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Computer-Aided Design AND APPLICATIONS

3D Reconstruction and Virtual Reality Display Technology of Tourism Art Resources CAD Based on NN

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Abstract. Tourism art resources are an important part of tourism resources, with profound historical and cultural heritage and unique artistic value. The traditional way of displaying tourism art resources often lacks vividness and vividness, which can't make people deeply feel the charm of tourism art resources. In this article, a Neural network (NN) model suitable for the identification of tourism art resources is constructed, and automatic identification and feature detection are realized by training and learning a large quantity of images. According to the extracted feature information, 3D reconstruction is carried out by using the construction and display of virtual environment. The results show that the algorithm is excellent in 3D reconstruction and virtual display of tourism art images, with lower modeling error, higher modeling accuracy and faster response speed. This algorithm performs better on all data sets. Through 3D reconstruction and virtual display of tourist art images, more accurate and realistic immersive experience can be provided, and users' cognition and understanding of tourist attractions can be enhanced.

Keywords: NN; Tourism Art Resources; CAD; 3D Reconstruction; Virtual Reality
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1 INTRODUCTION

With the growth of tourism, people's demand for tourism experience is escalating, especially for the experience of tourism art resources. Tourism art of tourism resources, with profound historical and cultural heritage and unique artistic value. Through 3D models and hybrid reality technology, cultural relics and scenes in museums can be digitally displayed, and viewers can view them through devices such as virtual reality glasses or mobile phones. This display method not only improves the viewing experience of the audience, but also solves some difficult problems in physical display, such as protecting cultural relics from damage. Barrile et al. [1] utilized 3D models and hybrid reality technology to achieve high-precision digital protection and recording of cultural heritage. These 3D models can not only be used for academic research, but also for the replication and display of cultural

relics. Meanwhile, through hybrid reality technology, this digital cultural heritage can be combined with the real environment to achieve dynamic display and interactive experience of cultural heritage. 3D models and hybrid reality technology can provide rich data support and visualization tools for scholars in the fields of art, archaeology, and cultural heritage. Through these technologies, scholars can more intuitively study the form, structure, and historical background of cultural relics. At the same time, these technologies can also promote communication and cooperation among scholars in different fields, and promote the progress of academic research. The traditional way of displaying tourism art resources often lacks vividness and vividness, which can't make people deeply feel the charm of tourism art resources. Virtual reality visualization is a technology that utilizes computer graphics and image processing techniques to present objects, scenes, or events in the real world.

In the field of cultural heritage protection, virtual reality technology can help us display and preserve historical and cultural heritage in a more vivid and intuitive way, allowing more people to deeply understand and experience these valuable cultural resources. In Istanbul Åatalcaïnğ in the case of iz cave, Büyüksalih et al. [2] obtained 3D data of the cave through 3D laser scanning technology and used it to establish a virtual scene. Then, virtual reality technology is used to realistically render and animate the interior of the cave, allowing tourists to freely explore and understand the history and culture of the cave in a virtual environment. In addition, virtual reality technology can also accurately display the shape and features of caves in detail, including the texture, color, and shape of rocks, as well as cultural heritage elements such as murals and carvings. In order to improve this situation, it is needed to introduce more advanced technical means, such as CAD 3D reconstruction technology and VR technology. Through the steps of image acquisition, image processing and feature detection, the 3D model of tourism art resources is obtained. 3D shape depth measurement learning is a technology that combines depth learning and 3D shape analysis. It learns and understands the features of three-dimensional shapes by training deep neural networks. Among them, the shape can be a three-dimensional model generated by computer-aided geometric design (CAGD) software, or it can be an actual object model obtained through three-dimensional scanning technology. Chen et al. [3] By applying CNN to three-dimensional shapes, we can learn complex features of shapes from raw point cloud data. Used to process sequential data, such as time series or text. In three-dimensional shape analysis, RNN can be used to handle shape changes or sequences, in order to understand shape changes over time. Autoencoder (AE) and Variational Autoencoder (VAE): Used for learning low dimensional representations of data. In 3D shape analysis, AE and VAE can be used to learn compact representations of shapes, facilitating shape classification, retrieval, and generation. This technology can more truly restore the details and forms of tourism art resources and provide people with a more intuitive and vivid visual experience. In the field of cultural heritage protection, digital reconstruction technology is gradually becoming an important means for repairing and restoring immovable cultural heritage assets. Comes et al [4] Taking the Dacian relief plate in the ie (Hongyan) area as an example, this article explores the application and value of digital reconstruction in this field. The Dacian relief plate is an important cultural relic of the site, recording the lives, beliefs, and culture of the Dacian people. However, due to prolonged weathering and other natural factors of erosion, many relief plates have been severely damaged. In order to protect and inherit this cultural heritage, researchers have begun to use digital reconstruction technology to restore and restore it.

