Metaverse Inspired VR Visualization Model of Italian Design Education

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Abstract. The basic idea and expression of virtual design based on VR immersion art is immersion communication, and VR art needs to play the creative role of design artists to create a brand-new VR world. This ariticle constructs a VR visualization model based on deep learning and computer-aided design (CAD) in Metaverse, thus providing theoretical and technical support for Italian design education. The results show that the theory of this paper can be well integrated into the teaching objectives of the group. The accuracy of the model is more than 95%. This can be further reflected in the expression of teaching content, and improve the combination level of students in art and teaching environment. Optimize teaching objectives. In the end, what students can better integrate into the society.

Keywords: Artistic Design; Metaverse; Deep Learning; Computer Aided Design.
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1 INTRODUCTION

Contemporary art design education is not only the training of modeling and expression techniques in the traditional sense, but also a complex system engineering that develops wisdom and cultivates comprehensive design ability [1]. Italian design research and education institutions have built a unique international design research and education network through various international strategies and measures. But teaching students how to learn knowledge. In the field of industrial design, VR has been widely used in automobile design and manufacturing, coal mining and oil mining [2]. The so-called VR art is actually an artistic form or means based on VR, which can provide people with diversified sensory experiences. When we appreciate an artistic design work, the application of VR art brings people a brand-new visual feeling, which can show a lively and immersive feeling [3]. The VR world can only be realized with the support of media input and output, and the virtual world is connected with the real world, which is inseparable from the

impetus of the media. That is to say, the deeper the experiencers are immersed, the lower their perception of the media will be [4].

In the field of computer vision, people hope to use computer to simulate biological vision to achieve the purpose of computer vision perception. The development of computer has become an important field in artificial intelligence. Its main content is to analyze two-dimensional images by computer to realize the reconstruction of three-dimensional scenes, and then complete related tasks. With the rapid development of the new generation of information technology, more and more industries have realized the importance of VR for the digital transformation and upgrading of the industry. The emergence of VR has provided a brand-new creative perspective and experience way in art design, and reached an unprecedented experience degree in enhancing artistic implication, which is the innate advantage of immersive communication in art design. Deep learning is a learning process that integrates cognition and application, the construction and migration of structural and unstructured knowledge, and the solution of real problems. VR environment helps students to explore independently in the simulated environment, gain cognition, and realize seamless connection between information and real environment. The main innovations and contributions of this research are as follows:

(1) In order to improve the quality of three-dimensional images, this ariticle designs a VR visualization model of art design based on VR, and realizes the reconstruction of three-dimensional images of art design.

(2) This model applies the superior features of VR to computer-assisted Italian art design education, and strives to realize the innovation of art design education means.

The first section of the article is the introduction, and puts forward the application of VR in Italian art design education. The second section is related work, which expounds the contribution of scholars to the digital protection of cultural heritage, and constructs a VR visualization model of art design based on deep learning. The fourth section verifies the advantages of the proposed VR visualization model and its significance in computer-aided art design education through simulation experiments. The fifth section is the conclusion, summarizing the contribution of the research to computer-aided Italian art design education, and proposing the next research direction.

2 RELATED WORK

With the gradual improvement of people's living standards, art design plays an increasingly important role in life. With the help of computers, people can improve their visual taste. Make the audience reach a better level of spiritual pleasure. In computer graphic design, people can better improve the design level of life through different computer aids [5]. Rogowsky et al. [6] investigated CAI. The computer assisted group used interactive education software to complete 10 minutes of personalized teaching every day. Performance test scores. In fact, the research refers to the integration of distance education institutions according to certain training objectives and teaching plans through distance education. Combine different education goals with tests to help students get the expected development according to the predetermined goals. In universities and schools in the field of computer science, it has become more popular to help students use technical tools instead of traditional technologies. Shahid et al [7] latest technology shows that no comprehensive research can analyze the different technical tools used in education, such as computer-based, game based, mobile based and multimedia technologies. Yang et al. [8] extended the depth learning tracker based on discriminant correlation filter (DCF) Various program interfaces are processed based on computer network and communication technology. Resource sharing and reuse are its two key characteristics. Therefore, different network training art education can cultivate talents in engineering. Keep track of students' different cross fields at any time. This means non-linear and multi-dimensional browsing of complex topics in teaching. That is, on different occasions, they return to the same concept from different directions. Distance education, as the upper concept of distance education, is essentially the separation of teaching and learning in time and space. In a narrow sense, distance teaching and distance education are the

