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Computer-Aided Design AND APPLICATIONS

Immersive Experience of Art Design Based on improved Generative Confrontation Network

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Abstract. In this article, a 3D modeling algorithm of computer aided design (CAD) for art design based on generative confrontation network (GAN) is proposed, which can generate high-fidelity 3D models by learning real-world objects and scenes. Moreover, this article also puts forward an improved GAN training method to simplify the training process and improve the accuracy of the generated model. The results show that compared with the traditional GAN and CNN algorithms, the modeling accuracy of this algorithm is improved by about 15%, and the interactive ability and user experience of the designed virtual reality (VR) system are greatly improved. The comparative experiments show that the improved GAN algorithm in this article has higher modeling accuracy and shorter time-consuming in artistic design CAD 3D modeling. Moreover, the art design VR system based on this algorithm has obtained a high user rating. Therefore, the research in this article is of great significance and application value in improving the accuracy of 3D modeling of art design CAD and immersive experience of VR system.

Keywords: Virtual Reality; CAD; Art Design; Immersive Experience
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1 INTRODUCTION

Computer, an efficient electronic appliance, is widely used, including machinery, aviation, electronics and other industries. However, due to more and more kinds of computer software, computers have begun to show great utility in other fields. GAN is a deep learning model composed of two neural networks: a generator and a discriminator. The goal of the generator is to generate data similar to real data, while the goal of the discriminator is to distinguish between generated data and real data. During this process, the two networks will engage in confrontation and continuously adjust their respective parameters to optimize their performance. In terms of sub solutions, Alawieh et al. [1] utilized GAN to generate data similar to the original data, and then used these generated data to train another model. This training process can generate more accurate predictions and more effective features. For example, suppose we have a set of image data and want to train a model to recognize objects in these images. We can use GAN to generate new images similar to the original image, and then train our classification model together with these new images and the original image. Due to the similarity between the generated data and the original data, this model may be more accurate than a model trained solely on the original data. By combining VR with CAD software, a brand-new way of art appreciation can be realized on the computer, so that the audience can appreciate and understand the works of art more deeply. Azarby and Rice [2] analyzed the potential impact of immersive virtual reality on spatial design decisions. Virtual reality (VR) technology has a profound impact on human spatial perception by creating highly realistic digital environments. VR technology can provide users with an immersive visual experience through head-worn devices, making them feel like they are in a completely real virtual environment. This immersive experience can enhance users' understanding and perception of the spatial environment. VR technology can not only provide visual immersion, but also help users better understand the structure and layout of space through 3D modeling technology. For example, in architectural design and urban planning, VR technology can be used to simulate different design schemes or plans, helping decision-makers more intuitively evaluate and compare various schemes. By adding interactive elements such as handles, touch, and drag in the virtual environment, users can operate in the virtual environment, thereby gaining a deeper understanding and experience of spatial design. This interactivity not only enhances users' sense of participation, but also helps them better understand and remember spatial relationships. Moreover, it also provides a new way for artists to design and display their works by using VR. VR is a newly applied sensory simulation technology in recent years. In the stage of applying this technology, based on the computer, it can provide users with an immersive experience by simulating the real world, which can not only provide users with a corresponding visual sense, but also provide a sense of hearing and touch, so it has strong immersion and perception.

With the continuous progress of technology, the application of virtual reality (VR) and augmented reality (AR) in the field of architecture is becoming increasingly widespread. Banfi explored [3] how these two technologies can enhance interactivity, immersion, and interoperability through digital models, further enriching and protecting architectural cultural heritage. With the help of VR and AR technology, users can have a deeper interaction with digital models, thereby gaining a more comprehensive understanding and experience of architectural cultural heritage. This interactivity is not only reflected in visual and auditory aspects, but also extends to touch, smell, and even taste. For example, through AR technology, users can "touch" virtual building models in the actual environment, feeling their materials and structure. This interactivity helps to increase user engagement and shift visitors from passive acceptance to active exploration. The visual presentation effect of digital models plays a crucial role in enhancing immersion. High precision 3D modeling technology can restore the details and environment of buildings, allowing users to immerse themselves in historical scenes. In addition, with the help of VR technology, users can experience the structure and atmosphere of the architectural space from a first person perspective, further enhancing their sense of immersion. AR technology can integrate virtual elements with the real environment, allowing users to observe and experience virtual architectural cultural heritage in the real world. Converting FDG-PET to T1 weighted MRI is a complex task, and Bazangani et al. [4] achieved this goal using 3D induced generation adversarial networks (E-GANs). Firstly, a set of FDG-PET and T1 weighted MRI image datasets needs to be collected. These data can be multimodal, including multiple images at different time points, in order to better capture pathological changes at different time points. Next, we need to design an E-GAN model that consists of two neural networks: a generator and a discriminator. The goal of the generator is to generate data similar to T1 weighted MRI images, while the goal of the discriminator is to distinguish between generated data and real data. During the training process, the generator and discriminator will confront each other and continuously adjust their respective parameters to optimize their performance. This process can be achieved by minimizing the adversarial loss function. Finally, the trained E-GAN model can be used to convert FDG-PET images into T1 weighted MRI images. This can be achieved by inputting FDG-PET images into the generator, which will output data similar to T1 weighted MRI images. This data can be further processed into true T1 weighted MRI images. In this article, a 3D modeling algorithm of art design CAD based on GAN is proposed. By optimizing VR modeling technology, the immersive experience of art design is improved.