VR technology is a technology that can simulate the real environment and make people feel immersive in the virtual environment. In the exhibition of tourism art resources, VR technology can display tourism art resources in a virtual environment, so that people can feel the charm of tourism art resources. It simulates human auditory and tactile senses, allowing users to immerse themselves in a highly realistic three-dimensional virtual environment. In the 3D modeling system of tourism product CAD, thereby providing more possibilities for tourism product design. The design is centered around tourism products, and Deng et al. [5] utilized virtual reality technology to construct a highly realistic 3D scene. The system should have the characteristics of easy operation, comprehensive functionality, and high stability. The tourism product CAD 3D modeling system mainly includes functional modules such as data collection, model establishment, scene construction, editing and modification. The data collection module is responsible. The model building module establishes a

three-dimensional model based on the collected data. The scene construction module places the model into a specific 3D scene. The editing and modification module can modify and optimize models and scenes. Computer Aided Design (CAD) is a modeling technique, Parametric design is based on strict mathematical calculations, which can ensure the accuracy and consistency of the design. Since parametric design is based on known rules and formulas, designers can predict the final effect of the design, which helps reduce errors and save time. Parametric design can greatly improve work efficiency, especially when conducting complex designs or large-scale projects. Parametric design can be easily replicated and modified, which helps improve the maintainability and scalability of the design, but there are differences in emotional response, flow experience, and operational performance. Fang and Kao [6] compared the performance of these two modeling methods in these aspects to explore their advantages and disadvantages. The data shows that participants have higher operational performance ratings. This may be because traditional parameterized computer-aided design modeling provides more accurate and stable model creation tools, enabling participants to complete modeling tasks more accurately. In contrast, participants in free form modeling of virtual reality may experience inaccurate or inefficient operations due to limitations of virtual reality technology.

Traditional CAD 3D reconstruction technology and VR technology often have some problems. For example, the traditional CAD 3D reconstruction technology needs manual feature detection and model reconstruction, and the operation process is cumbersome and the accuracy is not high. Traditional VR technology often lacks the ability to restore details such as real scenes and objects, and can't make people feel more real environment and objects. Gong [7] explored the application of these two technologies in architectural decoration aesthetics and analyzed their aesthetic manifestations and patterns. Extracting image information related to architectural decoration, such as color, texture, shape, etc., through image preprocessing, feature extraction, and other operations. Utilizing deep neural network models to train and learn a large number of architectural decoration images, enabling machines to autonomously recognize and classify different architectural decoration styles and elements. By constructing a neural network model, automatic segmentation, recognition, and reconstruction of architectural decoration images are carried out, providing intelligent support for subsequent virtual design and display. At the same time, machine vision technology can also be used to recognize and understand user actions and expressions, optimize user experience and improve the intelligent level of interactive display based on analyzing their behavior and reactions in virtual environments. By using NN technology, the automatic identification and feature detection of tourism art resources can be realized, so as to obtain a more accurate 3D model and provide people with a more real and vivid tourism experience. The main innovations of this study are:

(a) In the CAD 3D reconstruction and VR exhibition of tourism art resources, this article introduces NN technology.

(b) Traditional CAD 3D reconstruction technology needs manual feature detection and model reconstruction, and the operation process is complicated and the accuracy is not high. In this article, the algorithm realizes the automatic identification and feature detection of tourism art resources, thus obtaining a more accurate 3D model.

(c) The model has realized the automatic recognition and image processing of real environment and objects, obtained a more realistic virtual environment, and enhanced the effect of VR exhibition.

This article first introduces the theme and purpose of this article, then expounds the relevant research basis, and then puts forward the CAD 3D reconstruction and VR exhibition method of tourism art resources in this article. Finally, the application effect and advantages of this method are studied and the future research is prospected.

2 RELATED WORK

Virtual reality (VR) technology provides an innovative opportunity for the tourism industry to help overcome challenges by improving the sustainability of VR experiences. Reduce the impact of tourist destinations on the environment, such as reducing artificial lighting and energy consumption in

tourist destinations. VR technology can provide a realistic virtual environment, allowing tourists to experience the destination while reducing their impact on the local environment. Through this approach, Gegung et al. [8] reduced artificial lighting and energy consumption, promoting environmental protection and sustainable development. Promote the social, cultural, and environmental development of tourism destinations, such as increasing the tourism revenue and participation of local residents. By utilizing VR technology, tourist destinations can attract more tourists and improve the tourism revenue and participation of local residents. In the field of industrial manufacturing, URLLC can achieve more precise production control. Due to the high requirements for equipment accuracy and reaction speed in industrial manufacturing, URLLC's ultra-low latency characteristics can make communication between various devices faster and more accurate, thereby improving production efficiency and quality. For example, URLLC can be used to achieve real-time communication between robots, allowing them to collaborate more accurately. It provides various advanced services for latency 0 sensitive networking devices, and Time Sensitive Network (TSN) is another important component of 5G URLLC functionality. It will use a time aware traffic shaper to manage data flow. Hazarika and Rahmati [9] explored ultra-low latency communication in 5G and beyond. This new network architecture ensures that data packets are transmitted according to their schedules, thereby avoiding delays caused by waiting. The introduction of this method ensures the synchronization and real-time performance of data transmission, enabling URLLC to meet the requirements of highly reliable and low latency communication applications such as autonomous driving. AutoCAD in fields such as engineering drawing, architectural design, and mechanical design. AutoCAD is mainly used to draw plans, elevations, and sections, helping students master accurate drawing techniques and methods. Through case teaching, students can understand in practice. Teachers can select representative practical projects and guide students to design and optimize solutions. Encourage communication and discussion among students, and share their experiences and experiences in using computer-aided design software. At the same time, teachers can organize group discussions with students to compare and evaluate different design schemes. Jin and Yang [10] use more intuitively experience the effectiveness of design schemes during the design process, providing more possibilities for scheme deliberation and optimization. 3D immersive virtual reality (VR) has become an important component of real life. As a technology that can provide immersive experiences, 3D immersive virtual reality has brought unprecedented new perspectives to art consumption.

