Hindawi
Advances in Mathematical Physics
Volume 2021, Article ID 1097046, 12 pages
https://doi.org/10.1155/2021/1097046

Research Article

Application of Gabor Image Recognition Technology in Intelligent Clothing Design

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Received 24 September 2021; Accepted 3 November 2021; Published 19 November 2021

Academic Editor: Miaochao Chen

Aiming at the complex problem of image recognition feature extraction, this paper proposes an intelligent clothing design model based on parallel Gabor image feature extraction algorithm. Based on the intelligent parallel mode, the algorithm decomposes and merges the calculation process of the image Gabor transformation, decomposes the entire image Gabor feature extraction calculation process into a parallel part and a nonparallel part, and accelerates the parallel part by using multiple cores. The calculation results are then combined to achieve the purpose of multicore parallel acceleration of the entire calculation process. Secondly, based on the consideration of improving the real-time performance of the intelligent clothing design system, combined with the existing multicore environment, this paper uses the intelligent model to design and implement the image parallel Gabor feature extraction algorithm and uses image processing and analysis technology to analyze the visual elements of traditional clothing and identify and quantify to form a relatively complete clothing visual element evaluation system, which provides a basis for large-scale collection and automated evaluation of clothing visual effects, as well as clothing trend tracking and prediction. Experiments show that the algorithm can effectively shorten the calculation time of Gabor image feature extraction and can obtain a good speedup in a multicore environment. At the same time, it combines with a multiscale intelligent clothing classification algorithm, on the basis of the VS2008 platform, combined with OpenCV 2.0, designed and implemented an intelligent clothing design system, and conducted experiments and system tests. The experimental results show that the algorithm given in this paper can accurately segment fabric defects from the background, which proves that the detection algorithm has a good detection effect. Simulation results show that the algorithm proposed in this paper can more accurately identify the state of clothing features, and the real-time performance of intelligent clothing design in a multicore environment has been improved to a certain extent.

1. Introduction

Image recognition is one of the main technologies for identity recognition using biometric technology, which is used in many fields. Image recognition technology involves many professional fields, including clothing industrial intelligence, image processing and analysis, image coding, pattern recognition, computer vision, biometric technology, and other fields. It is one of the focuses of research in recent years [1]. In addition, image recognition technology has high security and high market demand. It can be applied to clothing personnel file management, suspect search and identification, safety verification and security systems, certificate and credit card verification, clothing machine interactive systems, access control and automatic teller machines, and many other occasions. Therefore, image recognition has greater theoretical research value and certain commercial development prospects [2]. With the development of science and technology, computer technology has been greatly developed, but the current clothing industrial intelligence technology is not enough to easily recognize images [3]. Because the characteristics of each image are different and when the data is collected, it is affected by the illumination, angle, distance, etc.; each image is different; and it is quite difficult to construct a description model with various invariances [4]. In addition, with the deepening of the degree of informatization, many application fields, such as e-commerce, security certification, and intelligent environment, put forward higher requirements for image-related information processing [5].

Related research units and apparel members at home and abroad have continued to carry out independent research on each module. The research on the connection between the modules is still a new problem, such as the automatic screening of clothing body shape data according to clothing styles, and the automatic imports of the clothing category body data into the clothing CAD rapid pattern design module, etc. are the key technical issues of the digital integration program of clothing design and development [6]. Due to the differences in the characteristics of the image itself and the different feature extraction methods, it is difficult to find a universally applicable clothing feature pattern recognition algorithm. Only for specific feature extraction, a more appropriate pattern recognition algorithm can be used to obtain a good recognition rate [7]. Among them, at the current stage, before the style design is fully intelligent and digitalized, the two-dimensional clothing style diagram is still the way of expression of the clothing style design, and the technical parameters of the clothing structure are judged from the clothing style to the clothing style according to the clothing style diagram and the clothing body shape for the important content of pattern technology conversion [8]. Therefore, it is of great significance to study reliable, fast, and efficient intelligent clothing design algorithms. The existing research on clothing feature detection based on clothing features has a low recognition rate and cannot meet the real-time requirements of intelligent clothing design. Feature extraction based on Gabor images can well capture the multiscale features of clothing features. Multiscale classification algorithms can mine feature information on multiple feature scales to obtain better recognition rates. At the same time, intelligent multicore parallel computing can speed up detection [9–11].

Based on the multiscale features obtained by the Gabor image feature extraction algorithm, this paper proposes a multiscale clothing image classification algorithm to classify clothing features and nonclothing feature images. The algorithm fully considers the characteristics of multiscale feature vectors and uses the characteristic that clothing features behave differently on different scales. The image category is judged on each scale, and then, the judgment results on each scale are combined to get the final classification results of clothing features. In the preprocessing of the image, the size and resolution of the sample image are firstly controlled to unify the specifications and structure of the image; then, the advantages and disadvantages of the two-dimensional algorithm and the FCM algorithm in image segmentation are discussed, and the improved algorithm is used for the segmentation of clothing category and background, virtual sewing of the pattern, the establishment of style diagrams, and the identification and measurement of gaps. In the analysis of fabric image segmentation, texture analysis methods such as texture elimination, enhancement, directional analysis, and nonprimary texture enhancement are the common features of these studies, after analyzing the experimental data and preliminarily establishing the conversion model of the gap between the waist or hip side seams and the looseness of the clothing in the clothing styles of the X-shaped and H-shaped body. At the same time, the study uses mathematical morphology to extract the contours of clothing categories and discusses the offset caused by morphological factors and their compensation methods. The experimental results show that the recognition rate of the multiscale classification algorithm proposed in this paper is better than the existing intelligent clothing design methods based on partial features.

