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Computer-Aided Design AND APPLICATIONS

Ceramic Automatic Design and Optimization Based on Deep Learning Technology

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Abstract. In the development of Chinese history since the Yuan and Song dynasties, the continuous expansion of the literati class has made elegance psychology become the spiritual and cultural life pursued by Chinese literati. At the same time, it also contributed to the artistic activities of Chinese literati dazzling talent, and decorative porcelain began to rise gradually. Under these circumstances, writing about porcelain is no surprise; It has also gradually become a common subject in paintings. Some people use porcelain modelling to express their spiritual pursuit of life and society, and the aesthetic development of ceramic utensils also reflects the social environment and humanistic features at that time. With the gradual deepening of modern science and technology, the requirements of modern life for ceramic ware are more demanding, which not only needs to meet the inheritance of aesthetics but also meet people's needs for material. Therefore, based on deep learning technology, this paper explores the automatic design of the ceramic model and uses three-dimensional virtual reconstruction technology to optimize the automatic design model under deep learning so as to improve further the effect of ceramic model design in practical application. First of all, it analyzes the style of literati Yaji in history and dialectically treats the relationship between it and ceramic ware from the perspective of literature and aesthetics. Secondly, a clear and complete acquisition of ceramic image features is a prerequisite for the automatic design of ceramic images. We use the deep learning extraction method and neural network as a platform to conduct mechanical labelling and feature training of ceramic images. According to the results of ceramic shape feature extraction, similarity detection and accuracy detection are completed, and the automatic design system model is built. Finally, due to the complex characteristics of ceramic ware, three-dimensional space is needed in the display and automatic design. We add 3D virtual reconstruction technology to optimize the automatic design model under deep learning so as to solve the problems existing in traditional plane modeling. The research results show that the automatic design of ceramic type based on deep learning technology can complete a variety of type requirements with the help of a large number of feature data, and the optimized automatic design system can complete the dynamic adjustment of data parameters and display effects in three-dimensional virtual space.

Keywords: Deep Learning; Literati Collection; Ceramic Utensil Type; Automatic Design; Three-Dimensional Reconstruction
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1 INTRODUCTION

Since its long history, the activity psychology of loving literati has gradually become the activity of the leisure period of Chinese literati. Until the Ming Dynasty, the expansion of some literati class and political frustration made them begin to live in the countryside, devote themselves to learning elegance and good, and pursue a spiritual life isolated from the secular world. In the field of ceramic automatic design, exploring the stable binding mechanism between material surfaces and potential ligands is crucial for developing advanced ceramic materials with specific functions. However, the detection and design of surface binding sites on ceramic materials remains a challenging task due to their complex structure and properties. Aggarwal et al. [1] drew inspiration from deep learning techniques in design and combined them with the characteristics of ceramic materials to develop a new framework called DeepPocket. This framework utilizes 3D convolutional neural networks for deep analysis of ceramic material surfaces, re-mining and optimizing potential binding pockets identified by geometric software such as Fpocket. This process is similar to finding stable complexes between molecules and receptors in design, which requires first identifying and optimizing binding sites. DeepPocket can not only identify the cavities on the surface of ceramic materials but also further segment and refine these cavities to identify the areas with the most binding potential. This special aesthetic orientation and spiritual needs have led to the development of various social sciences and arts. More art forms also changed their status due to the promotion of literati.

In the past fifteen years, although scientific research activities on nanostructured ceramics have flourished, the development of fully dense zirconia-based nanoceramics, especially in clinical applications such as dentistry, is still in its early stages of development. When Arena et al. [2] discussed the extension of the field of ceramic automatic design, the potential of zirconia-based nanoceramics became even more remarkable. This also applies to zirconia-based nanoceramics, which have improved mechanical strength, optical properties, and low-temperature degradation resistance. By precisely controlling the grain size and distribution of nanostructured ceramics, designers can customize the performance of ceramic materials to meet specific application requirements. By combining advanced computational methods and algorithms, designers can simulate and optimize the structure of ceramic materials to achieve optimal performance and cost-effectiveness. With the continuous development of nanostructured ceramics and ceramic automatic design technology, we are expected to see more innovative ceramic products emerge. In ceramic automatic design, designers have been seeking materials that can provide better performance and are easy to produce on a large scale. Nanostructured ceramics exhibit excellent performance improvements due to their reduced grain size to the nanoscale. In addition, ceramic automatic design technology can also accelerate the development process of new materials and shorten the cycle from laboratory to market. On the other hand, in ancient China, the beauty of porcelain spread all over the world, from the Song Dynasty to the Yuan, Ming and Qing Dynasties, pottery penetrated into the life of literati. The function and effect of pottery also gradually changed from the initial tool to the artistic appreciation. In this context, the collection of ceramic ware became an activity for scholars to highlight their own integrity and refinement. With the rapid development of materials science and advanced manufacturing technology, 3D printing technology is gradually becoming a cutting-edge method for manufacturing highly complex ceramic products due to its ability to achieve arbitrary design and infinite combinations of materials. Chen et al. [3] analyzed the key parameters that affect the densification of 3D printed ceramics, such as raw material properties, energy and material interactions. By combining advanced algorithms and computational models, designers can quickly simulate and optimize the structure and performance of ceramics, thereby achieving highly personalized designs. Combining the latest developments in the field of ceramic automatic design, this review not only delves into the four main principles of 3D printing technology.

