Image Processing Algorithm of Packing Design Based on Artificial Intelligence

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Abstract. The current image processing methods of packing design are inefficient and cannot meet the actual requirements of packing design image processing. In order to improve the image processing effect of packing design, this article analyzes the image processing method of packing design in detail, and proposes an image processing algorithm of packing design based on wavelet transform by using AI (Artificial intelligence) combined with CAD (Computer aided design) technology. At the same time, in order to further improve the quality of image denoising and restoration, an adaptive threshold setting method based on wavelet decomposition scale is designed, which can effectively adjust the threshold to retain effective information. The simulation show that compared with the matched filtering algorithm, the proposed algorithm has higher accuracy and lower mean square error. The error is about 4.12, and the accuracy can be stabilized above 90%. The proposed method can decompose the image, and through decomposition, the key content in the image and other contents can be selectively enhanced and deleted, so that the key content of the image can be expressed more clearly, and it has better ability to retain the details and edge information of the image. It completely meets people's demand for image processing of packing design.

Keywords: Artificial Intelligence; Computer Aided Design; Packing Design; Image Processing
DOI: https://doi.org/10.14733/cadaps.2024.S3.166-181

1 INTRODUCTION

Due to the growth of society, people are more and more fond of pursuing all kinds of favorite things, and shopping is a basic activity in people's lives. Product packing design can meet people's aesthetic needs to a certain extent and improve people's shopping satisfaction. Image conversion based deep learning model adversarial disturbance defense is a method of defense against adversarial disturbances in deep learning models. This method reduces or eliminates the impact of adversarial disturbances on the model through image conversion. Agarwal et al. [1] conducted computer image transformation classification based on deep learning algorithms. It constructs a database feature evaluation classification based on wavelet discrete transform. After training the model, adversarial attack techniques can be used to generate adversarial disturbances. Adversarial disturbances are artificially created disturbances that can deceive models into making incorrect judgments. After generating adversarial disturbances, image conversion techniques can be used to reduce or eliminate the impact of adversarial disturbances on the model. Image conversion can use some common algorithms, such as Histogram equalization, filtering, etc. to convert images. After obtaining the converted image, deep learning techniques can be used to retrain the model to improve its defense against adversarial disturbances. Therefore, enterprises need to strengthen the research on packing design. In the packing design of products, not only color matching and graphic adjustment should be carried out, but also various details should be handled skillfully, so as to better convey the designer's ideas and highlight the aesthetic feeling of product design. Chen and Dong [2] analyzed the image recognition of closed environment lighting conditions using neural network denoising for fast sorting of image packaging learning based on fiber optic differences. The fast recognition method of complex sorted images based on deep learning is a method that utilizes deep learning technology to recognize complex sorted images. Train the deep learning model using the preprocessed dataset to accurately recognize complex sorted images. Evaluate the performance of deep learning models, such as accuracy, recall, etc., to determine whether they can meet the requirements for recognizing complex sorted images. If the performance of the deep learning model does not meet expectations, the model can be optimized, such as adjusting hyperparameters, adding training data, etc., to improve its recognition accuracy and efficiency. It should be noted that the fast recognition method for complex sorted images based on deep learning needs to be optimized and adjusted for specific application scenarios to achieve the best recognition effect. At the same time, it is also necessary to consider issues such as the size and diversity of the dataset, the selection of deep learning models, and parameter settings to avoid overfitting and underfitting. In detail design, the content of product design is enriched and the product quality is improved. As a part of the huge application field of computer, the use of AI technology and CAD software for packing design provides a broader design space, richer design language and stronger design performance for relevant practitioners. Danso et al. [3] used wavelet transform under threshold for filter induced processing of noisy images. The security inspection image processing method using wavelet transform filters is an effective image processing method that can be used for image processing and defect detection in security inspections. Firstly, it is necessary to collect security inspection images, which can be collected using devices such as cameras and scanners. After collecting images, it is necessary to preprocess them in order to improve image quality and reduce interference. Wavelet transform filters can be used for image denoising, enhancement, and other operations. On the basis of the preprocessed image, wavelet transform can be used to extract the feature information of the image. Wavelet transform can decompose an image into components of different scales, thereby extracting multi-scale features of the image. After extracting image features, common image processing techniques and algorithms such as edge detection and morphological processing can be used to further extract defect features, classify and recognize them. Finally, the detected defect location, type, and other information will be output for subsequent processing and analysis. It should be noted that each step needs to be optimized and adjusted for specific application scenarios to ensure the accuracy and efficiency of detection. Meanwhile, wavelet transform filters and other image processing techniques can also be combined and adjusted according to actual situations to achieve better detection results. At present, people pay great attention to the research on image processing methods of packing design. With the assistance of AI and CAD technology in the field of product packing design, it plays an important role in improving the aesthetic appearance and practical function of product packing design. Through the method of texture distribution and information enhancement, the image processing of packing design can effectively improve the effect of packing design and is of great significance to the growth of product industry. Desai and Makwana [4] perform pattern recognition and power analysis of the feedforward network by analyzing the swing of the training layer over a half cycle. It proposes an innovative deep learning algorithm based on wavelet transform for transmission line analysis. The main idea of this algorithm is to apply wavelet transform to the input signal to obtain multi-scale features of the signal. Then, a deep learning model is used to learn and predict the transformed features to estimate the out of step situation and generate a correction signal. Finally, the correction signal is sent to the receiving end through relay transmission to restore the original signal. The advantage of this algorithm is that it can effectively handle out of step problems and improve the quality of signal transmission. In addition, this algorithm can also optimize the prediction performance of deep learning models through training, thereby achieving better performance.