2. Related Work

Related research mainly uses image processing and analysis methods to extract certain parts of the clothing body or the contours of flat clothing or analyze and interpret clothing colors or patterns through the spatial changes of colors on the image and analyze through statistics or pattern recognition methods. The clothing design system is developing towards the direction of intelligence to meet individual design requirements and realize the design method of clothing machine interaction; break through the fixed mode to achieve the largest space of re-creation and design applications; combine style design with structural design and craftsmanship which are connected to improve clothing design and production efficiency [12].

Yang et al. [13] used wavelet analysis to extract a single-pixel contour from the clothing category image. Based on the comprehensive use of multiscale wavelet transform to detect the step mutation point of image gray, the histogram equalization of the wavelet modulus maximum value is used to adaptively select the dual threshold value, and the non-maximum value point is suppressed to the edge. The line is refined, and the double threshold is used to track the connecting edge points, so as to obtain a single-pixel-level contour image of the clothing body. Chen and Yang [14] introduced concepts such as contour error and fulcrum and proposed a new contour extraction method and applied it to clothing images with printed patterns. First, the initial contour is extracted by the morphological method, and then, the initial contour is divided into several single-value branches, and finally, the texture noise in the branches is eliminated by the contour error calculation. The initial contour extraction algorithm based on the morphological method can remove the pixels inside the clothing image and the external shadows and watermarks; the contour error calculation can effectively identify the texture noise data and repair the influence of the printing pattern on the clothing contour. Wen [15] used circular histograms to count color features in a computer-aided design system and used edge growth algorithm to segment colors in clothing patterns to use circular histograms to quantify the colors on the clothing image and reduce shadows and highlights. The color cooccurrence matrix is used to characterize the spatial correlation of colors, and the appearance frequency of various colors on the clothing texture is counted. On this basis, the color block area on the clothing is agglomerated through the region growth algorithm, so as to achieve the purpose of decomposing the clothing texture.

The use of digital image processing technology to inspect some parameters in the textile and apparel field, as well as to perform performance testing on the appearance and internal quality of textiles, is an advancement in digital processing technology and a major advancement in inspection and testing in the textile and apparel industry. With the development of computer technology and large-scale integrated circuit technology, the software and hardware environment of digital image processing technology has been continuously improved, and the advantages of computing speed, test accuracy, data processing, and result reproducibility have been better played. Agrwal et al. [16] used online hand-drawn sketch recognition and understanding technology to design and implement a two-dimensional plan design CAD system that supports smooth user input. The stroke recognition and regularization technology of online sketches is suitable for the processing of complex sketches and can enhance the understanding of sketches in the process of industrial product innovation. Patil and Kumar [17] first used 3D virtual clothing preprocessing to process the 3D digital clothing category and output the clothing prototype. Then, the three-dimensional clothing body is mapped to the N-dimensional plane to form the contour line of the two-dimensional clothing body, and the noise is removed. The user designs two-dimensional clothing contours in real time on the two-dimensional clothing contours of the virtual clothing. The three-dimensional virtual clothing design system collects the required feature points on the contour line and decomposes and classifies the two-dimensional clothing contour line according to the feature points and the connection of the feature points at different positions of the clothing body to form a cross line and shape. At present, it is more and more obvious to study the problems in the textile and clothing field through image processing technology [18]. The scope of research has also gradually developed from fiber fineness and crimp degree, yarn blending ratio and uniformity, fabric density measurement to defect detection, pilling resistance, drape evaluation, clothing fold level, seam effect evaluation, three-dimensional clothing body measurement, and so on [19–21].

3. Construction of Intelligent Clothing Design Model Based on Gabor Image Recognition Technology

3.1. Gabor Filter Hierarchy Distribution. Gabor wavelet is widely used in the fields of machine vision and texture analysis. The two-dimensional Gabor wavelet can well simulate the contour information felt by the visual nerve of mammals. The recognition effect is similar to the clothing eye recognition effect, and it can obtain the best resolution in the time domain, space domain, and direction scale, so Gabor is used. Figure 1 shows the hierarchical topology of Gabor filtering.

The subspace-based method is a method of extracting overall features, that is, extracting the entire image and then performing comparative analysis and recognition. It is the current mainstream method of image recognition.

$$p(x(1), x(2),\cdots,x(n)) = \prod_{i=1}^{n} p\{x(n)|x(n-i+1)\},$$
$$C = \frac{2(p(x)\times p(n))^{1/2}}{p(x)+p(n)}. \tag{1}$$

According to whether the spatial transformation is linear, subspace-based algorithms can be divided into nonlinear subspace algorithms and linear subspace algorithms. This is a more effective extraction method than the PCA method. It improves the image description ability while eliminating the high-order statistical correlation between pixels, and the independent components do not need to satisfy the orthogonal relationship.

$$I = \{C(x, y), x \in (0, 1, 2,\cdots,n), y \in (0, 1, 2,\cdots,n-1), n \in N\},$$
$$L(x, y) = \sqrt{\sum [C_a(x, y) - C_b(x, y)]^2}. \tag{2}$$

Considering that the Gabor face is formed by convolution of multiple Gabor filters and images, the spatial dimension and the amount of calculation are greatly increased. In actual use, sampling or reducing the spatial dimension is usually adopted to reduce the amount of calculation to increase efficient.

$$g(x, y) = \frac{|k(x, y)|^2}{t\cdot e\left(\left(-\|k\|^2(x+y)\right)/2t\right)},$$
$$G(x, y) - \iint I(x, y)\times g(x-1, y-1)dxdy = 0. \tag{3}$$