Although 3D printed ceramics have significant advantages in personalized customization and complex structural design, insufficient density remains one of the main problems that restrict their widespread application. Similarly, stereolithography technology manufactures ceramics by layer-by-layer curing of liquid resin, where the performance and curing conditions of the resin are also crucial for the density of the ceramics. Secondly, it is necessary to precisely control the energy input during the 3D printing process to ensure uniform densification of ceramics. Powder bed melting technology constructs ceramic structures by melting powder particles at high temperatures, and parameters such as raw material properties and laser power will directly affect the density and microstructure of ceramics.

Porcelain has also become a common appliance in life and is closely connected with elegance, indifference and other temperament. Up to the Ming Dynasty, the activities of literati Yaji were mainly based on appreciating the stone, reciting poems and writing fun. Among them, the ancient people enjoy the scene of ceramic utensils. In addition to watching ceramics, playing chess, listening to the piano, appreciating paintings and writing books are also important scenes in the concentration of literati [4].

Ceramics with high, simple, indifferent quality, have become the main content of literati elegant collection activities. In the historical scroll display, the ancient tables are decorated with thick bronze and exquisite porcelain. The accurate classification of pottery plays a crucial role in archaeological investigations, involving the recording of changes in style and decoration, inference of age and ethnicity, analysis of trade routes, and more in-depth research [5]. However, this feature extraction and classification method based on contour images also has the potential to be applied in the field of ceramic automatic design. Meanwhile, it considers two types of interference samples to simulate complex environments in practical applications. These samples were carefully divided into training and testing sets for subsequent analysis and validation. In order to further explore the application of HXCT in ceramic automatic design, seven representative 3D-printed ceramic materials were selected as experimental samples. These algorithms each have their own characteristics and can reveal the internal structure of ceramic materials from different perspectives [6]. During the reconstruction process, we used various algorithms such as filtered back projection (FBP), algebraic reconstruction technique (ART), and maximum likelihood expectation maximization (ML-EM) to reconstruct the structural images of ceramic samples. And take 3D-printed ceramic materials as an example for analysis. These materials include but are not limited to alumina-based ceramics, silicon nitride-based ceramics, zirconia-based ceramics, silicon carbide-based ceramics, etc. Next, select the pixels of the region of interest (ROI) from the reconstructed image and extract the XAS data of these pixels. In the field of ceramic automatic design, the potential of this technology is particularly significant because it can simultaneously capture the morphology and chemical characteristics of ceramic materials. It can be seen that ceramic utensils have rich scientific, historical, cultural and other values. Since the 1990s, the wind of ceramic collection has gradually risen, which has brought a certain impact on the collection of ceramic ware. As a tool, the shape of traditional ceramic utensils is more close to the needs of life. With the influence of literati on ceramic utensils, exquisite, compact and more aesthetic ceramic products have gradually become popular.

Gualandi et al. [7] adopted a novel deep-learning architecture that can capture and parse complex shape information of the inner and outer contours of pottery fragments. The project not only implements an artificial intelligence-based application to identify archaeological pottery but also demonstrates enormous potential in the field of ceramic automatic design. This automated design process not only saves designers time and effort but also helps them explore more design possibilities and combinations.

However, ceramic design is a rigorous discipline, which requires professionals to design and innovate. Designers need to have a keen visual and tactile experience of ceramics, and there are certain subjective components in the design process. This subjective component has brought great limitations to the future design of ceramic ware. Therefore, with the needs of modern life, people's demand for ceramics is becoming more and more complex. Designers should make use of innovative technology and artificial intelligence means such as computers to improve the practical effect of

ceramic design. Among them, image features and element features are the main contents of ceramic design drawings. Due to differences in personal abilities, designers complete product design and planning through continuous trial and error. This unreliable and immature design method has obvious defects. Therefore, some experts have proposed the use of deep learning and machine vision processing to complete the automatic design of ceramic ware. From the above background, this paper also explores the effect of deep learning algorithms in the automatic design identification and optimization of ceramic ware.