Dong et al. [5] analyzed X-ray image denoising based on wavelet transform and Median filter. It constructs the transmission communication accuracy extraction of noise filtering by transmitting information on image quality. On the basis of the preprocessed image, wavelet transform can be used to decompose the image into components of different scales. Wavelet transform can decompose an image into multiple sub bands, each containing feature information of different scales. After getting the sub-band of wavelet transform, Median filter can be used to remove the noise. The Median filter is a nonlinear filter, which can retain the edge information of the image while removing noise and detail information. After removing noise, the inverse transform of wavelet transform can be used to merge the denoised sub-bands into a complete image. Image reconstruction can restore the structure and detailed information of an image, improving its visualization and readability. Image processing technology has been widely concerned in recent years, especially with the growth of modern communication and computer network, the requirements for image quality and clarity are also increasing. The traditional methods to deal with the packing design image mainly include the wavelet feature analysis, fuzzy feature identification and Harris corner detection. Nowadays, wavelet theory is developing rapidly, and the greatest demand for wavelet analysis in daily life is the wavelet threshold denoising method of images, which makes each self-contained image have different thresholds and achieves the purpose of image denoising by selecting appropriate thresholds. Wavelet transform is a time-domain and frequency-domain analysis method suitable for non-stationary signals, which has sensitive time-frequency localization and high resolution. From a mathematical point of view, wavelet is actually the expansion and approximation of mathematical expressions in a specific space according to the basic function called wavelet. As a fast, efficient and accurate approximation method, wavelet theory constitutes an important growth of Fourier analysis in the field of harmonic analysis. Different from Fourier transform and window Fourier transform, wavelet transform uses more accurate wavelet basis function. The detailed analysis of multiple components is realized by means of scaling and translation, so as to extract more component information, realize decomposition and synthesis in time domain or frequency domain, and make up for the lack and deficiency of many difficult problems in Fourier transform. In order to improve the image processing results of packing design, this article tries to use AI combined with CAD technology to propose an image processing algorithm of packing design based on wavelet transform. Its main innovations are as follows:

⊖ Through the fast decomposition algorithm of two-dimensional wavelet transform, the wavelet coefficients of each component of the image are calculated; Then the correlation between wavelet coefficients of the same component or adjacent components is utilized.

⊜ In order to further improve the quality of image denoising and restoration, an adaptive threshold setting method based on wavelet decomposition scale is designed, which can effectively adjust the threshold adaptively to retain effective information.

⊛ The packing design image was enhanced by guided filtering, and the packing design image was decomposed into multi-dimensional features by visual communication optimization and edge pixel fusion, so as to realize the packing design image enhancement.

Firstly, this article expounds the background, significance and topic selection idea of this topic; The development and research status of AI and CAD technology are systematically summarized.

Then, an image processing algorithm of packing design based on wavelet transform is proposed by using AI combined with CAD technology. The basic principle and specific implementation steps of the method are given, and the simulation results are compared with those of other algorithms. Finally, the research work and main contributions of this article are reviewed and summarized.

2 RELATED WORK

Eslami et al. [6] analyzed a semi-automatic structural reconstruction method for archaeological ceramic slices from three-dimensional images. By constructing approximate coefficients on the edge curves of the filtering algorithm, it analyzed the correlation coefficient feature classification of 2D images. After collecting images, preprocessing is required, such as denoising and enhancement, to improve the quality and readability of the images. Perform wavelet transform on the preprocessed image to decompose it into frequency bands of different scales. Wavelet transform can decompose an image into multiple sub bands, each containing feature information of different scales. After obtaining the frequency band after wavelet transform, common feature extraction algorithms such as edge detection, morphological processing, etc. can be used to extract the feature information of the image. The semi-automatic reconstruction of archaeological pottery fragments from 2D images using wavelet transform requires optimization and adjustment for specific application scenarios to achieve the best reconstruction effect. At the same time, it is also necessary to consider the parameter settings, feature extraction, and selection of matching algorithms for wavelet transform to avoid issues such as mismatches and missed matches. Feng et al. [7] conducted spatial environmental impact detection of image remote sensing quality. It unifies the structural framework of remote sensing technology images and constructs a higher quality dataset for dense network discussions. Optical remote sensing image denoising and super-resolution reconstruction based on wavelet transform domain optimized generation network is a technology that combines wavelet transform and generation network, used to simultaneously achieve image denoising and super-resolution reconstruction. This method first performs wavelet transform on optical remote sensing images to decompose them into frequency bands of different scales. Then, a generation network is used to optimize each frequency band to generate denoised and super-resolution reconstructed images. Generative networks can be implemented using deep learning techniques to generate high-quality images by learning a large number of datasets. Han et al. [8] analyzed the spatial structure of view content information labels using a 3D model of polymers. It proposes a model view of sequence labels and performs overfitting discrimination on the content information of the decoder. By dividing 3D data into multiple sequence views, the input size of RNN can be reduced, thereby reducing computational complexity. By using attention mechanism to weighted average each view, more accurate global feature representations can be learned, thereby improving the performance of the model. This model has good scalability and can further optimize its performance by adding more attention mechanisms. In general, this model is an effective 3D feature learning method, which can be applied in many 3D application fields, such as 3D Object detection, 3D scene understanding, etc.