Kim et al. [11] explored the advantages, applications, advantages and disadvantages, and future prospects of 3D immersive art consumption. 3D immersive virtual reality technology can help consumers, interact with art works from around the world, and enjoy art works from different cultural backgrounds anytime and anywhere. Consumers can independently choose the art works and display methods they want to experience based on their interests and needs. Meanwhile, through data analysis and user feedback, artists can better understand consumers' needs and preferences, providing consumers with a more personalized experience. Taking the Vatican Museum as an example, Kontopanagou et al. [12] delved into the influence of Byzantine culture through immersive technology. Firstly, through VR technology, visitors can virtually "enter" the exhibition hall of the museum and observe the details and historical background of Byzantine art. Secondly, through AR technology, visitors can obtain more multimedia information about these artworks during on-site visits, such as the manufacturing process of mosaic decoration and the characteristics of Byzantine art. In addition, MR technology can also be used to combine the virtual world with the real world. For example, in certain exhibition halls of the Vatican Museum, virtual interpreters or historical scenes can be added to provide a richer visiting experience. Exploring the influence of Byzantine culture in churches/monuments/museums using immersive technology in a real-time network environment is an innovative and effective method. Through these technologies, we can gain a more intuitive. Not only can it enhance the visitors' visiting experience, but it can also provide new perspectives and methods for historical and cultural research. Research directions include improving design efficiency, reducing technical barriers, enhancing data security, and achieving intelligent design. By introducing artificial intelligence technology, automated design scheme selection and optimization can be achieved. Liu [13] utilizing virtual reality (VR) and augmented reality (AR) technologies, we can

achieve visual and interactive experiences in product design, thereby better evaluating and optimizing design solutions. Through VR technology, designers can observe and experience products comprehensively in a virtual environment, including their appearance, structure, function, etc., in order to better identify problems and improve solutions. AR technology can combine virtual elements with real scenes, providing designers with a more intuitive and realistic interactive experience, thereby better evaluating the feasibility and user experience of products. Based on the requirements analysis results, develop multiple design schemes and evaluate the feasibility and advantages of the schemes. Create a product model using 3D CAD software for detailed design and overall layout. Optimize the model to improve product performance and quality. Convert the optimized model into production drawings for use by the manufacturing department. In computer-aided design, creative stimulation is a key link in teaching. Teachers should pay attention to students' individual characteristics and innovative awareness, and use various means to stimulate their creative thinking. For example, the visualization features of computer-aided design software can be utilized to guide students to freely create.

Teachers can provide necessary guidance and assistance to students in the practical process, encouraging them to make bold attempts and improvements [14]. Augmented reality assisted manufacturing technology is a real-time image processing technology based on artificial intelligence algorithms. It achieves real-time processing and post-processing by providing real scene information and virtual image information. Sahu et al. [15] use AR devices or image capture devices, such as cameras, scanners, etc., to collect real scene information, including the appearance, size, color, etc. of the product. Compare and fuse the generated virtual image information with real scene information to achieve real-time processing and post-processing. This can help manufacturing personnel more accurately understand product information, improve production efficiency and quality. Digital manufacturing is the entire process of using computer technology to achieve product design, manufacturing, and production. Augmented reality assisted manufacturing technology can help manufacturing personnel more intuitively understand product information, improve production efficiency and quality. The architectural design, and construction. AR technology can help us more accurately reconstruct and restore the details and historical background of cultural heritage, while providing a more optimized user experience. In the future, with the continuous development of technology, AR technology and remote sensing technology will be applied and developed in more fields. Shih and Wu [16] used a historical building site as an example to perform 3D virtual reconstruction of brick details using high-resolution cameras and AR technology. Firstly, image information of architectural sites is collected through high-resolution cameras. Then, AR technology is used to process the collected images and reconstruct the 3D model. Finally, realistic rendering of virtual scenes is achieved through texture mapping and rendering techniques. Users can interact with virtual scenes through AR devices to achieve free observation, scaling, rotation, and other operations. At the same time, AR technology can also achieve precise positioning and measurement through sensor data, improving the accuracy of reconstruction. The tourism industry is one of the largest industries in the world, and it has a significant impact on economic, cultural, and social development. However, the tourism industry also faces some challenges in its development process, such as resource consumption and environmental damage. In order to address these issues, the tourism industry has begun to seek new technological means to improve efficiency, reduce environmental impacts, and enhance the tourist experience. Virtual reality technology, as a technology with broad application prospects, has gradually received attention from the tourism industry.

Therefore, Sousa et al. [17] aimed to explore the intention of the tourism industry to adopt virtual reality technology and its sustainability impact. Through case analysis, it was found that the main intentions of tourism enterprises adopting virtual reality technology include improving the tourist experience, reducing costs, and improving efficiency. In terms of sustainability, virtual reality technology can help reduce resource consumption and environmental damage. The rural revitalization strategy is an important policy proposed by the Chinese government to promote rural development and improve the living conditions of farmers. The rural living environment is an important component of the rural revitalization strategy, and it is also a difficult and painful point for

