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# Element Identification and Feature Extraction of Chinese Painting Based on Computer Vision and CAD

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**Abstract.** In this article, computer vision and Computer aided design (CAD) technology are combined to construct an image identification and feature detection model based on Wavelet transform (WT) algorithm to realize element identification and feature detection of Chinese painting. By combining computer vision and CAD, the model can automatically identify and extract elements and feature information in Chinese painting. Moreover, the model is optimized, and the generalization ability and identification accuracy of the model are improved by adjusting the parameters and structure of the model. In this article, a large quantity of experiments are carried out to verify the model and Chinese painting images. The experimental results show that the model constructed by using CAD and WT algorithm can achieve high identification accuracy and recall. This model can effectively identify and extract the elements and feature information in Chinese painting, which is of great significance for the protection, inheritance and research of Chinese painting. The research results of this article not only provide new methods for the digital protection and inheritance of Chinese painting, but also promote the application and growth of machine vision and CAD in the art field.

**Keywords:** Computer Vision; Computer Aided Design; Wavelet Transform Algorithm; Chinese Painting; Element Identification; Feature Detection
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## 1 INTRODUCTION

As a treasure of China traditional culture, Chinese painting has a long history and is profound. The artistic conception and charm it pursues, as well as the unique painting style and expression techniques, make Chinese painting unique in the world art field. Chen et al. [1] used the study of the spatial relationship between ancient Chinese capitals and the natural environment as an example to explore the application of spatial information technology and cultural analysis in archaeology. Through GPS and remote sensing technology, we can accurately obtain the geographical location and terrain data of ancient capital cities, and then use GIS for environmental modeling to display the spatial relationship between ancient capital cities and the natural environment. GIS provides powerful spatial analysis functions, allowing us to conduct terrain analysis, hydrological analysis, line of sight analysis, etc., in order to reveal the strategies and reasons for selecting the location of the capital city. At the same time, through the map production and visualization functions of GIS, we can intuitively display the relationship between the capital city and the natural environment. By studying the material and intangible cultural heritage of ancient capital cities, we can understand their historical formation and development process, as well as their relationship with the surrounding natural environment. From the perspective of cultural ecology, we can study how the formation and development of ancient capitals were influenced by the natural environment, and how capitals in turn influenced the surrounding natural environment. From the perspective of cultural geography, we can study the spatial structure and functional zoning of ancient capital cities, as well as how these spaces and functions interact with the natural environment. However, in the process of creation and appraisal of Chinese paintings, it is often needed to rely on the artist's subjective experience and professional skills, which undoubtedly increases the difficulty of painting process and appraisal. Chinese landscape painting and classical private gardens are important representatives of traditional Chinese aesthetics, both reflecting unique spatial aesthetic styles. With the development of technology, it has become possible to use computer technology to transform the aesthetic styles of these two art forms. Hong et al. [2] introduced an aesthetic style conversion method based on deep neural networks for virtual scenes of Chinese landscape painting and classical private gardens. Deep neural networks are computational models that simulate the structure of human brain neural networks, with powerful feature learning and abstraction capabilities. In the field of image processing, deep neural networks can be used for image style conversion, which involves fusing the content of one image with the style of another image. The aesthetic style conversion method between Chinese landscape painting and classical private garden virtual scenes based on deep neural networks has broad application prospects. Firstly, it can be applied to virtual reality (VR) technology to provide tourists with a more realistic experience of classical private gardens. Secondly, it can be applied in game development to add more artistic style and aesthetic experience to game scenes. In addition, it can also be applied to digital art creation, providing artists with more creative inspiration and forms of expression.

Especially with the growth of digital technology, the emergence of computer vision and CAD provides new possibilities for solving this problem. In the manufacturing process of molecular products, process design is a key link that has a decisive impact on the properties and performance of the product. However, uncertainty in the manufacturing process, such as raw material quality, environmental conditions, equipment performance, etc., often leads to uncertainty in product properties. This article proposes a computer-aided molecular product process design strategy based on Monte Carlo methods to optimize product properties and reduce uncertainty. Jérme et al. [3] proposed a computer-aided molecular product process design strategy based on Monte Carlo method. Monte Carlo method is a numerical calculation method guided by probability and statistical theory, which simulates a large number of possible manufacturing processes and evaluates the probability of each possible result to obtain the optimal solution. This method can effectively handle the uncertainty in the manufacturing process and reduce the impact of product property fluctuations. Establish a detailed process model, including all parameters and uncertainty factors that may affect product properties. Then, Monte Carlo method is used to randomly sample each parameter, simulate a large number of manufacturing processes, and evaluate each result. Through statistical analysis, identify the optimal combination of process parameters to reduce uncertainty in product properties and improve product quality. Therefore, this article aims to explore the element identification and feature detection of Chinese painting based on computer vision and CAD.

At present, element identification and feature detection of Chinese painting are hot issues in current research. This involves many aspects, such as brush strokes, colors, composition and so on. Li et al. [4] proposed an AI driven human-machine interaction design framework for virtual environments based on feature extraction and comprehensive semantic data analysis. This framework aims to extract valuable information from massive data and achieve more intelligent and user-friendly human-computer interaction in virtual environments through comprehensive semantic analysis. Collect data on user behavior, preferences, emotions, etc. from various sources and perform preprocessing, including data cleaning, standardization, and normalization, in preparation for subsequent feature extraction and semantic analysis. Utilizing machine learning, deep learning, and other technologies to extract models that reflect user behavior and emotional characteristics from preprocessed data. These features can include user behavior patterns, interests, and psychological states. Utilize natural language processing (NLP) technology to conduct in-depth semantic analysis of user behavior and emotional features. This can include sentiment analysis, topic analysis, text mining, etc. Based on the results of comprehensive semantic analysis, design the interaction mode of the virtual environment. For example, providing personalized suggestions and feedback based on users' interests, hobbies, and behavioral patterns; Adjust the atmosphere and interaction mode of the virtual environment based on the user's emotional state.