Jiang et al. [9] conducted neural network function linking of image data. It constructs the hardware circuit of the neural network processing system to display the status. Input the preprocessed image data into a wavelet neural network for feature extraction and classification. Wavelet neural network is an algorithm that combines wavelet transform and neural network, which can effectively extract multi-scale features of images and perform adaptive classification. Implement an image scanning module on FPGA to input classified image data into FPGA for real-time scanning and detection. FPGA has the characteristics of high speed and low delay, which can achieve efficient Hardware acceleration and improve detection efficiency. Alarm and record the detected abnormal situations, so that maintenance personnel can handle them in a timely manner. This method can effectively detect faults and abnormalities in ship engines, improving the reliability and safety of the engines. In addition, the image scanning module based on FPGA can achieve high-speed and low latency real-time detection, suitable for application scenarios with high requirements for speed and accuracy. Pelliccia et al. [10] conducted technical participation in image construction through digital system simulation collaboration. The applicability of 3D factory simulation software in computer-aided participatory packaging image design is very high. This software can provide a very realistic environment, allowing users to simulate the actual situation of the factory and perform simulation operations on the factory. In terms of packaging image design, this software can be used to create and design various packaging, including product packaging and transportation packaging. By using 3D factory simulation software, designers can design and test packaging in a realistic environment to ensure the feasibility and reliability of packaging in the actual situation. In addition, this software can also be used to evaluate the sustainability of packaging, such as evaluating the environmental impact of packaging materials and designs. By using 3D factory simulation software, designers can better understand the production process and environmental impact of packaging, and take corresponding measures to improve the sustainability of packaging. Pourasad and Cavallaro [11] constructed image quality by considering algorithmic image compression transmission. It analyzes the image quality performance indicators of lossless compression. Lossless compression is a compression technique that reduces the size of an image by removing redundant information while maintaining its quality and readability. Lossy compression is a compression technique that can reduce the size of an image by sacrificing some image quality while preserving important features and information. For some scenarios with low requirements for image quality, such as digital video, network transmission, etc., lossy compression can better reduce image size and transmission bandwidth. The comprehensive application of lossless compression and lossy compression can achieve better compression results and image quality. You can first use lossless compression algorithms for initial compression, and then use lossy compression algorithms for secondary compression to reduce image size and transmission bandwidth while maintaining image quality. Wronkowicz et al. [12] conducted the detection and development of computer tomography images. It determines the accuracy of the structure through material tomography supported by actual images of wavelet transform. Distribution based segmentation algorithms can be used to identify cracks in X-ray tomography images. These algorithms are usually based on Statistical model or clustering algorithms, which can divide pixels in an image into different categories, where each category represents a different substance or structure. By identifying the distribution of cracks, they can be classified into different categories for further classification and analysis. Firstly, a distribution based segmentation algorithm can be used to classify the pixels in the image into different categories, and then wavelet analysis can be used to process the crack signals in each category, extracting and classifying their features. It should be noted that these methods need to be optimized and adjusted for specific application scenarios. For crack classification in composite material structures subjected to low-speed impact, it is necessary to select appropriate algorithms and parameters in order to achieve high-precision and high-efficiency classification and analysis.

Yang et al. [13] analyzed and introduced the modal data analysis of image biological labels based on standard image datasets. It constructs a dataset based on 2D and 3D images to simulate visual analysis of image analysis. By benchmarking medical images, it constructed label classification for the dataset. ShuffleNetV2: This is a lightweight network architecture designed specifically for mobile devices, with a small number of parameters and computational complexity. It adopts techniques such as channel separation and group convolution to reduce the complexity of the model while maintaining high classification accuracy. SqueezeNet: This is a very lightweight network architecture suitable for running on resource constrained devices. It adopts techniques such as feature compression and combustion to reduce the number of parameters and computational complexity of the model, while maintaining high classification accuracy. These benchmark architectures have been extensively validated through practice and can serve as the infrastructure for large-scale lightweight image classification tasks. The specific selection should be considered based on the requirements of the task and the limitations of the equipment. The image compression sensing deep network based on wavelet transform is a deep learning network used for image compression and sensing, which utilizes wavelet transform to compress and sense images. This kind of network usually consists of two main parts: a Convolutional neural network and a Recurrent neural network. Convolutional neural network is used for feature extraction of input image, while Recurrent neural network is used for feature compression and sensing. In Convolutional neural network, wavelet transform is usually used to decompose the image to obtain multi-scale features of the image. These features can be received and compressed by Recurrent neural network to generate sensing data. Yin et al. [14] conducted deep learning reconstruction on the sampling test optimization of image reconstruction. It analyzes the fast reconstruction process of images using wavelet algorithms based on sparse sampling networks. It can effectively compress image data while maintaining important features of the image, making image sensing easier and more efficient. In addition, this network can also optimize the compression and sensing effects through training, thereby achieving better performance. Overall, image compression sensing deep networks based on wavelet transform are a promising technology that can achieve efficient image compression and sensing in many applications. Zhdanov et al. [15] analyzed the preprocessing of wavelet scale images in databases. Through the evaluation and construction of the decision tree containing Feature selection, it proposes the parameter expansion analysis of retinal signal graph. Firstly, it is necessary to collect electroretinogram signals, which can be collected using an electro-retinograph. The electroretinogram signal is a signal that records the electrical activity of the retina and can reflect the physiological and pathological changes of the retina. After collecting the electroretinogram signal, it is necessary to preprocess it in order to improve signal quality and reliability. Wavelet transform or other signal processing techniques can be used for signal denoising, filtering, and other operations. On the basis of the preprocessed signal, wavelet scale graph processing technology can be used to further analyze the signal. Wavelet scale map is an image method that decomposes signals into different scales and can be used to extract multi-scale features of signals. After obtaining the wavelet scale map, common image processing techniques and algorithms such as edge detection and morphological processing can be used to further extract the feature information of the signal. Zhou et al. [16] analyzed the visual pixel image analysis and detection of packaging textures. The glass bottle bottom surface defect detection framework based on visual attention model and wavelet transform is an effective method for detecting glass bottle bottom surface defects. Firstly, it is necessary to preprocess the original image, including operations such as denoising and enhancement, in order to improve image quality and reduce interference. Then, wavelet transform is used to perform multi-scale decomposition on the preprocessed image to obtain image components at different scales. These image components can be used for subsequent feature extraction and defect detection. By calculating significance regions, the computational complexity of subsequent processing can be reduced and detection efficiency can be improved. After obtaining the salient regions, common image processing techniques and algorithms such as edge detection and morphological processing can be used to further extract defect features, classify and recognize them. Finally, the detected defect location, type, and other information will be output for subsequent processing and analysis. It should be noted that each step in the framework needs to be optimized and adjusted for specific application scenarios to ensure the accuracy and efficiency of detection. Meanwhile, techniques such as wavelet transform and visual attention model can also be combined and adjusted according to actual situations to achieve better detection results.

