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Computer-Aided Design AND APPLICATIONS

Research on the Innovation of Ceramic Art Products Based on CAD Technology Optimization

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Abstract. In the ceramic creation of modern art, how to standardize and standardize CAD design schemes has become an important criterion for measuring success rate and efficiency. Based on the ceramic art design, this article analyzes the innovative features of ceramic art products, puts forward the 3D CAD modeling algorithm of ceramic art products based on DL (Deep learning), and explores the computer-aided ceramic art design strategy driven by artificial intelligence. The results show that the F1 value of the algorithm is about 93%, and the highest value can reach 96.02%. At the same time, the algorithm has high efficiency and low errors, which has achieved the expected idea. In addition, the proposed ceramic image CAD method based on DL can effectively solve the problem that 3D images are not clear and stereoscopic, while maintaining the clarity of ceramic CAD images, and can accurately draw the edge contour of ceramic artworks, thus improving the innovative and creative design level of ceramic art products. The validity and reliability of this method are verified by the test. It provides a reliable and efficient method for innovative design of ceramic art products.

Keywords: Deep Learning; CAD Technology; Ceramic Art Products; Innovation and Creativity
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1 INTRODUCTION

At present, the digitalization process of computer Assistive technology is developing rapidly, which greatly satisfies people's pursuit of product functionality. Contemporary products are no longer limited to their functional attributes, but gain a sense of experience and spiritual enjoyment while satisfying their functionality. Porcelain, as one of the earliest global commodities in the world, is a bridge and link to promote the exchange and mutual learning and continuous progress of world civilization. Jingdezhen ceramics is an important cultural symbol for the world to know about China and China and an important carrier to inherit Chinese excellent culture. Usually used ceramic products are actually the embodiment of product processing technology and planning concept. Product image is the user's intuitive cognition of the external form of products, and products form the language of communication with people through their own morphological factors, such as shape, line, color and texture. Aesthetic design of ceramic products is mainly reflected in the modeling and decoration of objects, while modeling is based on the shaping of lines, and the lines of objects define the final modeling of products. The traditional design drawings of ceramic products are mainly hand-drawn or imitated, which has a large workload, high production cost and long production cycle, which has a great impact on the overall progress of the project.

Due to the growth of computer, especially microcomputer and computer drawing technology, the application of CAD technology in machinery, electronics, architecture, clothing and other industries has become more and more common. CAD is a software that is often used by people to help people carry out complex designs. When drawing the drawing of ceramic products, the function of three views is mainly used to express it. Most of the lines drawn and the methods used in the drawing process conform to the regulations that should be followed in architectural drawing. Introduce CAD technology, use 3D digital modeling software to model ceramic products, and use model drawing software to draw ceramic products. In this way, we can understand the material and texture of ceramic products more intuitively and clearly. At the same time, it can improve the innovative design level of ceramic art products.

In recent years, the growth of artificial intelligence has attracted more and more attention of researchers. The new technology represented by DL is gradually changing the growth of various fields. DL is an algorithm that can automatically acquire advanced features of data, and its algorithm structure is composed of multiple processing layers with nonlinear functions. Once the DL method was put forward, it immediately attracted the attention of academic circles, and many researchers started related research. The realization of DL algorithm can not be separated from ANN (Artificial neural network) technology. The motivation of establishing ANN is to simulate the human brain for analysis and learning, and take neurons as the most basic unit for learning. DL is generally optimized by learning methods related to mathematical statistics, so DL network has also been applied in mathematical statistics, and the local structure can be expressed by mathematical functions through statistical mathematical methods. Data-driven deep modeling learning technology, with enough data sets, uses the designed network model for training, which makes the task of 3D reconstruction simple and vivid from the original complexity, and becomes a new research direction at present.

The application of deep learning and CAD technology in the field of ceramic art product innovation is becoming increasingly widespread. This article aims to explore the innovation research of ceramic art products based on deep learning and CAD technology, in order to provide new ideas and methods for the development of this field. Both deep learning and CAD technology have been widely applied in the field of ceramic art product innovation. Deep learning algorithms can help process and analyze a large amount of image data, thereby achieving automated design innovation. CAD technology can assist designers in precise 3D modeling and virtual display, improving design efficiency. For the innovation of ceramic art products, the innovative design and production process of ceramic art products can be optimized from multiple perspectives such as design, production, and marketing. The specific strategy includes using deep learning algorithms to automate the processing of image data for ceramic art products, in order to achieve rapid iteration and optimization of design. By using CAD technology for precise 3D modeling, the production accuracy and efficiency of ceramic art products can be improved. Use Big data analysis technology to mine and analyze Market data to develop more targeted marketing strategies. A large number of ceramic art product image datasets were used for deep learning experiments, and various optimization methods were evaluated through comparative experiments. The results indicate that the optimization method combining deep learning and CAD technology has certain advantages in the field of ceramic art product innovation. In summary, this article proposes corresponding strategies from multiple perspectives such as design, production, and marketing based on deep learning and CAD technology optimization of ceramic art product innovation research. The experimental results indicate that these strategies have certain effects in the field of ceramic art product innovation. Future research directions include further optimizing algorithms and improving the scalability of strategies to promote further development in the field of ceramic art product innovation. Based on the research of DL and CAD technology, this article puts forward a 3D CAD modeling algorithm for ceramic art products based on DL. Its main work and innovations are as follows:

