Research Article

Traditional Ceramic Sculpture Feature Recognition Based on the Machine Learning Algorithm

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Aiming at the problems of low recognition accuracy, high line noise, and high time cost of feature recognition in traditional ceramic sculpture modeling feature recognition methods, this paper designed a traditional ceramic sculpture modeling feature recognition method based on the machine learning algorithm. By constructing the sparse representation model of a traditional ceramic sculpture image, the posterior probability of a traditional ceramic sculpture image was determined and Gaussian distribution of pixels in the image was carried out to determine the distribution law of pixels in the image and the super-resolution reconstruction of the traditional ceramic sculpture image was realized. The feature of the line state of a traditional ceramic sculpture image was determined and classified by the kernel classification method. Finally, the machine learning algorithm red BP neural network is introduced to construct the traditional ceramic sculpture modeling feature recognition algorithm and the error threshold is constantly iterated to realize the traditional ceramic sculpture modeling feature recognition. The experimental results show that the recognition algorithm designed in this paper has high accuracy in identifying the traditional ceramic sculpture features, can effectively suppress the line noise, and has a short recognition time overhead, which has a certain feasibility.

1. Introduction

The original origin of pottery can be traced back to the first living utensils invented by the ancestors on both sides of the Yellow River basin in ancient times. At that time, the utensils were more practical and mostly needed for life. Therefore, although the pottery sculpture in ancient times had its prototype, it did not realize its real “artistry” and paid more attention to usability [1]. With the exchange and replacement of various dynasties, ceramic sculpture has gradually realized its “artistry.” It is no longer simply used as a living vessel, but as a work of art that contributes to the royal family and nobility. After the development of Chinese contemporary sculpture in 2000, the introduction of media and images has affected the development of contemporary culture, making the sculpture in this period have new changes, and ceramic sculpture, as a branch of sculpture, has also changed [2]. Ceramic sculptures in this period are full of the flavor of modern science and technology. The intervention of light, shadow, and image enhances the interactivity of ceramic sculptures, making their visual colors rich and colorful and instantly attracting people’s attention. Among the traditional ceramic sculpture art, the traditional ceramic sculpture is an important aspect in modeling but it has not received people’s attention. People pay more attention to ceramic glaze, focusing on the decorative patterns and colors of ceramics; it is easy to ignore the importance of modeling. Modeling determines the basic structure and form of ceramics, as well as the efficacy of traditional ceramic sculpture. Modeling is the foundation of the beauty of utensils [3]. In China’s traditional ceramic sculpture, in China’s traditional ceramic modeling, the modeling lines are some free curves, not straight lines or geometric curves. The outline of traditional ceramic modeling is generally euphemistic, tortuous, free, and vivid, and the charm shown is suitable for aesthetics. Therefore, the modeling of a traditional ceramic sculpture expresses very key emotions [4]. With the continuous changes of people’s life and social needs, the attention of traditional ceramic sculpture to its shape gradually decreases in the process of creation, which affects
the overall beauty of a traditional ceramic sculpture and ignores the transmission of cultural emotion. Therefore, in the production of a traditional ceramic sculpture, the recognition of its modeling features has become the key to improve the quality of a traditional ceramic sculpture \[5\]. Therefore, relevant researchers have done a lot of research on the traditional ceramic modeling feature recognition methods and achieved some results.

