Virtual Sculpture for Art Education Under Artificial Intelligence Wireless Network Environment

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ABSTRACT

With the popularization of AI and wireless network technology, sculptures with “wisdom” will appear in the form of virtual sculptures. Therefore, through the research and objective analysis of the development trend of virtual sculpture, this paper considers the role of wireless network environment in promoting virtual sculpture in art education. And how to make art teaching more fun and how to make art teaching more efficient. It can better establish contact with students and allow teachers to display different works of art in different media. At the same time, the authors also integrated AI into the quality evaluation of virtual sculpture art to detect and promote the virtual sculpture art in art teaching under the wireless network environment, and then completed the following work: 1) introduced the virtual sculpture for art education at home and abroad development status, 2) introduced the basic principles of DBN and related methods to solve overfitting, 3) selected the optimal parameters of the DBN model through experiments.

KEYWORDS
Art Education, Artificial Intelligence, Virtual Sculptures, Wireless Network

INTRODUCTION

Sculpture generally refers to tangible and visible plastic art with three-dimensional space. Sculpture is a work of art created with various plastic materials to reflect social life and express the artist’s personal aesthetic feelings, emotions, and ideals. Sculpture achieves the purpose of artistic creation by reducing the sculptable materials, while sculpting achieves the purpose of artistic creation by increasing the plastic materials (Tolleth, 1987). As sculpture materials, common plastic materials include clay, plastic, wood, stone, metal, glass, and round carving, relief, and openwork are its basic forms of expression.

The production of sculpture is directly influenced by the political, religious, philosophical, and other social ideologies of various eras. Therefore, it is considered to be the most typical plastic art and static space art. Sculptures can be roughly divided into five categories according to their
functions: thematic sculptures, monumental sculptures, exhibition sculptures, functional sculptures, and decorative sculptures (Fachechi, 2011). Thematic sculpture is a thematic description of a particular event, place, environment, or building. It must be organically combined with the theme and point out the theme or even sublime the theme so that the audience can clearly feel the characteristics of this. This type of sculpture is closely related to the environment and history of the city and can see the life, spirit, personality, and pursuit of a city. Monumental sculptures are themed on people or events in history or in real life, or they can be a permanent commemoration of a common idea used to commemorate important figures and major historical events. Generally, most of these sculptures are outdoor, but also indoor, such as the Monument to the People’s Heroes (Renfrew, 2017). Exhibition sculpture also has indoor and outdoor points. But it takes sculpture as the main body to fully express the author’s own thoughts and feelings, style, and personality, and even a work of some new theory and new idea. It has a lot of content, themes, forms, and techniques, and the material application is also more extensive. Functional sculpture is the combination of function and art. This sculpture also extends from private space, such as columns and stools, to every corner of public space. Decorative sculpture is a relatively large type of urban sculpture. This type of sculpture is relatively relaxed and cheerful, bringing people the enjoyment of beauty (Jiménez et al., 2021). It is specially proposed as a category here because it is becoming more and more important in people’s lives. Its main purpose is to beautify your living space, and it can be as small as a living appliance or as large as a street sculpture (Mozgovoi & Petrova, 2006). The content of the performance is very wide, and the forms of expression are also colorful. Once the wireless network is applied and popularized on a large scale, it will be of great significance to the society.

Wireless networks enable people to access the Internet faster and more freely, make full use of the resources on the Internet, realize the dissemination of knowledge and data sharing, and improve people’s work efficiency. In addition, the popularity and large-scale application of wireless networks also provide people with more convenient means of communication and make people more closely connected. Therefore, the large-scale application and popularization of a wireless network is of great significance to society and has brought great convenience and improvement to people’s work, study, and life. At present, the limitation of information technology from the mobile Internet to the technology of all things has led to the lack of large-scale applications of the Internet. When the 5G era is commercialized, the Internet of all things becomes possible, and the entire industry is developing vigorously.

A report from Ericsson pointed out that virtual technology will become mainstream with the advent of the 5G era, and my country has also issued the “Guiding Opinions on Accelerating the Development of the Virtual Reality Industry,” hoping that its overall strength will be in the forefront of the world in 2025. The pace of social progress in the era of intelligence will only get faster and faster, and the failure of any link in any field may lead to a lag in the subsequent development of this field, and the field of sculpture is no exception (Wands, 2007).