In order to reduce the redundancy o_f the feature set, the method of optimizing the Gabor filter set based on the linear correlation criterion is generally adopted. Through the analysis of the correlation matrix of the Gabor filter, it is found that the scale set when the correlation matrix reaches the minimum is V1. A set of optimized filters can be obtained, which improves efficiency.

$$f(x) = x(i) + \frac{x(i)\times x(j)}{x(i)+x(j)},$$
$$T^2 = \frac{1}{\lim_{n\longrightarrow\infty} n\sum_{i=1}^{n}(p(i)-p(x))^2}. \tag{4}$$

By using the calculated image to calculate all extreme points in the scale space, each pixel is compared with 8 adjacent pixels on the same image and 9 adjacent pixels on the adjacent scale to find out that it is greater than or less than all pixels adjacent to the contrast point.

$$\begin{cases} x(i, 0) = a - x(j, 0), \\ x(i, 1) = b - x(j, 1), \\ x(i, j) = \sqrt{\dfrac{x(j, i)}{a+b}}. \end{cases} \tag{5}$$

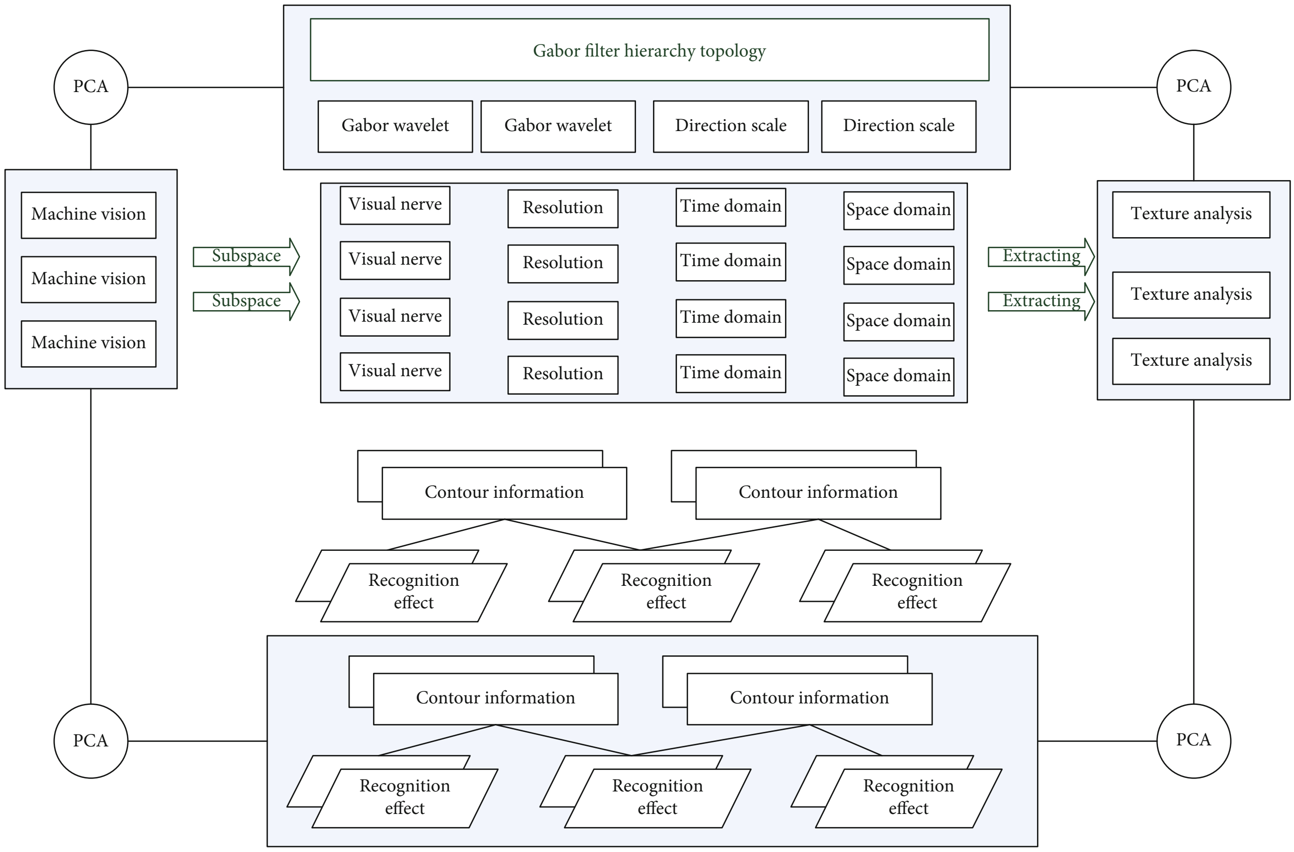

Figure 1: Gabor filter hierarchy topology.

By treating the nonstationary signal process as the superposition of a series of short-term stationary signals, using the principle of integration, a window is set to achieve short-term performance, and the entire time domain coverage is achieved by the translation of the parameter r.

$$U(x) = (I - C)^{-1} \times C^T - \lim_{n\longrightarrow\infty} \sum_{i=1}^{n} p(x) \times C(i) \cdot \lim_{n\longrightarrow\infty} \sum_{i=1}^{n} p(x) \times Z(i),$$
$$\mathrm{Sum}(x,t) = f(x-1,y) + f(x,y-1) - f(x-1,y-1). \tag{6}$$

By scaling and shifting the functions that meet the basic conditions of the wavelet function, a series of wavelet functions with different center frequencies, different bandwidths, and different directions can be obtained to form a family of wavelet functions. Constructing a series of wavelet families according to actual needs can realize the multiresolution analysis and processing of the signal, which greatly enhances the signal processing effect.