Reference \[6\] designed a product shape recognition method based on the product image and applied this method to the shape feature recognition of a traditional ceramic sculpture. According to the difference of the product image between different brands, this method creates the product shape with brand identification characteristics and puts forward the shape design method based on the principle of product image. According to the recognition composition of product image vision and concept, combined with the data analysis of modeling feature recognition experiment and evaluation, the modeling features with high recognition degree are extracted and analyzed. The semantic difference method is used to extract the elements of the product image style, and its modeling recognition semantics is analyzed. Finally, integrate the two for brand modeling innovation design. This method is feasible and scientific, but when it is applied to the traditional ceramic sculpture modeling feature recognition, there are fewer recognition parameters, resulting in low recognition accuracy. Reference \[7\] proposes an interactive effect evaluation system of product modeling features based on VR technology, which realizes the recognition of product modeling features through the system evaluation process. In order to improve the performance availability of gesture recognition technology in the product modeling feature interaction effect evaluation system, a product modeling feature interaction effect evaluation system based on VR technology is designed in this paper. The design system is divided into two parts: hardware and software. The hardware part selects the model of a virtual reality helmet and matches the hardware facilities of PC. The software part constructs the overall framework of the software, builds the product appearance model, and improves the compatibility through rendering and format conversion. The membership function of interaction effect evaluation is constructed, 10 kinds of gestures are used as the object index of interaction effect evaluation, and the fuzzy matrix of gesture recognition performance measurement is established. The proposed system is superior to the original system in terms of performance measurement time, number of errors, measurement efficiency, and other indicators and has certain practicability. However, this method does not deal with the noise in the features in the feature recognition and there is some interference, resulting in the problem of poor recognition accuracy. Reference \[8\] proposed a depth network recognition algorithm integrating multidimensional void convolution (MDC) operator and multilevel features, with the help of which the modeling features are recognized. In the target detection model based on the depth network, the algorithm only uses serial convolution operation. The model will lack the ability to describe the detailed information of different levels of the network and the global information of the characteristic graph, weaken the detection ability of small targets, and affect the detection accuracy. Based on the residual network structure, a depth network detection algorithm combining multidimensional void convolution (MDC) operator and multilevel features is proposed. Firstly, the MDC operator is designed. The convolution kernel has five different receptive fields and can obtain eight different semantic feature maps. The feature extraction link of a serial network is introduced to construct the feature layer. Then, the dimension of the detection layer is upgraded by transpose convolution operation, which is used to cascade different levels of feature layers to obtain the detection layer and ensure that the original features of the target can be retained to the greatest extent. Finally, non-maximal suppression is used to complete the construction of the detection algorithm. The algorithm can effectively improve the average detection accuracy of targets and the recognition ability of small targets, but the implementation process of the algorithm is complex and the recognition time is long, which needs to be further improved.

In order to solve the shortcomings of the aforementioned methods, a new modeling feature recognition method of a traditional ceramic sculpture based on the machine learning algorithm is designed in this paper. The machine learning algorithm is the core of artificial intelligence and the fundamental way to make computers intelligent. It is widely used in all fields of artificial intelligence. It mainly uses induction, synthesis rather than deduction. It is an interdisciplinary subject in many fields, which specializes in how computers simulate or realize human learning behavior, so as to obtain new knowledge or skills, reorganize the existing knowledge structure, and continuously improve its performance. This is also the theoretical basis of the concept definition of the machine learning algorithm, and realize the effective identification of its characteristics by introducing the relevant algorithms of machine learning. The effective recognition of its features is realized by introducing the relevant algorithm of machine learning. The main technical route of this paper is as follows:

1. By constructing the traditional ceramic sculpture modelling image sparse representation model, determine the traditional ceramic sculpture shape, the image of a posteriori probability, and the Gaussian distribution with the pixels in the image; determine the image pixel distribution; and realize the traditional ceramic sculpture modelling image super-resolution reconstruction, for subsequent recognition provides the high-quality images.

2. By determining the line state characteristics of traditional ceramic sculpture images and classifying them with the help of the kernel classification method, the line noises in different states are removed with the help of the filtering window to achieve the preprocessing of traditional ceramic sculpture images.

3. The machine learning algorithm red BP neural network is introduced to construct the traditional ceramic sculpture modeling feature recognition
algorithm, and the error threshold is constantly iterated to realize the traditional ceramic sculpture modeling feature recognition.

(4) Through experimental research, the recognition algorithm designed has high accuracy and can effectively suppress line noise in recognition and the recognition time is short, which can be applied to the actual traditional ceramic sculpture modeling feature recognition.

2. Design of the Traditional Ceramic Sculpture Modeling Feature Recognition Method Based on the Machine Learning Algorithm