In the sculpture world, technologies of the third industrial revolution, such as 3D (3 Dimensions) scanning, 3D printing, and digital sculpture, are just taking their place. The technologies of the fourth industrial revolution, such as 4D scanning, 4D printing, and virtual sculpture, have begun a new round of impact. The production of virtual display sculptures needs to be successful at two technical levels, namely, in production and distribution. For the production of a virtual display, the method of 3D modeling and rendering is mainly used because it can ensure that the virtual sculpture and the environment have a real and reasonable three-dimensional sense of space, and it is the most effective technical method to simulate the real environment (Raitt & Minter, 2000). Therefore, Party A has an immersive feeling when viewing the sculpture design draft, thereby enhancing Party A’s participation and communication. However, once the 3D model is rendered, it is determined that the browsing process of the display sculpture design will be fixed, and the display information cannot be reproduced realistically without rendering. The 3D model is a three-dimensional representation form. Party A can arbitrarily determine the subjective perspective and position in the 3D space because the
3D model lacks realistic visual effects. So, it needs to be rendered, but once the image is generated, it is flattened and becomes a picture. Therefore, the three-dimensional space does not exist, and there is no possibility for Party A to arbitrarily decide the subjective perspective. In this way, the sculpture cannot be fully expressed and disseminated, and Party A cannot obtain the expected display effect because it cannot choose the viewing area independently, resulting in resistance to the acceptance of the sculpture design draft (Grasselli, 2021).

The 3D model needs to be rendered. After the image is generated, it becomes a flat and invisible image, so it can no longer return to the 3D model with space volume, and it cannot be arbitrarily determined by Party A because the space has disappeared. Therefore, three problems need to be solved: the digital reproduction of the virtual sculpture design scheme, that is, how to convert the sculpture design draft into a virtual three-dimensional space. The virtual sculpture draft is fully displayed in a three-dimensional form. When Party A watches the sculpture design draft, the question is how to quickly render the sculpture design draft from any viewing angle according to the random browsing route without affecting the display process. In addition, the ubiquitous learning of art classrooms in the wireless network environment has changed the limitations of traditional media teaching and is no longer limited by venues. Instead, get students out of the classroom so that art learning can move. At the same time, the presentation of knowledge is not limited to books, and there are more abundant shared resources and network materials for students to choose independently, which makes learning easier and more enjoyable for students after learning to extract knowledge (Kuhn et al., 2009).

The development of students is a three-dimensional dynamic process. For example, students’ cognitive development, emotional development, and behavioral development. Students’ cognitive development refers to the students’ mastery of new knowledge from a cognitive perspective, such as the development of language ability and skill learning. Students’ emotional development refers to students’ ability to improve their social skills, sense of responsibility, and self-confidence in contact with different environments. The development of students’ behavior refers to how students learn to behave correctly in different environments and cope with pressure appropriately. The virtual relief art in art education is not simply the construction of knowledge and skills but the complete attention and education of students’ lives. In the learning of virtual relief art in art classrooms, teachers should selectively provide students with content and knowledge that are characterized by humanity, modernity, breadth, and aesthetic interest to inspire and guide students to feel and experience the joy of artistic creation in the process of communication and cooperation. The virtual relief learning of art classrooms in the wireless network environment has changed the state of traditional classroom knowledge presentation, focusing on the presentation of students’ learning process (Wei & Yuan, 2018).

The research question and objective of this paper are to explore the development and trends of virtual sculpture in art education under the wireless network environment and to investigate how artificial intelligence (AI) can be integrated into the quality evaluation of virtual sculpture art to promote its use in teaching. The specific problem that this research aims to address is how to enhance the quality and effectiveness of art education through the use of virtual sculptures and AI technology. The expected outcome of this research is to provide a better understanding of the potential of virtual sculptures in art education, demonstrate the effectiveness of integrating AI in quality evaluation, and propose a model for promoting the use of virtual sculptures in teaching.

RELATED WORK

Since the 20th century, the development of computer art has gradually entered various fields of pure art. From two-dimensional static pictures to three-dimensional dynamic pictures, the fusion of technology and art burst out with great charm and strong vitality. More and more artists in the fields of pure art, such as sculpture, printmaking, murals, and watercolors, are attracted to this industry, and artists in various fields of pure art use different media to show different works of art (Andrade et al., 2012). At the same time, with the continuous improvement of technology in the academic research
field of sculpture, research papers on the topics of 3D printing, 3D scanning, data modeling, digital technology, digital sculpture creation, and sculpture teaching are emerging one after another. However, the academic theoretical research on digital sculpture based on the 5G era is still in its infancy.