On the basis of related research, this article analyzes the image processing method of packing design in detail, and puts forward an image processing algorithm of packing design based on wavelet transform by using AI combined with CAD technology. The results show that the algorithm can enhance the useful signal and restrain the image noise to a great extent.

3 IMAGE PROCESSING IN PACKING DESIGN

3.1 Packing Design Based on AI and CAD Technology

Images have a certain visual language function to a certain extent, which can reflect the general silent effect. With the rapid progress of sc & tech, all kinds of computer software are becoming more and more popular in China, and the graphic image processing software represented by Photoshop is one of them. With the emergence of AI technology and CAD software, the application of graphics and image software in packing design has been fully demonstrated. Skillful use of graphics and image software for packing design is a skill that every designer must have. Packing design is mainly aimed at the object of commodity sales. When designing packaging, we should ensure that the theme is concise and clear, so that consumers can understand the product connotation through image language. At present, the rapid growth of social economy stimulates the intensification of market economy, which makes the requirements for packaging of products higher and higher. Therefore, the product packing design requires beautiful appearance, qualified quality and low cost. The purpose of packing design is not only to reflect the aesthetic feeling of packaging, but also to convey relevant information, arouse consumers' resonance and stimulate consumers' desire to buy.

Traditional packing design is mostly manual design, which not only consumes labor and time costs, but also reduces design efficiency. And when the design works are displayed, some design elements such as colors or patterns are difficult to show, and once design errors occur, it is very difficult to change them later. With the change of the times and the growth of economy, the technical industry has higher and higher requirements for product packing design and appearance specification manufacturing. As a means, the traditional model has problems in efficiency and accuracy, which seriously restricts the growth of various products. In packing design, the application of CAD software involves a lot of secondary combination and assembly of pictures. Designers can also ensure the best effect of design pictures by rendering and adjusting the software, which can better meet the actual needs.

Packaging design based on artificial intelligence and CAD technology can be achieved through the following steps:

Data collection: Collect data related to packaging design, such as product size, weight, shape, materials, etc.

Data pre-processing: pre-processing the collected data, such as Data cleansing and data normalization, to make it suitable for AI and CAD technology.

Packaging design: Use CAD technology to create packaging design, including the shape, size, material, color, etc. of the packaging.

Artificial intelligence application: Use artificial intelligence technology to optimize and evaluate packaging design, such as evaluating the appearance, function, cost, and other aspects of packaging design through deep learning algorithms, in order to determine the best packaging design solution.

Packaging production: Production is carried out based on optimized and evaluated packaging design schemes, including procurement, printing, assembly, etc. of packaging materials.

It should be noted that packaging design based on artificial intelligence and CAD technology needs to be optimized and adjusted for specific application scenarios to achieve the best design and production results. At the same time, it is also necessary to consider issues such as data quality and integrity, selection of artificial intelligence algorithms, and parameter settings to avoid issues such as misjudgment and errors.

3.2 Image Processing Algorithm of Packing Design Based on Wavelet Transform

Because wavelet transform is a new analysis tool based on Fourier transform, this kind of transform has strong time-frequency analysis ability and adjustable time and frequency resolution. This method is a new method to observe, understand and analyze time domain signals. Sometimes, some properties of the signal that cannot be observed in time domain can be clearly identified in frequency domain. It is the main content of multi-resolution analysis to carry out reasonable and necessary sequence analysis for a specific processing object. Multi-resolution analysis mainly carries out displacement and scale change according to binary. Once it encounters a high-frequency scene, it will lose its original function, but wavelet packet analysis can solve the problem of high-frequency scene. By applying wavelet transform, the time-varying image frequency characteristics can be described and analyzed, and then the image edge information can be accurately described, so it has obvious advantages compared with Fourier transform.