2 RELATED WORK

In technical education, ceramic production not only cultivates students' hands-on and innovative abilities but also increasingly focuses on the integration with ceramic automatic design technology to enhance their technical vision and adaptability. In an innovative ceramic class, Guan et al. [8] received guidance from the teacher on basic ceramic techniques and had the opportunity to experience the application of automatic ceramic design. The research results indicate that compared to the control group, students who use VR-based learning methods not only exhibit higher creativity in ceramic products but also have a deeper understanding of ceramic automatic design. Compared with the paper-based teaching method, the virtual reality-based teaching method not only improves students' behaviour, emotions, and social participation but also provides opportunities for students to interact with ceramic automatic design technology. In today's era of digitization and automation, pottery production is no longer limited to traditional production methods but is combined with advanced technological means to explore more possibilities. In order to construct a complete learning process of observation, action, and reflection, we introduced a ceramic-making method based on virtual reality and applied it to technical education in a junior high school. They are able to integrate automatic design technology with pottery production better, creating more innovative and technically rich works.

Hill et al. [9] paid special attention to the important role of ceramic oxide and nitride materials in promoting the development of this technology. Ceramic oxide and nitride materials provide ideal material choices for the manufacturing of 5G devices due to their unique physical and chemical properties. Ceramic materials have always played an indispensable role in wireless communication equipment due to their excellent electrical, thermal, and mechanical properties. We will analyze the historical applications of ceramic devices in wireless communication technology, especially in mobile phones and base station infrastructure, and their potential future applications in 5G systems based on the latest developments in the field of ceramic automatic design.

With the rapid development of the national economy, the material and spiritual cultural needs of the people have been constantly increasing. The standardization and scientificity of computer-aided design Auto CAD drawings provide scientific data and standardized design schemes for the production of daily ceramics and provide a scientific basis for expanding reproduction and large-scale production. Hu et al. [10] studied the scientificity of computer-aided design Auto CAD in the design and drafting of daily ceramics. The paper studied the application of examples in the design and drafting of daily ceramics. By summarizing and organizing a large number of examples, the scientific laws of computer-aided design and drawing of daily ceramics were summarized. People have increasingly high requirements for the quality and demand of daily ceramics. Under the scientific guidance of computer-aided design and drawing, daily ceramics are developing towards large-scale industrialization and healthy development. Focusing on the research of design data standardization starts with production needs and rigorously designing data standards. This paper focuses on demonstrating the advantages and scientificity of computer-aided design Auto CAD and verifies the role of computer-aided design in the industrial production of daily ceramics. Inkjet printing technology is highly favoured in the ceramic industry due to its ability to endow tiles with rich and realistic patterns. However, existing machine learning methods based on manual features can achieve certain results on simple patterned tiles. Although emerging deep learning-based methods have the potential to be applied to complex pattern detection, their high complexity makes it difficult to meet the needs of real-time detection. Especially in complex patterns, these defects are difficult to

identify with the naked eye, which brings great difficulties to the quality inspection of ceramic tiles. This technology also faces challenges such as nozzle blockage and inconsistent inkjet volume in inkjet printing equipment, which often lead to defects such as retention and colour blocks on the surface of ceramic tiles. In addition to optimizing defect detection, Lu et al. [11] extended this technology to the field of ceramic automatic design, providing designers with new design tools and inspiration. In the field of ceramic automatic design, HFENet can assist designers in avoiding potential printing problems when creating complex patterns.

Silicon carbide ceramics are important structural materials with extensive applications in industrial production and high-tech fields. The emergence of ceramic 3D printing technology has overturned the traditional ceramic manufacturing mode and has enormous development potential in the manufacturing of complex structures and composite performance ceramic components, integrated moulding, lightweight design, shortening research and development cycles, and reducing product costs. Direct writing moulding technology and UV curing moulding technology have received widespread research and attention due to their advantages of simple process, wide material applicability, and high moulding accuracy, respectively. However, traditional silicon carbide ceramic processing technology requires the use of moulds in the process of preparing ceramic billets. Mahouti et al. [12] proposed two new methods for preparing silicon carbide ceramic composites based on 3D printing technology combined with reactive infiltration sintering. Firstly, the preparation of silicon carbide composite slurry for direct writing moulding was carried out. This makes the entire production cycle time-consuming and costly and poses significant limitations in manufacturing ceramic components with complex shapes and composite structures. A water-based silicon carbide ceramic slurry with shear thinning behaviour was prepared using sodium alginate as a binder and silicon carbide powder, shortcut carbon fibre, and carbon black as raw materials, using the strategy of adding binders to improve the modulus of the slurry. Afterwards, a self-built direct writing moulding device was used for 3D printing, and the densification and near-net forming of silicon carbide ceramic composites were achieved through reaction sintering at 1650 ° C. The multiple printing layers and plastic film substrate significantly improve the cracking condition of dry bodies. Extrusion shear force induces directional distribution of short-cut carbon fibres. Navarro et al. [13] investigated the effects of printing conditions, slurry solid content, carbon black and shortcut carbon fibre content on sample forming and sintering. The sintering shrinkage rate of the sample is less than 2%, and the density is greater than 99%. The bending strength shows a trend of first increasing and then stabilizing with the increase of carbon black content, with a maximum bending strength of 275.26 MPa. With the increase of short-cut carbon fibre content, the viscosity of the slurry decreases, and the shear stress first increases and then decreases; The viscosity of the slurry is the lowest when the content of short-cut carbon fibre is 25vo1%. The slurries with different amounts of carbon black and short-cut carbon fibre have high dispersibility and exhibit typical shear thinning behaviour, which can meet the needs of direct writing moulding.