$$K(x,y) = \begin{bmatrix} k(x)(1-\sin x) & 1 \\ 1 & k(y)\cos y \end{bmatrix}. \tag{7}$$

According to its transform characteristics, Gabor transform is also called windowed Fourier transform or short-time Fourier transform. The Gabor transform is derived from the Fourier transform of the window, but it is the same as the wavelet transform because of its scalable window, adjustable frequency, and bandwidth of the kernel function.

$$H(x) = \begin{cases} 0, & x > t, \\ \mathrm{sign}\left[\sum_{t=1}^{T} a(t) \times g(x,t)\right], & x < t. \end{cases} \tag{8}$$

The entire comparison process can run efficiently, and most of the points can be removed in the first few comparisons. The Gaussian function is the only scale space kernel. The scale space definition function $L(x,y)$ of a picture can be obtained by convolution of the image $I(x,y)$ with the Gaussian composite function $G(x,y)$.

3.2. Image Recognition Algorithm. Generally, the grayscale image is 256-level grayscale. The binarization of the image requires threshold processing, and the original grayscale image is a binary image represented by the foreground color and the background color. Video images often need to be preprocessed to be able to perform feature extraction and recognition.

$$g(w(i)|w(i-n+1),\cdots,w(i-1)) = \frac{P(w(i-n+1),\cdots,w(i-1),w(i))}{P(w(i-n+1),\cdots,w(i-1))}. \tag{9}$$

The quality of the preprocessing work will directly affect the recognition effect. The main problems to be solved in the image recognition of image clothing features include image binarization, smoothing, and denoising. The method of dynamic threshold selection considers not only the gray value of the pixel and the gray value of surrounding pixels but also the information of the coordinate position of the pixel. It can process images with low image quality, but the calculation time is longer.

$$V(x)=\frac{\lim_{n\longrightarrow\infty}\sum_{i=1}^{n}\sum_{j=1}^{n}w(i,j)\times(x(i)-x)\times(x(j)-x)}{\lim_{n\longrightarrow\infty}\sum_{i=1}^{n}\sum_{j=1}^{n}w(i,j)\times x(i,j)}. \tag{10}$$

Therefore, it is less used in image recognition. Local threshold and dynamic threshold can perform better binarization processing on poor quality images, but their overhead is relatively large, and in practical applications, the image processing of local threshold and dynamic threshold will produce distortion that the overall threshold will not produce. Therefore, in the image binarization process, the overall binarization method is often used for the binarization process. Table 1 shows the description of image binarization processing attributes.

Table 1: Description of image binarization processing attributes.

Attribute index	Threshold range	Sampling factor	Feature dimension
1	20-75	17.1	3510
2	13-47	21.5	1440
3	5-37	25.7	1971
4	42-69	19.6	2710

In practical applications, image recognition is to extract the identity features contained in the image to be recognized from the input image and then analyze and compare it with the image in the image library to determine the identity of the subject. The filter size and decomposition direction are selected and analyzed, and then, the Gabor filter determined by these parameters is used to decompose the fabric image along different scales and directions to obtain multiple decomposed subimages containing different information. A complete image recognition system is composed of image preprocessing, feature extraction, and classifier design. Figure 2 shows the framework of the image recognition algorithm. The given algorithm flow shows that the new method is divided into two parts: training and detection: in the training part, first, the training image sample set is obtained through parallel Gabor wavelet transform to obtain multiscale and multidirectional Gabor image feature matrix and then through feature direction fusion to obtain the fusion feature vector set.

In the detection part, the detection image also first undergoes parallel Gabor wavelet transform and directional feature fusion to obtain the fusion feature vector, and then the detection image fusion feature vector is subjected to multiscale classification in the fusion feature vector set of the training sample, and finally, a comprehensive judgment is made. The Gabor wavelet transform process of the image will convolve the original image with 40 different Gabor cores, which requires a large amount of calculation. For an intelligent clothing design system, real-time requirements are an important indicator of the performance of the detection system.

3.3. Composition of Clothing Design Elements. Clothing is generally supported by the shoulders. In addition to the practical purpose of a comfortable fit, the shoulder shape is also an important part of clothing aesthetics. The shoulder shape also has a great influence on the overall shape of the clothing. Different shoulder shapes can not only highlight the S-shaped soft curve of the breast and waist but also imitate the male inverted triangle to show the strong attitude of modern women. In clothing structure, shoulder slope angle and shoulder slope drop are usually used as the most basic shoulder shape parameters. First, analyze the meaning of each bright spot in the spectrogram, and then through threshold segmentation, extract the characteristic coordinate points that characterize the fabric texture, and finally calculate the frequency range of the fabric texture. This research uses image processing methods to identify the shoulder oblique angle and the amount of shoulder drop of the clothing category, so as to provide a basis for the extraction of the visual elements of the shoulder. In the problem of profile recognition, the average width of each segment is extracted from the image as the feature quantity, and the feature formulas of A shape, T shape, H shape, X shape, and O shape are established. The larger the characteristic value of a certain profile is, the closer the outer contour of the garment is to that profile. The reason for this design is that this study believes that any kind of clothing silhouettes is relative; that is, there is a gradual transition between various silhouettes without clear boundaries. Therefore, under this scheme, five eigenvalues are output when identifying any valid sample. If you want to investigate whether the clothing silhouette is obvious, you can judge by the characteristic coefficient corresponding to the maximum characteristic value. Figure 3 shows the attribute distribution map of clothing profile feature coefficients. The closer the characteristic coefficient is to 1, the more obvious the profile.