2.1. Super-Resolution Reconstruction of the Traditional Ceramic Sculpture Modeling Image. A traditional ceramic sculpture is one of the varieties of sculpture. All hard material sculptures made of clay or porcelain clay are collectively referred to as ceramic sculpture. Because ceramic sculptures need to be fired in kilns, their shape cannot be too large due to the limitation of the kiln space, so they are generally in the form of small, on-board, and desk sculptures. Just like the Mausoleum of the First Qin Emperor Terracotta Army, life size pottery works are rare. Large ceramic sculptures are usually fired separately from different parts and assembled again. Ceramic sculptures can produce different visual effects through the surface treatment of glazed and unglazed, overglaze color, underglaze color, and no color. As early as the Neolithic age, Chinese ceramic sculpture art was very popular. In modern and contemporary times, not only ceramic sculpture has survived for thousands of years but also derived the popular modern ceramic art from the traditional ceramic art. This is a comprehensive art integrating the different characteristics of painting, sculpture, arts, and crafts. Good ceramic works are ingenious in conception and unique in shape and pay great attention to the color, material, and texture effects. With their main shape, they give people pleasant aesthetic enjoyment and wisdom enlightenment. In order to realize the modeling feature recognition of the traditional ceramic sculpture modeling image, this paper first reconstructs the traditional ceramic sculpture modeling image with super resolution in order to improve the high-precision recognition of traditional ceramic sculpture modeling. Sr (super resolution) is a classical ill-posed inverse problem. The purpose is to reconstruct HR (high resolution) images from LR (low resolution) observations [9]. In order to make up for the missing information, the reconstruction process needs the prior knowledge of the ideal high-resolution image. In order to make full use of this prior knowledge, the problem of image super resolution is usually modeled as the maximum a posterior estimation problem [10] and the image with better visual quality is reconstructed by maximizing the posterior probability of the high-resolution image. In order to reconstruct the high-resolution image more truly, the selection of the prior distribution of the original high-resolution image is very important. Therefore, in this super-resolution reconstruction of traditional ceramic sculpture modeling image, it is effectively reconstructed through sparse characteristics, so as to obtain the traditional ceramic sculpture modeling image with better resolution, which lays the foundation for subsequent recognition.

Figure 1: Schematic diagram of modeling image characteristics of the traditional ceramic sculpture.
According to the determined maximum a posteriori probability estimation value, the pixels in the traditional ceramic sculpture modeling image are Gaussian distributed [12] and the following results are obtained:

\[
G[\beta(a)] = \frac{1}{\sqrt{2\pi}\theta_n} \exp \left( -\frac{1}{2\theta_n^2} ||a - Da||^2 \right). \tag{3}
\]

Among them, \( \theta_n \) represents the standard deviation of the Gaussian distribution of pixels in the unified ceramic sculpture modeling image.

In order to improve the stability of pixels in the Gaussian distribution in traditional ceramic sculpture modeling images, \( a \) needs to follow the Laplace distribution with zero mean:

\[
P(a) = \prod_i P(a_i) \times \prod_i \exp \left( -\frac{\sqrt{2}|a_i|}{\eta} \right). \tag{4}
\]

Among them, \( \eta \) represents the standard deviation value of the pixel point distribution in the traditional ceramic sculpture modeling image.

In the super-resolution reconstruction of a traditional ceramic sculpture modeling image, it is actually to restore the degraded image of traditional ceramic sculpture modeling image into a high-definition image, which is a reverse process [13]. At this time, in order to reduce the complexity of work, it is necessary to reduce the prior knowledge of a traditional ceramic sculpture modeling image and the reduced space range is as follows:

\[
F = \arg \min \|y - Ha\|^2 + \chi(a), \tag{5}
\]

where \( \chi(a) \) represents the regular term constructed by the prior knowledge of the traditional ceramic sculpture modeling image, that is, the sparse degree of the representation coefficient of the traditional ceramic sculpture modeling image on dictionary \( D \) [14]. At this time, the sparse characteristic reconstruction model of the traditional ceramic sculpture modeling image, that is, the reconstructed super-resolution image of the traditional ceramic sculpture modeling image, is

\[
(a, \beta_i) = \arg \min \sum_i \|S_i a - V\phi_i\|^2 + y\alpha_i \tag{6}
\]

s.t. \( \|y - Ha\|^2 \leq \eta^n \).

### Table 1: Line shape classification of traditional ceramic sculpture modeling images.

| Line type          | Stepped                                                      | Stair type                                                  | Triangular ridge                      | Square wave ridge                      | Double-ridge type |
|--------------------|--------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------|----------------------------------------|------------------|
| First derivative   | Maximum value point > 0                                       | Maximum value point > 0                                      | At midnight                             | At midnight                             | Double over zero |
| Second derivative  | At midnight                                                  | At midnight                                                  | Maximum value point > 0                | Maximum value point > 0                | Bipolar point: maximum point > 0; minimum value point < 0 |
| Line point type    | Point of inflection                                          | Point of inflection                                          | Maximum value point                    | Maximum value point                    | Double great value point |

![Figure 2: Traditional ceramic sculpture modeling image preprocessing process.](image)

Among them, \( S_i \) represents the image block selected in the traditional ceramic sculpture modeling image, \( V \) represents the basis function, and \( y \) represents the sparse regularity term.