By training models to identify successful elements and reasons for failure in historical designs, AI systems can generate new design proposals that not only meet specific performance requirements but also have innovation and practicality. In the field of ceramic automatic design, deep learning models are used to learn and identify complex relationships between various design parameters [14]. By simulating and analyzing the performance of different designs under stress, temperature, and other environmental factors, AI systems can find the optimal structural configuration to achieve maximum strength and stiffness while maintaining the lightweight characteristics of the material [15].

3 PATTERN RECOGNITION AND AUTOMATIC DESIGN OPTIMIZATION OF CERAMICS

3.1 Type Feature Recognition

It has become the traditional etiquette and fine tradition that the gentleman meets his friends with literature and helps benevolence with his friends. The elegant collection of Literati also represents the gathering activities of the literati and officials with the same personality ideal. Various cultural

activities such as piano, chess, calligraphy, painting, poetry, etc. are carried out in the same scene to express the mood and highlight the spiritual outlook. This phenomenon of elegant collection has become a unique landscape in Chinese history and culture. With the evolution of the historical dynasties, the activities of literati show different styles and characteristics, from traditional chess and poetry to the appreciation of instruments and art. Under the depiction of the historical scroll, in the place where the literati gathered, ornamental objects mainly based on ceramic utensils frequently appeared. As an ornamental handicraft, ceramics also has its own unique characteristics. Ceramic first colour highlights the pure beauty, the high development of this simple glaze colour, whether celadon, white porcelain or other glaze colours, reflects the realistic description of the words such as sunny after rain, green colour, and autumn water shear wave. The relationship between Yaji and literati lies more in the friendship of gentlemen, so the ceramic type and ceramic appreciation became the hot objects in the cultural circle at that time.

The deep learning algorithm is a minimum unit computing method that takes neural units as information processing and intelligent devices are formed through the establishment of neural units and neural networks. The deep learning algorithm also completes the classification task processing of machine learning through the perception model, carries out secondary classification for the input multidimensional data features, uses the gradient downward algorithm to train the data samples, and completes the automatic learning update and weight result output. This makes the neural network not only have the function of learning but also the effect of training. Traditional neural networks and deep learning algorithms can only deal with linear problems on single-layer perceptrons, and cannot learn nonlinear or functional relationships, which also makes deep learning algorithms fall into a trough. Subsequently, with the inspiration of convolutional neural networks, the operation of the human visual system has become the core content of deep learning. Through the input data neuron competition, output the most responsive data information. The multi-layer neural network is added to the training model by using the self-updating method of deep learning. This makes deep learning go further towards imitating the operation mechanism of the human brain and lays a solid foundation for subsequent applications in various fields.

American researchers applied deep learning algorithms in automotive sensing equipment for the first time. In the optimization process of automotive internal structure, deep learning is used to complete mechanism training, so as to improve the sensitivity and accuracy of automotive sensing equipment. It also meets the need for more agile interaction between humans and machines. They also propose backpropagation algorithms to optimize deep learning models, allowing input information to be processed through layers to complete the desired goal. With the addition of backpropagation, errors in data iteration can be automatically corrected. German researchers put forward the use of deep learning algorithms to deal with data prediction and other problems. We found that data training and gradient calculation in deep learning can reduce the noise in the information, thereby improving the effectiveness of the result prediction. Both the quantity and quality of literati collection activities have reached the highest level in the historical dynasties. The appreciation of lyrics has become an important part of the life of literati, which is related to the prosperity of culture and economy at that time, and the demand of literati for art and special aesthetic taste. From a large number of literary and painting works in the historical dynasties, it can be known that the type of ceramic ware has changed greatly with the changes of The Times. Ceramic is also a general term for pottery and porcelain, which has a long historical value in human production and life. Ceramics use clay and other minerals as raw materials, and after formulation, design, crushing, moulding and high-temperature firing, gradually react into hard substances. It has many kinds of daily necessities and art appreciation, in addition to strong practicality, but also has higher aesthetic literacy. In the gradual development of craft technology, ceramic design reflects the comprehensive content of the technological level of The Times, artistic style, cultural elements and so on. We made statistics on the number of research times in the era of rich ceramic-type design in the historical dynasties, as shown in Figure 1.