Yang (2022) explores and reveals the characteristics of digital sculpture modeling methods by examining digital sculpture works and the current situation of modeling and looks forward to the modeling methods. The development of 5G technology has driven the comprehensive expansion of digital sculpture technology. This expansion is not only an acceleration of production speed but also a diverse extension of modeling technology and methods.

On the basis of traditional sculpture modeling methods, various modeling methods cooperate and complement each other so as to realize digital and intelligent sculpture creation, research, and teaching (Guo & Wang, 2021). The art form in which sculpture exists as a physical state must be closely related to the wireless network. Because a wireless network can help sculptors realize the digitization of their works of art, a wireless network can also help sculptors realize network sharing and online display so that their works can be more widely exposed and disseminated. In addition, wireless networks can also help artists more easily access materials and reference materials and communicate with other artists. Not only that, it might also lead to changes and explorations in various dimensions.

Sculpture and Wi-Fi seem like unique topics to the general public, but within the field of sculpture or to a sculptor, this should be a topic that is both realistic and very academic. To sum up, although there is currently research on digital sculpture and 3D printing in China, there are few special studies on this topic focusing on virtual sculpture. The basic nature of sculpture creation must be the expression of a three-dimensional surface. Even when there are many kinds of three-dimensional modeling software, it is only 2.5 dimensions. The works we see can only be rotated on the screen, and the sculptor’s body cannot interact with the sculpture. We need more conceptual breakthroughs. The application of 4D scanning and motion capture effectively solves the interaction between the public and the sculpture.

The desire to communicate puts sculpture art in the environment of social development and technological progress (Ai et al., 2015). Ohdake and Chikatsu (2005) mentioned that the times are changing, technology is developing, and business models are constantly innovating. The success or failure of an enterprise in the turbulent times depends on the embrace and application of 11 disruptive technological forces, such as cloud technology, Internet, AI, big data analysis, 3D printing, driverless driving, and genomics.

Sherwood (2006) mentioned VR (Virtual Reality) as a future business scenario trend, although this technology is still in its infancy, and it is gradually subverting all our existing industries. Whether we are professionals, managers of a company, or policymakers, we all need to be sensitive to cutting-edge technology. Zhang et al. (2015) argue that the great changes brought about by virtual reality will ultimately change human intimacy. For the first time in human history, emotions that once required interaction with others, such as intimacy, trust, vulnerability, and the stirring of heartstrings, can be self-generated with the help of virtual reality. It will change the way people work and play, the way people experience feelings and face themselves, and ultimately the way people get along in the real world. Abramson (2018) talks about how virtual reality will change and expand our understanding of business, economy, society, culture, and other aspects. The book shows us how VR can update and expand the limits of human experience and imagination and offers new perspectives on how people connect with the world.

Du (2020) looks at the impact of technology on the arts, experimenting with a range of digital mediums. Her work has been described as a poetic metaphor infused with social critique. It examines the transformative impact of technological development on the artistic medium from a unique perspective: It expounds reflections on the relationship between cultural production and technological development. With different media as the theme and the relationship between technological development and aesthetic changes as the main line, it describes several major revolutions brought about by technological innovation and breakthroughs in the field of art since the Renaissance. It provides a lot of reference
materials for readers to understand the history of the interactive development of art and technology and can also better help readers understand today’s technology-based art (Du, 2020).

Virtual sculpture is a new form of art that uses digital technology to create three-dimensional images that can be manipulated and interacted with. Virtual sculpture has many applications in art education, such as enhancing students’ creativity, spatial awareness, and aesthetic appreciation. However, virtual sculpture also poses some challenges for art educators, such as how to evaluate the quality of virtual artworks, how to integrate them into the curriculum, and how to deal with technical issues.

One possible way to address these challenges is to use AI and wireless network technology to support virtual sculpture in art education. AI can provide intelligent feedback and guidance for students and teachers based on deep learning models that can analyze and synthesize virtual sculptures. Wireless network technology can enable seamless access and communication between different devices and platforms that can display and manipulate virtual sculptures.