Designing large-scale immersive tours in architecture, engineering, and construction can help clients, visitors, and team members better understand the design philosophy, technical characteristics, and construction process of the project. Below, I will elaborate on how to achieve this large-scale immersive visit design for you. Belaroussi et al. [5] utilized 3D modeling and virtual reality (VR) technology to digitize the overall design of the project. This will include all major aspects of the project, such as architectural design, structural design, electrical design, water supply and drainage design, etc. At the same time, high-resolution cameras equipped with drones can also be used to take on-site photos, and then these photos can be used to create more realistic 3D models. Secondly, use virtual reality technology to create a virtual tour path for the project. These paths can be adjusted according to the actual situation of the project, so that visitors can better understand the construction process of the project. At the same time, head mounted displays (HMDs) and other virtual reality devices can also be utilized to allow visitors to experience the construction process of the project firsthand. With the continuous development of technology, the application of hybrid, augmented, and virtual reality (AR/VR) technologies in the field of art teaching is becoming increasingly widespread. These technologies can provide students with an immersive learning experience, showcasing teaching content in an intuitive and visual manner, thereby better stimulating students' interest and creativity in learning. Cabero et al. [6] used an art teaching case as an example to explore the application effects and significance of hybrid, augmented, and virtual reality technologies in art teaching, and analyzed their future development trends and possible application scenarios. In this case, mixed reality technology is widely applied in art teaching. Teachers use hybrid reality technology to combine virtual elements with real scenes, creating an immersive learning environment for students. For example, in painting teaching, teachers use mixed reality technology to integrate the creative process of famous paintings or artists with the real environment, allowing students to learn skills and expression methods through observation and imitation. In addition, teachers can also use augmented reality technology to provide students with an interactive learning experience. For example, by scanning painting works, students can see dynamic 3D scenes on mobile screens, thereby better understanding the composition and color application of art works. The main innovations of this article are as follows:

(1) A 3D modeling algorithm of art design CAD based on GAN is proposed, which can generate high-fidelity 3D models by learning real-world objects and scenes;

(2) Aiming at the shortcomings of the existing GAN in 3D modeling, an improved GAN training method is proposed to simplify the training process and improve the accuracy of the generated model;

(3) The effectiveness of the proposed method is verified by experiments, and the generated 3D model is applied to VR to realize the immersive art design experience.

The article is structured as follows:

Section 1: Introduce the research background, significance and related work of this article. On this basis, the research purpose and method of this article are put forward.

Section 2: Introduce the basic concepts of VR and CAD and their importance and application in art design.

Section 3: Propose 3D modeling algorithm based on GAN.

Section 4: Compare the performance of different algorithms in modeling accuracy, and the performance of different algorithms in VR system immersive experience scoring.

Section 5: Summarize the research results and conclusions of this article, and put forward the prospect of future work.

2 THEORETICAL BASIS

The immersive 3D geographic visualization environment using game engines for landscape design teaching can provide students with a highly attractive and realistic virtual reality experience. In this environment, students can intuitively observe and understand geographic information, as well as the interaction between terrain, vegetation, buildings, and other landscape elements. However, to achieve the effectiveness and long-term appeal of this teaching method, Carbonell et al. [7] analyzed the user experience (UX) and motivation of students in this environment. User experience (UX) is an important indicator of whether a system or product is easy to use and meets user needs. In an immersive 3D geographic visualization environment, user experience includes multiple aspects such as visual experience (such as resolution, color, lighting, etc.), interactive experience (such as operation mode, response speed, etc.), and content experience (such as accuracy and richness of data). For landscape design teaching, a good user experience can help students more easily understand and master landscape design knowledge. With the rapid development of technology and the improvement of people's living standards, the tourism industry has gradually shifted from traditional sightseeing tourism to experiential tourism. In order to meet the increasing demand of tourists and improve the competitiveness and innovation of the tourism industry, Deng et al. [8] explored how to use virtual reality (VR) technology to design a CAD 3D modeling system for tourism products. This system will provide a brand-new display and experience platform for tourism products, thereby bringing more commercial value and development potential to the tourism industry. Virtual reality (VR) technology is a computer technology that can create and experience virtual worlds. It simulates human auditory, visual, and tactile senses, allowing users to immerse themselves in a highly realistic virtual environment. Augmented reality (AR) technology is the fusion of virtual information with the real world, enabling virtual information to interact with real-world objects and achieve a richer user experience.