Whether there is an obvious waistline in the clothing category, and the height and width of the waistline are also important contour elements. The essential problem is to determine the waist position, and then, its height and width can be easily derived. In contrast to the visual experience of clothing, we found that if there is an obvious waist in the clothing body, then, the waist should be in the middle of the CW section. The hem is also an important contour element. It may be a skirt or a hem. The key to calculating the height of the hem is to confirm the position of the hem. According to visual experience, we regard the position where the width changes in the T and C sections as the hem. First, remove the brightest point (origin) in the center of the image, and then select an appropriate threshold to segment the image to eliminate snowflake-like background points. Threshold segmentation is a region-based image

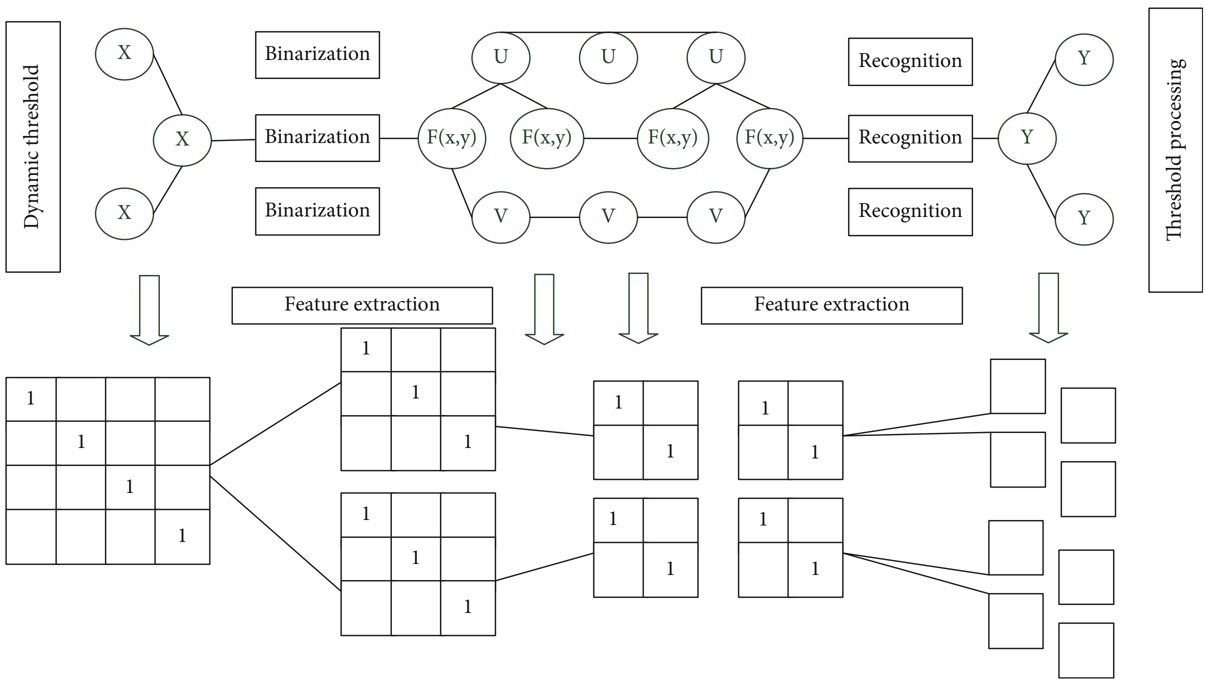

Figure 2: Image recognition algorithm framework

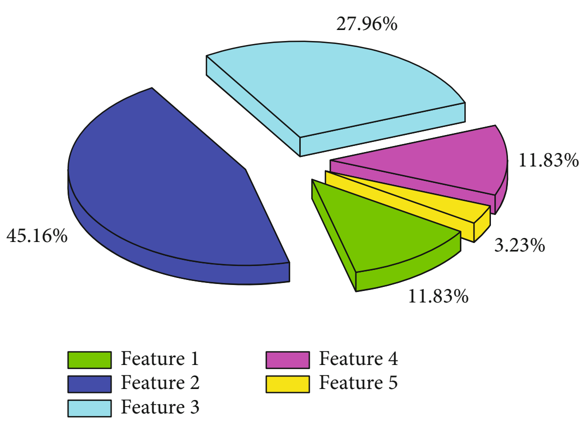

Figure 3: Attribute distribution diagram of clothing profile feature coefficients.

segmentation technology, which is especially suitable for images where the target and background occupy different grayscale ranges. The active contour model extracts the image contour based on the energy functional information of the image; that is, the edge of the target object is described by using a continuous curve, and on this basis, an energy functional is defined. The edge curve is an independent variable of the energy functional. The process of solving the minimum value of the energy functional is the process of contouring. Under normal circumstances, the function to be solved is Euler's equation, and the minimum value of the energy functional is converted to solving Euler's equation. When the energy obtained by the Euler equation reaches the minimum, the position of the curve is the position of the target object's contour.

3.4. Model Weight Factor Update. In high-dimensional multimode problems, it is difficult to ensure the convergence of the algorithm by applying clustering and other classification methods, and the amount of calculation is very large. Distance-based classifiers show its advantages in such problems. The step is to first combine the image subspace features extracted by Gabor moment features and NMF (nonnegative matrix factorization) to obtain a 31-dimensional vector and use the image sample represented by the vector as the input of the neural network classifier. The general application mode of the distance classifier is to first set the statistical average of the pattern vector of each type of mode as a reference template of the type and then compare the test sample to be recognized with the reference template of each type of mode. At the same time, according to the needs of recognition, the threshold can be set, and the rejection can be calibrated according to the relative information of the distance obtained in each category. The correlation coefficients of 64 Gabor filters form a $64 * 64$ matrix. At this time, we will find that this matrix is a symmetric matrix, and the diagonal elements are all 1, and the range of the correlation coefficient is [-1,1]. Figure 4 shows the histogram of the correlation coefficients of the subspace features of the Gabor image. If [0, 1] is mapped to the Di degree scale interval [0, 255], the characteristics of this symmetric matrix are already obvious.