current rural development in China. Computer virtualization technology provides new ideas and methods for improving rural living environment. Sun et al. [18] explore how to use computer virtualization technology to improve rural living environment and propose corresponding countermeasures and suggestions. Through virtualization technology, rural planning and design can be simulated on a computer, and plans can be evaluated and optimized to improve the scientificity and rationality of planning. Virtualization technology can achieve real-time monitoring of rural environment, including environmental indicators such as air quality, water quality, and noise, providing data support for rural environmental protection. The use of virtualization technology can achieve digital protection of rural cultural heritage, allowing more people to understand and inherit rural culture through virtual display and interactive experience. At present, research on computer-aided brand product development systems mainly focuses on design methods, process planning, performance evaluation, and other aspects. Among them, there is relatively little research on product primitive language recognition, and existing research mainly focuses on primitive language recognition in specific fields or products. Wang et al. [19] utilized deep learning technology to construct a model to automatically extract and recognize product primitives from design drawings. The computer-aided brand product development system, as an advanced technological means, can help enterprises improve efficiency, reduce costs, and improve quality in the product development process. Among them, product primitive recognition is an important link in computer-aided brand product development systems, which plays a crucial role in accurately understanding user needs, guiding product design and optimization. The virtual reality tourism experience provides tourists with a new way of traveling, while also having a profound impact on their cultural dissemination behavior. Zeng et al. [20] explored the impact of virtual reality tourism experiences on tourists' cultural communication behavior and their future development in the tourism and hotel industry. Virtual reality technology enables users to experience tourist attractions firsthand by simulating real tourism environments. This new type of tourism not only enriches the tourism experience, but also provides more convenient ways for tourists to travel. At the same time, virtual reality tourism experiences have also provided new avenues for tourists' cultural dissemination behavior. The cultural connotations behind scenic spots, thereby more effectively spreading the cultural value of tourist destinations.

3 TOURISM ART RESOURCES CAD 3D RECONSTRUCTION AND VR EXHIBITION

3.1 Art Style Learning and Feature Detection

Deep neural network (DNN) is a multi-layer NN, which can automatically learn the essential features of data by extracting features layer by layer, thus completing various complex tasks. In the technology of CAD 3D reconstruction and VR exhibition of tourism art resources, NN can be used in image recognition, object recognition and so on. Convolutional neural network (CNN) can the images of tourism art resources, so as to obtain different types of tourism art resources images. We can also use recurrent neural network (RNN) to automatically generate and translate the text descriptions of tourism art resources, thus providing people with a more comprehensive tourism experience. 3D reconstruction of CAD refers to the use of computer-aided design technology to obtain the 3D model of an object through 3D scanning, image processing, feature detection and other steps. In CAD 3D reconstruction, AutoCAD and 3D Studio Max are the most commonly used software. This software can get the 3D data of the object by taking pictures or scanning the object from multiple angles.

CAD 3D reconstruction technology is widely used in the field of architectural and mechanical design, which can help designers to design more intuitively, and carry out simulation test and optimization. In the field of tourism, CAD 3D reconstruction technology can also be used to model tourist attractions and cultural relics, thus providing people with a more realistic and vivid visual experience. VR exhibition refers to the use of computer technology to build a virtual scene in which people can interact and experience. This technology can be used in game development, film and television production, tourism and other fields, which can make people understand and experience different cultures and landscapes more deeply. In VR exhibition, the most commonly used software is

Unity and Unreal Engine. This software can get a more realistic and vivid virtual environment by modeling and rendering the virtual scenes. In the field of tourism, VR exhibition technology can be used to model and display tourist attractions and cultural relics. Moreover, VR technology can also be used to protect and inherit cultural heritage.

Tourism art resources refer to those artistic works, cultural landscapes, historical sites and other resources with tourism value. These resources have profound historical and cultural heritage and unique artistic value, and are an important part of tourism development. Traditional ways of displaying tourism art resources often use text description and picture display, which can't vividly show the details and charm of tourism art resources. Through CAD 3D reconstruction and VR technology, the form and details of tourism art resources can be more truly restored, providing people with a more intuitive and vivid visual experience.

In the 3D reconstruction of CAD, it is needed to carry out image acquisition, image processing, feature detection and other steps to obtain the 3D model of tourism art resources. This process needs to consider the morphological characteristics and detailed characteristics of different tourism art resources, so as to get a more accurate 3D model. In VR exhibition, it is needed to build a real virtual environment and display the tourism art resources in it. In tourism art resources, the extraction and understanding of artistic style and characteristics is very important for its CAD 3D reconstruction and VR exhibition. In this section, NN will be used for artistic style learning and feature detection. First of all, it is needed to collect a large quantity of images of tourism art resources, including painting, sculpture, photography and other forms. These images need to be preprocessed, including resizing and normalization, so as to facilitate the training and testing of NNs. In addition, we need to build a label data set for training NNs. This data set will contain the artistic style and feature information of the source image and the corresponding target image (that is, the image after style transfer). The artistic style learning process based on sparse coding is shown in Figure 1.

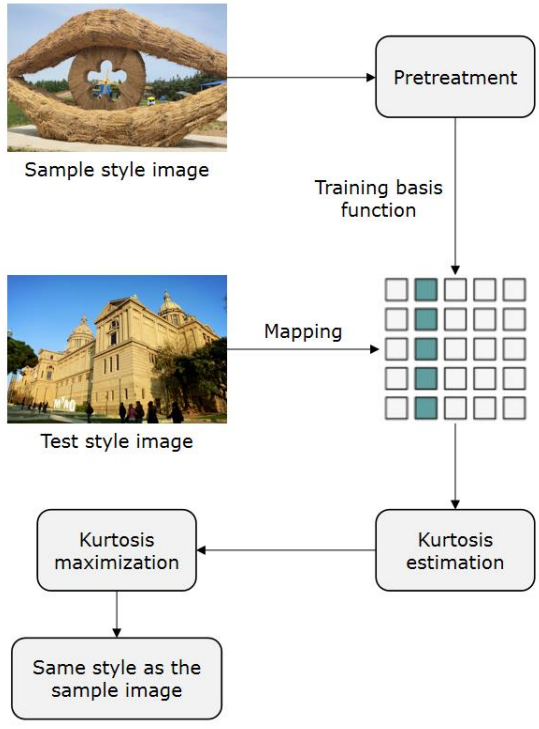

Figure 1: Art style learning.