(1) Based on ceramic art design, this article analyzes the innovative features of ceramic art products, and innovatively proposes a 3D CAD modeling algorithm for ceramic art products based on DL.

(2) DL network uses multi-level feature fusion and attention mechanism to improve and optimize the 3D feature extraction process, and uses multi-network collaborative learning method to optimize the network parameters. The results show that this method has better performance than the classical method.

This article analyzes the innovative ideas of the article structure for the ceramic research topic. Its structure is divided into 5 parts. The first part elaborates on the development background of CAD technology in ceramic material production areas. The second part elaborates on various aspects of research related to computer-aided construction of three-dimensional ceramic models. Section 3 conducted DL based ceramic art product design and CAD technology optimization. Section 4 conducted standardized design for the construction of deep learning ceramic algorithm models. Section 5 summarizes the entire text, and research shows that the ceramic image CAD method based on DL can effectively solve the problems of unclear and three-dimensional 3D images.

2 RELATED WORK

Algharaibeh et al. [1] prepared a composite material with uniaxial compression to control ceramic volume. This conforming material has a heterogeneous microstructure similar to pearls, which shows a high arrangement of polymers and has been subjected to bending analysis for material polymer penetration. New biomimetic ceramic/polymer composite materials have shown great potential. Alshali and Alqahtani [2] analyzed the influence of bleaching agents on the microhardness of ceramic materials. By using different samples of ceramics for different bleaching treatments, the color measurement levels of microhardness and spectrophotometry after treatment were analyzed. Ghoul et al. [3] carried out the effective analysis of the mechanical load of ceramic materials under the computer-aided manufacturing of mechanical energy. Through the analysis of the verification data of multivariate Logistic regression, the number of repairable failures under axial load was constructed. Hu et al. [4] conducted a method for digital ceramic manufacturing and printing molding based on 3D printing. Build. By constructing a CAD assisted steady-state balance, it analyzed the problem of forming defects caused by non-digital control factors. The results indicate that 3D ceramic products based on complex contour surfaces have great potential in the art of printing. Kim et al. [5] conducted analysis of different ceramic microstructure disc patterns. The microstructure and Fracture toughness of the oxide ceramics were tested by wear reduction and stereolithography. The diameter of pore crystal particles in the sample was studied using CAD based electron microscopy. The dominant difference is satisfied in different ceramic Fracture toughness. Ceramic materials typically have higher strength and toughness, but they may also be more brittle. During the mechanical loading process, if the loading exceeds the load-bearing capacity of the material, it may lead to the fracture of the ceramic material. Kim et al. [6] can understand the fracture mechanism and Failure cause of ceramic materials by CAD aided fracture morphology analysis of fractured ceramic materials. The results of statistical analysis indicate that the ceramic inspection under sample factor analysis of variance meets the basic requirements. Kyratsis et al. [7] developed a three-dimensional finite element model. The number of simulation runs is reduced by creating orthogonal arrays of variables for ceramic tool turning AISI-D3. Further determined the feed rate of the ceramic 3D model and the impact of its generated components. The research results indicate that the development of statistical models has achieved strong correlation. Liu et al. [8] analyzed the differences in the dielectric properties of microwave dielectric ceramics at different temperatures. The research shows that the high-precision filter in Digital Light Processing can produce satisfactory performance. Nabih et al. [9] constructed CAD three-dimensional finite element models of different ceramic materials for repairing inlays. By analyzing the mechanical and thermal stresses of different ceramic materials for repairing the clamp body, we have diligently conducted repair experiments. The results indicate that the thermal wave of temperature has a significant impact on ceramic restorations. OğUz et al. [10] designed a CAD model of resin ceramic parts and imported it into finite element analysis (FEA) software. Mesh the resin ceramic parts in FEA software and divide the model into small units for numerical calculations. Define the mechanical properties of resin ceramics, such as elastic modulus, Poisson's ratio and strength. Calculate the stress and strain distribution of resin ceramics under load conditions through finite element analysis. Evaluate the loading effect of resin ceramics. For example, check if there are local high stress and high strain areas, and if the strength limit of the material has been reached. Based on the analysis results, optimize the design and improve the structure and material selection of resin ceramic parts to enhance their load capacity. It should be noted that the load effect analysis of resin ceramics is a complex process that requires consideration of multiple factors, such as material properties, geometric shape, load conditions, and boundary conditions. When conducting analysis, it is necessary to carefully select and analyze data to ensure the accuracy and reliability of the results. The damage of loaded teeth varies among different CAD/CAM modules, and after analyzing the fracture strength of tooth materials, the maximum and minimum effective loads are obtained. Pelanconi et al. [11] elaborated on the development of honeycomb structures based on CAD ceramic technology. The complex structure of ceramic additive manufacturing was analyzed by constructing a finite element model. It has developed an innovative model for cutting machinery tools based on a random architecture. It provides continuity solutions between different structures. Pîrvulescu et al. [12] conducted a morphological analysis of the color hardness changes of the semi-transparent microstructure of ceramic materials. The susceptibility of ceramic thresholds was analyzed by evaluating color changes using a spectrophotometer based on CIELab parameters. In the material changes after simulating SEM images, it has been proven that ceramics are the least affected material. Safonov et al. [13] conducted printing analysis of complex geometric ceramic structures based on CAD auxiliary functions. By establishing different ceramic compression parameters, a compression experimental structure was constructed for testing. Schönher et al. [14] analyzed the manufacturing of ceramic filler additives based on CAD lithography. By analyzing the characteristic resolution and quality processing of thermoplastic polymers, the heat treatment of glass ceramics and related problem substitution analysis were constructed. Simultaneously, optical to digital CAD3D printing analysis testing was conducted. Shen et al. [15] carried out the strength analysis of the ceramic compression monitoring system structure through CAD Digital Light Processing. It exhibits similar mechanical responses under stress using an exponential model related high compressive strength. Skorulska et al. [16] analyzed the application of high-performance ceramic hybrid materials based on CAD in clinical restoration. Research has shown that using ceramic materials can effectively test and develop polymers, thereby further enhancing the aesthetic value of ceramics.