The use of intelligent design methods based on generative adversarial networks (GAN) is an emerging design paradigm in designing comprehensive solutions for shear wall structures, demonstrating strong potential. However, GAN's data format is heterogeneous from the widely used CAD drawings and models in the industry, and GAN has high requirements for users' computer software and hardware environments, making it difficult to embed them into industry production processes. Fei et al. [9] proposed a solution to this problem, which is an integrated intelligent generation design system based on GAN. Specifically, firstly, it developed a preprocessing method for building CAD drawings to connect with upstream architectural design. This step can enable GAN's design results to be more accurately transformed into CAD drawings that can be applied in practical engineering. Secondly, it has built a user-friendly cloud design platform. This platform can greatly reduce the requirements for users' local computer environment, allowing more ordinary designers to easily use GAN for complex structural design. Finally, it proposes a heterogeneous data transformation method and a parameterized modeling process. Based on the design generated by GAN, we can automatically establish a structural analysis model, which provides great convenience for subsequent in-depth design. This method provides a feasible solution for the practical application of GAN in shear wall structures. Frutiger et al. [10] conducted simulation experiments on various possibilities of molecular product process design within the framework of probability models through Monte Carlo simulation. In this way, a series of simulation results can be obtained, which can serve as approximate solutions to the problem. In addition, the Monte Carlo simulation method has two major advantages: simplicity and speed, which can be understood and used by ordinary people. At the same time, this method can be implemented through computer programs, which can greatly improve design efficiency. With the continuous development of technology, virtual reality technology has gradually become an emerging teaching tool in modern education. Especially immersive virtual reality technology, which enables students to experience and learn knowledge firsthand through highly realistic virtual environments, has shown great potential in many fields. Horvat et al. [11] explored the potential of immersive virtual reality in design education, with the aim of providing some insights for the future development of design education. In terms of teaching mode, by constructing an immersive virtual reality classroom, the combination of autonomous learning and cooperative learning can help improve students' learning interest and participation. At the same time, using immersive virtual reality technology can also simulate real design work environments, allowing students to learn and master design skills in practice. In terms of teaching resources, immersive virtual reality technology can provide students with rich and diverse learning resources. For example, by simulating the design styles and characteristics of different countries or regions, students can be exposed to diverse design materials and broaden their horizons. In addition, immersive virtual reality technology can also simulate design styles from historical periods, allowing students to understand the design characteristics of different periods, thereby deepening their understanding of design history.

Jin et al. [12] used 3D modeling technology and VR devices to create a highly realistic virtual environment of a spring morning in the Han Palace. In this environment, students can see various details of the architecture, gardens, costumes, etiquette, and other aspects of the Han Palace. At the same time, they can also feel the atmosphere of spring, such as the singing of birds and the fragrance of flowers. Through multi touch desktop technology, students can engage in various interactions in a virtual environment. For example, they can use their fingers to drag the screen and observe various corners of the Han Palace 360 degrees from all angles; You can also carefully observe various details of the Han Palace through operations such as scaling and rotating. In a virtual environment, students can learn various knowledge of traditional Chinese art. For example, they can learn about the architectural style, color application, and other architectural arts of the Han Palace; You can also learn the essence of cultural and artistic elements such as etiquette, clothing, and music in the Han Palace. With the continuous development of technology, virtual reality technology has gradually integrated into various fields and brought new visual experiences. In art design, the introduction of virtual reality technology not only expands the expression forms of visual art design, but also provides designers with a more flexible and free design platform. Li [13] explored the methods and principles of virtual reality visual art design, as well as its differences and connections with traditional visual art design. Virtual reality technology is a three-dimensional environment generated through computer technology that can simulate the real world, allowing users to experience things in virtual space firsthand. Visual art design is an art form that conveys design ideas and creativity through visual elements. Applying virtual reality technology to visual art design can enable designers to create and showcase in a virtual environment, improving design efficiency and quality. Virtual reality (VR) technology can play an important role in the appreciation of painting art exhibitions. This advanced technology can simulate or enhance human sensory experiences, allowing users to immerse themselves in the virtual world created by art works. Lin et al. [14] analyzed the role of virtual reality in the appreciation of painting art exhibitions. In art exhibitions, VR technology can allow viewers to appreciate art works in a new way through methods such as headsets or touch screens. For example, viewers can enter a virtual art exhibition hall through specific VR devices, such as Oculus Rift or HTC Vive, and appreciate paintings from various angles and distances. This technology not only provides greater viewing freedom, but also allows the audience to feel immersive and immersive. VR technology is particularly helpful for displaying artworks that are remote or difficult to access. In addition, VR technology can reconstruct the scene of artworks in a deconstructive manner, revealing their contextual, historical, aesthetic, and intellectual significance. The audience is no longer just passively accepting information, but can actively "enter" and explore artistic works, thereby gaining a deeper understanding and appreciation of them.