In the continuous space $L_2(R)$, let $\varphi(x)$ and $L_2(R)$ be a pair of Fourier transforms, if $\hat{\varphi}(\omega)$ satisfies the following conditions:

$$C_{\varphi} = \int_R |\hat{\varphi}(\omega)|^2 |\omega|^{-1} d\omega < +\infty \tag{1}$$

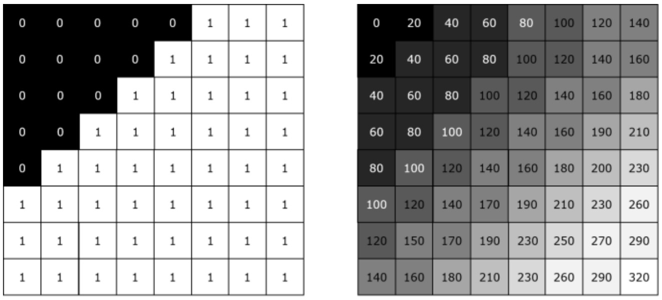
Then $\hat{\varphi}(\omega)$ is a mother wavelet, which can also be called basic wavelet. At this point, if the function $\varphi(x)$ is scaled and translated, it will be:

$$\varphi_{a,b}(x) = \frac{1}{\sqrt{|a|}} \varphi\left(\frac{x-b}{a}\right) \tag{2}$$

Where $\varphi_{a,b}(x)$ is a wavelet sequence and its scaling factor is $a(a \neq 0)$; b is the translation factor. Using wavelet theory to denoise and optimize the image, the graphics need to be modeled first. Generally, a two-dimensional plane image can be modeled in the form of a two-dimensional array $f(x,y)$, which is expressed as follows:

$$F = \begin{bmatrix} f(1,1) & \dots & f(1,N) \\ \dots & \dots & \dots \\ f(N,1) & \dots & f(N,N) \end{bmatrix} \tag{3}$$

In the soft-threshold image, all the coefficients with small wavelet coefficients are required to be set to "0", while the coefficients with large wavelet coefficients are required to approach "0" in a continuous and gentle way. The image can be transformed into a series of sub-images with different resolutions through wavelet analysis, and the higher the resolution, the more data points the sub-image has, and the value tends to zero, but for ordinary images, most sub-images are of low resolution. The image can be compressed by keeping the high-resolution part and removing the low-resolution part after wavelet decomposition, which is also the most concise image compression method. Two-dimensional multiresolution analysis is formed by tensor product of one-dimensional multiresolution analysis. A binary image can be represented by a two-dimensional array of 0 and 1, with 0 representing black and 1 representing white, as shown in Figure 1(a). For more complex gray-scale images, it can be represented by 8-bit binary numbers. 0 represents black, 255 represents white, and the remaining numbers represent different degrees of gray, as shown in Figure 1(b).



(a). Binary image schematic diagram (b). Schematic diagram of Grayscale

Figure 1: Image schematic diagram.

The application of hard threshold image denoising in packing design image processing will not damage the image edge information, but because the hard threshold function does not have continuous characteristics, other noises may be generated in image processing. In the process of image decomposition and reconstruction, superimposed noises such as Gaussian noise and white noise are filtered, and the mutual interference between various scales of the image is not considered. In order to avoid interference between multiple scales, this article introduces phase filtering algorithms within the same scale and between adjacent scales respectively. Let $W_{2^j}^{1d} I(x,y)$ and $W_{2^j}^{2d} I(x,y)$ be the horizontal and vertical components on the j scale after the original image is decomposed, then the modulus of the image on the j scale is:

$$M_{2^j} I(x,y) = \sqrt{\left|W_{2^j}^{1d} I(x,y)\right|^2 + \left|W_{2^j}^{1d} I(x,y)\right|^2} \tag{4}$$

In the j scale, the calculation expression of its phase is:

$$P_{2^j} I(x,y) = \arctan \frac{W_{2^j}^{2d} I(x,y)}{W_{2^j}^{1d} I(x,y)} \tag{5}$$

In this article, wavelet transform is applied to ANN, and an optimized ANN can be obtained, which will improve the learning approximation function of ANN in essence. As shown in Figure 2, the structure diagram of WNN used for approximation.

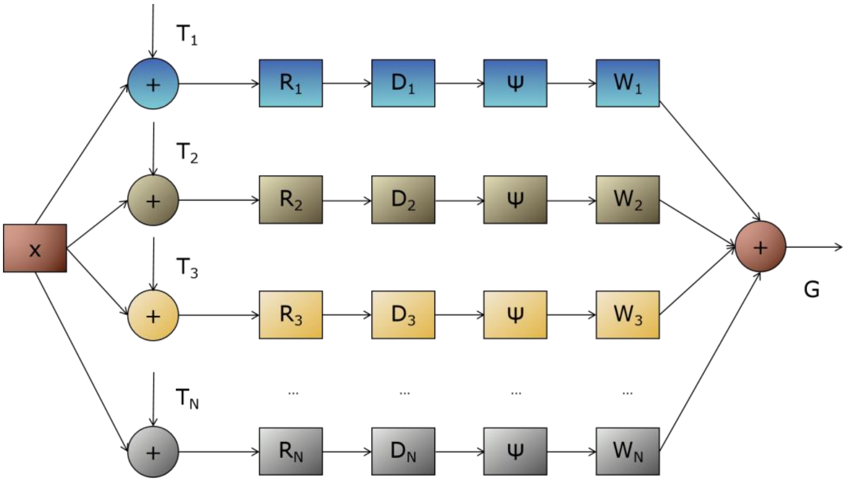


Figure 2: Structure diagram when WNN is used for approximation.