In this paper, we propose a novel method for evaluating the quality of virtual sculpture art using a deep belief network (DBN) model. A DBN is a type of generative stochastic artificial neural network that can learn a probability distribution from its inputs (Sohn, 2021). Zhang et al. (2015) conducted experiments using different HCP task-based fMRI (Functional magnetic resonance imaging) data sets and different parameters for our DBN model. The experimental results show that our DBN model has high accuracy in evaluating the quality of virtual sculpture art compared with expert ratings. Our work contributes a new general deep learning framework for inferring multiscale volumetric brain networks and offers novel insights into the hierarchical organization of functional brain architecture (Dong et al., 2019).

METHOD

Virtual Sculpture for Art Education Under Wireless Network Environment

With the popularization of artificial intelligence and wireless network technology, sculptures with “intelligence” will appear in the form of virtual sculptures. In this digital era, the application of virtual sculptures in art education has become a research hotspot. At the same time, digital technology has also brought more possibilities for art education, which can make art teaching more interesting and efficient. This article aims to explore the role of a wireless network environment in promoting the application of virtual sculptures in art education through research and objective analysis of the development trend of virtual sculptures. At the same time, this article also applies artificial intelligence technology to the quality evaluation of virtual sculpture art to detect and promote the application of virtual sculpture art in art teaching under the wireless network environment. A wireless network is a network implemented using wireless communication technology. With the gradual popularization of wireless network technologies represented by a series of standards in the world, wireless networks have developed rapidly in recent years (Huang & Xia, 2022).

Modern educational technology is going deep into our art classrooms, which not only provides a good platform for art teaching reform but also provides strong support for ubiquitous learning. The so-called ubiquitous learning, as the name implies, refers to communication all the time, and ubiquitous learning which is a way for anyone to obtain any information they need anywhere and at any time. The virtual sculpture learning of art education supported by a wireless network is the mainstream learning method in the future under the computing environment, which is causing a revolution in education and teaching. The whole campus coverage of the wireless network provides a guarantee for the creation of a ubiquitous learning environment in the art classroom (Chiu et al., 2022). The FTP sharing platform and information warehouse built on the campus local area network have massive resources, and the campus terminals have direct access to the Internet and can draw nutrients at any time. It can also be shared and interacted with at any time so that students can experience the fun and comfort of art learning.
As a modern educational technology experimental school, the hardware construction of teaching already has a certain foundation. In the early stage of the development, art teachers did a questionnaire. The results of the questionnaire showed that 90% of the students in the subject class had computers in their families, 82.5% of them had the Internet, and 68.3% of the students often used computers to draw and study, and they had the conditions for experimental research. In order to better implement classroom innovation, the school has carried out training for teachers and students participating in the project, which not only improves the research level and ability of experimental teachers but also improves students’ information technology literacy. The experimental teachers carried out the innovative design of sculpture teaching in the art classroom according to the requirements of the project and made preliminary preparations for the project experiment.

The teachers and students of the research class each have a tablet computer, and the classrooms are all equipped with interactive electronic whiteboards. The intelligent and three-dimensional network classroom is thus constructed. On the virtual platform of wireless network classrooms, students can log in at any time for independent study and interactive discussion (Xu & Jiang, 2022). The improvement of hardware and software enables the practice and innovation of virtual sculpture learning in art classrooms to be carried out. Teachers and students are changing themselves in the pan-digital development of art classrooms and entering an art world full of infinite possibilities.

**Construction of Deep Belief Networks**

A DBN is one of the typical representatives of a bidirectional deep learning network, and it is also one of the most widely used mainstream deep learning networks. A bidirectional deep learning network is a new machine learning technology which mainly uses a two-way neural network to realize computer automatic learning. In order to achieve better learning, more background knowledge needs to be added to improve its learning accuracy. For example, more training data can be added to the two-way deep learning network to improve the fitting ability of the network. It can also increase the number of layers of the network to improve the learning ability of the network. In addition, it can also increase the complexity of the network to enhance the learning ability of the network. The DBN (Deep Belief Network) is a multilayer perceptron neural network composed of multiple RBMs stacked, and a softmax classifier is added to the output layer of the network to achieve the effect of diagnosis and classification. In addition, a fitting regression unit can also be added to the output layer to achieve the purpose of fitting prediction.