The visual art design method based on virtual reality has broad application prospects in the field of product design. Lorusso et al. [15] utilized virtual reality technology for conceptual modeling, which enables designers to design and evaluate products more efficiently, improving design quality and efficiency. With the continuous development of technology, we can foresee that the application of virtual reality technology in the field of visual art design will become increasingly widespread and in-depth. Future visual art design will place greater emphasis on user experience and emotional design. Therefore, we can expect that in the future, visual art design methods based on virtual reality will become more diverse and diverse, bringing more innovation and development to product design. The digital immersive interactive experience design of museum cultural heritage based on virtual reality (VR) technology can bring users into a simulated and immersive virtual environment. Through intuitive and emotional interaction, one can experience and understand various aspects of cultural heritage up close. Multi source information art painting is an art form that transcends the boundaries of traditional art forms. It creates through multiple sources of information, including text, images, audio, video, and more. This art form can more richly express the artist's thoughts and emotions, and broaden the expressive power of art. Combining multi-source information art painting with VR technology can create unique interactive 3D dynamic scenes, providing broader space for artistic creation and display. Pan and Deng [16] explored the integration of multi-source information art painting and VR technology, as well as their application in interactive 3D dynamic scenes. At the same time, VR technology can provide rich interactive functions, such as allowing users to choose exhibits of interest and gain a deeper understanding of the historical stories and cultural connotations behind them; Or engage in online communication and sharing with other users to experience this unique cultural heritage together. The virtual reality heritage system is a user centric digital tourism application. Poux et al. [17] By combining digital technology with virtual reality technology, users can access it anytime, anywhere. Experience cultural heritage and tourist attractions from around the world through computers or mobile devices. Firstly, the system provides a 3D virtual environment where users can freely explore various cultural heritage and tourist attractions.

In today's digital age, computer-aided design (CAD) and intelligent assembly modeling have become important components of the manufacturing industry. Especially in the process of product design and development, effectively capturing and expressing design intent through product information modeling plays a crucial role in improving production efficiency, reducing costs, optimizing product design, and meeting customer needs. Mo et al. [18] conducted product information modeling to capture design intent in computer-aided intelligent assembly modeling. Computer Aided Design (CAD) is a method of using computer technology for product design, which can help designers create, modify, and analyze product designs, as well as perform performance analysis and optimization. Intelligent assembly modeling is the use of CAD technology to establish product assembly models, in order to achieve automated production and assembly of product components. The digital reconstruction of historical buildings and the virtual integration of murals is a complex task that requires professional technology and profound historical and cultural knowledge. In this process, virtual reality (VR) technology can play an important role in creating interactive and immersive experiences for people. Soto et al. [19] analyzed the digital reconstruction of historical buildings and the virtual fusion of murals. The virtual fusion of murals is the digital integration of historical murals into a virtual environment. Through virtual reality technology, people can "walk into" historical buildings in a virtual environment, observe their structure and decoration, and feel the historical atmosphere of the time. At the same time, people can also interact with murals in virtual environments, such as changing perspectives, zooming in and out, changing colors, etc., in order to better understand and appreciate murals. Sun et al. [20] analyzed the design and implementation of a construction prediction and management platform based on building information modeling and 3D simulation technology in Industry 4.0. The design and implementation of a construction prediction and management platform in the Industry 4.0 era requires the integration of Building Information Modeling (BIM) and 3D simulation technology. Collect a large amount of construction process data from various sources such as sensors, cameras, workers, management systems, etc. These data require appropriate preprocessing, such as data cleaning, format conversion, normalization, etc., for subsequent analysis and prediction.

3 METHODOLOGY

3.1 3D Modeling Algorithm of Art Design CAD Based on GAN

In this article, a deep convolution neural network will be used to design the generator and discriminator. Specifically, a multi-layer convolutional neural network will be used to realize the generator, which can map random noise vectors into the space of a 3D model. Moreover, a similar convolutional neural network is used to realize the discriminator, which can divide the input 3D model into realistic and false categories. The algorithm mainly includes two stages: training stage and generating stage. The operating principle of the GAN model proposed in this article is shown in Figure 1.

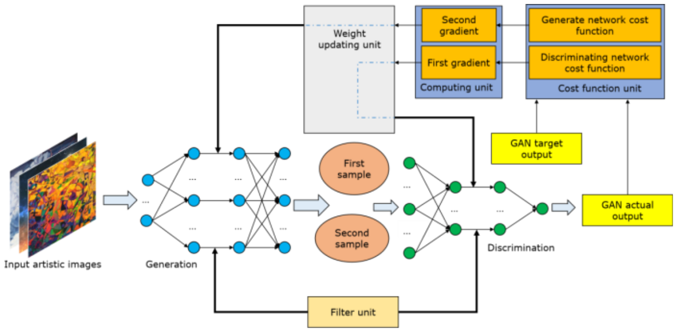

Figure 1: The operation principle of GAN model.

In the training stage of GAN, there will be a "competition" between the generation network and the identification network. The generating network will try its best to generate samples that look more like real data, so that the authentication network is difficult to distinguish; The authentication network will try its best to better distinguish between real data and generated data. This confrontation process will continue until it reaches a state of equilibrium, that is, the data samples generated by the generation network are difficult to distinguish from the real data, and the identification network cannot reliably distinguish the real data from the generated data. The antagonistic learning architecture is shown in Figure 2.