These elements are of great significance to the style, artistic conception and appraisal of Chinese painting. The processing of 3D point cloud data has always been an important research topic in the fields of computer vision and graphics. With the continuous development of various 3D scanning technologies, people can obtain more and more 3D point cloud data. These data usually contain a large amount of information and details, so an effective method is needed to process these data for subsequent analysis and application. Traditional feature matching methods typically rely on pixels or geometric features, but these methods may encounter some challenges when processing 3D point cloud data, such as occlusion, noise, and incomplete observations. In this context, Liu et al. [5] proposed PuzzleNet as a new deep learning model. It can effectively perform feature matching and assembly of non-overlapping 3D point cloud data. The PuzzleNet model utilizes a combination of convolutional neural networks (CNN) and recurrent neural networks (RNN) to effectively process 3D point cloud data. The experimental results indicate that the PuzzleNet model can effectively perform feature matching and assembly of non-overlapping 3D point cloud data. Compared with traditional feature matching methods, the PuzzleNet model has higher accuracy and robustness. However, due to the complexity and diversity of Chinese painting, how to accurately identify and extract these elements is still a challenging problem. Yue Opera is one of the unique forms of Chinese drama, and its clothing design, as an important part of performing arts, has profound cultural connotations. In recent years, with the development of technology, virtual simulation technology has gradually penetrated into various fields, including fashion and textile design. Liu et al. [6] explored how to combine elements of Yue Opera with virtual simulation technology to achieve modern expression and fashion presentation of Yue Opera costumes. The uniqueness of Yue Opera costumes lies in their delicate lines, exquisite embroidery, and unique color combinations. These traditional elements provide rich materials for modern fashion design. By extracting and reconstructing these traditional elements, we can inject new vitality into modern fashion design. For example, the patterns and colors of Yueju costumes can be used in modern dress, jacket, or accessory designs to showcase the fusion of fashion and tradition. By combining elements of Yue Opera costumes and virtual simulation technology, we can create a brand-new fashion product. Firstly, draw inspiration from Yue Opera costumes and design styles, colors, and patterns. Then, virtual simulation technology is used to transform these designs into digital models with immersion and interactivity. Consumers can view and experience the perfect combination of traditional elements of Yue Opera and modern fashion through VR devices or computers. The introduction of computer vision and CAD provides new ideas and methods to solve this problem.

Computer vision and CAD have broad application prospects in element identification and feature detection of Chinese painting. For example, computer vision technology can be used to identify and extract strokes and colors of paintings; The composition of painting can be analyzed and optimized by CAD.

MeshCNN is a convolutional neural network-based model specifically designed for processing three-dimensional mesh data. Luo et al. [7] first preprocessed the B-Rep model using MeshCNN to extract the geometric features and topology information of the model. Then, using this information, a CSG model is constructed, which includes both the shape information of the original model and the construction process of the original model. This algorithm can be widely applied to the processing of various 3D CAD models. For example, during the design phase, designers can use this algorithm to convert complex 3D models conceived into easily understandable CSG models for easy communication and discussion with others. During the manufacturing phase, engineers can use this algorithm to convert B-Rep models into CSG models for operations such as CNC programming (CAM) or 3D printing. In addition, this algorithm can also be used for tasks such as repairing and optimizing 3D models. Moreover, the introduction of computer vision and CAD provides new possibilities for the creation and appraisal of Chinese paintings. Through the accurate identification and extraction of Chinese painting elements, we can better understand the characteristics of painting style, artistic conception and composition. Robust deep neural network is a specially designed deep neural network that is robust to noise and outliers. R-DNNs can better handle medical image data with noise or anomalies by adopting special network structures and training methods, thus performing well in cancer detection and classification tasks. Cancer detection and classification based on robust deep neural networks is one of the current research hotspots. By applying R-DNNs and other forms of computational intelligence technology, we can achieve more accurate and efficient cancer detection and classification, thereby improving the efficiency and effectiveness of medical services. In addition, this interdisciplinary research method also provides us with new perspectives and ideas to solve other complex medical problems. By combining R-DNNs and medical imaging technology, Mansour [8] can achieve automatic detection and classification of cancer. Firstly, preprocess medical image data, including steps such as image enhancement and denoising, to improve image quality. Then, R-DNNs are used to train and predict the processed images. R-DNNs can learn effective ways to extract useful information from images and automatically classify cancer. This can not only improve the efficiency of Chinese painting, reduce labor costs, but also improve the accuracy of identification. This article constructs an image identification and feature detection model based on WT algorithm to realize element identification and feature detection of Chinese painting. Its innovations are as follows:

㊀ In this article, WT algorithm is used to decompose the Chinese painting image at multiple scales, thus extracting the feature information of the image at different scales. WT algorithm can analyze the detailed information of images at different scales, and can effectively extract the subtle features and local information of Chinese painting, a painting form with rich details and texture features.

㊁ This article combines computer vision and CAD to realize automatic identification and feature detection of Chinese painting images. Computer vision technology can effectively analyze and identify various elements and features in images, while CAD can provide accurate image processing and analysis tools, and the combination of the two can extract elements and feature information in Chinese paintings more efficiently.

This article first introduces the basic principles and methods of computer vision and CAD, and constructs an image identification and feature detection model based on WT algorithm. Then, an experimental study is carried out to identify and extract elements such as strokes, colors and composition of Chinese paintings. Through the analysis of the results, we can deeply discuss the application value of these technologies in improving the efficiency of Chinese painting creation and appraisal.

## 2 RELATED WORK

The application of 3D factory simulation software in the industrial field is becoming increasingly widespread. Pelliccia et al. [9] explored the applicability of 3D factory simulation software in computer-aided participatory design of industrial workplaces and processes, as well as its impact on industrial manufacturing processes. 3D factory simulation software is a software that utilizes computer technology to simulate industrial manufacturing processes by establishing 3D models. This software can simulate the entire manufacturing process, from raw material procurement, processing, assembly to final product inspection, thereby helping enterprises optimize manufacturing processes, improve production efficiency, and reduce costs. Process computer-aided participatory design is a method that allows users to participate in product or process design through computer-aided design tools. Through 3D factory simulation software, designers and users can jointly participate in the design process, making real-time modifications and optimizations to the design scheme. By integrating with 3D factory simulation software, automated design becomes possible. Designers can utilize the automation functions of software to quickly generate and modify design proposals, thereby improving design efficiency and quality. 3D factory simulation software has broad application prospects in computer-aided participatory design of industrial workplaces and processes. It can optimize manufacturing processes, improve production efficiency, reduce costs, and improve product quality and safety. Deep Separated Convolutional Neural Networks (DS-CNN) is a novel deep learning model that is particularly suitable for processing high-resolution image data with complex textures and spatial layouts. We adopted the DS-CNN model and combined it with the characteristics and needs of hypertensive retinopathy to construct a new computer-aided detection system. Qureshi et al. [10] achieved excellent results in the experiment using the DS-CNN model for computer-aided detection of hypertensive retinopathy. The experimental results show that the system can effectively recognize and classify hypertensive retinopathy in retinal images, with accuracy, sensitivity, and specificity exceeding 90%. In addition, the output results of the system have good interpretability, which can help doctors better understand the condition and severity of the lesion.