same concept. Yang and Ren [9] It mainly explores the art fusion by mapping, and records and analyzes the graphic changes in multi stereoscopic vision. In the case of relative separation from students' learning, teaching and learning can be re integrated through various technical media to help students get the expected development according to the predetermined goals and requirements. At the same time, aesthetic comparison is carried out and the computer model diagram drawn is optimized. Zhong et al. [10] the coordinates were analyzed and constructed by using cross sites. Let learners transform from one knowledge point to another when learning, the network topology between knowledge points. At the same time, for the learning of the same knowledge point, we can also arrange different teaching modes in the distance learning system to learn it. Let learners complete the learning of this knowledge point in different situations.

This article designs a VR visualization model of art design based on VR, and applies the superior features of VR to computer-aided Italian art design education, thus providing theoretical and technical support for Italian design education.

3 METHODOLOGY

3.1 Feasibility of VR Application in Art Design Education

With the continuous development of technology, some art designers began to try to use immersion communication to create works. If the penetration rate of immersion communication is not enough to support the synchronization of some basic matters, at least from the technical and artistic point of view, many projects have reached the level of supporting use. As far as immersion communication is concerned, it must be combined with art and optimized from the artistic point of view, so as to bring enough visual impact and artistic sense to the experiencer. TThe application of VR in art design is to show students the objective reality on which knowledge depends with a new face through various virtual environments. The teaching method of art design conducted by VR art is very flexible, and it is also a kind of teaching activity with strong creativity and practicality.

Compared with other disciplines, art design majors not only require students to master the basic methods and rules of artistic creation, but also focus on cultivating students' aesthetic feeling. The application of immersion communication in art design major and its reappearance space has further enhanced people's aesthetic concept, further liberated aesthetic freedom, and provided more independent choice space for experiencers. VR is a new form of art design. Since the development of human civilization, art has always developed in step with technology, and the involvement of VR art has also brought new impetus to the creation and appreciation of art. In terms of visual art design rules, VR art and traditional art follow the rules of formal beauty and structural plane and three-dimensional. In terms of aesthetic and visual effect evaluation, VR art and traditional art are also based on similar or identical evaluation mechanisms.

There are many practical teaching activities that can't be fully realized in the process of students' study at school, but some practical teaching activities with teaching demonstration significance can be copied and made into multimedia teaching courseware composed of sound, image, words, pictures and other elements. Computer simulation teaching has the characteristics of strong adaptability to instructional environment, high teaching efficiency, strong repeatability, large amount of information and strong participation of students. It is an important teaching method among modern teaching methods. Art comes from life, and the improvement of life quality needs artistic decoration. Art and life are originally a pair of good brothers that complement each other. If VR works are to be fully displayed, and the VR system is to achieve the perfect combination of technology and art, it is necessary to create a new visual expressive art by combining science and technology with art, not only focusing on art or technology, but also inseparable from each other. The virtual environment architecture is shown in Figure 1.

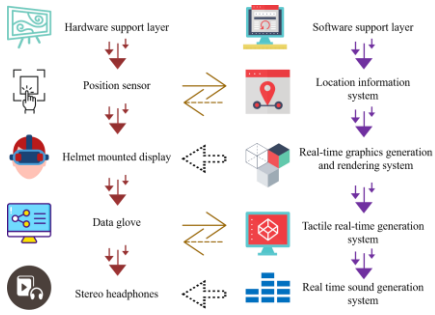

Figure 1: Architecture diagram of virtual environment.

