Data in SHP format. In order to avoid the confusion of attribute data, hierarchical conversion can be carried out.

4. Generate tin. Use the createtinfromfeatures tool in 3danalyst toolbar in ArcGIS to generate irregular triangulation.

5. Generate DEM. Use the convert/tintoraster tool in the 3danalyst toolbar in ArcGIS to generate DEM.

In the process of urban 3D terrain modeling, in order to make the 3D visualization effect of terrain more realistic, digital orthophoto images are usually superimposed on DEM, so making high-quality digital orthophoto images is an important part of 3D terrain modeling[17]. Compared with line mapping, remote sensing image orthophoto has many incomparable advantages, so it has special applications in urban planning, land management, railway, highway route selection and so

on. The production of digital orthophoto mainly includes image correction, image fusion and image evaluation.

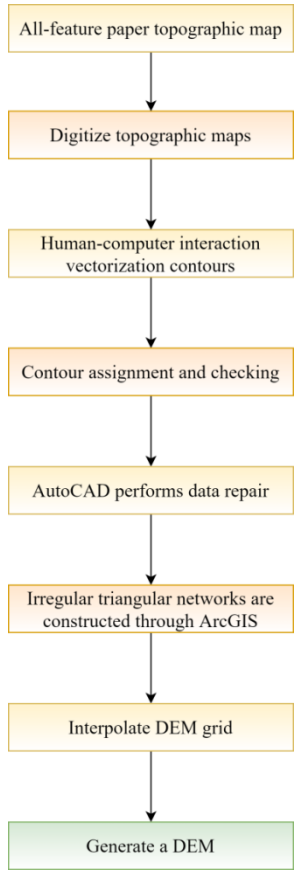

Figure 3: The Process of Establishing Digital Elevation Model Based on ArcGIS.

Image correction. It refers to the orthophoto correction of satellite images in the operation area based on DEM and GPS control points with satisfactory accuracy. The commonly used correction method is to use the physical model of imaging to strictly correct the image according to the imaging principle and conformation equation of the image[14]. The specific operation process is shown in Figure 4.

1.Image fusion. Image fusion is the process of processing image data and other information from multiple remote sensors. This process can improve the accuracy of image data processing and enrich image information, such as the fusion of high-resolution panchromatic image and low-resolution multispectral image. The fused image has the characteristics of high spatial resolution and multispectral. Image fusion can improve image spatial resolution, improve image geometric accuracy, improve classification accuracy, enhance feature display ability, improve change monitoring ability and so on. Image fusion includes data registration, selection of fusion methods, panchromatic data processing, multispectral processing and other key technologies.

2.Image evaluation criteria. In general, the indicators to evaluate DOM are: accuracy, clarity, real-time, etc.

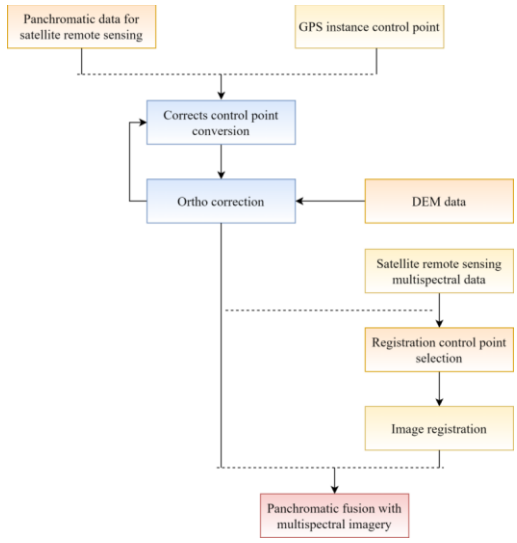

Figure 4: Image Correction Process.

4 RESULT ANALYSIS AND DISCUSSION

In order to more clearly and concretely see the practical application effect of the virtual reality municipal scenery statue three-dimensional reconstruction method proposed in this paper, we compare it with the traditional municipal scenery statue three-dimensional reconstruction method, and compare its landscape fidelity. In order to ensure the accuracy of the experiment, the two three-dimensional reconstruction methods of municipal scenery statue were placed in the same experimental environment to test the verisimilitude of landscape structure. During the experiment, two different three-dimensional reconstruction methods of municipal scenery statue were used in the same experimental environment to analyze the changes of landscape fidelity. The comparison of experimental results is shown in Figure 5.