Tian et al. [11] designed a dynamic hazard proximity zone system for excavators based on computer vision 3D robotic arm attitude estimation to improve the safety and efficiency of excavator operation. This system captures the surrounding environment of the excavator, uses computer vision technology to perform three-dimensional reconstruction of the environment, and determines whether there is a danger. If there is a danger, the system will issue a warning to remind the operator to adjust the operation. This system can effectively avoid danger caused by misjudgment. The excavator dynamic danger proximity zone system based on computer vision 3D robotic arm pose estimation has broad application prospects. Firstly, it can improve the operational efficiency of excavators, as operators can more accurately judge the surrounding environment. Secondly, it can improve the operational safety of excavators, as the system can monitor the surrounding environment of excavators in real-time and remind operators of the dangers present. Finally, it can reduce the maintenance cost of excavators, as the system can monitor the status of excavators in real-time and detect potential problems in advance. Yang et al. [12] utilized image recognition technology to identify and extract graphic elements from CAD construction drawings. For example, it is possible to identify elements such as walls, doors and windows in a building plan, and extract their size and location information. Based on the extracted graphic element information, use BIM software to automatically generate the corresponding BIM model. For example, the wall part of a building model can be automatically created based on wall size and location information. The advantage of this method is that it can greatly reduce the workload of manual modeling, improve modeling efficiency, and reduce the requirements for modeler skills. In addition, this method can also reduce errors and avoid missing information to a certain extent, thereby improving the quality of modeling. However, this method also has some limitations. Firstly, the recognition and processing process of CAD construction drawings may be affected by factors such as drawing quality and complexity of graphic elements, resulting in recognition errors or incomplete information extraction. Secondly, the construction process of BIM models may require coordination and matching of drawings from different disciplines, which requires a certain level of experience and skills. Finally, this method still requires partial manual adjustment and optimization of the model to meet practical needs. With the increasing complexity of engineering design, traditional CAD systems face many challenges when processing large-scale data. CAD systems based on big data technology can process large-scale data, improve design efficiency, and therefore have been widely applied in the fields of engineering design and manufacturing. Yang et al. [13] introduced the development and optimization of CAD systems based on big data technology. A certain automobile manufacturing enterprise adopts a CAD system based on big data technology for automobile design and optimization. By introducing big data technology, the enterprise is able to quickly process and analyze large-scale automotive design data, improving design efficiency and quality. At the same time, the use of artificial intelligence technology for automated design and optimization has improved design efficiency and accuracy. In the end, the company's automotive design and manufacturing capabilities have significantly improved.

Yang et al. [14] explored the synthetic brushwork of Chinese ink and wash animation and how to combine this brushwork with computer animation and virtual worlds to create more distinctive Chinese animation art. The combination of Chinese ink and wash animation with computer animation and virtual world is an innovative attempt, as well as a cultural inheritance and development. Through this combination, we can create animation art with more Chinese characteristics, and also promote the innovation and development of Chinese characteristic animation art. In the future, we look forward to seeing more researchers and technicians conduct in-depth research and practice in this area, in order to achieve the perfect combination of traditional Chinese culture and modern technology. Combining the synthetic brushwork of Chinese ink and wash animation with computer animation and virtual worlds can not only create unique artistic forms, but also promote the innovation and development of Chinese characteristic animation art. Through this combination, we can better inherit and promote traditional Chinese culture, and at the same time, we can combine this culture with modern technology to achieve the modernization of cultural development. Through head-worn displays (HMDs) or other display devices, users can see scenes where virtual objects and information are combined with the real world. The key issues that need to be addressed in visual interfaces are how to integrate virtual objects and information into real scenes, as well as how to improve the clarity and comfort of visual perception. Sound interface is a way of human-computer interaction through auditory channels. In spatial AR, the sound interface can provide additional information or navigation instructions, making it more convenient for users to interact. The key issues that need to be addressed in the sound interface are how to combine virtual sound with the real environment, and how to improve the quality and clarity of sound. A sports interface is a way of human-computer interaction through the user's body movements or gestures. In spatial AR, motion interfaces can provide a more natural and intuitive way of interaction, allowing users to interact with virtual objects and information through gestures or body movements. The key issue that needs to be addressed in the motion interface is how to accurately capture user actions and gestures, and how to convert them into effective input signals [15].

In the era of big data, data visualization has become a key means of studying and understanding complex data. Especially when dealing with data with historical and time series properties, visual analysis can provide more in-depth and intuitive insights. Zhang et al. [16] introduced a visual analysis system for queue interaction exploration based on historical data, aiming to address the challenges faced by existing visualization tools when processing time series data. With the development of technology, historical data visualization has shown great potential in various fields such as finance, healthcare, transportation, etc. However, existing visualization tools have some limitations when dealing with historical data with time series properties. For example, it is not possible to visually display the temporal dynamic changes of data, and it is not convenient to compare multiple time points. Therefore, developing a visual analysis system for queue interaction exploration based on historical data is of great significance for solving these problems. With the development of technology and the improvement of medical level, the design and manufacturing of personalized rehabilitation prostheses have gradually become a research field that has received much attention. The 3D model construction system for personalized rehabilitation prosthetics based on machine vision introduced by Zhang et al. [17] can quickly and accurately obtain the 3D model of patient limbs through non-contact measurement technology, providing data support for the design and manufacturing of personalized rehabilitation prosthetics. The application prospects of this system are broad, with high practical value and important social significance. Using high-resolution cameras and specialized light sources to obtain multi angle images of the patient's limbs. Using machine vision technology, preprocess, feature extraction, and 3D reconstruction are performed on the collected images to generate a 3D model of the patient's limbs. Convert the generated 3D model into a file format that can be used for rehabilitation prosthetic design. The system is responsible for the operation control and user interaction of the entire system, including image acquisition, processing, data output, and other operations. Traditional CAD systems typically only allow a single user to design. In this system, the emotions of designers may affect their creativity, decision-making process, and the way they use design tools. Although traditional CAD systems have relatively few users, they still play an important role in many industries. In traditional CAD, the challenge of emotional analysis lies in how to integrate emotional factors into the design process. To solve this problem, we need to develop design tools and algorithms that can understand and respond to these emotions. Zhou et al. [18] foresaw that future CAD systems would be more intelligent and user-friendly. They will be able to better understand and utilize the emotions of designers to promote more efficient and creative design processes. Future CAD systems may utilize advanced machine learning algorithms to identify and understand the emotional states of designers, and adjust their functions and characteristics accordingly. In addition, they may provide more feedback mechanisms to help designers better understand their emotional states and how to utilize these emotions for more effective design.