In the super-resolution reconstruction of a traditional ceramic sculpture modeling image, the similar traditional ceramic sculpture modeling image blocks are changed by zero mean coefficient distribution and nonzero mean distribution to improve the super-resolution reconstruction effect of traditional ceramic sculpture modeling image [15]. The characteristics of the reconstructed traditional ceramic sculpture modeling image are shown in Figure 1:

2.2. **Image Preprocessing of the Traditional Ceramic Sculpture.** In order to realize the effective of traditional ceramic sculpture modeling image features, firstly, the traditional ceramic sculpture modeling images are classified. The line morphological features of traditional ceramic sculpture
modeling image mainly exist in the edge of the image, and the edge exists between target and background, target and target, region and region, and primitive and primitive [16]. According to the difference of the gray value change between image edge regions, the line edge types of the traditional ceramic sculpture modeling image are classified to clarify the line edge features of different categories in a traditional ceramic sculpture modeling image, as shown in Table 1: In the classification of traditional ceramic sculpture images, the lines of traditional ceramic sculpture images are divided into the step type, stair type, triangular roof ridge, square wave roof ridge, and double roof ridge type. The discrimination of different types of traditional ceramic sculpture image lines is of great significance to the recognition of image features. Therefore, this paper effectively determines on the image line shape of different types of traditional ceramic sculptures [17].

In the classification of traditional ceramic sculpture modeling image line morphology, the original sample of a traditional ceramic sculpture modeling image line is input into the sample and projected into a high-dimensional space. We transform a linear nonseparable problem of a low-dimensional space into a linear separable problem of a high-dimensional space.

Set the original sample set \( X = \{x_1, x_2, \ldots, x_n\} \). For a nonlinear mapping: \( \varphi : \mathbb{R}^d \rightarrow \mathbb{R}^f \), the original sample set is projected to the high-dimensional kernel space \( F \), and then, the optimal linear partition interface is found in \( F \) for classification and identification, which can maximize the interclass dispersion matrix and minimize the intraclass dispersion matrix [18]. After the nonlinear mapping, the projected sample set is

\[
X^\varphi = (\varphi(x_1), \varphi(x_2), \varphi(x_3), \ldots, \varphi(x_n)).
\]  

This subinterface maximizes here; \( n \) represents the total number of samples for each class. According to the renewable kernel theory, the complex inner product operations in the feature space \( F \) can be replaced by the kernel function \( h(x, y) \) that satisfies the Mercer conditions [19]. The kernel function is
The line status of traditional ceramic sculpture images: where selected as the center point, and then, a square modeling image lines, the pixel point of a line is randomly processed. From the traditional ceramic sculpture modeling image, the noise in the red components, and represents the interclass dispersion matrix of red components.

According to the above-determined line type of the traditional ceramic sculpture image after median filtering; r(k) represents the gray value of the initial pixel. The preprocessing process of traditional ceramic sculpture image is shown in Figure 2:

\[ P(i,j) = \text{med} \{ r(k) | \nu(i,j) \in Nv(i,j) \} \]  

In the formula, \( P(i,j) \) is the gray value of the pixels in the traditional ceramic sculpture image after median filtering; \( r(k) \) represents the gray value of the initial pixel. The preprocessing process of traditional ceramic sculpture image is shown in Figure 2:

In the traditional ceramic sculpture modeling image preprocessing, by determining the line state characteristics of the traditional ceramic sculpture modeling image, classifying it with the help of the kernel classification method, and removing the line noise in different states with the help of the filter window, the traditional ceramic sculpture modeling image preprocessing is realized.

### 2.3. Traditional Ceramic Sculpture Modeling Feature Recognition Algorithm

Based on the abovementioned traditional ceramic sculpture modeling image preprocessing, the machine learning algorithm is used to realize the recognition of traditional ceramic sculpture modeling features. The machine learning algorithm uses artificial intelligence technology, which can automatically find out the parameters and modes required by operation after training and learning a large number of sample sets. The algorithm takes a neural network as the main core algorithm, including key algorithms such as the BP neural network, convolutional neural network, and genetic algorithm. Among them, the BP neural network is a more prominent algorithm with certain advantages. The algorithm achieves the final research purpose through multiple levels of processing. The algorithm has great advantages in studying the feature extraction of things. It inputs the research data into it and deeply excavates the abstract characteristics of its data, which can solve the data generalization ability in the artificial intelligence algorithm. The internal structure of the BP neural network is shown in Figure 3:

**Table 2: Experimental parameter design.**

| Parameter                  | Content     |
|----------------------------|-------------|
| Number (picture)           | 4           |
| Sample shape image size (Dpi) | 256 * 256  |
| Line type (type in the image) | 3         |
| Noise range in the image lines (dB) | [−3−2]   |
| Neural network hierarchy (layer) | 3         |
| Number of neurons in (individual) | 20       |
| Output the corresponding recognition rate (%) | [1,100] |

\[
h(x, y) = (X^\psi)^T X^\psi. \]

After the three color components of the original color image to the feature space \( F \), we will use the Fisher criterion to extract red, green, and blue components of the differential feature model, in the process, and ensure each orthogonal between each other and finally will extract the three differential feature vectors into a differential feature vector for classification identification [20].