After image preprocessing, a standard normalized image can be obtained. Before pattern recognition and classification, image feature extraction needs to be performed. There are many image feature extraction algorithms, and many algorithms have achieved good results to a certain extent. The task of feature selection and extraction is to find the most effective feature vector for classification. Reasonable feature vector extraction algorithms can extract recognition

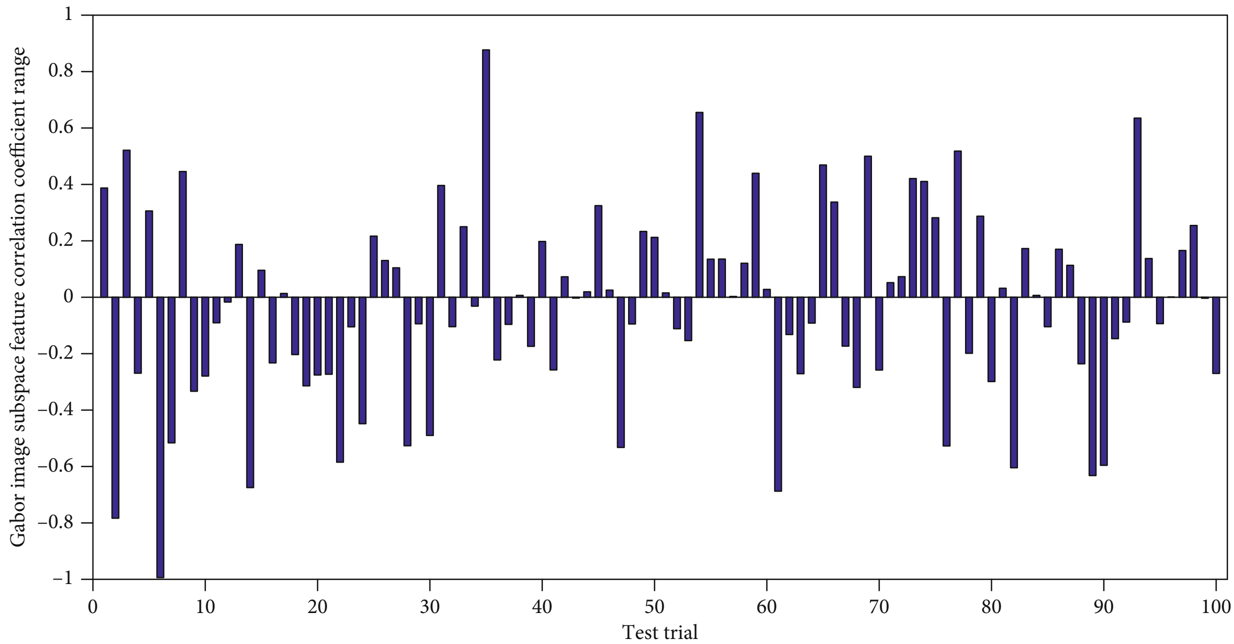

FIGURE 4: Gabor image subspace feature correlation coefficient histogram.

algorithms that are more conducive to feature classification according to different applications. The system obtains the digital image of the grey fabric through the scanning of the linear camera. The Gabor filter method is used to process the image in order to improve the detection effect, and the final result is analyzed to obtain geometric features for pattern recognition and classification. Contour tracking can be used to achieve the extraction of target contours in binary images. There are two types of pixels, target and background, in binary images. The process of contour tracking is the process of generating contour chain codes, that is, selecting a seed contour point, then traversing the contour points of the area in a clockwise or counterclockwise direction, and recording the historical information as the contour chain code. A contour chain code is obtained every time, and by adjusting the strategy of finding the first edge pixel, the remaining contours can be tracked in the same way. Image detection methods are mainly divided into two categories: one is based on statistics, which treats the image as a multidimensional vector, and converts the image detection problem into a detection problem of signal distribution in a multidimensional space; the other is based on the standard class, according to the basic characteristics of the image; we establish corresponding standards to transform the image detection problem into a hypothesis/verification problem.

4. Application and Analysis of Intelligent Clothing Design Model Based on Gabor Image Recognition Technology

4.1. Gabor Image Data Processing. When using Gabor transform to analyze fabric texture, in order to eliminate the influence of resolution on center frequency, the frequency range of woven fabric texture is normalized to 0~1, f is the frequency of fabric texture, $F_{\max}$ is the maximum frequency of fabric texture, so the image resolution after normalization has no effect on the center frequency. Therefore, if you do not know the image resolution, you can directly normalize the frequency to 0~1 to determine the center frequency of the Gabor filter. If you need to extract the frequency band information of the image, then you need to perform low-pass filtering, band-pass filtering, or high-pass filtering. To extract different image features, different image preprocessing operations are required. The background must be removed first, and then geometric normalization and gray-scale normalization are performed. Geometric normalization processing is actually to rotate all clothing faces after positioning to the same angle and adjust them to the same size, while gray-scale normalization processing refers to adjusting the images to the same brightness and contrast to avoid lighting changes. Figure 5 shows the histogram of the eigenvector value of the center frequency of the Gabor image. From the perspective of feature extraction, Gabor filtering can be considered extracting various features of the image from different scales and directions. If you use 5-scale 8-direction Gabor wave, then filter the image to get 40 groups of feature vectors with different properties and simply cascade these 40 groups of feature vectors into a long feature vector X; then, the feature vector X performs learning and recognition classification.