3D CAD modeling plays an important role in the manufacturing of ceramic products. Especially in the imitation and creative design of ceramic art products, using CAD software related to 3D digital models and drawings can allow customers to fully simulate and render virtual products, and also provide reference for future ceramic mold opening work. At present, there are not many achievements in optimizing the design of ceramic art products using CAD technology, and high-level research is also rare. Based on the research on DL and CAD technology, this paper analyzes the innovative features of ceramic art products from the perspective of ceramic art design, and proposes a 3D CAD modeling algorithm for ceramic art products based on DL. On this basis, the algorithm design and corresponding algorithm implementation of the model are provided. The results indicate that the algorithm design in this article has certain reference value for the design field of ceramic art products.

3 DESIGN OF CERAMIC ART PRODUCTS BASED ON DL AND CAD TECHNOLOGY OPTIMIZATION

3.1 Modeling Design of Ceramic Art Products Based on CAD Technology

CAD (Computer-aided design) technology can be used in the modeling design of ceramic art products. With CAD software, designers can carry out 3D modeling and create virtual models of products. This method is more accurate and efficient than manual drawing, and can greatly improve design efficiency. In ceramic art product design, CAD technology can help designers perform the following operations: design rapid prototypes: Through CAD technology, designers can quickly create three-dimensional models of products, and then create physical prototypes. This helps to validate and optimize the design plan before production, saving on later modifications and production costs. Accurate 3D modeling: Using CAD technology, designers can accurately construct a 3D model of a product, including its shape, dimensions, details, and more. This helps to reduce the number of sample production and modifications, improve design accuracy and production efficiency. Conduct manufacturability analysis: Through CAD technology, designers can conduct manufacturability analysis, which checks whether the product design meets manufacturing requirements. This helps to identify potential manufacturing challenges in advance and solve them, avoiding difficulties and cost waste in the later manufacturing process. Generate manufacturing drawings: Finally, using CAD technology, designers can generate manufacturing drawings to provide accurate manufacturing instructions for the manufacturing process. CAD technology provides strong support and assistance for the design of ceramic art products, helping designers better realize their creativity.

With the evolution of the times, people's aesthetic consciousness will gradually change, which also makes people's original intention of designing ceramic products change. Personalized customization has become young people's pursuit of fashion. Ceramic art products bearing thousands of years of Chinese culture have become the goal of customization for young people, and some personalized customization platforms for ceramic products have been launched one after another. The design of ceramic art products needs to achieve both practicality and aesthetics. Therefore, the ceramic industry needs to strive for aesthetics and practicality in product design. At the same time, from shape design to function construction, it is necessary to achieve the perfect combination of ancient and contemporary, intellectual and rational, strict function and warm artistry. In addition to satisfying its basic functionality, pursuing aesthetic forms and emotional expressions as much as possible has become an important consideration in the design of contemporary ceramic art products. Ceramics is an invention with profound cultural connotation, and the birth of each personalized ceramic product contains a unique meaning and connotation. It will be of great significance if this implication and connotation can be materialized through multimedia technology. 3D CAD digital modeling plays an important role in the application of traditional ceramics. It can collect data from masterpieces or antiques and process them by reverse forming software; Ceramic art products can be innovated based on 3D data. CAD technology has more advantages than the hand drawing method by sketching the shape of ceramics with the simplest lines. When drawing ceramic graphics, we should use the powerful function of the software to adjust its size to some extent, so that each part has a good proportional relationship and ensure the coordination and aesthetics of the overall appearance of the product.