## 3 COMPUTER VISION TECHNOLOGY AND CAD

### 3.1 Computer Vision Technology

Computer vision is a science that studies how to make computers get information from images or videos, understand the content and make decisions. Its research direction is very extensive, but it can be roughly divided into the following categories:

Image classification and identification: This kind of research mainly focuses on how to use computers to automatically recognize objects, scenes and behaviors in images. By training the depth neural network, the computer can automatically identify the content in the image, and classify and label it.

3D reconstruction and modeling: This kind of research mainly focuses on how to obtain 3D information from 2D images or videos and establish corresponding 3D models. Through this method, we can accurately describe the shape, position and posture of an object or scene.

Target detection and tracking: This kind of research mainly focuses on how to automatically detect and track target objects from images or videos. In practical applications, such as intelligent transportation, security monitoring and other fields, it is needed to accurately detect and track specific targets.

Behavior analysis and understanding: This kind of research mainly focuses on how to automatically analyze and understand human behavior from images or videos. Through the analysis of human posture, gestures and movements, we can realize the application in human-computer interaction, intelligent monitoring, sports analysis and other fields.

Image generation and synthesis: this kind of research mainly focuses on how to automatically generate images or videos with specific characteristics or styles by using computers. This method can be applied to image restoration, super-resolution reconstruction, virtual reality and other fields.

### 3.2 CAD

CAD is a tool for product design and drawing by computer and related software. The main functions of this technology include: 2D drawing: drawing various 2D graphic elements, such as points, lines, circles, arcs and polygons, and editing and modifying them. 3D modeling: Using 3D modeling technology to create geometric models of products, such as solid modeling, surface modeling and assembly modeling. Parametric design: By defining parameters and constraints for product design, parts and assemblies can be automatically generated and optimized and analyzed. Simulation analysis: Carry out various simulation analysis on the product, such as structural analysis, thermal analysis and fluid analysis, to verify its performance and reliability.

### 3.3 Application of Computer Vision and CAD in Art Field

Table 1 below shows the use of computer vision and CAD in the art field.

| *Application* | *Explain* | *Application* | *Explain* |
|---|---|---|---|
| Image | Image processing of artistic | architectural | It can be used in building |

| | | | |
|---|---|---|---|
| processing | works, such as contrast enhancement, noise reduction, color adjustment, etc., can improve the quality and expressive force of artistic works. | design | model establishment, drawing and structural analysis. CAD software can accurately draw architectural drawings and improve design efficiency and accuracy. |
| Style transfer | Apply one artistic style to another artistic work, thus creating a new artistic work. This method has been widely used in painting, photography, video and other fields. | Mechanical design | It can be used in parts design, assembly design and engineering drawing. CAD software can simplify the process of mechanical design and improve the efficiency and accuracy of design. |
| Image identification and classification | Classification and identification of works of art, such as automatic extraction and classification of information such as style, theme and author of paintings. | Sculpture design | The sculpture model is established by 3D modeling technology, and simulated and optimized. |
| Virtual Reality and Augmented Reality | Through virtual reality technology, the audience can enjoy the ancient paintings or sculptures, and augmented reality technology can bring more real artistic experience to the audience. | Jewellery design | It can be used in gem setting, metal casting and other links. CAD software can accurately draw jewelry drawings and improve design efficiency and accuracy. |

**Table 1**: Application of computer vision and CAD in art field.

Computer vision and CAD are widely used in the art field, and their combined application can bring more possibilities for artistic creation and design. For example, through computer vision technology for image processing and feature detection of artistic works, CAD can be used for accurate modeling and simulation, so as to realize digital reproduction and re-creation of artistic works. The combination of computer vision and CAD can also be used to protect and maintain works of art, such as automatic detection and classification of damaged works of art through image identification technology, and digital repair and restoration of damaged works of art through CAD.

## 4 CLASSIFICATION AND CHARACTERISTICS OF CHINESE PAINTING ELEMENTS

Chinese painting elements include brush strokes, color, composition, texture and many other aspects, among which brush strokes are one of the most important elements. Brush strokes are one of the basic expressions of Chinese painting, which can show the unique style and charm of Chinese painting. According to different classification methods, Chinese painting elements can be divided into the following categories: ⊖ brush elements. ⊜ Color elements. ⊛ Composition-like elements. ④ Texture elements. See Table 2 for details.

| *Classification method* | *Element species* | *Include content* | *Form of expression* |
|---|---|---|---|
| Brush strokes | Brush stroke | Various brush strokes, such as points, lines, faces, etc. | Different styles and emotions can be expressed through |

| | | | |
|---|---|---|---|
| | shape | | different strokes. |
| Color class | Color | Various colors, such as red, yellow, blue, etc. | Different colors can show different emotions and atmospheres. |
| Composition class | Composition method | Various composition methods, such as symmetry, balance, repetition, etc. | Different compositions can show different artistic conception and aesthetic feeling. |
| Texture class | Vein | Various textures, such as smooth, rough, soft, etc. | Different textures can show different materials and textures. |

**Table 2**: Classification of Chinese painting elements.

The characteristics of Chinese painting elements include: ㊀ uniqueness: Chinese painting has a unique style and characteristics, and its expression and application methods are also different from other painting forms. ㊁ Sensitization: Chinese painting emphasizes emotional expression and artistic conception, and the expression and application of its elements are also more emotional and subjective. ㊂ Diversification: Chinese painting has a very rich variety of elements and expressions, and its combination and application of elements are also more diversified.