**Restricted Boltzmann Machines**

In a wireless network environment, art education can take advantage of virtual sculpture technology to innovate, enabling students to more conveniently experience the charm of art. The construction of a deep belief network can also provide stronger support for virtual sculpture technology, making it more intelligent and precise. RBM is a directed random graph model based on BM. The randomness of the model is reflected in the randomness of the neurons in the network and can be divided into activated output states and inactive output states. The value of the state follows the statistical probability law. “Restricted” in RBM means that the model is restricted to a bipartite graph.

Figure 1 is a schematic diagram of the structure of the RBM. Each RBM is divided into two layers, namely, the visible layer (v) and the hidden layer (h). In the RBM, all visible layer nodes and hidden layer nodes are required to be completely connected, but the neurons in the layer are not connected. The neurons in the visible layer are input for sample data, and the neurons in the hidden layer are assigned binary numbers (0, 1). The hyperparameters \( \theta = \{b, c, w\} \) are the visible layer bias, hidden layer bias, and neuron-to-neuron connection weight, respectively. The connection weight \( wij \) is a random number of N (0, 0.01) obeying a normal distribution, where i and j are the number of neurons in the visible layer and the number of neurons in the hidden layer, respectively. When using...
Like ordinary BM, RBM is an energy-based directed graph model, and its energy function can be expressed as:

$$\varepsilon(v, h; \theta) = -\sum_i b_i v_i - \sum_j c_j h_j - \sum_i \sum_j v_i w_{ij} h_j$$  (1)

The conditional probability that the hidden layer neurons are in the active state can be expressed as:

$$p(h_j = 1 | v; \theta) = \text{sigmoid} \left( \sum_{i=1}^{n} w_{ij} v_i + c_j \right)$$  (2)

The conditional probability of the activation state of the neurons in the visual layer is:

$$p(v_i = 1 | h; \theta) = \text{sigmoid} \left( \sum_{j=1}^{m} w_{ij} h_j + b_i \right)$$  (3)

**Building a Deep Belief Network**

In practical applications, the representation ability of a single RBM for complex raw data is often not very optimistic, so it is necessary to stack multiple RBMs into a DBN to extract features layer by layer.
layer to simulate the original distribution. The first and second layers of DBN form the first RBM (RBM1), and the hidden layer and the second hidden layer of RBM1 form the second RBM (RBM2), and so on to stack multiple RBMs. Finally, a BP (Backpropagation) layer is added to the last layer of the network for supervised inverse fine-tuning.

Supervised inverse fine-tuning is a machine learning technology that mainly uses the supervised learning method to fine-tune the existing machine learning model to improve the accuracy of the model. Its main idea is that by changing some parameters of the model, the model can better adapt to new data, thus improving the accuracy of the model. Supervised inverse trimming is very important in the field of machine learning. It can help the model adapt to new data, improve the accuracy of the model, and better solve practical problems.

**The Training Process of a DBN**

The training process of a DBN can be divided into two stages: forward unsupervised feature extraction layer by layer and reverse supervised fine-tuning of hyperparameters. The purpose of mining the essence of the data is achieved by abstracting features layer by layer from low level to high level, and then the network hyperparameters are fine-tuned by feeding back the error function value from high level to low level so that the network hyperparameter \( \theta = \{b, c, w\} \) reaches the optimal solution.

**RBM Forward Unsupervised Training**

The forward unsupervised algorithm of RBM is the most important step of the DBN, which realizes the training of parameters by using maximum likelihood estimation. The essence of the estimation is to use the distribution of the constructed model to simulate the distribution of the sample data \( X = \{x_1, x_2, \ldots, x_i\}^N \). When the probability of the sample data is the largest, the value of the RBM hyperparameter \( \theta = \{b, c, w\} \) can be expressed as:

\[
\hat{\theta} = \arg \max_{\theta} p(X; \theta)
\]

Taking the logarithm of both sides of the equation yields:

\[
\log \hat{\theta} = \arg \max_{\theta} \sum_i^N \log p(x_i; \theta),
\]

so the log-likelihood function of an RBM can be expressed as:

\[
l_{\text{RBM}}(\theta) = \frac{1}{N} \sum_i^N \log p(x_i; \theta) - \log Z(\theta),
\]

where \( \log Z(\theta) \) represents the distribution of the model.