Ceramic products include pottery and porcelain, while ceramic design includes daily-use ceramics, artistic porcelain, architectural porcelain and sanitary porcelain. Household porcelain is most closely related to our production and life. Contemporary people's living habits and aesthetic taste also directly affect the design of daily-use ceramics. However, with the improvement of people's living standards, art porcelain has also begun to rise on a large scale. The brittleness and hardness of ceramic materials are very high, and cracks are easy to appear in manufacturing. In addition, complex ceramic parts also need to be formed by molds. However, due to the high manufacturing cost and long research and development cycle, it is difficult to adapt to the constantly updated products. In addition to polymer materials and metal materials, 3D digital modeling has also made some breakthroughs in ceramic materials. With the intelligentization of CAD technology, the original tedious operations are gradually handled by computer intellectualization; Its 3D modeling establishes the corresponding 3D solid model in the computer, which can reflect the design intention more intuitively and comprehensively. In the 3D view of ceramics, it is necessary to show all the details of modeling clearly and accurately, and random lines are absolutely not allowed. All lines, labels, connections and turns between lines in the drawings are the embodiment of design language, representing the structure of appearance, and embodying the volume, size and volume space composition of porcelain. Layer is a unique concept of CAD system. In order to facilitate processing, different elements can be placed in different layers, and each layer can be closed, frozen and locked separately. It has many functions of drawing lines, and the purpose of choosing polysemy lines is to facilitate the construction of lumen contour and solid surface. 3D CAD modeling is characterized by fast manufacturing speed and is not constrained by the shape of parts. It has a good application prospect and conforms to the trend of future development. 3D surface model can display its modeling effect by blanking display, shading, smooth coloring, etc., without making it into a physical model. If the design effect is not ideal, it can be revised again, which undoubtedly greatly reduces the design cost. The 3D view of ceramic design can accurately mark the structural relationship of all parts of ceramics on the chart, so as to achieve harmony and unity between form and space, which is one of the main links of ceramic drawing design. Using 3D CAD digital modeling, a variety of manufacturing processes of ceramic art products can be realized.

3.2 3D CAD Modeling Algorithm of Ceramic Art Products Based on DL

The realization of DL algorithm is inseparable from ANN technology. Generally, the output information is called output vector. The fully connected layer is generally located behind the pool layer and before the output layer, and its main function is to aggregate all local features extracted from the previous layer, and then integrate them with nonlinear functions to get global features and map them to the corresponding sample label space; Finally, input the classifier to realize feature classification. Although the deep network will improve the performance of the network model, it also brings some problems, not just the problem of increasing the quantity of parameters. Gradient disappearance or gradient explosion is easy to occur in deep NN, and if improper activation function is used, it will also affect the performance of the network. At present, the commonly used regression classifier is Softmax, and its classification result output is the probability between (0,1). Sigmoid functions are often followed by the full connection layer as activation functions. However, it also has its own defects, and it is easy to cause gradient disappearance when the output is close to 0 or 1. Therefore, this article adopts a better Relu function. The Relu function image is shown in Figure 1.

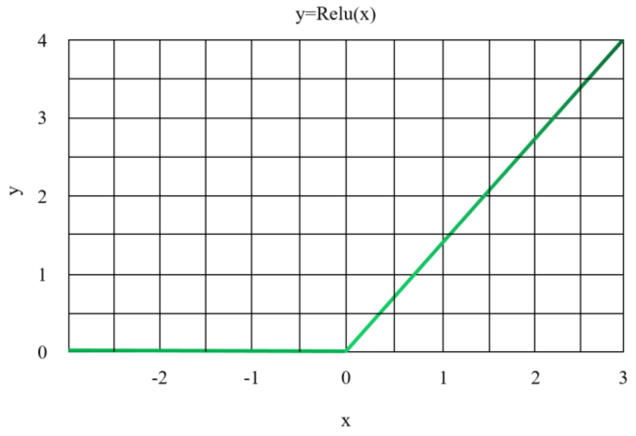

Figure 1: Relu function image.

The introduction of Relu activation function greatly improves the nonlinear modeling ability of NN, and can also regulate the amplitude of network back propagation error, which can effectively avoid the problems of gradient explosion and gradient disappearance.