## 5 IMAGE IDENTIFICATION AND FEATURE DETECTION MODEL CONSTRUCTION

### 5.1 Selection of Image Identification and Feature Detection Methods

Chinese painting element identification and feature detection is an important research direction in the field of computer vision, which involves many aspects of element identification, such as brush strokes, colors, composition and so on. Generally speaking, the algorithms that can be used for element identification and feature detection of Chinese painting are as follows: ㊀ Algorithm based on edge detection: Brush strokes are one of the important elements in Chinese painting, which can be identified by detecting the edge in the image. Edge detection algorithm can detect the edge in the image by analyzing the difference of pixel gray value, so as to identify the shape and direction of brush strokes. ㊁ Algorithm based on color histogram: Color is also one of the important elements in Chinese painting, and color features can be extracted by analyzing the color histogram of the image. Color histogram can describe the frequency of various colors in an image, thus identifying different color styles and characteristics. Color histogram can be used to classify and retrieve images, or to compare the similarity with other images. ㊂ Algorithm based on Hough transform: Hough transform is an algorithm for detecting simple shapes in images, such as lines and circles. In Chinese painting, lines, circles and other shapes can be detected by Hough transform, so as to identify different elements and features in composition. ④ WT-based algorithm: WT is an algorithm for signal processing, which can analyze the characteristics of signals at different scales and frequencies. In Chinese painting, the image can be regarded as a 2D signal, and the image can be decomposed by WT, so as to extract features at different scales and frequencies.

Considering the quality and quantity of data sets, the complexity and interpretability of the model and other factors, this article finally chooses WT algorithm to identify elements and extract features of Chinese paintings. This will be discussed in detail in the next section.

### 5.2 Chinese Painting Element Identification and Feature Detection Based on WT Algorithm

WT is a powerful mathematical tool, which can analyze the local characteristics of signals at different scales and frequencies. In recent years, WT has been widely used in the field of image processing, especially in image identification and feature detection. This section will discuss how to use WT algorithm to identify and extract features of Chinese painting elements.

WT is a frequency domain analysis method, which analyzes signals in time and frequency through a set of wavelet functions. These wavelet functions are local and adaptive, and can adapt to the shapes and characteristics of various signals. In Chinese painting element identification and feature detection, it is needed to first WT the Chinese painting image and decompose the image into different frequency bands in order to extract the features of the image.

Before WT, Chinese painting images need to be preprocessed, including image denoising, image enhancement and other steps. These steps can improve the image quality and enable WT to better extract the features of the image. Let the basic model of a signal polluted by noise be:

$$f(t) = s(t) + n(t) \tag{1}$$

Where $s(t)$ is a useful signal and $n(t)$ is a $N \sim (0,\sigma^2)$ wide stationary Gaussian white noise. Assuming that the transformation matrix of discrete WT is $W$, the above formula is WT:

$$W\left[p(i,j)\right] = W\left[f(i,j)\right] + W\left[n(i,j)\right] \tag{2}$$

Order:

$$\begin{cases} P = W\left[p(i,j)\right] \\ F = W\left[f(i,j)\right] \\ N = W\left[n(i,j)\right] \end{cases} \tag{3}$$

Then:

$$P = F + N \tag{4}$$

Then, WT algorithm is used to decompose the preprocessed image in multi-scale to get the coefficients of different frequency bands. These coefficients contain the characteristic information of images at different scales. Through the analysis of these coefficients, the characteristics of Chinese painting elements can be extracted. Specifically, the WT algorithm decomposes the Chinese painting image into several sub-bands, and each sub-band corresponds to a different scale and direction. By extracting and analyzing the characteristic information of these sub-bands, we can obtain the local characteristics of Chinese painting in different scales and directions.

Let WT algorithm take three consecutive image sequences in a Chinese painting as follows:

$$f_{k-1}(x,y), f_k(x,y), f_{k+1}(x,y) \tag{5}$$

By adjusting the sensitivity coefficients of image hue $H$, saturation $S$ and brightness $I$, each frame of the obtained sequence image is transformed into an improved HSI image which can highlight the moving target better:

$$f_i(x,y) = \left(W_H H_i(x,y), W_S S_i(X,Y), W_I I_i(X,Y)\right) = \left(H'(x,y), S'(x,y), I'(x,y)\right) \tag{6}$$

Where: $W_H$, $W_S$ and $W_I$ are the set sensitivity coefficients of hue, saturation and brightness, respectively. Differentiate the $k$ and $k-1$ frame images converted by the above formula, and the $k+1$ and $k$ frame images. The frame difference image calculation model is as follows:

$$f_{d1}(x,y) = \left(\left|H'_k(x,y) - H'_{k-1}(x,y)\right|, \left|S'_k - S'_{k-1}(x,y)\right|, \left|I'_k - I'_{k-1}(x,y)\right|\right) \tag{7}$$

$$f_{d2}(x,y) = \left(\left|H'_{k+1}(x,y) - H'_k(x,y)\right|, \left|S'_{k+1} - S'_k(x,y)\right|, \left|I'_{k+1} - I'_k(x,y)\right|\right) \tag{8}$$

Where: $f_{d1}(x,y), f_{d2}(x,y)$ is the result of frame difference of three consecutive image sequences. Selecting appropriate wavelet function and transform scale range, the Chinese painting image is subjected to multi-scale WT, and a series of sub-band images are obtained. These sub-band images can be regarded as the detailed information of Chinese painting in different scales and directions, including the local characteristics of the images. Secondly, feature detection is carried out for each sub-band image. The edge detection algorithm can be used to extract the edge information of the image, and analyze the shape, direction and changing law of the edge at different scales. Finally, by comparing the feature information of different sub-band images, we can further extract the local features of Chinese painting at different scales. For example, we can compare the texture features at different scales and analyze their changing rules at different scales; We can also compare the edge information at different scales and extract its shape and direction features at different scales. By carrying out multi-scale WT on Chinese painting and extracting feature information at different scales, we can effectively extract and analyze subtle features and local information in Chinese painting. The multi-scale decomposition process of WT-Laplacian is shown in Figure 1.