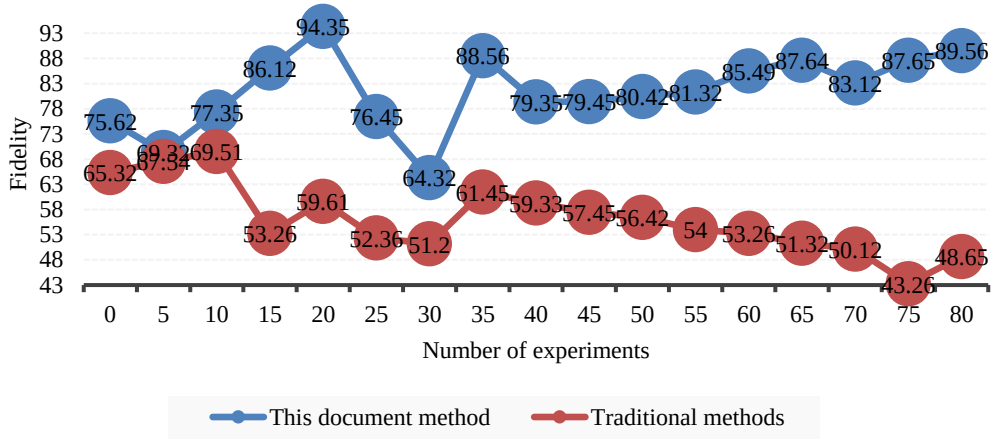

Figure 5: Comparison of Experimental Results.

As can be seen from Figure 5, the 3D reconstruction method of municipal scenery statue based on virtual display designed in this paper has high fidelity of 3D landscape construction, with an initial fidelity of 75%. With the increase of the number of experiments, the fidelity increases steadily. When the number of experiments is 80, the fidelity is close to 90%. The initial fidelity of the traditional method is 65%, which is far lower than the design method in this paper, and with the increase of the number of experiments, the fidelity of the constructed landscape fluctuates greatly, even lower than 43%. Therefore, the method designed in this paper is much higher than the traditional method in the fidelity and stability of 3D landscape construction, and has obvious advantages.

Linear array jitter error is a unique error of linear array 3D SAR imaging system. The jitter error of an array element is different at each slow time, and the jitter of each array element is also different at the same slow time. Therefore, linear array jitter error will affect not only the focus along the track, but also the focus of the tangent track, which must be considered in the design of linear array 3D SAR imaging system. In the linear array 3D SAR imaging system in the mode of multiple transmitter and multiple receiver, the transmitting array element is generally installed at both ends of the aircraft wing, and the receiving array element is installed in the middle of the wing. During the movement of the carrier aircraft, the wing will vibrate in the tangential track height plane, making each array element deviate from the original position, so that the equivalent virtual array element also deviates from the original position in the tangential track height direction. The simulation of the dynamic error adopts the system parameters measured before. The sound velocity of the medium used is 2500m/s, the thickness of the wing is 5cm, the jitter frequency of the tangential track f_y is 100Hz, the jitter amplitude is 0.5mm, the maximum characteristic amplitude of the altitude jitter is 2mm and the first three orders are taken. The formula is used to calculate the position error of each array element, and the obtained array element position with error is used for simulation. The simulation results are shown in Fig. 6 and Fig. 7.

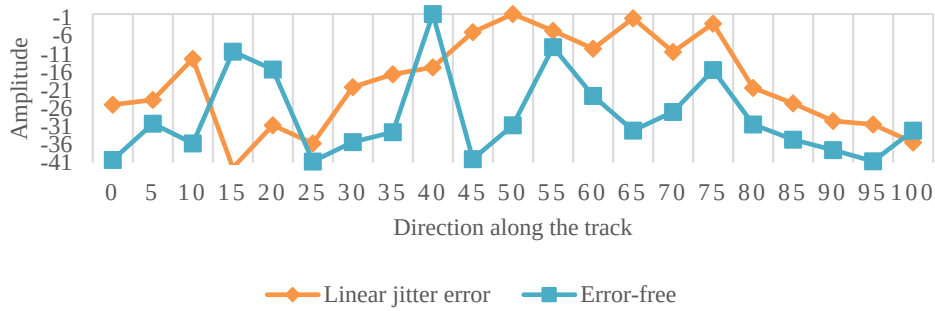

Figure 6: Effect of Linear Array Jitter Error on Along Track.

The variation of range history caused by linear array jitter error is very small, so it will not affect the point spread function in the range direction. Figure 6 and Figure 7 show the influence of linear array jitter error on the tangential and along track point spread functions. It can be seen from the figure that when there is mechanical jitter error, the defocus phenomenon along the track is relatively serious, and there is ghosting phenomenon; The sidelobe of the ambiguity function of the tangent track is seriously increased, the energy of the main lobe is reduced, and the defocusing phenomenon is serious. The simulation results show that the array jitter error will have a fatal impact on the 3D imaging quality. Therefore, the array jitter error must be strictly controlled in the design of the online 3D SAR imaging system, or the array jitter error must be compensated in the imaging processing.

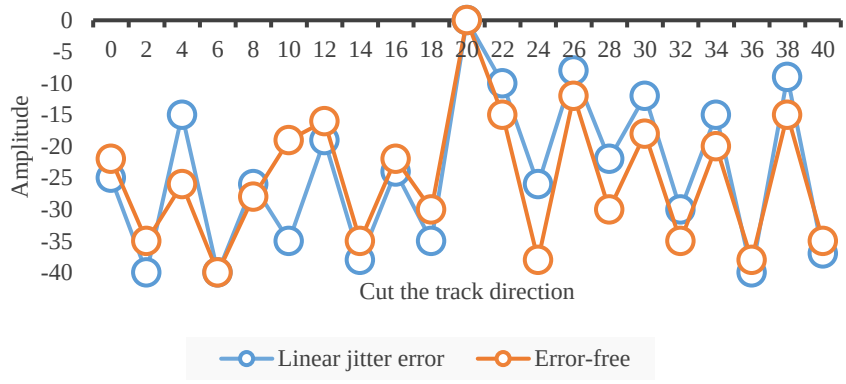

Figure 7: Effect of Linear Array Jitter Error on Tangent Track.