In the network environment, the virtual instructional environment allows students to get out of textbooks and classrooms, to contact and solve some practical problems in person, and to transform their theoretical knowledge and professional skills into practical abilities. Through the network, teachers and students can promote and stimulate each other, so as to deepen mutual understanding and establish a harmonious teacher-student relationship. The "chain" teaching method under the network environment breaks through the limitation of time and space between teachers and students, provides favorable conditions for the communication between teachers and students, and provides more methods and ways for the teaching interaction between teachers and students. VR art has lost some skills of traditional hand-painted design in art design, but the works designed by VR art also bring a sense of clarity and decoration. In traditional teaching, the textbook with paper books as the carrier is a one-way teaching situation, and there can be no interaction between textbook and learners. Now, in the "chain" teaching under the network environment, multimedia e-books with computers as media realize the two-way interaction between learners and teaching materials. The space and phenomenon created by immersion communication are not created out of thin air, but are shaped based on the aesthetic feeling of designers. Immersive communication can be said to be the highest expression form of contemporary art, which needs a high sense of beauty and art as the foundation.

3.2 VR Visualization Model of Art Design Based on Deep Learning

In the depth estimation task, the generator network is responsible for generating the depth map corresponding to the input image according to the input image and random noise, which belongs to the end-to-end intensive prediction task. Taking the generated image as an example, the generator converts the input random noise into an image, that is, generates a sample, which is expected to be similar to the real sample. The discriminator is responsible for judging the authenticity of the sample and expects to distinguish the generated sample from the real sample. During the training process, the generator constantly improves its generating ability, and the generated image is more similar to the real sample.

In the image description model, the information in the image is very rich, and there may be various objects. However, it is required that the generated description statements can fully express the semantic information of the input image, so it is not only necessary to locate the objects in the input image, but also to reasonably judge the relationships among the objects. Therefore, sufficient depth features are needed to abstract the semantic information of the input image. The VR 3D interaction model based on deep learning is shown in Figure 2.

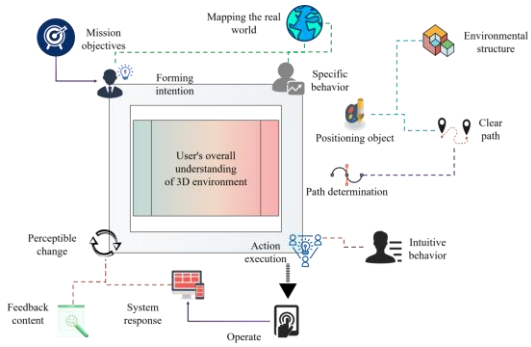

Figure 2: VR three-dimensional interaction model.

Influenced by lighting conditions, scene complexity, shooting angle and camera parameters, it is difficult to estimate depth information from a single image. In essence, because the same image can correspond to countless real physical world scenes, the estimation of depth of a single image is a morbid problem. Theoretically, binocular vision system can accurately calculate the image depth value, but in practice, due to the influence of baseline distance, matching algorithm and high system complexity, the application of binocular vision system is limited. According to the characteristics of intensive forecasting tasks, the input size and output size of the network are usually large, which requires higher computing resources, which puts forward higher requirements for the design of network structure and hyperparameters. For intensive forecasting tasks, the input and output of the network are semantically different. Estimate the depth information from the image, input it as a two-dimensional image, and output it as the depth value corresponding to each point, that is, the depth map.