Noise-reducing self-encoder adds noise to input data. By adding noise, the encoder learns the characteristics of real data except noise, which makes the finally obtained coding characteristics more robust. During the training of the automatic encoder, a new signal will be generated at the decoding layer for each training sample. In this article, the encoder part of the network takes color pictures with resolution of 480*640 as input. The self-encoder consists of six convolution blocks, each convolution block consists of two convolution layers. After convolution operation of the encoder, the low-dimensional features of color pictures are mapped to the high-dimensional feature space. Sparse self-encoder with sparsity restriction is added to the intermediate feature coding. Sparse self-encoder mainly solves the redundancy and complexity of deep convolution network, and adds regularization term to the hidden layer. This is helpful for the network to control the self-encoder coding to get the advanced features with sparsity when optimizing.

In this article, the normalized samples are trained until they converge under the condition that the total error is less than the given error. When the difference between the actual output and the target value is large, the error will be propagated back, and the connection weight will be revised continuously until the output error meets the accuracy requirements or the set quantity of iterations. First, the output of neurons in each layer is calculated from front to back:

$$O^{(q)}(q=1,2,3,\ldots,4) \tag{1}$$

Membership function establishment layer:

$$O^{(2)}=\mu_{ij}^{(2)}=\exp\left(-\frac{(x_i-c_{ij})^2}{2\sigma_{ij}^2}\right) \tag{2}$$

Hidden layer:

$$\begin{aligned} &Net^{(q)}=\sum_{q=1} w_{ij}^{(q)} \\ &O^{(q-1)} \\ &O^{(q)}=1/\left(1+\exp\left(-Net^{(q)}\right)\right) \end{aligned} \tag{3}$$

Calculate the error of actual output and expected output every time. Calculate the weight corrections $\Delta w_{ij}^{(4)}$ and $\Delta w_{ij}^{(3)}$ of the fourth layer and the third layer from the back to the front, and use the back-propagation algorithm of the additional momentum term to calculate the center correction value Δc_{ij} and the width correction value $\Delta \sigma_{ij}$ of the membership function of the second layer. Correction. After the minimum error is reached, the fuzzy quantity is defuzzified to get the final result.

The network is composed of multiple layers, and each layer is composed of multiple sensors. Dendrites can be abstracted as the input of perceptron, axons can be abstracted as the output of perceptron, and a threshold needs to be set to simulate the excitement of cell body. In the case of uneven distribution of sample data, standardizing the data is a very common skill of model training. Data standardization refers to transforming the distribution of data into a distribution with a mean value of 0 and a variance of 1. This practice will speed up the change of gradient descent during training, and the accuracy of the final model test may also be high. The standard NN learning algorithm uses the static steepest descent method, and the learning rate is a constant, so it is difficult to adaptively judge the running stage of the algorithm and cannot automatically adjust the learning rate value. Therefore, this article adopts traingdx training method, that is, the learning algorithm of adaptive learning rate with momentum factor. The structure of Point Net network based on DL in this article is shown in Figure 2.

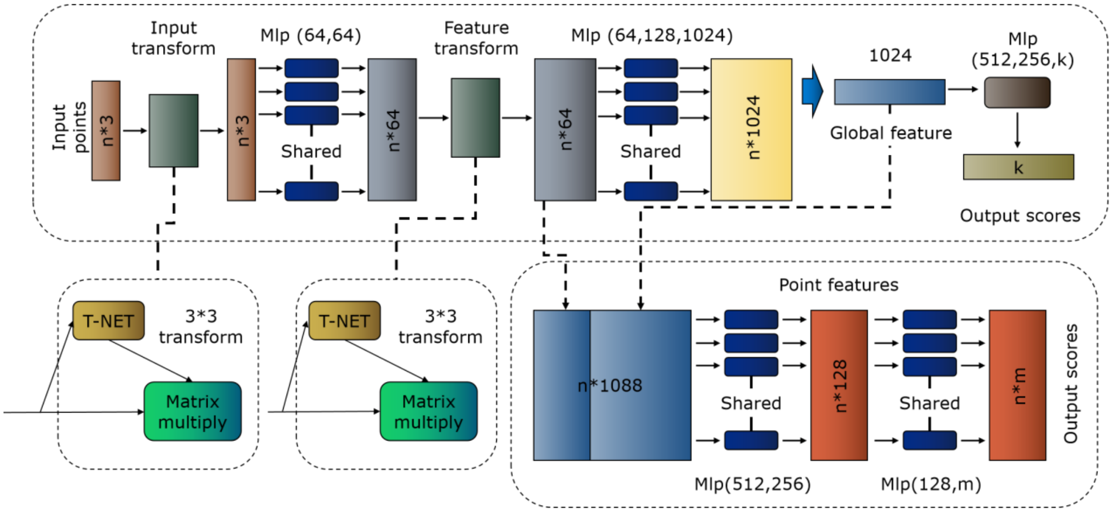

Figure 2: DL-based Point Net network structure diagram.