This study extracted the general features of the image from 500 images of clothing and clothing categories and calculated the range of differences between each sample and the general features of the image. These samples try to include subjects with different attributes (in terms of gender, skin color, clothing category, etc.) in order to generalize their characteristics, but they may still not be applicable to special

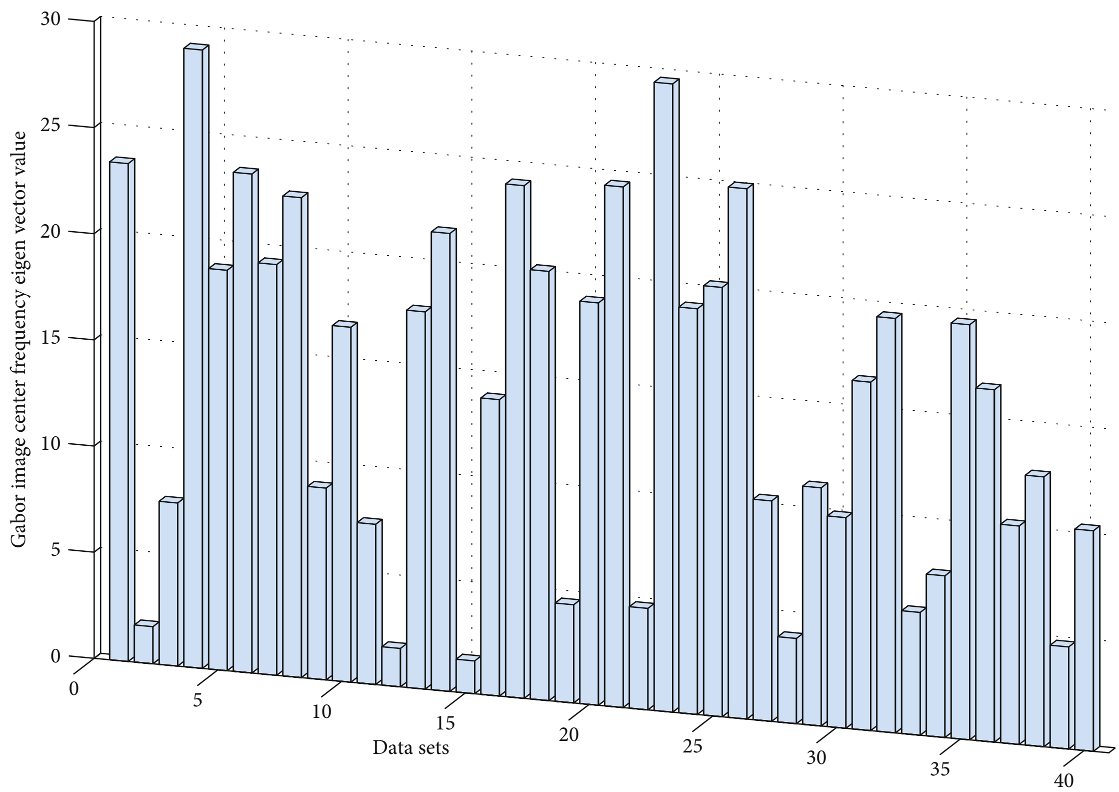

Figure 5: The histogram of the eigenvector value of the center frequency of the Gabor image.

groups (such as children). If it is to be applied to a special group, it is necessary to reexamine the head-to-body ratio changes and extract general features. This method first uses a calibration board marked with a number to complete the calibration of each camera. Then, with the help of the points in the common area captured by the adjacent cameras, the relationship between the local world coordinate systems of the adjacent cameras is found, so as to complete the data splicing and realize the calibration of the entire system. In the feature extraction part, the choice of feature dimension will affect the final recognition rate. Generally, the recognition rate will increase as the feature dimension increases, but after a certain feature dimension, the recognition rate will not continue to increase. Therefore, for the ORL image library on different feature dimensions (including 20, 25, 30, 35, and 39 dimensions), the same training samples are used, 10 simulation experiments of the detection samples, and 200 training samples are randomly selected for each simulation experiment (5 samples per clothing category), the remaining 200 are used as test samples, and the average of 10 times is used as the final result. In the feature extraction part, PCA, Fisher face, and Gabor feature are used, respectively; PCA is obtained under the same training and detection conditions. The feature dimension with the highest recognition rate is 39, and the Gabor feature is 30. The experimental results are obtained.

4.2. Realization of Clothing Design Model Simulation. The specific configuration of the experimental platform used in this article is as follows: CPU is Intel Pentium E5200; graphics card supports Direct3, and the video memory is 1G (RAM DDR2 800 2G, hard disk 320G; 1 SD camera; Windows XP system and Matlab 7.1 version). The ORL database collected a total of 40 images of clothing, and they were all shot at different times, with different background lighting, different expressions, some with eyes open, some eyes closed, some smiling, and some serious. Among them, there are 10 pieces for each clothing category, a total of 400 pieces, the gray level is 256, and the image size is 92×112. The recognition method is the same as the recognition and measurement method of the model height in the sleeve length recognition and measurement program. Then, start to identify the amount of gap in the hip detection area, starting from the first pixel in the upper left corner of the detection area, scan it column by column along the column direction, and find the red pixel to find the position of the buttocks.