According to the Fisher criterion [21], the identification feature model \( \omega^\phi \) of red components is calculated to classify the line status of traditional ceramic sculpture images:

\[
\max \omega^\phi = \frac{\left| (\omega_i^\phi)^T \mu_i^\phi \right|}{\left| (\omega_i^\phi)^T \mu_i^\phi \right|},
\]

where \(|\cdot|\) represents the determinant of a square matrix, \( \mu_i^\phi \) represents the interclass dispersion matrix of red components, and \( \omega_i^\phi \) represents the interclass dispersion matrix of red components.

According to the above-determined line type of the traditional ceramic sculpture modeling image, the noise in the line is processed. From the traditional ceramic sculpture modeling image lines, the pixel point of a line is randomly selected as the center point, and then, a square field is determined around the center point. The pixel values of all points in the square field are counted and sorted, and the middle value is selected to replace the randomly selected pixel value of the center point [22]. Using the filter window to obtain the intermediate value instead of the gray value of the original image, the traditional ceramic sculpture modeling image line filtering and denoising is realized, that is,

\[
P(i,j) = \text{med} \{ r(k) | \nu(i,j) \in Nv(i,j) \}. \]

**Figure 5: Experimental environment diagram.**
In the process of feature recognition of the BP neural network, neurons will scan the features of the input network according to the law, multiply the matrix elements of the features of the input network in the receptive field, and superimpose the deviation \[24\], that is, 
\[B^{i+1}(i, j) = f \sum_{j=1}^{n} w^{n+1}_{k} v(i, j) + b,\]  
where \(B^{i+1}\) represents the network output corresponding to the layer, \(w\) represents the corresponding network input of the first layer, \(b\) represents the amount of deviation, \(w(i, j)\) represents the pixels present in the feature graph, \(f\) represents the size of the convolution kernel, and \(v\) represents the number of channels corresponding to the feature graph.

Therefore, this paper realizes the design of the traditional ceramic sculpture modeling feature recognition algorithm through the BP neural network, so as to improve the effect and quality of traditional ceramic sculpture modeling feature recognition. When the BP neural network identifies the modeling features of a traditional ceramic sculpture, the learning process of a BP neural network is a learning method of reverse propagation. During forward propagation, the data is transferred from the input layer, processed through the hidden layer nodes, and finally, the results are obtained in the output layer. If the difference between the output result and the expected value is large, it is necessary to carry out back propagation to adjust the weight of the neural network and allocate the error to the weight in each layer according to the weight \[25\], so that the whole neural network tends to the expected value. By repeating the above-mentioned process, an acceptable error is finally obtained and the final neural network model is obtained. The learning process of the BP neural network is the process of constantly adjusting the network weight. In the traditional ceramic sculpture modeling feature recognition, the neural network weights are initialized first \[26\]. The weight \(z_{ij}, e_{ij}\) in the neural network and the threshold \(\theta_i\) give the value of \([0,1]\), respectively, that is, the line characteristics of the traditional ceramic sculpture shape, to initialize the BP neural network. Then, the input \(U_i\) and output \(h_i\) of the hidden layer nodes of the neural network are calculated. These two input values are the line state characteristics of the traditional ceramic sculpture shape, and the results are

\[U_i = \sum_{i=1}^{n} z_{ij} x_i - \theta_i,\]

\[h_i = f(U_i) = \frac{1}{1 + \exp(-U_i)}.\]  

Thirdly, the training sample data \(y_j\) of the line state characteristics of the traditional ceramic sculpture shape is input to the BP neural network node and the output result value \(y_t\) is

\[y_j = \sum_{i=1}^{n} z_{ij} h_i - u_i,\]

\[y_t = \frac{1}{1 + \exp(-g_i)}.\]  