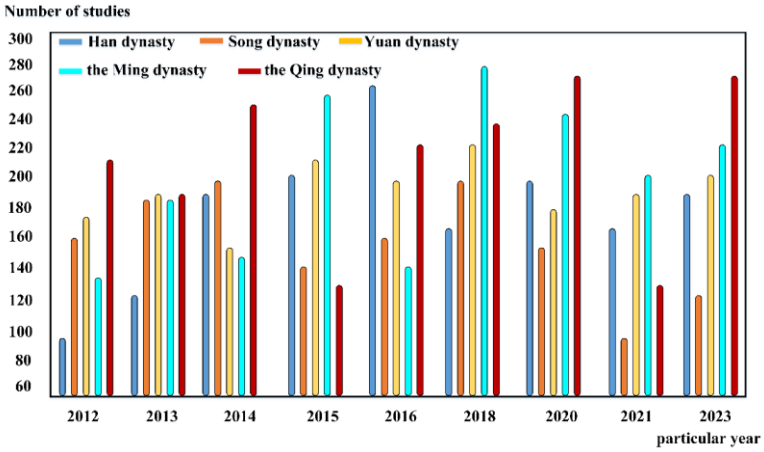

Figure 1: Changes in the frequency of research on ceramic design during historical dynasties.

As can be seen from Figure 1, with the change in research time, the number of research times in the middle Han Dynasty, Song Dynasty, Yuan Dynasty, Ming Dynasty, and Qing Dynasty fluctuated greatly, which can also reflect the change in people's appreciation of ceramic utensils in different periods. Chinese ceramics are an important part of the Chinese cultural heritage because of their extensive development system and widespread. The design of ceramic types related to ceramic technology has also become a hot topic in current research. In order to complete the construction of a ceramic automatic design system, we need to combine deep learning algorithms and use machine learning to simulate human thinking to complete complex design requirements. Let the deep learning algorithm process the collected ceramic image or video and other data, and through the calculation of two-dimensional image information, the automatic design system is built by integrating mathematics, statistics, and probability disciplines.

The representative data information is added to the morphological and image analysis, and the instrumental database is established. The data of ceramic style is quantified, and the related design style network is set up. By using the deep learning algorithm, the useful feature points in the ceramic model are judged, geometric analysis and gradient training are added, and finally, the automatic design sample of the ceramic model is output. Since ceramic image features are easily affected by style and decorative elements in the extraction, we need to generalize the relevant background pixels and image features before digital image processing. Among them, the input sample of the ceramic image is 1:1 of the original image, and the resolution of the scanned original image in both vertical and horizontal directions reaches 300 dpi. Firstly, different colours of ceramic ware are divided into spaces, and black and white pixels are used to represent them. Colour space reflects the depth of human vision, and there is no correlation between colour and brightness, so we set the value of colour space as follows:

$$V = \max(R,G,B)_0 \tag{1}$$

$$S = 1 - \frac{\min(R,G,B)}{V} \tag{2}$$

In ceramic design, different types of patterns and features will change the spatial feature vector. Use the above formula to redefine the colour value of the device design:

$$R = \frac{V - R}{V - \min(R,G,B)_0} \tag{3}$$

$$G = \frac{V - G}{V - \min(R,G,B)_1} \tag{4}$$

$$B = \frac{V - B}{V - \min(R,G,B)_0} \tag{5}$$

We need to quantify and identify the feature values, adopt a grey mixed matrix and texture feature recognition formula, normalize the feature points of different elements, and use Euclidean-style distance to represent the data formulas of different dimensions:

$$\begin{Bmatrix} X = (x1, x2, x3, \ldots, xn) \\ Y = (y1, y2, y3, \ldots, ym) \end{Bmatrix} \tag{6}$$

The larger the distance in the space vector, the larger the gap between feature points, and the smaller the distance, the closer the similarity of feature points. The above space vector formula is summarized as:

$$(F1, F2) = \sqrt{\sum\nolimits_{i=1}^{n} (f_{1i} - f_{2i})^2} \tag{7}$$

It is assumed that the ceramic image in the matrix is composed of pixel translation, and the feature points conform to the grey value. Next, the whole image is counted, and the probability of different grey elements appearing at the same time is calculated as:

$$p(g1, g2) = \frac{p(g1, g2)}{R} \tag{8}$$

$$R = \begin{cases} N(N-1), L = 0 \\ (N-1)2, M = 45 \end{cases} \tag{9}$$

In the formula, P Represents the result of a probability calculation. After roughness calculation, pixel smoothing data is used as a convenient input to enhance the mean calculation result:

$$A_k(X,Y) = \sum_{j=0}^{i} x + 2^{k-1} \,/\, x - 2_{k-1} \tag{10}$$

$$B = (x,y)_0 + \sum\nolimits_{j=y-2}^{y+2^{k-1}-1} g(i,j) \tag{11}$$

Among them, B Represents the intensity value of the design image when the feature point pixel is a grey value. Since the image is easy to encounter obstacles in multidimensional space, such as smoothness, curves, or broken lines in the process of generating different shapes, we also need to carry out geometric processing on the shape design:

$$F = (x,y,z) \frac{1}{m \times n} \sum\nolimits_{i=1}^{m} s \tag{12}$$

$$F_{con} = \frac{\sigma a^4}{x + y + z} \tag{13}$$

In the formula, F_{con} Represents the contrast ratio in the spatial dimension. The direction is related to texture, element and shape arrangement, which is the embodiment of the overall style of ceramic ware, so we need to arrange and combine it. The formula is defined as follows:

$$u = \sum_{j=1}^{n} pw_{t+1}(x+y)(y-z)^2 \tag{14}$$

Considering that geometric matrices need to be compared and classified in the automatic generation of features of different ceramic types, we define the identification accuracy of classification:

$$f(x) = \int_{\infty}^{x} \sqrt{2x} dt \tag{15}$$

The correlation point features of ceramic shape extracted by deep learning algorithm are prone to blur the edge contour after numerical calculation, so we also need to add binary image pixel processing to strengthen the geometric texture of ceramic shape by using grey value.

3.2 Automatic Design Optimization

Ceramics is the wisdom of the Chinese people, and it is also a representative object in the development of ancient history. With the improvement of the material level and the progress of The Times, the ceramic type has gradually changed from practicality to aesthetics and artistry. Each ceramic ware itself reflects the culture and manufacturing style of a different period of the contemporary era. Utensil type refers to the appearance shape of the mouth, bottom, neck, shoulders, feet, abdomen and other positions of the ceramic utensil. In the past few years, deep learning algorithms have proved to be excellent machine learning and training models in many fields, which perform data representation at an abstract level through multi-layer processing calculations. In turn, the complex structure of large-scale, dynamic data can be captured. Because of the traditional deep learning technology in the process of ceramic automatic design, most of the images generated face the plane layer. If we want to improve the performance and aesthetics of automatic ceramic design, we also need to optimize the deep learning automatic design model by using 3D recombination and virtual modelling. The optimized deep learning training structure and ceramic shape recognition effect are shown in Figure 2:

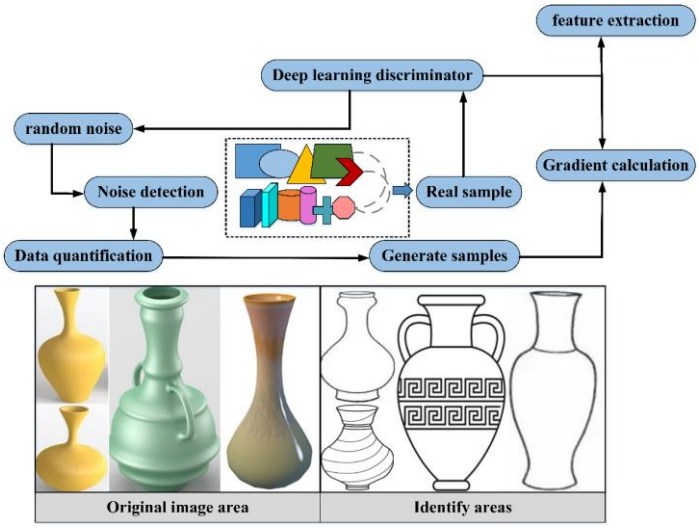

Figure 2: Optimized deep learning training structure and ceramic shape recognition effect.

As can be seen from Figure 2, real sample data is added to the deep learning neural network discriminator to complete the classification and processing of sample data, and the automatic design image after gradient calculation is output through the quantization of random noise and relevant feature points. Then, the image is added to the 3D virtual modeling system to realize the recognition and extraction of ceramic type. The representation method of the three-dimensional model can display the shape of the ceramic directly in front of the eyes, and it has more depth information than the two-dimensional plane. At the same time, we also added the renderable ceramic display effect in the virtual construction of the 3D model. Two conditions need to be prepared before the start of the renderable process: one is the relevant data provided by the deep learning automatic design model, and the other is that the renderable database needs to be infinitely close to the actual work of the ceramic. The 3D model parameters can be added to the renderer to complete the display after the

automatic design of the ceramic model. We will represent the renderable process and the 3D projection of the image, as shown in Figure 3:

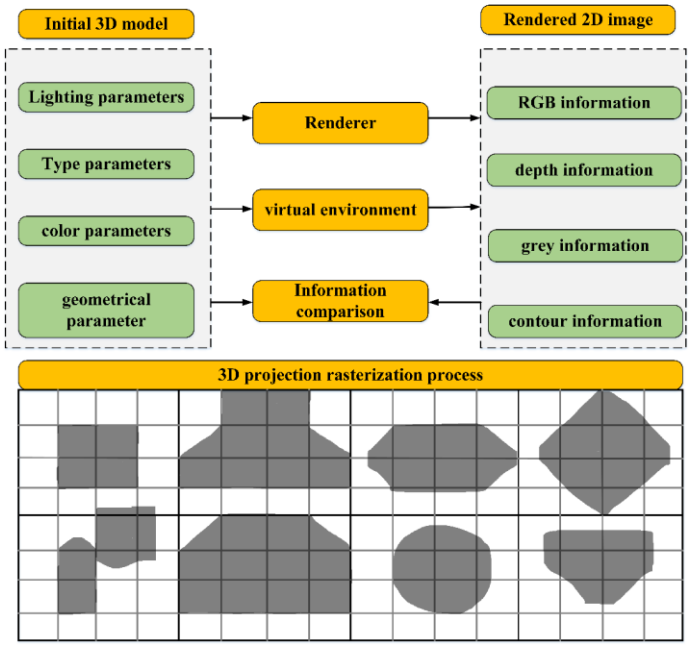

Figure 3: The rendering process and three-dimensional projection gridding of images.