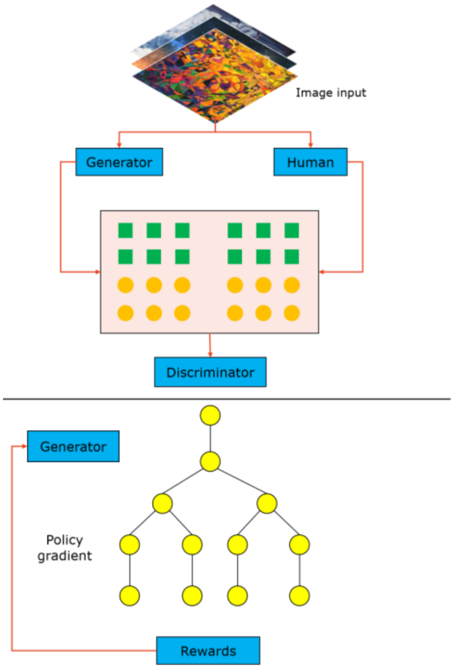

Figure 2: Antagonistic learning architecture.

GAN is a deep learning model, which consists of a generating network and a discriminating network, and new data samples are generated through the confrontation between them. The discriminant equation is:

$$f = F(x;\varnothing_r) \tag{1}$$

$$D_{\varnothing}(s) = sigmoid(\varnothing_1, F(s;\varnothing_r)) = sigmoid(\varnothing_1, f) \tag{2}$$

The generator equation is:

$$g, h_t^M = M(f_t, h_{t-1}^M; \theta_m) \tag{3}$$

$$O_t, h_t^W = W(x_t, h_{t-1}^w; \theta_W) \tag{4}$$

Set m and n equal, and due to the constraint of optimal transmission quality conservation:

$$\sum_{j=1}^{n} T_{ij} = \frac{1}{m} \tag{5}$$

$$\sum_{i=1}^{m} T_{ij} = \frac{1}{n} \tag{6}$$

In the training stage, training data sets and GAN models need to be prepared. Firstly, a large number of 3D model data are collected from the real world, which can be artistic design works, natural objects or scenes. Then, a 3D model conversion tool is used to convert these real-world objects and scenes into digital models and save them in a training data set. Next, the generator and discriminator networks are designed and trained with training data sets. The goal of the generator is to cheat the discriminator by generating a realistic 3D mode. Through this way of confrontation training, the generator and discriminator will gradually improve their respective abilities until they reach a balance point. The structure of multi-level generator is shown in Figure 3.

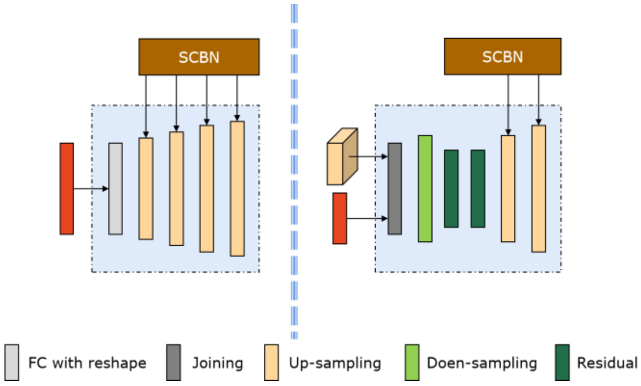

Figure 3: Multi-level generator structure.

The goal of generating network is to generate data samples as close as possible to the real data distribution. It obtains the initial input from random noise or a prior distribution, and then generates an output through the propagation stage of the network, which is designed to conform to the distribution of real data as much as possible. During the training process, the generated network will constantly adjust its parameters to make the data samples generated by it as close as possible to the real data. This adjustment is achieved by minimizing an objective function called "loss function", which measures the difference between the data samples generated by the network and the real data. The goal of the authentication network is to distinguish between real data and data generated by the generating network. It receives an input data sample, and then outputs a probability value through the propagation stage of the network, which indicates the probability that the data sample is real data. The training sample of GAN consists of two parts:

$$X = [x_1, x_2, x_3, \ldots, x_{n1}]^T \tag{7}$$

For the expected output vector:

$$T = [t_1, t_2, t_3, \ldots, t_{N3}]^T \tag{8}$$

The output of the hidden layer node h and the output of the output layer node s are:

$$y_h^k = f\left(\sum_{i=1}^{N1} w_{ih} x_i^k + \theta_h\right) \quad k = 1,2,3,\ldots,N \tag{9}$$

$$o_s^k = g\left(\sum_{h=1}^{N2} w_{hs} y_h^k + \theta_s\right) \quad k = 1,2,3,\ldots,N \tag{10}$$

In the training process, the identification network will constantly adjust its parameters to make its ability to distinguish real data from generated data as strong as possible. This adjustment is also achieved by minimizing an objective function, which will measure the network's ability to distinguish between real data and generated data.