Compared with wavelet analysis, WNN has more degrees of freedom because it introduces two new parameter variables, namely expansion factor and translation factor, which makes WNN have more flexible and effective function approximation ability. The most important thing is to use what criteria to remove the wavelet coefficients belonging to noise and enhance the parts belonging to the signal. Traditional image enhancement methods have some shortcomings, such as enhancing noise or introducing new noise. The multi-scale image enhancement methods proposed in this article have suppressed this deficiency to some extent. It can not only enhance the image information, but also restrain the noise to some extent, and get better enhancement effect. Figure 3 shows the transformation realization of Contourlet and the Laplacian multi-scale decomposition process.

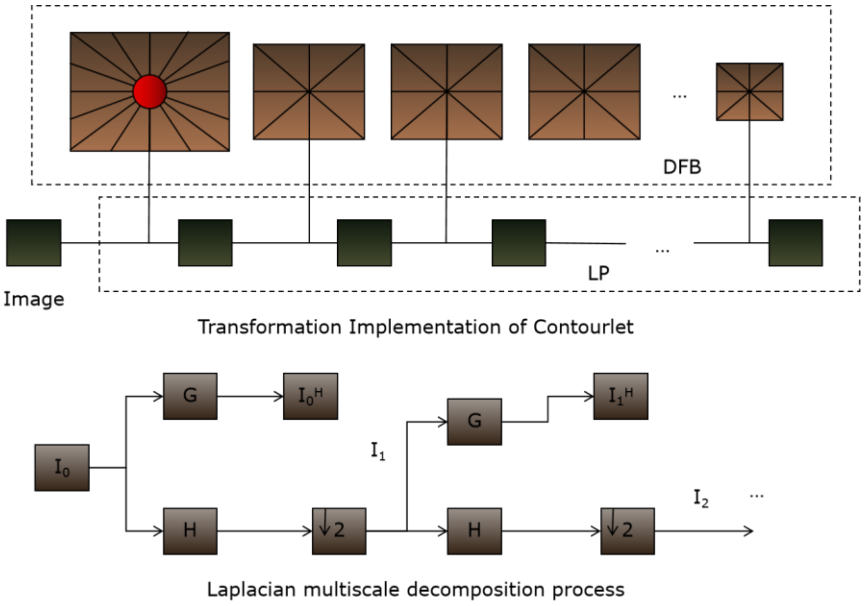


Figure 3: Transformation realization of Contourlet and Laplacian multi-scale decomposition process.

In the image processing of packing design, discrete wavelet transform can reflect the decomposability of image processing. Therefore, this article chooses wavelet threshold function denoising algorithm for image processing. It is the main content of multi-resolution analysis to carry out reasonable and necessary sequence analysis on a specific processing object. Multi-resolution analysis mainly carries out displacement and scale change according to binary. Once it encounters a high-frequency scene, it will lose its original function, but wavelet packet analysis can solve the problem of high-frequency scene. In this article, the low-pass filter detection method is used to decompose the scale of the packing design image, and the scale decomposition function is obtained, which is described by I . The adaptive feature distribution sequence of the packing design image is as follows:

$$P = \sum_{k=1}^{n} I_{(k)}(i, j) \times 2^{l} / b \tag{6}$$

Where k is the gray edge feature set of the packing design image; (i, j) is a multi-scale input pixel sequence of the packing design image. The optimization parameters of packing design images are fused, and the information fusion results are as follows:

$$W = P[2(i-1)+u, 2(j-1)+v] \tag{7}$$

$$u \in \{1,2\} \quad v \in \{1,2\} \tag{8}$$

Where u enhances the information intensity of the distribution set for packing design image information; v Information fusion degree of image information distribution set for packing design. Through the fusion of gray histogram, the transcendental visual analysis model of packing design image is obtained, and the neighborhood information components of the image are obtained by using the guiding filter function of packing design image:

$$r_\lambda^* = \begin{cases} W/CS_k & 1 \le \lambda \le i-j \\ \varepsilon_\lambda & otherwise \end{cases} \tag{9}$$

Where λ is the ambiguity enhancement coefficient of the packing design image; C is a standardized quantization set of packing design images; S_k is gray information; ε_λ is the filter coefficient of different levels of digital images. Adaptive wavelet transform enhancement is shown in Figure 4. When the correlation indicates that it is noise, the enhanced proportional function indicated by the dotted line in the figure is selected, and when the correlation clearly indicates that it is a useful signal, the enhanced proportional function indicated by the thick red line in the figure is selected.