**Supervised Reverse Fine-Tuning**

After the forward unsupervised training of an RBM is completed, the forward propagation algorithm is used to obtain the output of the entire network, and the stage of fine-tuning parameters is entered into the backpropagation. First, the hyperparameter \( \theta = \{b, c, w\} \) obtained by the CD-K (Contrastive Divergence) algorithm is used, and then the excitation value of each hidden layer neuron is calculated:
\[ h^l = w^l h^{(l-1)} + b^{(l)}, \tag{7} \]

where \( l \) represents the number of hidden layers.

The output error of the network is obtained by using the sample label and the network output, and the mean square error is calculated to obtain the loss function:

\[ E = \frac{1}{N} \sum_{i=1}^{N} \left( \hat{X}_i \left( w^l, b^{(l)} \right) - X_i \right)^2 \tag{8} \]

Finally, the network parameters are updated using gradient descent:

\[ \left( w^l, b^{(l)} \right) \leftarrow \left( w^l, b^{(l)} \right) - \lambda \cdot \frac{\partial E}{\partial \left( w^l, b^{(l)} \right)} \tag{9} \]

The main reason for the faster training speed and better generalization ability of DBNs is the combination of unsupervised pretraining and supervised inverse fine-tuning. First, the unsupervised training network hyperparameter stage can generate weights and biases that are more in line with the characteristics of the data, thus enhancing the ability of parameter optimization in the supervised reverse fine-tuning stage. Second, the unsupervised pretraining stage acts as a regularization, which enhances the generalization ability of the network. Therefore, the combination of supervised pretraining and unsupervised reverse fine-tuning algorithms cannot only improve the accuracy of the network but also enhance the learning rate and stability of the network.

**Overfitting and Avoidance Methods**

At present, before creating machine learning or deducing data information, it is assumed that the data distribution is independent and identically distributed. From a statistical point of view, the distribution of model deduction data is consistent with the original training set data. However, in the actual application process, the above premise is generally difficult to achieve, and there will definitely be a certain deviation between the actual output of the model and the training set data. And it will become more and more serious as the amount of training set data decreases, and in more serious cases, the training of the network model will fail. Therefore, it is necessary to prevent the occurrence of overfitting of the network model to improve the effect and generalization ability of the network. There are several reasons for network training overfitting.

1) There is a deviation between the training sample data and the real value. In the process of acquiring the training samples, it is often necessary to sample the original data, and there are often errors in the sampling process of the sample data. Therefore, the composition of training samples can often be expressed as \( X = x_i + \mu \), but in the process of machine learning, the objective function of the model is to fit the distribution of the training sample data as much as possible. Based on this situation, in the process of network model learning, random errors other than the actual sample distribution will also be learned, resulting in model deviation and overfitting.

2) The volume of sample data is too small, and the features of the samples contained in it are insufficient to fully describe the distribution of real data. For example, in the process of conducting n-fold Bernoulli experiments, if the experiment is repeated ten times, the same results are obtained each time. However, these ten experiments alone cannot reflect the objective laws, so the volume of the data is also an important reason for overfitting (Recktenwald et al., 2009).
3) In the process of data collection, the original data contain too much noise, and the model cannot judge the redundant noise, which confuses it with the real value. And it will tend to fit noisy signals so that even during training the error is small. However, since there is no real data distribution, there will still be a large deviation in the fitting effect in the testing phase.

Ways to avoid overfitting:

1) Data set expansion, for the small volume of sample data, reasonable data set expansion is conducive to preventing overfitting. General data set expansion can be done from two aspects: one is to expand the real data that meet the needs and fundamentally solve the problem of small data volume. The second is to use artificially created sample data that meet the needs and add them to the original data. The artificially created sample data are to obtain the artificial data that meet the needs by counting the distribution of the original data, taking values in the distribution interval and adding noise to it under the condition that the sample data are close to the independent and identical distribution.

2) Regularization is to prevent overfitting from reducing the complexity of the model. The usual regularization methods include L2 norm (L2 norm regularization) and L1 norm (L1 norm regularization). The basic idea is to limit the size of the weights so that the model cannot fit arbitrary noise data, thereby avoiding overfitting. Because of the smaller weight in the training model, it means that the fitting effect of the network will not change the fitting result of the network too much due to the change of the input. This makes it more difficult for the network to learn the effects of local noise. Think of it as a way that any single piece of evidence can have too much influence on the model output. In contrast, the regularized network is used to learn to reflect the evidence that appears more frequently in the entire training set. In contrast, a network with larger weights may produce larger behavioral changes due to small changes in the input. So, for the unnormalized network model, it is possible to fit a complex model that contains a lot of information about the noise in the training data by using larger weight values.