In the generation stage, the trained GAN model is used to generate a 3D model. Firstly, a virtual 3D model is generated by random noise vectors. Then, the virtual 3D model is input into the discriminator to evaluate its fidelity. If the discriminator judges that the virtual 3D model is true, then the generation of the 3D model is completed. Otherwise, the virtual 3D model will be optimized and adjusted, and it will be input into the discriminator for evaluation again until a realistic 3D model is obtained.

3.2 Design and Implementation of VR system

The art design VR system designed in this article adopts a typical client-server architecture. The client is responsible for interacting with users, including receiving user input, rendering virtual environment and model, and transmitting the user's perspective and operation to the server for processing in real time. The server is responsible for managing the overall state of the virtual environment, handling user operations and sending data needed for rendering to the client. On the client side, the mainstream VR helmet display (HMD) is used as the user interface, and the user's input information is captured by devices such as handles. In order to provide a more natural and realistic visual experience, real-time ray tracing technology is used to render the model. In addition, advanced eye tracking technology is introduced, which enables users to interact with the virtual environment through their eyes and improves the overall user experience.

In the aspect of model rendering, real-time ray tracing technology is adopted to provide more realistic and lifelike visual effects. Ray tracing technology can simulate the propagation and reflection effect of light, making the effect of the model more natural and real under light irradiation. In addition, advanced rendering techniques such as shadow mapping, reflection and refraction are introduced to further enhance the visual effect. In order to present the details and characteristics of art design more realistically, an advanced texture mapping technology is also adopted. This technology can apply different textures and materials to the surface of 3D model according to the characteristics and needs of art design, thus presenting more colorful visual effects.

4 RESULT ANALYSIS AND DISCUSSION

In this article, a 3D modeling algorithm of art design CAD based on GAN is proposed, which can generate a high-fidelity 3D model by learning real-world objects and scenes. After experimental verification, it can be found that the 3D modeling algorithm of art design CAD based on GAN can effectively improve the immersive experience of art design. 3D models with high fidelity are successfully generated through the training of GAN. These models not only have accurate shapes and structures, but also have realistic textures and details. These generated 3D models are applied to VR, and the immersive art design experience is realized. Viewers can enter the virtual environment through head-mounted displays or other devices to observe and interact with these high-fidelity 3D models. This way of experience can not only improve the artistic design level of the audience, but also enhance their sense of participation and immersion. In this experiment, the performance of 3D modeling algorithm of art design CAD based on GAN is tested, and the art design VR system is constructed, and the immersive experience of the system is scored. The hardware equipment of this experiment includes high-performance computer, GPU accelerator, high-precision sensor, etc. TensorFlow is used as the deep learning framework in the software environment, and AutoCAD is used as the 3D modeling software.

4.1 Performance Evaluation of GAN 3D Modeling Algorithm

In this experiment, we will compare the performance of improved GAN algorithm with traditional GAN algorithm and CNN algorithm in 3D modeling of art design CAD, focusing on modeling accuracy, modeling error and time-consuming artistic image processing.

Figure 4 shows the comparison of the modeling accuracy of different algorithms, and the results show that the modeling accuracy of the algorithm in this article is improved by about 15%. This result shows that the algorithm proposed in this article is superior to the traditional GAN algorithm and CNN algorithm in modeling accuracy.

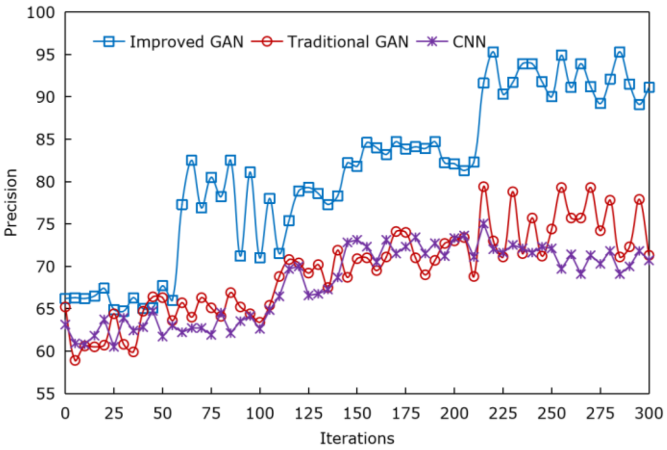

Figure 4: Accuracy of different algorithms.

The algorithm in this article is significantly superior to the traditional GAN algorithm and CNN algorithm in modeling accuracy. This advantage may make the algorithm have a good application prospect in the field of art design and other types of 3D modeling tasks.

In the stage of modeling, different algorithms may produce different degrees of errors. The root mean square error (RMSE) of the algorithm is evaluated by comparing the errors between the models generated by different algorithms and the original models. Figure 5 shows the error comparison of different algorithms in the identification of art design CAD modeling. The algorithm proposed in this article has a lower error, which is reduced by more than 20% compared with the traditional algorithm. This result shows that the accuracy and fidelity of the algorithm in this article have been significantly improved in the modeling process.