In the VR modeling of computer-aided art design, set the normal vector of each triangle in the related triangle group of vertexes v_i as n_k, the center as x_k, and the area as a_k. Then the plane constructed by the normal vector and center defined below is called the average plane of the vertex:

$$N = \frac{\sum n_k a_k}{\sum a_k} \tag{1}$$

$$n = \frac{N}{|N|} \tag{2}$$

$$x = \frac{\sum x_k a_k}{\sum a_k} \tag{3}$$

The offset from point P to grid model TM in 3D space is defined as:

$$d(P, TM) = \min\left(d(P, X)\right) \tag{4}$$

Where $d(P, X)$ is the Euclidean distance from point P to point X. For vertex P, there are k triangles around it. Let the unit normal vector of the ith triangle be:

$$n_i \quad (i = 1,2,3,\ldots,k) \tag{5}$$

Define the normal vector of vertex P as the average of the normal vectors of all the triangles around it, and use n_p to represent the normal vector of vertex P, then:

$$n_p = \frac{1}{k}\sum_{i=1}^{k} n_i \tag{6}$$

Normalize it:

$$n_p = n_p / \left|n_p\right| = \frac{n_{px}\vec{i} + n_{py}\vec{j} + n_{pz}\vec{k}}{\sqrt{\left(n_{px}\right)^2 + \left(n_{py}\right)^2 + \left(n_{pz}\right)^2}} \tag{7}$$

Because the normal vectors between adjacent rectangular patches are similar, it starts with rectangular patch λ, and the existing rectangular patches $D_i(x,y)$ and $D_i^{'}(x,y)$ are searched by iterative method. The way to judge whether they are adjacent is as follows:

$$\left|\left(d(\lambda) - d\left(\lambda^{'}\right)\right)\cdot n(\lambda)\right| + \left|\left(d(\lambda) - d\left(\lambda^{'}\right)\right)\cdot n\left(\lambda^{'}\right)\right| < 2\rho_1 \tag{8}$$

Where ρ_1 is the depth of the image of the corresponding r pixel at the center of $d(\lambda)$ and $d\left(\lambda^{'}\right)$; $\lambda^{'}$ gives $n\left(\lambda^{'}\right)$ after the new number is initialized to $R\left(\lambda^{'}\right)$, $H\left(\lambda^{'}\right)$ and $d\left(\lambda^{'}\right)$. If the rectangular patch λ_0 is on the outer surface of the image set U, the following relation is satisfied:

$$\left|H(\lambda)\right|(1 - v*(\lambda)) < \sum_{b_i \in U(b)} 1 - v*(\lambda_i) \tag{9}$$

The λ_0 point is filtered. If the rectangular patch λ_0 is inside the image set U, the $S(\lambda_0)$ and $H(\lambda_0)$ of all points are recalculated. If $\left|H(\lambda_0)\right| < \beta$, filter point λ_0.

In the calculation process, if the input signal is $x \in R^{n\times m}$, the size of convolution kernel is $w \in R^{s\times k}$. The resulting output signal:

$$y = x * w \in R^{u\times v} \tag{10}$$

Select the size of the feature:

$$u = \left[\frac{n - s + 2\cdot Zeropadding}{Stride}\right] + 1 \tag{11}$$

$$v = \left[\frac{m - k + 2\cdot Zeropadding}{Stride}\right] + 1 \tag{12}$$

The key of convolution operation is to reduce unnecessary weight connection and use local connection to reduce the number of parameters, so as to avoid over-fitting.

The gray values of the neighboring pixels are compared with those of the pixels, and a binary value is obtained:

$$s(p_c, p_i) = \begin{cases} 1, p_i \geq p_c \\ 0, p_i \leq pc \end{cases} \quad (1 \leq i \leq 15) \tag{13}$$

Finally, the binary values of neighboring pixels are coded in sequence to find the distance between the vertical lines of the central pixel:

$$LBP = \sum_{i=1}^{15} s(g_c, g_i) 2^{i-1} \tag{14}$$

Assuming f_a and f_b are the feature vectors of image a and image b, respectively, the Euclidean distance is expressed as follows:

$$D(a,b) = \sqrt{\sum_{i=0}^{N-1} [f_a(i) - f_b(i)]^2} \tag{15}$$

4 RESULT ANALYSIS AND DISCUSSION

Through the establishment of the interactive platform of art design education, the art design works will be transformed into digital cultural forms. The interactive scoring results of the built VR modeling system are shown in Table 1 and Figure 3.