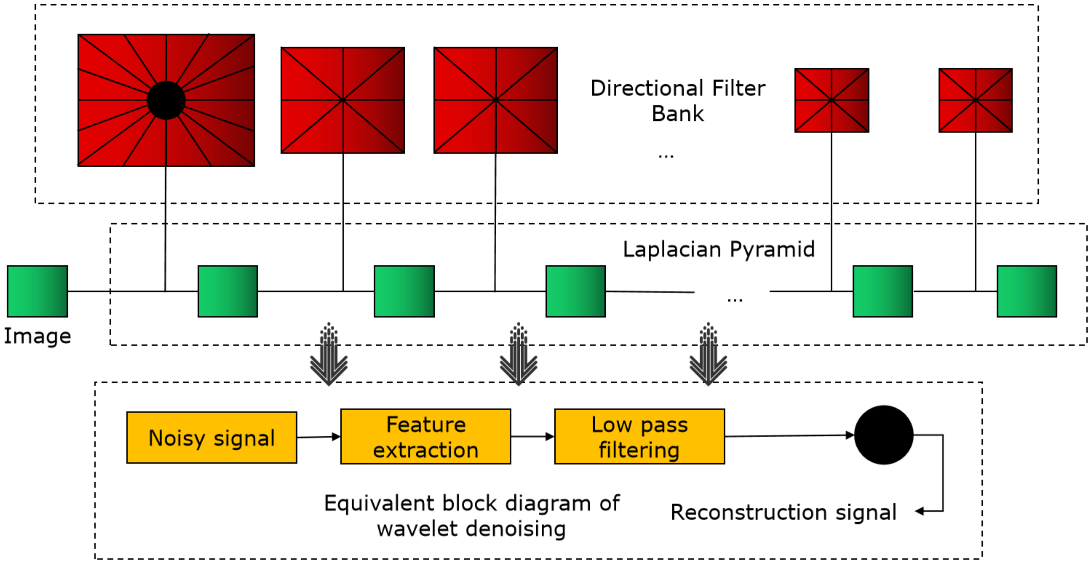


**Figure 1**: WT-Laplacian multi-scale decomposition process.

Mallat algorithm is a signal tower multi-resolution decomposition and reconstruction algorithm proposed by Mallat by combining the image tower decomposition algorithm with WT multi-resolution analysis theory. In this article, Mallat algorithm is applied to signal decomposition, which can realize fast wavelet decomposition of signals on discrete grids. It calculates wavelet coefficients through discrete convolution and second-order sub-sampling process, and the specific decomposition formula is as follows:

$$\begin{cases} \mathrm{c}_{\mathrm{j+1}}\ k = \mathrm{c}_{\mathrm{j}}\ k * L\ 2k \\ \mathrm{d}_{\mathrm{j+1}}\ k = \mathrm{d}_{\mathrm{j}}\ k * H\ 2k \end{cases} \tag{9}$$

In the formula, $\mathrm{c}_{\mathrm{j}}\ k$ and $\mathrm{c}_{\mathrm{j+1}}\ k$ respectively represent the approximate coefficients under the scales $j$ and $j+1$; $\mathrm{d}_{\mathrm{j}}\ k$ and $d_{\mathrm{j+1}}\ k$ respectively represent the detail coefficients under $j$ and $j+1$, that is, the wavelet coefficients to be extracted in this article; $L$ and $H$ represent low-pass and high-pass filters, respectively. The decomposition process is shown in Figure 2.

WT algorithm can effectively analyze and identify various elements and features in images, while CAD can provide accurate image processing and analysis tools, and the combination of the two can extract elements and feature information in Chinese paintings more efficiently.

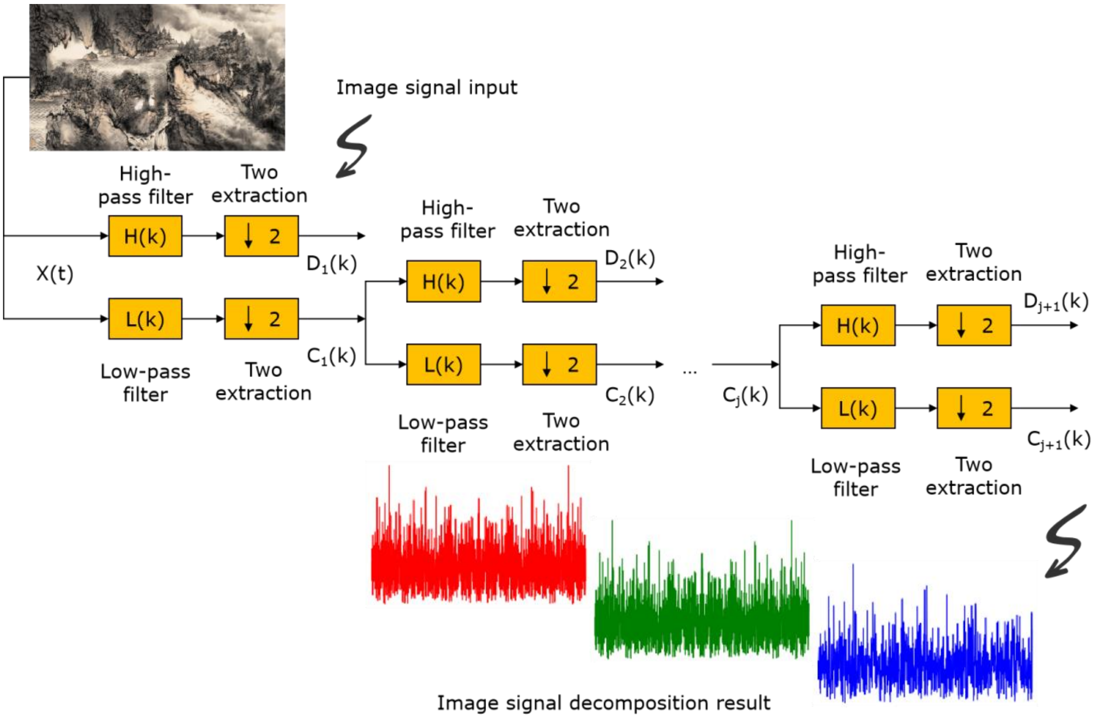


**Figure 2**: Algorithm decomposition process.

This method not only improves the accuracy of Chinese painting research, but also helps to dig deep into the artistic value and connotation of Chinese painting. In addition, we need to consider how to use the extracted features to classify, identify and retrieve Chinese painting elements. This needs to be combined with knowledge and technology in the fields of computer vision and pattern identification.

## 6 EXPERIMENT OF CHINESE PAINTING ELEMENT IDENTIFICATION AND FEATURE DETECTION BASED ON THE MODEL

This section will introduce in detail how to use WT algorithm to carry out the experiment of element identification and feature detection in Chinese painting. The purpose of this experiment is to use computer vision and CAD to automatically identify and extract features of Chinese paintings, so as to improve the efficiency and quality of the protection, inheritance and research of Chinese paintings. The stage of the experiment mainly includes the following steps:

Image preprocessing: Firstly, the Chinese painting image is preprocessed, including image denoising, image enhancement and other steps to improve the quality and clarity of the image.