In order to compare the quality differences of the synthesized virtual viewpoints more objectively, we calculate the PSNR value to compare. PSNR measures the fidelity of the target viewpoint. The larger the value, the smaller the distortion, that is, the more similar the virtual viewpoint is to the real image. Using the objective quality evaluation model, PSNR is calculated for each virtual viewpoint image, and 1-30 frames of "breakdancers" and "balloon" sequences are selected for experiments. The comparison of PSNR of the target viewpoint images drawn is shown in Fig. 8 and Fig. 9.

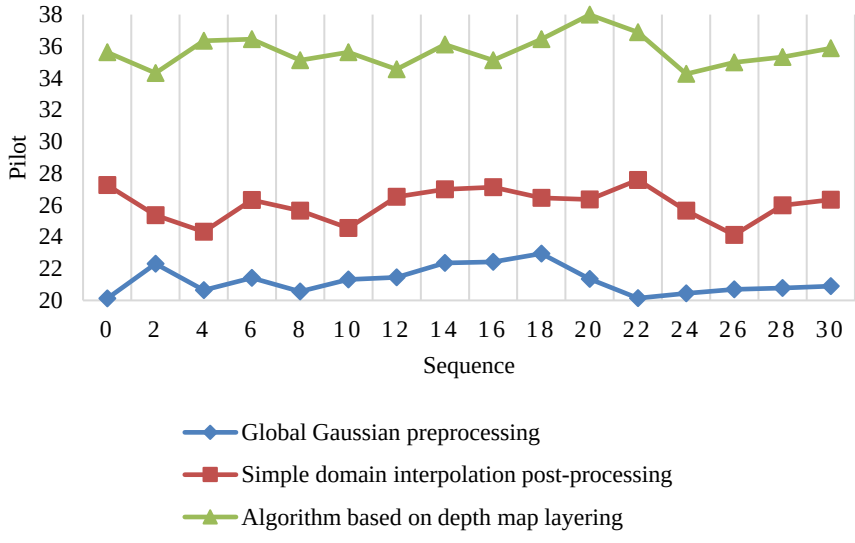

Figure 8: PSNR Comparison of "Breakdancers" Sequence.

As shown in Figure 8 and Figure 9 above, the abscissa is 1-30 frames of the virtual viewpoint image drawn by the virtual viewpoint, and the ordinate is the PSNR value calculated by comparing the virtual viewpoint with the real image. By comparing the PSNR curves drawn by various methods, it can be seen that the virtual viewpoint synthesis algorithm based on depth map layering proposed in this paper has higher PSNR than other algorithms, and its distortion degree is the smallest.

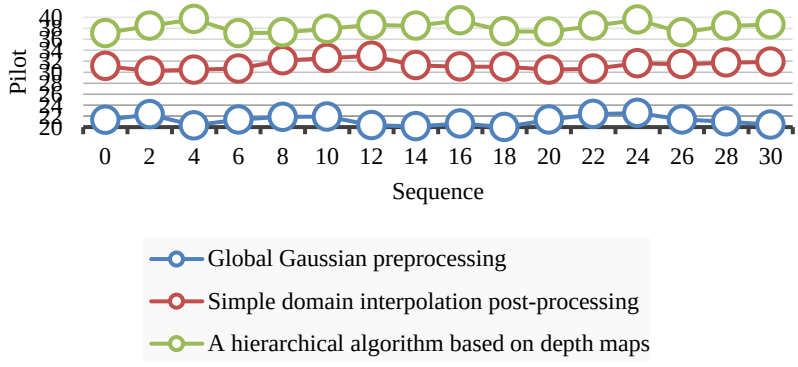

Figure 9: PSNR Comparison of "Balloon" Sequence.

5 CONCLUSIONS

In this paper, a modern municipal scenery statue planning and design scheme based on three-dimensional virtual reconstruction is proposed. A variety of three-dimensional methods are combined, and three-dimensional municipal scenery statue is visualized by using three-dimensional laser scanning imaging technology to realize planning and design. Finally, simulation test analysis is carried out. This result fully shows that using GIS to establish a three-dimensional landscape sculpture planning system provides a feasible way, which undoubtedly has a very important significance and value for the standardization of landscape sculpture planning and design, the improvement of urban planning and design level, and the restoration of municipal scenery statue. It will provide visual management and analysis for digital city planning and construction. It not only visually reproduces the style of landscape sculpture, but more importantly, it can promote information sharing and exchange through the exchange, fusion and mining of various information on the basis of thematic analysis of various information, optimize the allocation in regional space, and formulate a comprehensive and reasonable regional development plan.

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