Figure 6: Sample image of the traditional ceramic sculpture.
Then, the output node $t$ weight error of the line state feature of traditional ceramic sculpture modeling is $e_i$, thus obtaining

$$e_i = (c - y_i) y_i (1 - y_i). \quad (14)$$

On this basis, by calculating the weight error of the line state features of the traditional ceramic sculpture modeling on the hidden layer node, we obtain

$$r_j = y_j \sum e_i (1 - h_i). \quad (15)$$

Finally, update the characteristic weights $d_{ij}$ and threshold $k_i$ obtained from the abovementioned limit to obtain

$$\delta_{ij} (n + 1) = d_{ij} (N) + \gamma e_i k_i. \quad (16)$$

According to the actual feature recognition error determined, if the recognition accuracy requirements are met, stop the training of the line state features of the traditional ceramic sculpture B modeling and realize the design of the traditional ceramic sculpture modeling feature recognition algorithm. The modeling feature recognition process of a traditional ceramic sculpture based on the machine learning algorithm is shown in Figure 4:

### 3. Experimental Analysis

#### 3.1. Experimental Scheme Design

In order to verify the effectiveness of the proposed method, experimental analysis is carried out. In the experiment, the traditional ceramic...
sculpture modeling images are selected from MySQL database as the sample images for the study. A total of 4 traditional ceramic sculpture modeling images that meet the experimental requirements are selected, and the selected traditional ceramic sculpture modeling images are preprocessed to make them meet the experimental requirements. The experimental environment is shown in Figure 5:

According to the experimental environment in Figure 5, set relevant parameters in the experiment, as shown in Table 2:

The traditional ceramic sculpture modeling image selected in the experiment is shown in Figure 6:

3.2. Experimental Index Setting. In the experiment, the indicators are set as the accuracy of traditional ceramic sculpture shape recognition, the effect of line noise suppression in recognition, and the time cost of feature recognition. Among them, the traditional ceramic sculpture modeling recognition accuracy includes complete recognition, partial recognition, and unrecognizable sample feature accuracy. The accuracy of the recognition method is verified by using the methods of this paper, reference [6], reference [7], and reference [8]. In the experiment, the suppression of line noise in the process of feature recognition of the four methods is compared and the effectiveness of the method is analyzed by analyzing the level of noise in the line. The time cost of feature recognition refers to the time required for feature recognition of sample data.

3.3. Analysis of Experimental Results

3.3.1. Accuracy Analysis of Traditional Ceramic Sculpture Modeling Recognition with Different Methods. Firstly, the experiment analyzes the methods of this paper, reference [6], reference [7], and reference [8], to identify the modeling features of the sample traditional ceramic sculpture. In the experiment, taking the modeling feature image of the sample traditional ceramic sculpture as the research object, identify the marked feature area in the image and verify the recognition accuracy of the four methods based on the accurate recognition accuracy. The results are shown in Figure 7:

By analyzing the experimental results in Figure 7, it can be seen that there are some differences in the accuracy of identifying the modeling features of traditional ceramic sculptures by using the methods of this paper, reference [6], reference [7], and reference [8]. Among them, using the recognition method in this paper, the recognition area of four traditional ceramic sculpture modeling feature images is consistent with the sample image, which can be seen that the recognition accuracy of this algorithm is high. The accuracy of feature recognition of the method in reference [6] is within a reasonable example. The accuracy of feature recognition of the method in reference [7] is lower than that of the other two methods. In contrast, the recognition accuracy of the method in this paper is higher than that of the other three methods. This is because the method in this paper classifies it with the help of the kernel classification method and removes the line noise in different states with the help of a filter window, so as to realize the preprocessing of traditional ceramic sculpture modeling image. Finally, the machine learning algorithm red BP neural network is introduced to construct the traditional ceramic sculpture modeling feature recognition algorithm and constantly iterate the error threshold to realize the traditional ceramic sculpture modeling feature recognition and improve the recognition accuracy.