As can be seen from Figure 3, the initial 3D model includes relevant parameters of the ceramic utensil-type structure. After the relevant parameters are added to the renderer, the slice information of the two-dimensional plane is obtained. After texture, information processing, contour processing and other steps, it is compared with the physical image. In the three-dimensional projection representation, each pixel can only have two states, that is, black and white pixels together represent the outline shape of an object. In the follow-up research, we also verified and analyzed the actual effect of deep learning and its optimization algorithm in the automatic design of ceramic ware.

4 ANALYSIS OF RESEARCH RESULTS

4.1 Research Results

It is a complicated task to use machine learning to generate a ceramic pattern recognition process. Before the start of the experiment, we need to query the ceramic image that meets the requirements according to certain standards, and then input this initial data information into the deep learning training model. In the external visual characteristics and judgments, ceramic ware forms are closely related to their constituent materials. In the process of its production, the relevant raw materials used by different types of porcelain will bring changes in the style of porcelain. As the main component of ceramic ware, glaze structure can make ceramic works show colourful colour features. These colour features and background elements will affect the recognition effect of deep learning on ceramic ware features. To this end, in the automatic ceramic design system formed by the deep learning algorithm, we add ceramic samples with different colour backgrounds to judge the effectiveness of the algorithm.

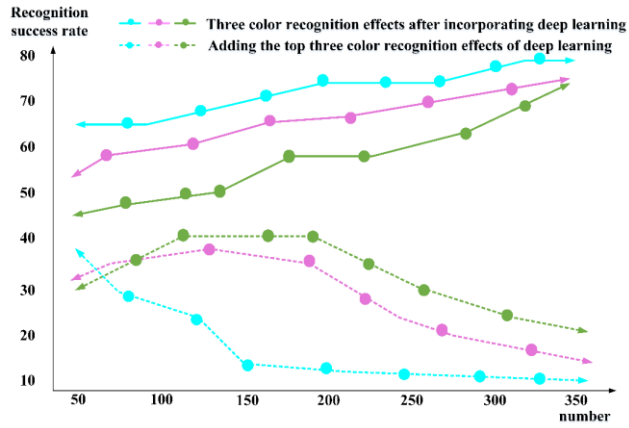

Figure 4: The recognition effect of ceramic pattern samples with different coloured backgrounds.

As can be seen from Figure 4, pink, light blue and white were selected as colour elements in the selection of ceramic ware types, and the feature recognition effect of the automatic design system for ceramic ware types before and after the addition of deep learning was compared. It can be seen that the automatic design system formed by deep learning can effectively distinguish the ceramic ware types in different colours and is less influenced by colour elements. In the automatic design model formed by the deep learning algorithm, pixels are automatically recognized as the background in the selection of the target body, and the geometric lines of the ceramic ware are used as the two-layer background for feature processing. However, the gap between the plane sketch provided by the automatic design model and the actual work needs to be reflected through the three-dimensional model construction. At the same time, we also found that in the mutual integration of ceramic and literati, the works with exquisite design of ceramic can better reflect the related descriptions in literary works.

4.2 Analysis

The continuous evolution of ceramic type in the historical evolution reflects the culture and craft level of a specific period, and the inheritance of ceramic type style also allows modern design to further blend with it. At present, the problems facing ceramic product design mainly come from the fact that the design of the finished product needs to consume a lot of manpower and material resources, and the designer needs to have a certain painting foundation. Many ceramic design enthusiasts who have no foundation in painting are discouraged from using ceramic design. There are many kinds of ceramic ware with different shapes. In order to complete the design of ceramic ware, we need to learn a lot of historical documents. Therefore, in our research, we hope to use deep learning optimization technology to realize the automatic design process of ceramics under the style of literati. On the basis of the experiment, 3D virtual reconstruction is added to optimize the deep learning algorithm so as to increase the display effect of the automatic design of ceramic ware. First of all, we collate the data set, and through literature investigation, we know that the number of various ceramic ware types is distributed in bottles, bowls, cups, POTS, bottles, and plates. Through the analysis of these types of ceramics, it is known that three-dimensional space processing is required at the geometric level. Therefore, we compare the changes in design image accuracy of automatic design of deep learning ceramics after adding three-dimensional virtual reconstruction. As can be seen from Figure 5, before the deep learning algorithm is optimized, the ceramic shape contour formed is relatively fuzzy in terms of accuracy. The accuracy of design image output by automatic generation system with 3D virtual reconstruction is higher. In the experiment, we also added rendering techniques to increase the display effect of 3D models.