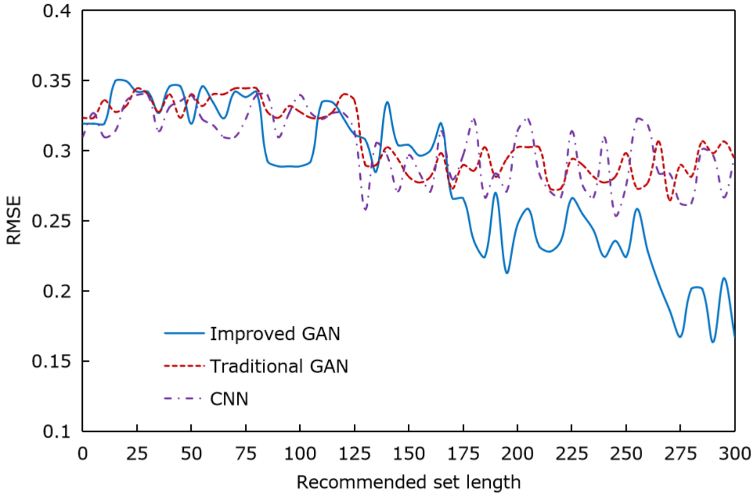

Figure 5: RMSE comparison of art design CAD modeling recognition.

When comparing the traditional GAN algorithm and CNN algorithm, we can see that the traditional GAN algorithm and CNN algorithm have poor performance in modeling error, and the error is relatively large. This may be because these two algorithms are difficult to capture the key features and details in the data when dealing with art design CAD data with complex characteristics, which leads to large modeling errors. The algorithm in this article has lower error in the recognition of art design CAD modeling and shows better performance. This advantage may provide a good foundation for the use of this algorithm in the field of art design and other types of 3D modeling tasks.

In the stage of 3D modeling of art design CAD, image processing is a time-consuming and important link. In order to compare the time consumption of different algorithms in artistic image processing, the time required for each algorithm from input image to output model is recorded. The shorter the processing time of artistic images, the higher the efficiency of the algorithm.

Three different methods are used to compare the time-consuming of artistic image processing, including traditional GAN algorithm, CNN algorithm and VR image processing method proposed in this article (Figure 6). These methods have different characteristics when dealing with artistic images. Among them, the traditional GAN algorithm and CNN algorithm may face high time complexity and memory occupation when dealing with large-scale artistic image data, while the VR image processing method proposed in this article uses GPU acceleration and parallel processing technology to improve the efficiency of the algorithm.

As the number of pixel points of feature information increases, the processing time of various methods increases accordingly. This result shows that the larger the amount of artistic image data, the more computing time and resources are needed, whether it is the traditional GAN algorithm, CNN algorithm or the VR image processing method proposed in this article. Traditional GAN algorithm and CNN algorithm have poor performance in processing time, especially when the number of characteristic pixels increases, their processing time increases significantly. This may be because these two algorithms do not make full use of the advantages of GPU acceleration and parallel processing when processing large-scale artistic image data, resulting in slow computing efficiency and speed. The VR image processing method proposed in this article has obvious advantages over the contrast method in processing time. Even when processing large-scale artistic image data, this method can keep relatively low processing time. This advantage is mainly attributed to the adoption of GPU acceleration and parallel processing technology, which improves the calculation efficiency and speed of the algorithm, thus reducing the processing time.

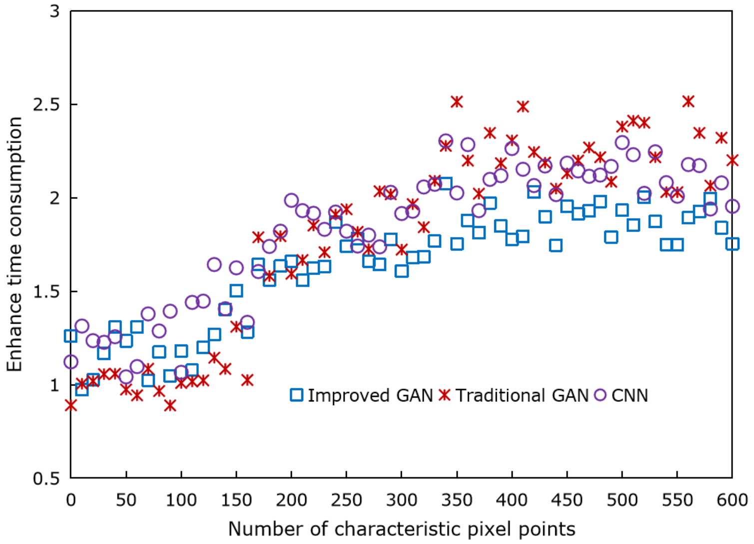

Figure 6: Time-consuming image processing of different methods.