Point Net is divided into classified network module and divided network module according to different functions. After dividing the network module, the global features are obtained, which are combined with the 64-dimensional local features of a single point through full connection, and then each point after combination is searched in the global features. Finally, the segmentation results of n points in k categories are obtained through the processing of two multi-layer perceptrons. In the hidden layer, each layer takes the output values of all neurons in the previous layer as input values, and then combines them with the previous weight to calculate the output by nonlinear operation. Too few hidden layers may affect the approximation accuracy of nonlinear functions; Too many numbers will increase the network training time, and may also lead to "over-fitting" phenomenon. Therefore, the reasonable selection of the quantity of hidden layer nodes should comprehensively consider the complexity of the network structure to ensure the smooth operation of the network. In this article, the formula for determining the quantity of hidden layer neuron nodes is as follows:

$$G = \sqrt{N + H} + \alpha \tag{4}$$

Where: G is the hidden layer neuron node; N is the input layer neuron node; H is the output layer neuron node; α is usually an adjustment constant between [1-10].

The intermediate feature coding of input data is obtained by using self-coding network, and then the feature of an image is proposed by using Alex Net. The distance loss constraint is constructed by using the feature coding obtained by self-coder. Finally, the image feature extraction network and self-coder network are trained by mixing. In practice, the sample data set is often small. This article adopts a method of artificially synthesizing data, that is, data enhancement. For image data, methods such as image translation, scaling, cropping, rotation and adding image noise can be used to increase the data volume.

4 EXPERIMENTAL ANALYSIS

Using 3D CAD for modeling design can save a lot of design time. Because we can observe the three-dimensional modeling of products from all directions and angles, we can also send the design to users from the network, so that the products are more suitable for the aesthetic taste of the market, save a lot of production funds and increase the competitiveness of products. Based on the research of DL and CAD technology, this article analyzes the innovative characteristics of ceramic art products from the perspective of ceramic art design, and puts forward a 3D CAD modeling algorithm for ceramic art products based on DL. In order to explore the reliability of the method, this section carries out simulation experiments.

In order to narrow the difference between the modeling feature results of ceramic art products and speed up the convergence of the training network, firstly, the modeling feature values of ceramic art products are normalized so that they are all distributed between [0,1]. The effect after numerical normalization is the same as the original, but the normalized value input in DL will not lead to too small gradient of activation function, which can accelerate convergence. The DL network is embedded into the CAD design system, and a computer-aided modeling design system which can timely evaluate new forms in the design process is constructed. Firstly, the DL algorithm is trained for many times, and the result of data error changing with noise in the training set is shown in Figure 3.

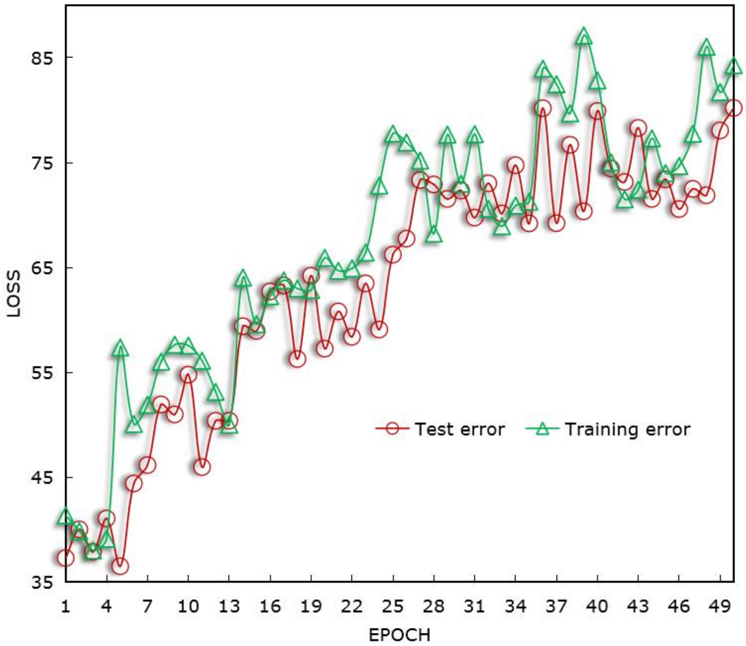

Figure 3: Variation results of data error with noise in training set.

The purpose of maximum pooling and global average pooling in this article is to reduce the feature dimension and network parameters, and to fuse multi-view image features. The purpose of the two fully connected layers is to increase the nonlinear expression ability of features. In addition, DL algorithm is sensitive to the initial value of neurons, and the quantity of iterations for different initial values to reach the optimal solution is different, so it is necessary to choose the appropriate initial value in this algorithm.