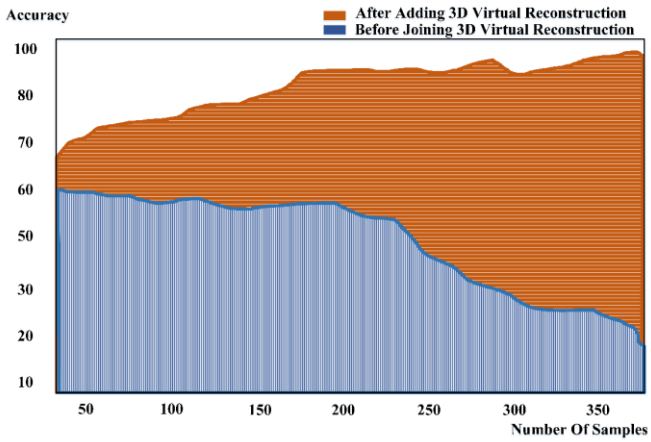

Figure 5: Changes in the accuracy of deep learning algorithms before and after use.

Set the distance between the render camera and the model to two meters and the azimuth Angle to between 180 degrees. According to the above constraints, the 3D model of ceramic ware was randomly selected under different camera positions. Compare the coefficients of the optimized rendering model in authenticity, as shown in Figure 6.

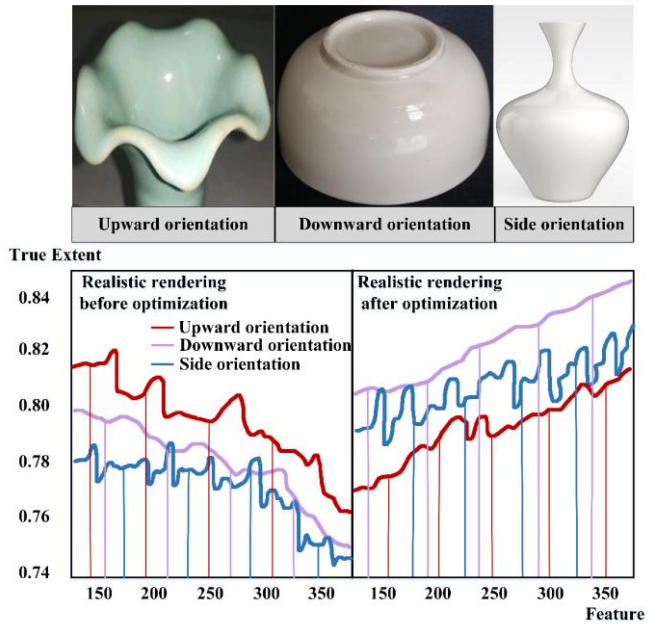

Figure 6: Comparison of authenticity before and after system optimization.

As can be seen from Figure 6, we extracted the 3D model of the ceramic shape design from the three angles of the top orientation, the bottom orientation and the side orientation respectively. Through the authenticity comparison of the rendering model, it can be seen that the optimized automatic design system of the ceramic shape has a higher degree of authenticity. It can be seen that the algorithm proposed in this paper has good practicability.

5 CONCLUSIONS

With the development of the social economy, people pay more and more attention to the elegant activities in history, and the literati integrate into the spiritual material that modern people pursue. In reposting the soul and edifying the taste, the literati set carries the Chinese historical and traditional culture. The social development and cultural connotations in different periods have a certain impact on the appreciation of the angle of ceramic utensils. As an important treasure in China's long history, ceramic ware has attracted wide attention in many aspects, such as its type design and colour-matching display. Based on deep learning technology, this paper probes into the automatic design process of ceramic ware under the Wenya collection and optimizes the automatic design system of ceramic ware with 3D virtual modeling. Firstly, a deep learning algorithm is used to extract and analyze the image features of different ceramic types. Deep learning algorithm has good generalization and gradient computing ability. With the continuous improvement of learning quantity and accuracy of data extraction, we have also achieved certain advantages in feature judgment. Secondly, it is known from the literature survey that there are many complicated styles of ceramic ware. We use three-dimensional virtual reconstruction to transform the two-dimensional image formed by deep learning into a 3D model and solve the spatial problem in the feature extraction and recognition of ceramic ware. Finally, the three-dimensional grid representation of ceramic ware is realized by the optimization algorithm, which solves the problem of noise and authenticity in data calculation. Automatic ceramic design works are generated in 3D space and virtual environment and displayed in real scenes. The research results show that the automatic design system based on deep learning and 3D reconstruction optimization can meet the needs of modern people for stylish ceramic artworks, and the optimization algorithm also has a good effect on feature extraction and recognition generation.

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