Feature detection: then, using computer vision technology, feature detection is carried out on Chinese painting images. In this article, WT algorithm is used to decompose Chinese painting images at multiple scales, and the statistics of coefficients in each frequency band, such as mean, variance and edge information, are extracted to obtain the basic characteristics of Chinese painting elements. In addition, other characteristic information such as texture and color of the image is also used.

Model building: Next, using CAD and WT algorithm, the model of Chinese painting element identification and feature detection is built. Through the training and learning of a large quantity of

Chinese painting images, the model can automatically identify and extract the characteristics and laws of Chinese painting elements.

Analysis of experimental results: Finally, the effect of element identification and feature detection in Chinese painting of the model is tested and analyzed. In this article, a variety of evaluation indicators, such as accuracy, recall and F1 value, are used to evaluate the performance and effect of the model. Figure 3 shows the accuracy of the model, Figure 4 shows the recall rate of the model, and Figure 5 shows the F1 value of the model.

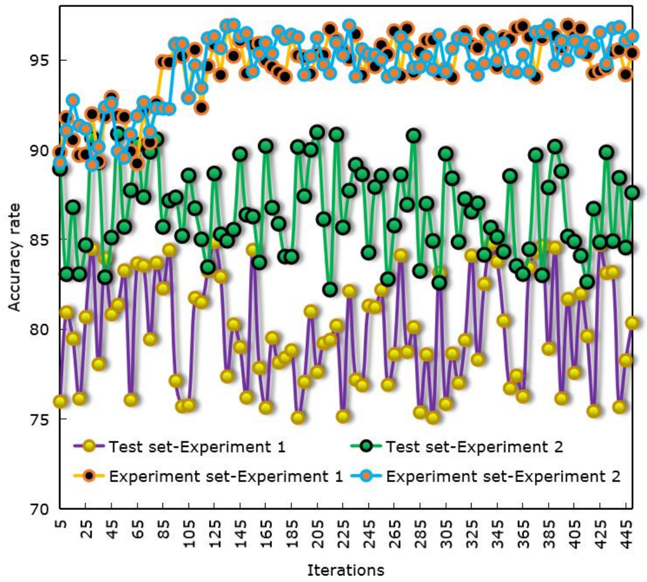


**Figure 3**: Accuracy of the model.

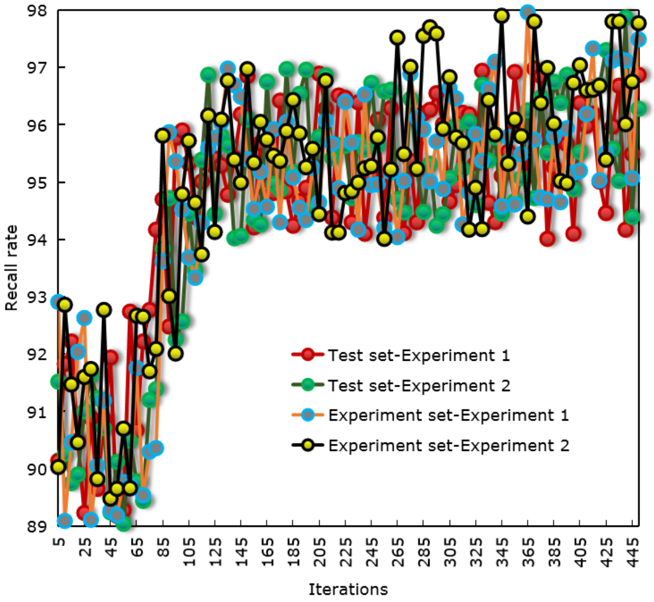


**Figure 4**: Recall rate of the model.

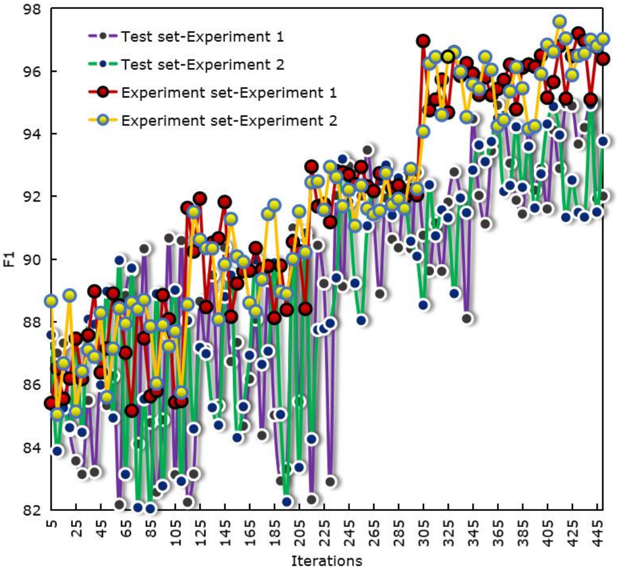


**Figure 5**: F1 value of the model.

Through the experimental verification, it can be found that the method of Chinese painting element identification and feature detection based on WT algorithm can extract the feature information of Chinese painting elements, and the model constructed by using CAD and WT algorithm can achieve high identification accuracy and recall. Specifically, WT algorithm can decompose Chinese painting images at multiple scales, and extract the statistics of coefficients in each frequency band, thus obtaining the basic features of Chinese painting elements. Through the analysis and processing of these characteristics, we can get the information of the shape, texture and color of Chinese painting elements. The model constructed in this article has good learning and generalization ability. Through training and learning a large quantity of Chinese painting images, the model can automatically extract the characteristics and laws of Chinese painting elements. The results show that the model can achieve high identification accuracy and recall, and has fast running speed and strong generalization ability.

The following experiment adopts the model of image identification and feature detection based on CAD and WT algorithm, and carries out element identification and feature detection on Chinese painting images. Moreover, in order to simulate the actual application scene, this article selects some Chinese painting photos as experimental samples. Figure 6 shows the results of element identification and feature detection of Chinese painting by using CAD and WT algorithm model.

The results show that the method of Chinese painting element identification and feature detection based on WT algorithm has high accuracy and reliability in dealing with details and local features. This is helpful to improve the efficiency of the protection, inheritance and research of Chinese painting.

In order to compare the effects of element identification and feature processing in Chinese painting, this section adopts an image identification and feature detection model based on WT algorithm, and selects China traditional painting as an experimental sample. In the experiment, the following four methods were used for comparison. The comparison between element identification and feature processing in Chinese painting is shown in Figure 7.