Next, use CNN to learn artistic style and extract features. CNN is a deep learning model, especially suitable for processing image data. By training CNN, the model can learn the style transfer law from the source image to the target image. In the process of data preparation, the collected images of tourism art resources need to be preprocessed, including image size adjustment and normalization. In addition, each image needs to be assigned a label to indicate its artistic style and characteristics. The model takes the input image as input and outputs the image after style transfer. In the process of building the model, layered convolution, pooling and other operations are used to gradually extract the artistic style and characteristics of the image.

$$w\ \ i,j\ \ = \frac{1}{Z\ \ i}\exp\left(-\frac{d\ \ i,j}{h^2}\right) \tag{1}$$

$$W^{'} = \frac{1}{2}f\ \ x^{'},y^{'},z^{'}\ \ + E \tag{2}$$

After having the data and model, the back propagation algorithm. Through training, the model will learn the style transfer law from the source image to the target image. In the process of training, and adjust and optimize it according to the assessment results. The model takes the input image as input and outputs the image after style transfer. In order to suppress noise, the smoothing function can be convolved with the image function:

$$G\ \ x,y,\sigma\ \ = \frac{1}{2\pi\sigma^2}\exp\left(\frac{x^2+y^2}{2\sigma^2}\right) \tag{3}$$

$$\left|V^*\ \ p^{'}\right|\ 1-g^*\ \ p\ \ < \sum_{p\in U\ \ p}\ 1-g^*\ \ p \tag{4}$$

$$\Phi\ \ p\ \ = \begin{cases} 1, & p \in M \\ 0, & p \notin M \end{cases} \tag{5}$$

Statistics are made by assigning thresholds to gray pixels:

$$p\ \ \alpha_{_i}\ \ = \begin{cases} \dfrac{p}{h} & h_{_i} > p \\ \dfrac{h_i}{h} & h_{_i} < p \end{cases} \tag{6}$$

3.2 VR Exhibition of Tourism Art Resources

VR provides a new possibility for the display of tourism art resources. This section will discuss how to use VR technology to create and display a 3D model of tourism art resources. First of all, it is needed to use CAD to reconstruct the image data of tourism art resources and generate its 3D model. In this process, the artistic style and feature information extracted before can be used to control the appearance and style of the 3D model. See Figure 2 for the prior learning framework of depth images of tourism art resources.

In this study, the artistic style of the source image is transferred to the 3D model, thus making it more artistic. In this study, image data containing tourism art resources are collected, and these data are preprocessed, such as removing background and image segmentation, so as to facilitate the subsequent 3D reconstruction. Using CAD to reconstruct the processed image data and generate the corresponding 3D model. In this process, the artistic style and feature information extracted before can be used to control the appearance and style of the 3D model.

Using NN algorithm to display VR of tourism art resources is divided into two steps: training, learning and identification. The mathematical model of gesture recognition adopts bidirectional circular linked list for real-time gesture recognition, as shown in Figure 3, which shows a gesture recognition execution process from left to right.

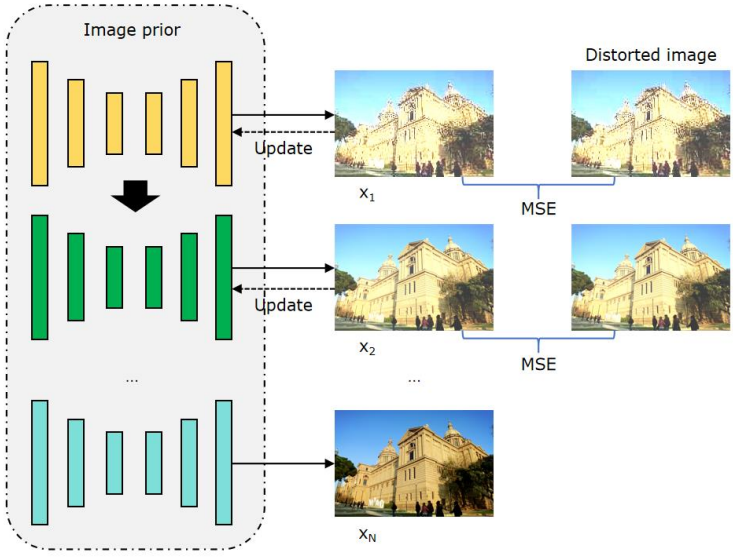

Figure 2: Deep image prior learning framework.

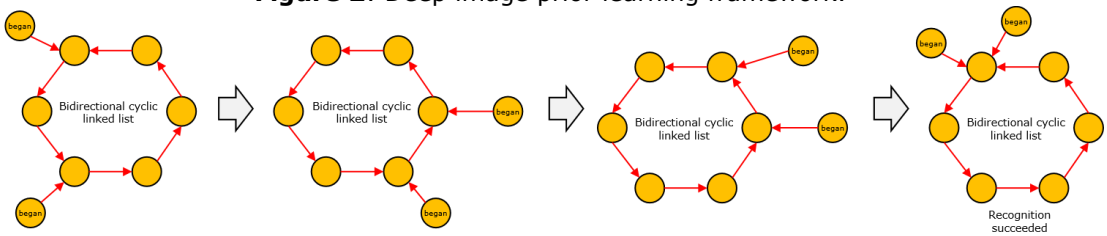

Figure 3: Real-time gesture recognition process with bidirectional cyclic linked list.