3.3.2. Analysis of the Noise Suppression Effect of Different Methods on Traditional Ceramic Sculpture Shape Recognition. On the basis of ensuring the accuracy of traditional ceramic sculpture shape recognition, the noise suppression effects of different recognition methods in traditional ceramic sculpture shape recognition are experimentally analyzed. The effectiveness of the experimental method is reflected by comparing the noise levels of the four recognition methods. The results are shown in Figure 8:

By analyzing the experimental results in Figure 8, it can be seen that there are some differences in the noise in the traditional ceramic sculpture shape recognition by using the methods of this paper, reference [6], reference [7], and reference [8]. With the change of recognition times, the noise in the traditional ceramic sculpture shape recognition of samples by the four methods always changes to a certain extent. Among them, the noise in this method is always kept at a low level, its variation range is about −2dB, and the curve trend is relatively stable. While the other three methods identify samples, the noise curve in the traditional ceramic sculpture shape recognition fluctuates greatly and always shows an upward trend. Therefore, it can be seen that the noise in the recognition using this method is always maintained at a low level. This is because the median filter method is used in the method design to filter out the noise in the lines, which improves the effectiveness of the method.
follows:

the traditional ceramic sculpture algorithm is constructed and the error threshold is conditional. Ceramic sculpture modeling feature recognition machine learning algorithm and BP neural network, the traditional ceramic sculpture modeling feature recognition machine learning algorithm is designed. Through the ceramic sculpture feature recognition method based on the ceramic sculpture feature recognition methods, a traditional ceramic sculpture. Because of the low recognition accuracy of traditional ceramic sculpture, recognition will be studied to improve the accuracy of recognition.

Table 3: Time cost of traditional ceramic sculpture shape recognition with different methods (s).

| Identification times (time) | Paper method | Paper method | Reference [6] method | Reference [7] method | Reference [8] method |
|-----------------------------|--------------|--------------|-----------------------|----------------------|----------------------|
| 20                          | 3.2          | 3.6          | 3.8                   | 3.5                  | 3.9                  |
| 40                          | 3.1          | 3.9          | 3.8                   | 3.6                  | 4.0                  |
| 60                          | 3.3          | 4.2          | 4.3                   | 3.9                  | 4.2                  |
| 80                          | 3.2          | 4.3          | 4.5                   | 4.2                  | 4.3                  |
| 100                         | 3.3          | 4.5          | 4.9                   | 4.3                  | 4.5                  |

3.3.3. Time Cost Analysis of Traditional Ceramic Sculpture Shape Recognition with Different Methods. In order to verify the effectiveness of the proposed method, the experiment further analyzes the time consumption of four methods to identify the modeling features of the traditional ceramic sculpture. The results are shown in Table 3:

By analyzing the experimental data in Table 3, it can be seen that the time cost of using the four methods to identify the characteristics of sample data is different. With the continuous change of recognition at this time, the time consumption of the four methods to identify the modeling characteristics of traditional ceramic sculpture has changed to a certain extent. Among them, using this method to identify the modeling characteristics of traditional ceramic sculpture takes the shortest time and it is always maintained at about 3.3 s, which is relatively stable. Compared with the other three methods, it can be seen that other methods are time-consuming. The effectiveness of the proposed method is verified.

To sum up, the recognition accuracy of this method is high, which can realize the shape feature recognition of the traditional ceramic sculpture. Using this method, the noise is always kept at a low level, its variation range is about −2 dB and the curve trend is relatively stable. Using this method to identify the modeling characteristics of a traditional ceramic sculpture takes the shortest time and is always maintained at about 3.3 s, which is relatively stable and has strong performance.

4. Conclusion

Because of the low recognition accuracy of traditional ceramic sculpture feature recognition methods, a traditional ceramic sculpture feature recognition method based on the machine learning algorithm is designed. Through the machine learning algorithm and BP neural network, the traditional ceramic sculpture modeling feature recognition algorithm is constructed and the error threshold is constantly iterated to realize the traditional ceramic sculpture modeling feature recognition. The conclusions are as follows:

1. The accuracy of traditional ceramic sculpture feature recognition based on the machine learning algorithm is high.

2. The noise is always kept at a low level in the identification of the proposed method, and its variation range is around −2 dB, and the curve trend is relatively stable.

3. The designed algorithm takes a short time in the process of traditional ceramic sculpture modeling feature recognition and has a good effect.

4. Although the method in this paper can achieve effective feature recognition at the present stage, there are still some errors. In the future, more image features will be studied to improve the accuracy of recognition.

Data Availability

The author can provide all the original data involved in the research.

Conflicts of Interest

The author indicates that there was no conflict of interest in the study.

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References

[1] J. M. Guillout, “Epigraphic one-upmanship: remarks about text/image relationship in 15th,” Century Monumental Sculpture, vol. 14, no. 21, pp. 145–155, 2020.

[2] Z. Milojevi, “Copyright protection of 3D digitized artistic sculptures by adding unique local inconspicuous errors by sculptors,” Applied Sciences, vol. 11, no. 20, pp. 637–641, 2021.