In the CAD model of ceramic art products based on DL algorithm, the outline layer can be opened and the three-dimensional layer can be closed by using the object characteristics toolbar. Using the viewpoint command, the 3D view is changed into a plane view, and the contour curve and axis are translated out of the three-dimensional area. Generate a symmetrical outline by using a mirror image command; Filling into a semi-sectional view by using a pattern filling command;

Use other commands to organize into a plan view. After choosing an appropriate viewing angle, 3D surface model can be created by rotating surface, stretching surface and other methods. You can also create a solid model directly through the 3D solid command. In this section, several widely used error evaluation indexes are used to evaluate the algorithm model. The specific formula of each index is as follows:

$$MSE = \frac{1}{n}\sum_{k=1}^{n}\left(y_k - \hat{y}_k\right)^2 \tag{5}$$

$$RMSE = \sqrt{\frac{1}{n}\sum_{k=1}^{n}\left(\left|y_k - \hat{y}_k\right|\right)^2} \tag{6}$$

$$MAE = \frac{1}{n}\sum_{k=1}^{n}\left|y_k - \hat{y}_k\right| \tag{7}$$

$$MAPE = \frac{1}{N}\sum_{k=1}^{n}\left|\frac{y_k - \hat{y}_k}{y_k}\right| \tag{8}$$

Where y_k is the actual value and $\hat{y}_k$ is the output value. In this article, we consider using the above different error indicators to carry out experimental tests to explore the reliability of the proposed method. Table 1 shows the test results of various error indexes of several classical algorithms.

Algorithm	*MSE*	*RMSE*	*MAE*	*MAPE*
Classical BPNN algorithm	5.84	0.635	1.63	0.419
Classical CNN algorithm	6.02	0.619	1.86	0.368
Algorithm in this article	4.37	0.542	1.32	0.254

Table 1: Experimental results of test indexes of several algorithms.

The test results are shown in Figure 4, and the precision performance of the constructed classical algorithm is shown in Figure 5. The F1 value test results of the algorithm in this article are shown in Figure 6.

In order to improve the nonlinear modeling ability of the model, an activation function is added behind each layer of network. The input is the modeling design parameters of ceramic art products, and the quantity of nodes is the quantity of design control parameters. The output is the modeling characteristics of ceramic art products. The network is trained with data, and some samples are reserved as test samples to verify the efficiency of the algorithm. The efficiency comparison of different algorithms is shown in Figure 7.

This section makes an experimental analysis of DL algorithm. The results show that the F1 value of this algorithm is about 93%, and the highest value can reach 96.02%. At the same time, the algorithm has high efficiency and low errors, which has achieved the expected idea. The proposed ceramic image CAD method based on DL can effectively solve the problem that 3D images are not clear and stereoscopic, while maintaining the clarity of ceramic CAD images, and can accurately draw the edge contour of ceramic artworks, thus improving the innovative design level of ceramic art products. The above tests effectively verify the effectiveness and reliability of the algorithm in this article.

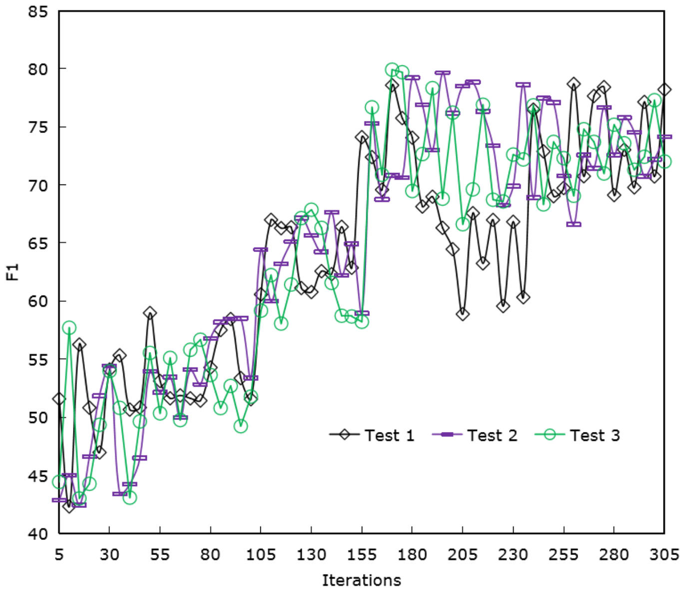

Figure 4: F1 value of classical CNN algorithm.