Optimize the generated 3D model, such as repairing the defects in the model, adjusting the size and proportion of the model, etc., in order to improve the accuracy and aesthetics of the model. In this process, we can use the artistic style and feature information extracted before to control the effect of texture mapping. Add lighting and shadow effects to the 3D model to improve the 3D sense and realism of the model. In this process, we can use the lighting model and shadow algorithm in VR technology to simulate natural lighting and shadow effects.

$$\frac{R}{R+x}=\frac{R-h}{R} \tag{7}$$

After simplification, you get:

$$x=\frac{hR}{h-R} \tag{8}$$

There are,

$$s-x^{*}{}^{2}+t-y^{*}{}^{2}+z^{*}=\left(\frac{hR}{h-R}\right)^{2} \tag{9}$$

So, you can get:

$$\sin\theta = \frac{\left|AB\right|}{\left|A^*B^*\right|} = \frac{am+bn+cp}{\sqrt{x_1^*-x_2^{*\ 2}\ \ y_1^*-y_2^{*\ 2}\ \ z_1^*-z_2^{*\ 2}}} \tag{10}$$

By adding animation and interactive functions to the 3D model, the user's immersion and experience are improved. For example, you can add animation effects to show the creative process of artistic works; We can also add interactive functions to let users interact with the 3D model, such as rotating, zooming in and zooming out the model. Update and optimize the virtual scene in real time, such as adjusting and optimizing the scene according to the user's operation and feedback, repairing possible errors, etc. Through the above steps, we can use VR technology to embed the 3D model of tourism art resources into the virtual environment, and add rich interactive functions and special effects to it.

Then, we need to use VR technology to embed the created 3D model into the virtual environment. In this process, VR helmets, handles and other equipment can be used to let users feel the charm of tourism art resources in an immersive way. Moreover, the user's immersion and experience can be enhanced through the simulation of special effects such as sound and light.

4 SIMULATION TEST

4.1 Data Preparation and Parameter Setting

The purpose of the experiment is to study the 3D reconstruction and virtual display technology of tourism art images. By analyzing the reconstruction effect and virtual display quality of different types of tourism art images such as natural scenery, historic sites, urban landscapes, folk customs, portraits and works of art, the modeling error, modeling accuracy and response speed of the algorithm are assessed, which provides theoretical basis and practical guidance for further optimizing the virtual display of tourism art images. Before the experiment, all the original material images were preprocessed by gray-scale conversion, compression and interception of the square diagram (512×512 pixels), and 52 material images of natural scenery, 52 materials of historical sites, 36 materials of folk customs, 22 materials of urban landscape, 22 materials of portraits and 22 materials of works of art were obtained. A representative example of each type of material image is shown in Figure 4.

Figure 4: Different types of tourist artworks.

Each type of material image is divided into two categories: training set and test set. When a sample graph is randomly selected from all the materials of a type as a training set to train a set of basis functions, then all the materials except the training set of this style are used as a test set.

4.2 Algorithm Testing and Analysis

The 3D reconstruction algorithm based on deep learning is adopted, and the mapping relationship from 2D images to 3D models is learned by training NNs, so as to realize the reconstruction of tourism art images. Using VR technology, the reconstructed 3D model is embedded into the virtual environment, and presented to users through helmets, handles and other devices, thus realizing the immersive tourism art experience. The modeling error, modeling accuracy and response speed of different algorithms (including this algorithm, SVM algorithm and RF algorithm) are tested, and the performance of various algorithms is assessed.

In the experiment, the modeling errors of this algorithm, SVM and RF algorithm are shown in Figure 5. The comparison of the modeling accuracy of the algorithm is shown in Figure 6.

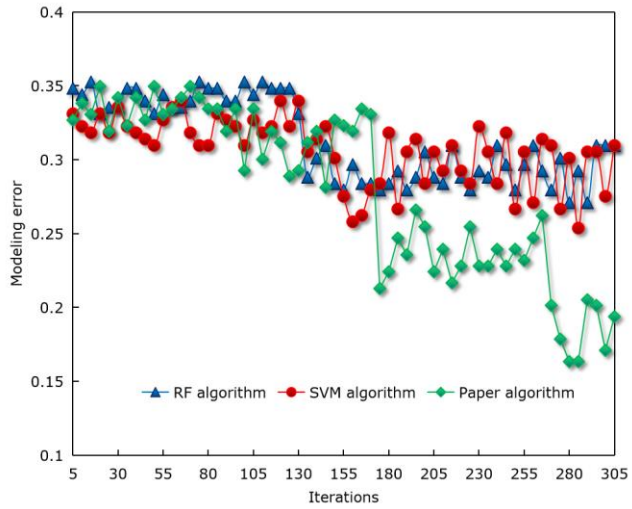

Figure 5: Modeling error of algorithm.