By comparing the experimental results, we can draw the following conclusions:

㊀ This method can effectively identify and extract elements and feature information in Chinese painting. When processing Chinese painting images, the previous image processing methods often can't accurately extract the elements and feature information in the images, but this method can effectively solve this problem.

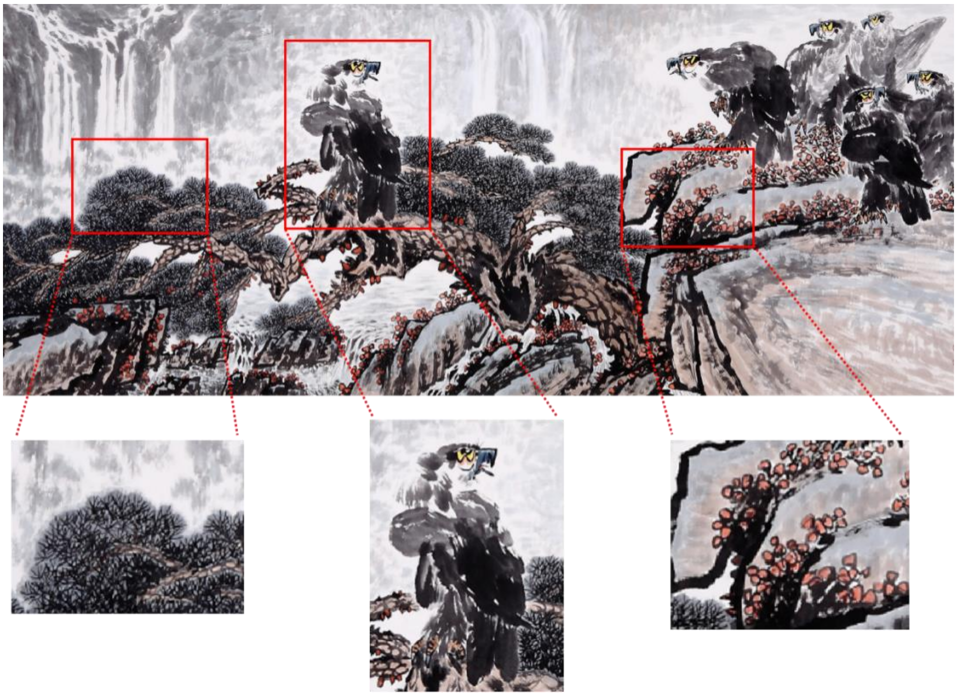

**Figure 6**: Results of element identification and feature detection of Chinese painting by model.

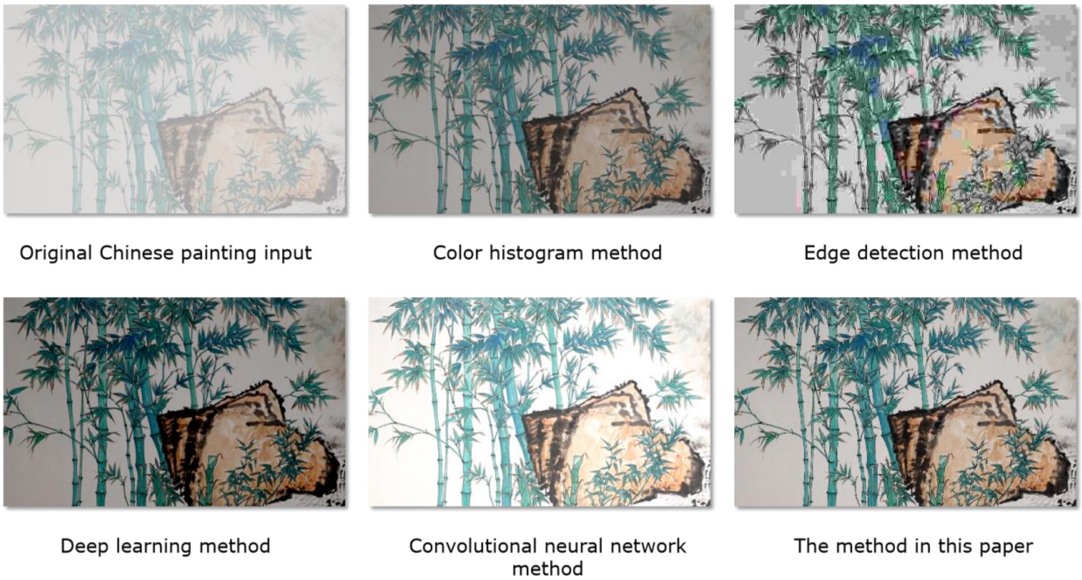


**Figure 7**: Effect of element identification and feature processing in Chinese painting.

⊜ This method can better preserve the detailed information of Chinese painting. By using WT algorithm for multi-scale decomposition, this method can extract the feature information of images at different scales, thus better preserving the detailed information of Chinese paintings.

⊛ The visual effect of Chinese painting images processed by this method is better. By comparing the experimental results with the original images, we can find that the Chinese painting images processed by this method are clearer and have stronger visual impact.

To sum up, this experiment uses computer vision and CAD to automatically identify and extract features of Chinese painting elements, and achieved good experimental results. This provides useful reference and technical support for further promoting the digital protection, inheritance and research of Chinese painting.

## 7 CONCLUSIONS

With the continuous growth of digital technology, computer vision and CAD are more and more widely used in element identification and feature detection of Chinese painting. Combining computer vision and CAD, this article constructs an image identification and feature detection model based on WT algorithm, aiming at realizing automatic element identification and feature detection of Chinese painting. The advantage of this model is that it adopts WT algorithm, which can analyze the detailed information of Chinese painting images at different scales, thus extracting the feature information of images at different scales. Moreover, the automatic identification and feature detection of Chinese painting images are realized by combining computer vision and CAD, which improves the efficiency and quality. The results show that the model can achieve high identification accuracy and recall, and has fast running speed and strong generalization ability. This shows that WT algorithm has obvious advantages in extracting subtle features and local information in Chinese painting. Moreover, the model also has a wide application prospect, which can be applied to element identification and feature detection of other painting forms, and promote the development and digital protection of the art field. Future research needs to further explore more effective technical methods to improve the accuracy of identification. In addition, it is needed to further study how to combine computer vision and CAD with artists' creative thinking and aesthetic concepts in order to realize a more natural and harmonious artistic creation process.

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