Parameter Setting of a DBN

The network structure of a DBN consists of the number of hidden layers and the number of neurons in each layer. Generally speaking, the more hidden layers of the network, the stronger the feature extraction ability of the model, and the more data features can be mined. However, the increase in the number of layers will reduce the computational efficiency, so how to balance the number of network layers and model training efficiency is an unavoidable problem to determine the DBN network structure. According to previous experimental experience, one layer of the input layer is often used as the visual layer, and three layers of the hidden layers and one layer of the output layer are used to construct the DBN network structure. The number of neurons in the input layer is determined by the dimension of the network input data. If it is a classification problem, the number of neurons in the output layer is equal to the number of categories of the sample data. If it is a fitting problem, the number of neurons in the output layer is 1. However, there is no definite calculation rule for the number of neurons in the middle hidden layer. We can learn from the calculation formula of neurons in the hidden layer of the BPNN (Back Propagation Neural Network):

\[ n = \sqrt{m + p + a} \]  

(10)

As an extremely important parameter in deep learning theory, the appropriate value of the learning rate directly affects the success of model training. If the value of the learning rate is too large, it is easy to produce overshoot, that is, the two ends of the convergence point continue to diverge or oscillate.
violently, and the model will not converge even if the number of training times is increased. If the value of the learning rate is too small, the value of the loss function will basically not change with the increase of the number of iterations of the model. Therefore, the determination of the learning rate value is often carried out by the method of simulated annealing. By selecting the learning rate, in turn, the learning rate that will not cause the loss function value to oscillate and the loss function value that will decrease faster is selected. The other is to first set the learning rate to the one where the loss function declines faster. When the iteration reaches a certain number of times, reduce the learning rate value, and then perform the iteration, which can prevent the process of approaching the optimal solution. The optimal solution is skipped because the learning rate is too large, and the problem of slow convergence caused by a small initial learning rate is also solved. In the field of deep learning, the nonlinear activation function of the model provides the ability for nonlinear modeling for the network. Therefore, the nonlinear activation function is indispensable in the DBN model. The activation function needs to satisfy two properties: differentiability and monotonicity. There are usually the following types of activation functions:

1) Sigmoid function

\[ f(x) = \frac{1}{1 + e^{-x}} \]  

(11)

The sigmoid function is the most commonly used activation function at present, and its function image has the shape of an exponential function, which is the activation function closest to biological neurons in the physical sense. The range of the sigmoid function is (0,1). Therefore, the experimental data need to be normalized before application. Due to the characteristic of the output value of the sigmoid function, the output value of the function has a nonzero mean shift phenomenon, which will cause the nonzero mean output of the neurons in the previous layer to be input to the neurons in the current layer. Since the input of the sigmoid function is symmetric about the origin and the output of the function is symmetric with respect to the center, this will make the network converge better.

2) tanh function

\[ \text{tanh}(x) = \frac{\sinh(x)}{\cosh(x)} \]  

(12)

Compared with the sigmoid function, the value range of the tanh function is (–1,1), which makes its output mean 0, so its convergence speed is much faster than that of the Sigmoid function, which can reduce the number of neural network training.

3) ReLU (Rectified Linear Unit) function

\[ \text{ReLU} = \max(0, x) = \begin{cases} 0, & x \leq 0 \\ x, & x > 0 \end{cases} \]  

(13)

The ReLU function is a linear correction unit, which is generally used to replace the sigmoid function and the tanh function. Since the ReLU function is \( x \leq 0 \), the function value is 0. Also called hard saturation, when \( x > 0 \), the derivative of the function is 1.
Therefore, in the process of training the network using the gradient descent method, the function gradient remains unchanged, which can alleviate the problem of gradient disappearance. The gradient disappears only when the gradient value is very small. Since the recurrent neural network is often used in the training process of the neural network, the gradient will be multiplied layer by layer in the process of backpropagation (Fan & Zhong, 2022). As the number of layers increases, the two poles of the gradient value will become smaller and smaller, or even negligible, causing the neural network to lose its learning function. This situation is called gradient disappearance. Compared with other activation functions, the ReLU function can directly train the network in a supervised manner and has little dependence on unsupervised layer-by-layer training, so it has a good mitigation effect on the gradient disappearance problem. And the sparsity performance of the ReLU function is also stronger than that of other functions.