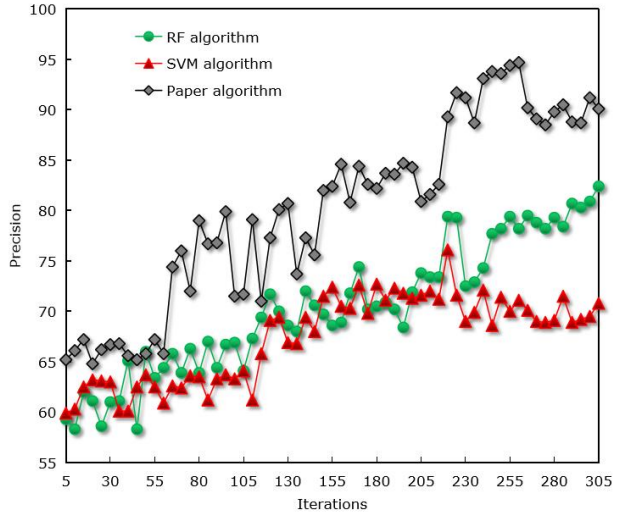

Figure 6: Modeling accuracy of algorithm.

The modeling error of this algorithm is low, compared with SVM and RF algorithm, the modeling error on each data set is small. This shows that the algorithm in this article can learn the information of 3D model from 2D images more accurately, so as to get a more accurate 3D model.

The modeling accuracy of this algorithm is high, especially on natural scenery, historical sites and works of art data sets, and the modeling accuracy of this algorithm is obviously higher than the other two algorithms. The algorithm in this article has lower modeling error and higher modeling accuracy, and can realize more accurate 3D reconstruction and virtual display. This provides a more accurate and realistic immersive experience for the display of tourism art images.

Figure 7 shows the comparison of the response speed of each algorithm. This shows that this algorithm can learn the information in the image more quickly and generate the corresponding 3D model.

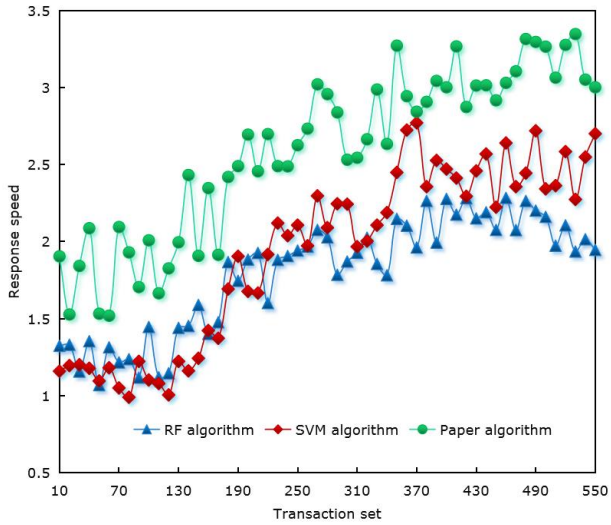

Figure 7: Comparison results of algorithm response speed.

The speed of response is often related to the complexity of the algorithm. SVM algorithm and RF algorithm usually involve complex calculation process, including matrix operation, feature detection and other steps, so their response speed is relatively slow. The algorithm in this article is based on deep learning technology, which reduces the computational complexity and improves the response speed by learning the feature representation of the image layer by layer.

The algorithm in this article is excellent in 3D reconstruction and virtual display of tourism art images, with lower modeling error, higher modeling accuracy and faster response speed. These characteristics make the algorithm in this article have great advantages in practical application, and it can realize efficient and accurate 3D reconstruction and virtual display. In the 3D reconstruction and virtual display of tourism art images, this algorithm adopts deep learning technology, especially CNN to learn the feature representation of images. By learning the features of the image layer by layer, this algorithm can better capture the artistic style and feature information in the image and improve the quality of the reconstruction effect. Through 3D reconstruction and virtual display of tourist art images, more accurate and realistic immersive experience can be provided, and users' cognition and understanding of tourist attractions can be enhanced.

5 CONCLUSION

Tourism art resources are an important part of tourism resources, with profound historical and cultural heritage and unique artistic value. In the exhibition of tourism art resources, VR technology can display tourism art resources in a virtual environment, so that people can better feel the charm of tourism art resources. This article studies the 3D reconstruction and virtual display technology of

tourism art images. By analyzing the reconstruction effect and virtual display quality of different types of tourism art images such as natural scenery, historical sites, urban landscapes, folk customs, portraits and works of art, the advantages of this algorithm in reconstruction effect, virtual display picture quality and response speed are verified. Compared with SVM algorithm and RF algorithm, the modeling error of this algorithm is smaller and the accuracy is higher. This shows that the algorithm in this article can better capture the artistic style and feature information in the image when reconstructing the 3D model of the tourism art image, and improve the quality of the reconstruction effect. In addition, the algorithm in this article has a fast response speed. This shows that this algorithm can learn the information in the image more quickly and generate the corresponding 3D model.

To sum up, the algorithm in this article is excellent in 3D reconstruction and virtual display of tourism art images, with low modeling error, high modeling accuracy and fast response speed. These characteristics make the algorithm in this article have great advantages in practical application, and it can realize efficient and accurate 3D reconstruction and virtual display. Future research can further expand the use fields of this method, such as cultural heritage protection and virtual tourism. Moreover, the implementation details of the algorithm can be further optimized to improve its performance and practicability.