The experimental results of modeling accuracy show that the modeling accuracy of the improved GAN algorithm is higher than that of the traditional GAN algorithm and CNN algorithm. On the root mean square error (RMSE) index, the improved GAN algorithm has smaller values, which indicates that the generated model is closer to the original model. Time-consuming experimental results of artistic image processing show that the improved GAN algorithm takes less time in artistic image processing. This shows that the algorithm has higher efficiency in the process from the input image to the output model, and can complete the modeling task in a shorter time.

In terms of modeling accuracy, the improved GAN algorithm in this article performs best. This shows that the improved GAN algorithm has higher accuracy and detail retention ability when generating 3D models. This advantage may be due to the introduction of new network structure and training method in the improved GAN algorithm based on the traditional GAN algorithm, thus improving the generation ability and discrimination ability of the model. In terms of RMSE, the improved GAN algorithm in this article also has a lower value. This further confirms the high fidelity and accuracy of the improved GAN algorithm in the modeling process. Compared with the other two algorithms, the improved GAN algorithm can better capture the details and features of the original model and reduce the prediction error of the model. In terms of time-consuming artistic image processing, the improved GAN algorithm in this article performs well. This advantage may be due to the efficient calculation and parallel processing ability of the algorithm, which can shorten the processing time and memory occupation when processing large-scale artistic image data. This means that in practical application, using the improved GAN algorithm can speed up 3D modeling and improve work efficiency.

4.2 Construction of CAD System and Immersive Experience Scoring

In this experiment, the 3D modeling algorithm of GAN is used to construct the art design VR system. Firstly, several 3D models are generated by using GAN, and they are evaluated and screened. Then, according to the screening results, the 3D model is imported into CAD software for editing and optimization, and finally imported into VR system. When assessing the immersive experience, a combination of questionnaire survey and actual test is adopted. The questionnaire survey mainly focuses on the participants' feelings of vision, hearing and interaction, while the actual test mainly evaluates the stability and fluency of the system. Based on the comprehensive evaluation results, the score of immersive experience is obtained.

Figure 7 shows the immersive experience scoring results of the art design VR system based on the CAD 3D modeling algorithm in this article. As can be seen from the figure, the art design VR system based on this algorithm shows strong advantages in interactive ability and user experience.

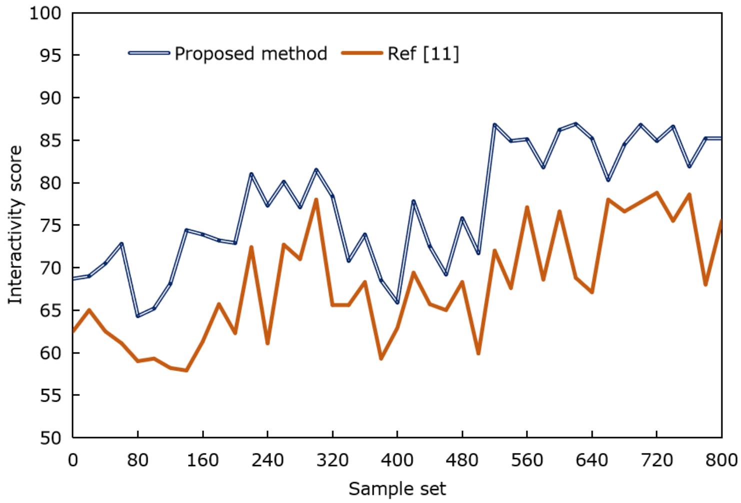

Figure 7: System immersive experience score.

The art design VR system based on this algorithm shows strong advantages in interactive ability and user experience. The algorithm in this article is excellent in modeling accuracy, and can better capture the details and features of the original model, thus improving the immersive experience of VR system. High-quality 3D models can better present the details and visual effects of artistic design works and provide users with more real feelings.

5 CONCLUSIONS

By combining VR with CAD software, a brand-new way of art appreciation can be realized on the computer, so that the audience can appreciate and understand the works of art more deeply. In this article, VR and CAD are combined, and the 3D modeling algorithm is optimized by introducing GAN(GAN) to improve the immersive experience of art design. In this article, a 3D modeling algorithm of art design CAD based on GAN is proposed, which can generate a high-fidelity 3D model by learning real-world objects and scenes. Moreover, this article also puts forward an improved GAN training method to simplify the training process and improve the accuracy of the generated model. Through comparative experiments, the improved GAN algorithm in this article shows higher modeling accuracy and shorter time-consuming for artistic image processing in 3D modeling of art design CAD. Moreover, the art design VR system based on this algorithm has obtained a high user rating.

In this article, the application of GAN 3D modeling algorithm in art design VR system is explored. Although some achievements have been made, there are still some problems and shortcomings. For example, the training time and stability of GAN 3D modeling algorithm still need to be further improved, and at the same time, in terms of immersive experience, the stability and fluency of the system need to be further improved. In the future, we will continue to conduct in-depth research on CAD 3D modeling algorithms and explore more efficient optimization methods, so as to further improve the quality and speed of CAD 3D model generation and provide a more realistic and immersive VR experience for the art design field.

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