Sample set	Proposed method	BPNN
100	80.47	78.3
200	76.95	68.64
300	89.73	78.77
400	75.88	66.5
500	76.57	70.48
600	93.13	80.34
700	96.69	86.79
800	96.99	86.02

Table 1: System interactivity score.

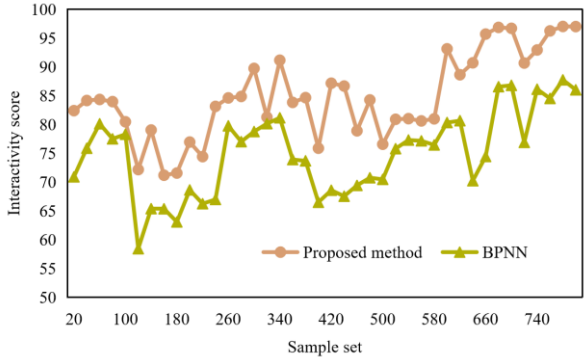

Figure 3: System interactivity score.

As can be seen from Figure 3, compared with other systems, this system has higher interactivity and better user experience. Different levels of output feature maps have different sizes, and

smaller feature maps mean that more image details are lost. Because the output feature map of a single layer is relatively single in scale, and the abstract degree of features is consistent, if only the output of a single layer is used as the coding result, it is not conducive to the network to make full use of the feature information. With the deepening of the network layers, semantic information is constantly coded, which shows that the spatial resolution of the feature map is decreasing but the channel dimension is increasing. The decoder learns to map high-level semantic information to the target domain space, which shows that the resolution of the feature map increases and the channel dimension decreases on the feature map. During DNN training, the real depth map corresponding to the input image should be provided as the supervision information. In the test phase, DNN estimates the corresponding depth map according to the input test image. The training of VR visualization model is shown in Figure 4.

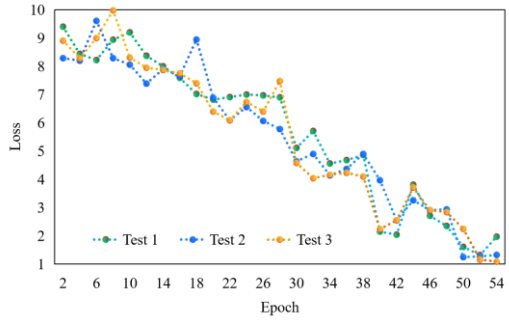

Figure 4: Training of the algorithm.

According to the visual 3D reconstruction process, 3D point cloud can be reconstructed by using depth map and camera's internal and external reference matrix, which is essentially the conversion between depth map and 3D point cloud coordinate system. The error of cloud reconstruction comes from the quality of depth map and the accuracy of calibration of camera's internal and external parameter matrix. For a given camera imaging system, the internal and external parameter matrices are fixed, so the quality of depth map becomes the main factor restricting the accuracy of 3D point cloud reconstruction. Table 2 and Figure 5 show the error of the algorithm.

Iterations	*Proposed method*	*BPNN*
40	0.729	0.698
80	0.743	0.66
120	0.728	0.53
160	0.654	0.509
200	0.625	0.466
240	0.644	0.414
280	0.602	0.365

Table 2: Error comparison of algorithms.

As soon as possible, the errors of different algorithms show a downward trend in the training process, but the VR visualization model proposed in this article has obvious advantages. In this model, the output feature maps of multiple layers of encoder are used as input, and the feature maps from different layers are spatially aggregated, and the feature maps of multi-level feature

aggregation are output to realize the integration of features. Table 3 and Figure 6 show the modeling accuracy of the algorithm.