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REFERENCES

[1] Barrile, V.; Bernardo, E.; Fotia, A.; Bilotta, G.: Integration of laser scanner, ground-penetrating radar, 3D Models and Mixed Reality for Artistic, Archaeological and Cultural Heritage Dissemination, Heritage, 5(3), 2022, 1529-1550. https://doi.org/10.3390/heritage5030080

[2] Büyüksalih, G.; Kan, T.; Özkan, G.-E.; Meriç, M.; Isın, L.; Kersten, T.-P.: Preserving the knowledge of the past through virtual visits: From 3D laser scanning to virtual reality visualisation at the Istanbul Çatalca İnceğiz caves, PFG–Journal of Photogrammetry, Remote Sensing and Geoinformation Science, 88(2), 2020, 133-146. https://doi.org/10.1007/s41064-020-00091-3

[3] Chen, M.; Zou, Q.; Wang, C.; Liu, L.: Edgenet: deep metric learning for 3D shapes, Computer Aided Geometric Design, 72(6), 2019, 19-33. https://doi.org/10.1016/j.cagd.2019.04.021

[4] Comes, R.; Neamțu, C.-G.-D.; Grec, C.; Buna, Z.-L.; Găzdac, C.; Mateescu, S.-L.: Digital Reconstruction of Fragmented Cultural Heritage Assets: The Case Study of the Dacian Embossed Disk from Piatra Roșie, Applied Sciences, 12(16), 2022, 8131. https://doi.org/10.3390/app12168131

[5] Deng, Y.; Han, S.-Y.; Li, J.; Rong, J.; Fan, W.; Sun, T.: The design of tourism product CAD three-dimensional modeling system using VR technology, Plos one, 15(12), 2020, e0244205. https://doi.org/10.1371/journal.pone.0244205

[6] Fang, Y.-M.; Kao, T.-L.: Comparisons of emotional responses, flow experiences, and operational performances in traditional parametric computer-aided design modeling and virtual-reality free-form modeling, Applied Sciences, 13(11), 2023, 6568. https://doi.org/10.3390/app13116568

[7] Gong, M.: Analysis of architectural decoration esthetics based on VR technology and machine vision, Soft Computing, 25(18), 2021, 12477-12489. https://doi.org/10.1007/s00500-021-05986-w

[8] Gegung, E.-M.: International tourism and the Covid-19 pandemic: The use of virtual reality to increase tourism destination sustainability and how users perceive the authenticity of VR experiences, Jurnal Kepariwisataan Indonesia: Jurnal Penelitian Dan Pengembangan Kepariwisataan Indonesia, 15(1), 2021, 9-15. https://doi.org/10.47608/jki.v15i12021.9-15

[9] Hazarika, A.; Rahmati, M.: Towards an evolved immersive experience: Exploring 5G-and beyond-enabled ultra-low-latency communications for augmented and virtual reality, Sensors, 23(7), 2023, 3682. https://doi.org/10.3390/s23073682
[10] Jin, H.; Yang, J.: Using computer-aided design software in teaching environmental art design, Computer-Aided Design and Applications, 19(S1), 2021, 173-183. https://doi.org/10.14733/cadaps.2022.S1.173-183
[11] Kim, Y.; Lee, H.: Falling in love with virtual reality art: A new perspective on 3D immersive virtual reality for future sustaining art consumption, International Journal of Human–Computer Interaction, 38(4), 2022, 371-382. https://doi.org/10.1080/10447318.2021.1944534
[12] Kontopanagou, K.; Tsipis, A.; Komianos, V.: A framework for exploring churches/monuments/museums of byzantine cultural influence exploiting immersive technologies in real-time networked environments, Technologies, 9(3), 2021, 57. https://doi.org/10.3390/technologies9030057
[13] Liu, F.: Fast industrial product design method and its application based on 3D CAD system, Computer-Aided Design and Applications, 18(S3), 2020, 118-128. https://doi.org/10.14733/cadaps.2021.S3.118-128
[14] Liu, F.; Yang, K.: Exploration on the teaching mode of contemporary art computer aided design centered on creativity, Computer-Aided Design and Applications, 19(S1), 2021, 105-116. https://doi.org/10.14733/cadaps.2022.S1.105-116
[15] Sahu, C.-K.; Young, C.; Rai, R.: Artificial intelligence (AI) in augmented reality (AR)-assisted manufacturing applications: a review, International Journal of Production Research, 59(16), 2021, 4903-4959. https://doi.org/10.1080/00207543.2020.1859636
[16] Shih, N.-J.; Wu, Y.-C.: AR-based 3D virtual reconstruction of brick details, Remote Sensing, 14(3), 2022, 748. https://doi.org/10.3390/rs14030748
[17] Sousa, N.; Jorge, F.; Teixeira, M.-S.; Losada, N.; Melo, M.; Bessa, M.: An exploratory study about the effect of COVID-19 on the intention to adopt virtual reality in the tourism sector, Sustainability, 15(11), 2023, 8725. https://doi.org/10.3390/su15118725
[18] Sun, B.; Pan, H.; Shao, S.: Countermeasures for improving rural living environments under the background of a rural revitalization strategy based on computer virtualization technology, Sustainability, 15(8), 2023, 6699. https://doi.org/10.3390/su15086699
[19] Wang, W.; Su, J.; Zhang, X.; Qiu, K.; Zhang, S.: Research on product primitives recognition in a computer-aided brand product development system, Computer-Aided Design and Applications, 18(6), 2021, 1146-1166. https://doi.org/10.14733/cadaps.2021.1146-1166
[20] Zeng, Y.; Liu, L.; Xu, R.: The effects of a virtual reality tourism experience on tourist's cultural dissemination behavior, Tourism and Hospitality, 3(1), 2022, 314-329. https://doi.org/10.3390/tourhosp3010021