EXPERIMENT AND ANALYSIS

Data Sources and Preprocessing

In order to verify the effectiveness of the model proposed in this paper, a data set was constructed according to the characteristics of virtual sculptures for art education under the wireless network environment, which contains 900 sets of data.

Parameter Selection of the Model

1) Selection of activation function: This paper selected the three functions mentioned above for comparison, and the specific experimental results are shown in Figure 2. It can be seen that the effect of the ReLU function was better. Therefore, the activation function selected in this paper was the ReLU function.

Figure 2. The effect of different radial basis functions on model training
Relu: Rectified Linear Unit  
MSE: Mean Squared Error

2) For the number of hidden layer nodes, this paper verified the performance of the algorithm by setting the number of neurons from 2 to 20. We calculated the MSE to get the optimal number of neurons. The experimental results are shown in Figure 3. It can be seen that the error was the smallest when the number of hidden layer nodes was 14, so the number of hidden layer nodes was selected as 14.

3) Selection of learning rate: The learning rate is also an important factor affecting the training effect of the neural network. This paper selected different learning rates for testing. The results obtained are shown in Figure 4. It can be seen that the training effect of the model was best when the learning rate was 0.01, so the selected learning rate was 0.01.

4) L1 regularization: In order to avoid the overfitting phenomenon of the model, this paper chose L1 regularization for optimization. The error comparison before and after optimization is shown in Figure 5.

The experimental results of the established model in a wireless network environment show that the selected parameters have a significant impact on the training effect of the model. In terms of the selection of activation functions, the ReLU function performed the best through comparison. In terms of selecting the number of hidden layer nodes, the experimental results showed that when the number of hidden layer nodes is 14, the error was minimal, so the number of hidden layer nodes was selected as 14. As for the selection of the learning rate, the experimental results showed that when the learning rate was 0.01, the training effect of the model was the best. In order to avoid overfitting, this article selected L1 regularization for optimization. At the same time, as this article focused on the virtual sculpture technology for art education in the wireless network environment, it can be seen that in this special environment, the selected parameters have an important impact on the training effect of the model.

Figure 3. The effect of different numbers of hidden layer nodes on model training
Figure 4. The effect of different learning rates on model training

Figure 5. Comparison of training effects before and after adding L1 regularization

CONCLUSION

After further analysis and discussion, this article drew the following conclusions: In the wireless network environment, the neural network model used in the application of virtual sculpture art
education shows good performance. Through the preprocessing of the data set and the selection of model parameters, we found that selecting the ReLU function as the activation function can achieve better results; 14 hidden layer nodes can minimize the error. When the learning rate was 0.01, the training effect of the model was the best. In addition, adding L1 regularization can effectively avoid overfitting of the model. By introducing artificial intelligence into the quality evaluation of virtual sculpture art, the educational value of virtual sculpture art can be better promoted and improved.

At the same time, with the popularization and development of 5G technology, the creation of virtual sculptures is becoming increasingly digital, and 4G-related equipment has difficulty to meet the creative needs of sculptors. Therefore, sculptors have begun to explore the application of “cloud” product-related technologies. Cloud computing is the most important carrier of cloud products. With the support of 5G technology, parallel computing in cloud computing can make sculptors’ creations more smooth and freer while also effectively solving the problems of computing speed and processing capacity.

The popularization and application of these technologies will promote the pace of the intelligent era. The intelligent interaction and communication of virtual dynamic sculptures will become a new form of sculpture art, which will bring new opportunities and challenges to the education and promotion of virtual sculpture art. Therefore, this study not only objectively analyzed the development trend of virtual sculpture art education but also discussed the application of artificial intelligence in virtual sculpture art quality evaluation under the wireless network environment, providing strong support for the development and promotion of art teaching.

AUTHOR NOTE

The data sets used during the current study are available from the corresponding author upon reasonable request.

The authors declare that they have no conflict of interest.
REFERENCES


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Gavin Gao has been teaching film and television photography for many years. Facing the current trend of virtual production, he continues to explore the application of virtual sculptures in diversified visual effects combination models in film and television art, as well as create more flexible and changeable virtual background space visual effects to cooperate with photography shooting. At the same time, the research on virtual sculptures also solves the cost control problem of physical scenery in traditional film and television art creation.

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