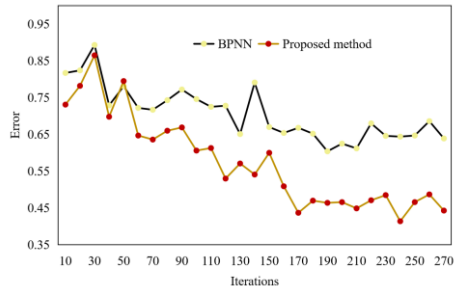

Figure 5: Error comparison of algorithm.

Iterations	*Proposed method*	*BPNN*
40	81.97	92.68
80	81.3	93.05
120	82.73	92.42
160	82.52	92.74
200	82.31	96.32
240	72.77	94.43
280	84.78	91.26

Table 3: Accuracy comparison of algorithms.

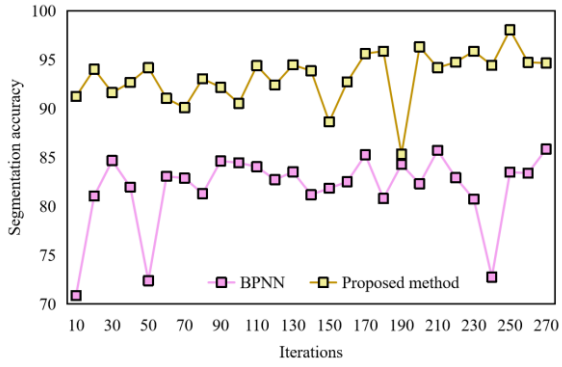

Figure 6: Accuracy comparison of algorithms.

It can be seen from the graphic content that the accuracy of this method is higher than 95%. During network prediction, all neurons are used, which can be regarded as the combination of different networks obtained during training. Therefore, the robustness of the network is improved and the over-fitting phenomenon is reduced. Figure 7 shows the comparison of the number of wrong pixels in each frame.

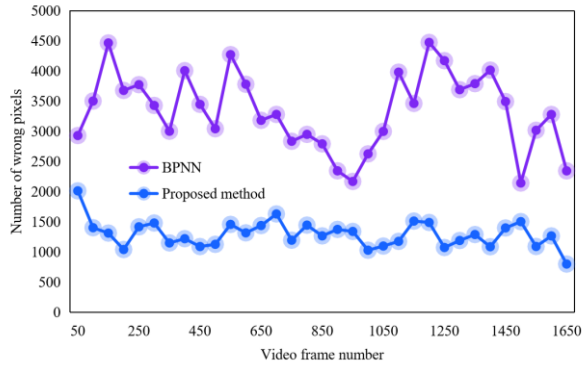

Figure 7: Comparison of the number of wrong pixels in each frame.

It is not difficult to find from Figure 7 that the segmentation results of VR visualization model in this article are better than those of other methods in most video frames.

5 CONCLUSIONS

Contemporary art design education is not only the training of modeling and expression techniques in the traditional sense, but also a complex systematic project to develop wisdom and cultivate comprehensive design ability. VR is more and more used in teaching because of its advantages of immersion and creating situations across time and space. In this ariticle, a VR visualization model based on deep learning and CAD is constructed in Metaverse, which provides theoretical and technical support for Italian design education. The experimental results show that the modeling accuracy of this method is higher than that of the comparison algorithm, reaching more than 95%. And release themselves in virtual space. VR technology enables students to get a more comprehensive and realistic experience in the virtual world, and promotes the development of students' deep cognitive ability. The wide application of VR in the field of art design teaching makes all teaching links in its instructional environment show some abstract or incomplete instructional contents in a more intuitive and vivid way. Introducing VR art into art design teaching can show the instructional content more vividly and vividly, and effectively create a instructional environment combining art and technology.

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