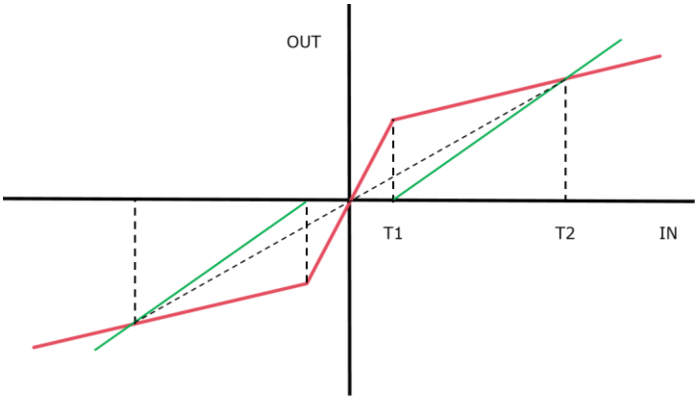


Figure 4: Adaptive wavelet transform enhancement.

According to the position correspondence between the coefficients, the position of the corresponding coefficient in the high frequency sub-band is obtained by mapping the position of the coefficient in the low frequency sub-band; At the same time, the coefficients in different sub-bands of the same scale and in each sub-band of different scales are operated, thus accelerating the texture synthesis process. In the process of constructing the threshold function, the parameters of the function gradually increase. For the function, differential calculation can be used to calculate, which can effectively alleviate the complexity of the calculation process. In order to meet the requirements of different wavelet decomposition scales, it is necessary to use an adaptive global threshold:

$$\lambda_J = \frac{\sigma_n \sqrt{2\lg|MN|}}{\log_2(J+1)} \tag{10}$$

Where J stands for wavelet decomposition scale. When $J=1$, the adaptive threshold will degenerate into the traditional Donoho global threshold. Image data is not only useful data, but also contains some redundant information. Compression is to delete all kinds of redundant information and only keep the image information, thus greatly reducing the image storage. The method in this article can ensure a higher compression ratio of images and greatly shorten the compression time. With the gradual increase of wavelet decomposition scale, the amplitude of image noise coefficient will gradually decrease. By setting the adaptive threshold, noise information can be effectively eliminated, effective information can be retained, and image distortion can be avoided. At the same time, the feature decomposition function of the image is obtained by block area detection, and the optimized feature identification processing of the packing design image is carried out by the method of guided filtering detection.

4 EXPERIMENTAL ANALYSIS

4.1 Image Processing Simulation of Packing Design

In order to verify the effectiveness of the image processing algorithm of packing design based on wavelet transform, this article uses the image with noise to carry out simulation test. According to the above parameters, the packing design image is processed by wavelet transform algorithm. Table 1 shows the image detection rates of different wavelet basis functions.

Wavelet basis function	*Haar*	*Meyer*	*Mexican Hat*	*Db4*
Image 1	75.73%	84.72%	83.53%	91.64%
Image 2	87.08%	82.88%	82.09%	93.39%
Image 3	79.86%	84.24%	85.91%	94.43%
Image 4	79.56%	80.06%	84.92%	94.74%
Image 5	72.39%	88.51%	82.58%	91.62%

Table 1: Detection rate of different wavelet basis functions.

Db4 wavelet basis function is more accurate than other wavelet functions in image effect processing. Therefore, this article uses Db4 wavelet as wavelet basis function for endpoint detection.

When the gray value of an image is too concentrated, the visual effect is not ideal. However, when the values of each pixel point are evenly distributed in the whole gray range, the contrast of the image is generally moderate, the details are kept well, and the vision is clear. The simulated image to be processed in this section is shown in Figure 5. The result of image filtering is shown in Figure 6.

Figure 5: Image to be processed.

According to the filtering result of Figure 6, the packing design image is processed by wavelet transform algorithm, and the image processing result is shown in Figure 7.

As can be seen from the simulation experiment image in Figure 7, this method can effectively enhance the information of packing design images and improve the visual expression ability of packaging images. The proposed method can decompose the image, and through decomposition, the key content in the image and other contents can be selectively enhanced, deleted and reduced, so that the key content of the image can be expressed more clearly and meet people's needs for packing design images. Compared with single median filtering and wavelet denoising, the proposed method has more thorough denoising effect, can effectively filter Gaussian noise and impulse noise, and has better ability to preserve image details and edge information.

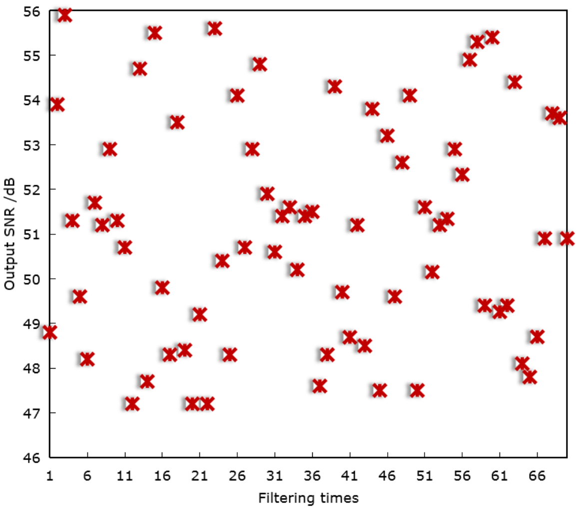


Figure 6: Image filtering result.

Figure 7: Image processing result.

4.2 Analysis of Algorithm Test Results

The multi-texture of packing design image is constructed by using the texture information clustering method of rough set. In order to test the superiority of the algorithm, this article introduces the commonly used matched filtering algorithm for comparison. By writing the corresponding program code, it forms a complete systematic comparison with the image processing algorithm based on wavelet transform in the same simulation environment and experimental conditions. The experimental environment of this experiment is a computer with 4G memory and Windows operating system, and the development software of the algorithm is Matlab. In order to ensure the objectivity and comparability of the experiment and the reliability of the experimental results, different algorithms are given the same training conditions. The mean square error of the algorithm is shown in Figure 8.