[3] N. Goncharova and A. Belikov, “Greek faces. Anthropological analysis of ancient Greek,” Sculpture, vol. 24, no. 2, pp. 47–52, 2020.

[4] G. Joge and V. Sontakke, “A note on the recently found stone sculpture at Ramtek dist,” Nagpur, Maharashtra, vol. 31, no. 2, pp. 179–183, 2021.

[5] C. Fjsab, “A certifying and dynamic algorithm for the recognition of proper circular-arc graphs,” Theoretical Computer Science, vol. 14, no. 25, pp. 3677–3682, 2021.

[6] Y. Jun and L. Yang-yi, “The brand modeling identification design of engineering machinery based on product image,” Packaging Engineering, vol. 42, no. 10, pp. 191–199, 2021.
[7] L. Xiaobin and S. Xiaodong, “Design of VR technology based interactive effect evaluation system of product modeling features,” Modern Electronics Technique, vol. 44, no. 16, pp. 120–124, 2021.

[8] Z. Xinliang, X. Heng, Z. Yunji, W. Wanru, and W. Shengqiang, “Deep networks detection algorithm fusing multiple dilated convolution operator and multi-level characteristics,” Pattern Recognition and Artificial Intelligence, vol. 33, no. 10, pp. 898–905, 2020.

[9] F. P. D. Santos, C. Zor, J. Kittler, and M. A. Ponti, “Learning image features with fewer labels using a semi-supervised deep convolutional network,” Neural Networks, vol. 132, no. 15, pp. 131–143, 2020.

[10] E. Toraaason, V. L. Adler, N. A. Kurhanewicz et al., “Automated and customizable quantitative image analysis of whole C. elegans germlines,” Genetics, vol. 217, no. 3, pp. 367–372, 2021.

[11] J. Yan, S. Li, K. Liu et al., “An image features assisted line selection method in laser-induced breakdown spectroscopy,” Analytica Chimica Acta, vol. 1111, no. 12, pp. 139–146, 2020.

[12] B. Sungwoo, C. Hongyoon, and L. D. Soo, “Discovery of molecular features underlying the morphological landscape by integrating spatial transcriptomic data with deep features of tissue images,” Nucleic Acids Research, vol. 14, no. 2, pp. 4554–4559, 2021.

[13] C. Sitaula, S. Aryal, Y. Xiang, A. Basnet, and X. Lu, “Content and context features for scene image representation,” Knowledge-Based Systems, vol. 36, no. 2, pp. 1369–1373, 2021.

[14] B. Solihah, A. Azhari, and A. Musdhofilah, “The empirical comparison of machine learning algorithm for the class imbalanced problem in conformational epitope prediction,” JUTA Jurnal Informatika, vol. 9, no. 1, pp. 131–135, 2021.

[15] K. Lee, S. Kang, M. Kang, S. Yi, S. Hyun, and C. Kim, “Modeling of laser welds using machine learning algorithm part I: penetration depth for laser overlap Al/Cu dissimilar metal welds,” Journal of Welding and Joining, vol. 39, no. 1, pp. 27–35, 2021.

[16] A. Plante and H. Weinstein, “A machine learning algorithm for the detection of function-related rare events in MD trajectories of biomolecular systems,” Biophysical Journal, vol. 120, no. 3, pp. 301a–3306, 2021.

[17] R. Sanjeetha, A. Raj, K. Saivenu, M. I. Ahmed, B. Sathvik, and A. Kanavalli, “Detection and mitigation of botnet based DDoS attacks using catboost machine learning algorithm in SDN environment,” International Journal of Advanced Technology and Engineering Exploration, vol. 8, no. 76, pp. 445–461, 2021.

[18] G. A. Prenosil, T. Weitzel, M. Fürstner et al., “Towards guidelines to harmonize textural features in PET: Haralick textural features vary with image noise, but exposure-invariant domains enable comparable PET radiomics,” PLoS One, vol. 15, no. 3, pp. 6378–6382, 2020.

[19] M. H. Abdo, J. Michaelsen, L. Langenbrink, M. Wiertz, E. Altiook, and R. Hoffmann, “Impact of tube angulations and imaging mode on radiation dosage using image noise reduction technology,” Coronary Artery Disease, vol. 31, no. 2, pp. 34–42, 2021.

[20] A. HajiRassouliha, S. P. Richardson, A. J. Taberner, M. P. Nash, and P. M. Nielsen, “The effect of camera settings on image noise and accuracy of subpixel image registration,” Machine Vision and Applications, vol. 32, no. 4, pp. 652–658, 2021.