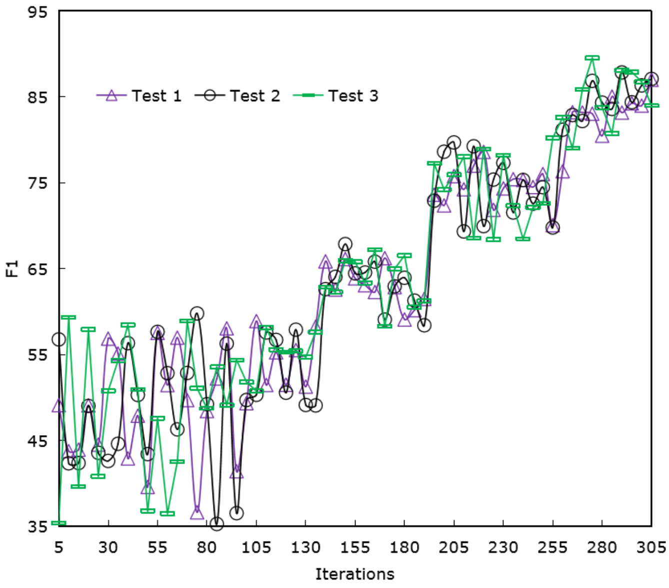

Figure 5: F1 value of classical BPNN algorithm.

5 CONCLUSIONS

The design of ceramic products is no longer a simple artistic act. The involvement of computer technology provides a convenient and fast tool for the graphic design of ceramic art products, and the powerful function of CAD drawing greatly improves the design efficiency. Based on ceramic art design, this article analyzes the innovative characteristics of ceramic art products, and expounds the method of digital 3D modeling in ceramic art product design.

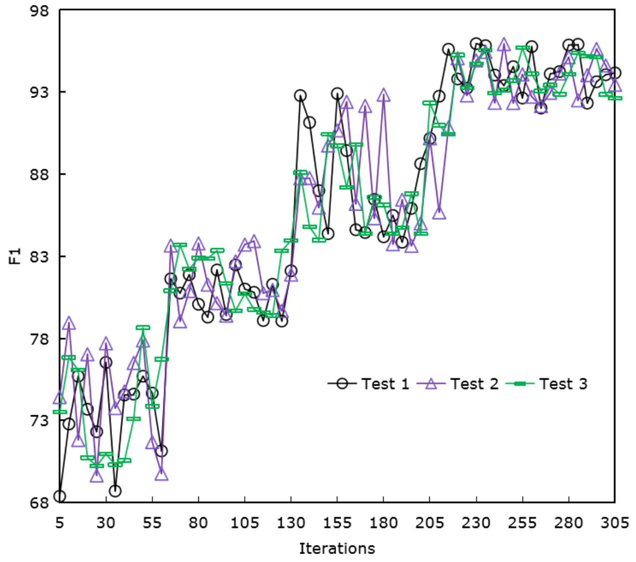

Figure 6: F1 value of DL algorithm.

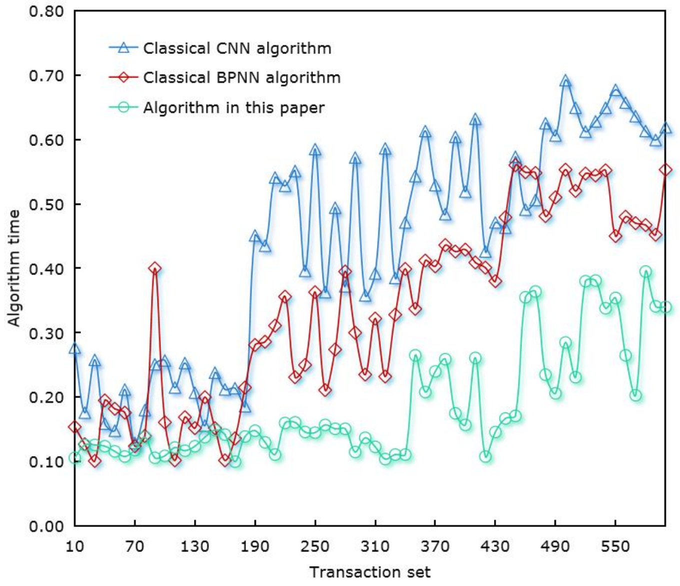

Figure 7: Efficiency comparison of different algorithms.

On this basis, a 3D CAD modeling algorithm for ceramic art products based on DL is proposed. The test results show that the F1 value of the algorithm is about 93%, and the highest value can reach 96.02%. At the same time, the algorithm has high efficiency and low errors, which has achieved the expected idea. The above tests effectively verify the effectiveness and reliability of the algorithm in this article. The proposed ceramic image CAD method based on DL can effectively solve the problem that 3D images are not clear and stereoscopic, while maintaining the clarity of ceramic CAD images, and can accurately draw the edge contour of ceramic artworks, thus improving the innovative design level of ceramic art products.

CAD is intelligent, 3D, integrated and networked. This has opened up more space for the growth of ceramic art products and promoted the diversification of products. Due to the growth of computer technology and software, ceramic art product design based on DL and CAD technology optimization will become more common.

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