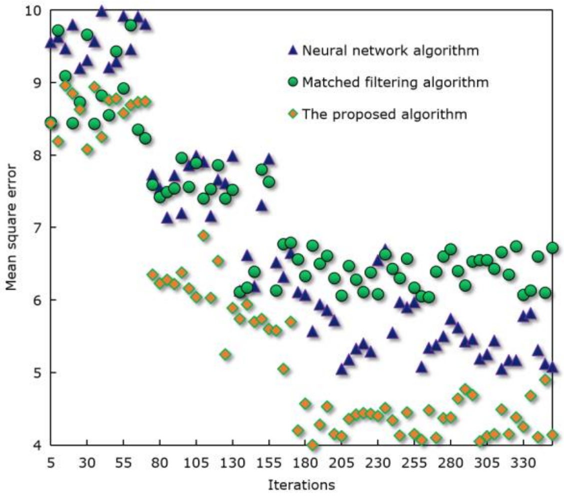


Figure 8: Mean square error result.

The wavelet threshold function used in this article has no breakpoint, which can effectively retain effective information and avoid retaining redundant noise information.

The traditional image denoising method is to filter the image signal frequency through special equipment to achieve the denoising effect, but its resolution of noise frequency can not achieve the expected goal, and the image denoising effect is extremely poor. Using this method, the noise frequency in the image can be accurately analyzed, the initial noise signal can be transformed by using a specific wavelet basis, and the noise signal can be removed flexibly by reverse transformation. The following experiments have been carried out for several different neural network models. The accuracy change results of different neural network models are shown in Figure 9.

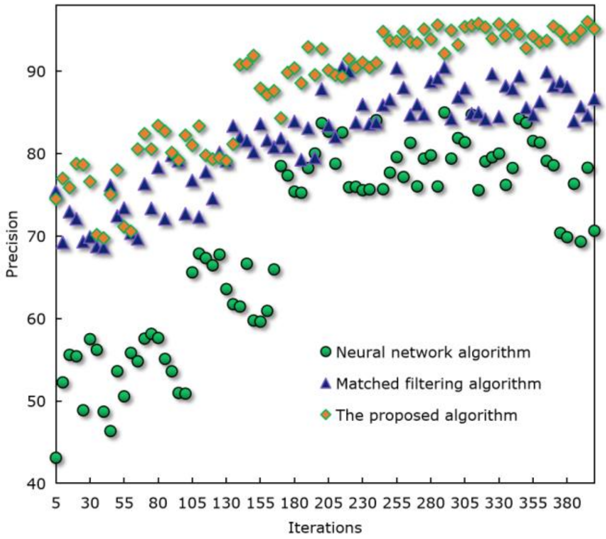


Figure 9: The accuracy of the model.

In order to reflect the results more concretely and intuitively, five of the results are selected and drawn into a table, as shown in Table 2.

Experimental serial number	BPNN model	CNN model	WNN model
1	75.67%	87.42%	95.48%
2	72.31%	88.26%	93.04%
3	76.13%	80.45%	94.95%
4	78.81%	86.27%	92.59%
5	75.34%	87.13%	93.69%

Table 2: Accuracy change of the model.

The simulation results show that compared with the matched filtering algorithm, the proposed algorithm has higher accuracy and lower mean square error. The error is about 4.12, and the accuracy can be stabilized above 90%. The proposed method can keep the image edge smooth while denoising, and the visual effect of image enhancement is obvious. The results verify its effectiveness and superiority.

5 CONCLUSIONS

The combination of AI, CAD technology and image processing of packing design can not only improve the quality and efficiency of product packing design appearance, but also ensure the upgrading and growth of related product packing design industry. Aiming at the problem of image processing in packing design, this article tries to use AI combined with CAD technology to propose an image processing algorithm for packing design based on wavelet transform. This method calculates the wavelet coefficients of the image in each component through the fast decomposition algorithm of two-dimensional wavelet transform. Then the correlation between wavelet coefficients of the same component or adjacent components is utilized; At the same time, the corresponding wavelet coefficients are used to reconstruct the processed image, forming a complete image processing scheme for packing design. At the same time, the packing design image is enhanced by guided filtering method, and the packing design image is decomposed into multi-dimensional scale features by using the methods of visual communication optimization.

The simulation results show that the algorithm proposed in this article has higher accuracy and lower mean square error compared with the matched filtering algorithm. The error is about 4.12, and the accuracy can be stabilized above 90%. The results show that the algorithm is effective and superior. In addition, the simulation results of image processing in packing design show that the method designed in this article significantly improves the image denoising and restoration effect. Compared with the existing threshold setting methods, the proposed method not only improves the image restoration degree, but also has high practicability. Generally speaking, the packing design image processing algorithm based on wavelet transform has obvious advantages in the application of packing design image processing. At present, product packing design and production are facing the growth of high quality and quantity, and all kinds of CNC automation operations and intelligent technology applications are inseparable from AI and CAD technology. With the cooperation of AI and CAD technology, the packing design industry has developed steadily, which not only improves the high-quality production of product packing design, but also ensures the quality of product packing design and manufacturing, and realizes the vigorous growth of modern products.

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