At each position, the size of the sliding window is gradually changed, and the feature matrix of the image in the window is extracted and compared with the general features of the image. The results obtained are filled into a matching table, which contains three fields of position coordinates, size, and difference; that is, it contains the difference value corresponding to various sizes at each position. Figure 6 shows the center frequency deviation curve of the Gabor image. Search the matching table, and consider the entries with a difference of less than 6 (slightly larger than the maximum difference of 5.73) as image feature regions; if there are overlaps in the positions of several feature regions, only the smallest difference is selected. This method is to determine the texture primitives, extract a small number of characteristic parameters in the normal texture, establish the corresponding texture model, and then analyze the image to be tested to find abnormal information to determine whether the defect exists. According to this process, the computer program was used to detect the remaining 400 pictures, and the hit rate reached 99.5%. To determine the decomposition scale, calculate the main frequency in the spectrogram to be 0.14 cycle/mm. According to the relationship between the main frequency and the frequency range, determine the decomposition scale of the Gabor filter to be 3 scale, which can be obtained according to the half-peak tangent condition. When $L = 0$ angle, the center frequency of each filter on the horizontal axis is 0.08, 0.16, and 0.31, the standard deviation on the horizontal axis is 0.02, 0.04, and 0.09, and the standard deviation on the vertical axis is 0.02, 0.03, and 0.07, the center frequency and standard deviation of each scale when $L = 0$ are determined, and filters of other angles can be obtained by rotation. It can be seen that the sampling factor has a certain impact on the recognition rate, but the impact is not very large. When the dimension of each picture after sampling exceeds 103, the time consumed by PCA processing rises rapidly, indicating that the PCA processing time of the picture feature dimension has a great influence. Therefore, in actual application, a suitable sampling factor must be found. In this paper, it is more appropriate to change the sampling factor to 100.

4.3. Example Application and Analysis. This article uses 112 different clothing categories in the AR database; each clothing category has 13 sample images; manually cut the edge of each image, reduce the size of the image to 48x20, and divide the AR image library into two sublibraries. The two sublibraries are composed of 112 different clothing categories, and each clothing category contains 10 sample images. After the Gabor transformation, the original image and the Gabor kernel function are convolved, the dimensionality becomes very high, reaching $70 * 200 * 200$, and the amount of data and calculation is greatly increased. For this reason, it is necessary to find the most essential feature that best represents the image. According to the discussion in the previous chapter, sampling processing is required at this time. The relationship between the size of the sampling factor and the recognition rate and PCA processing time is shown in the text. The number of training samples is 5, and the number of pivotal features is 80. Figure 7 shows the distribution of the fluctuation range of clothing image factors. The calculated fluctuation range of the symmetry factor of each sample is 0.12-0.39. The Yale image library contains 15 different clothing categories, and each clothing category has 11 samples (images), including various expressions such as surprise, frowning, and laughter; in this article, it is the dimension of each feature (from 20 to 39). In each simulation, 75 samples (5 samples for each clothing category) are randomly selected as training samples, and the remaining 90 are used as test samples. Therefore, when using the sliding window to scan the image, the symmetry factor y is calculated first, and only when $y > 0.1$ (slightly smaller than 0.12) can it be used as a feature region to be determined for feature matrix extraction

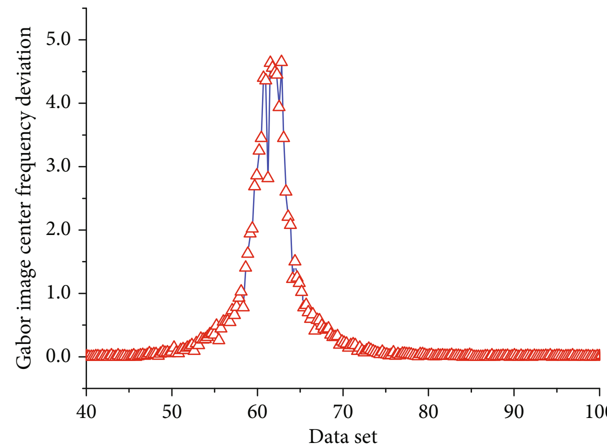

FIGURE 6: Gabor image center frequency deviation curve.

and comparison. In addition, when extracting the feature matrix, only the left half of the sliding window is calculated. Since there are a large number of nonfeature regions in the scene image and the feature regions only occupy a small proportion of the area, this approach can shorten the calculation time by more than 60%.

We run the program of identifying and measuring the gap amount at the side seam of the waistline of clothing in MATLAB 7.0, respectively, identify and measure the gap amount between the clothing and the clothing body at the side seam of the waist line in each clothing style diagram, and get the waist circumference on the left and right side. Observing the experimental data, as the waistline becomes looser, the gap at the waistline side seams also becomes larger, but due to different styles, each set of data and the magnitude of the increase change are also different. High-frequency information in the frequency domain corresponds to a signal that changes drastically in the spatial domain, while a low-frequency signal corresponds to a signal that changes slowly in the spatial domain. If the image itself has spatial periodicity, the peak energy concentration in the Fourier spectrum corresponds to the main direction of the texture mode. However, the amount of voids in each group increases with the equal difference of waist circumference and basically increases by the same value. All 75 sets of data are imported into SPSS data processing software for analysis. First, the correlation between the two is analyzed. The correlation analysis performed is Pearson's analysis, and the analysis results are obtained. It can be seen from the data that under the same waist slack, the gaps at the side seams of the waist of different styles are different. This is because the amount of voids has a direct relationship with specific clothing styles, such as the distribution position and distribution amount of the waist circumference of the clothing. Therefore, in order to obtain a more accurate regression model, a more detailed style grouping is required.

The main purpose of this experiment is to compare the two image recognition algorithms Gabor+PCA and PCA and to further verify the advantages of the Gabor+PCA algorithm proposed in the paper. In the experiment, choose the same experimental conditions, that is, the same training

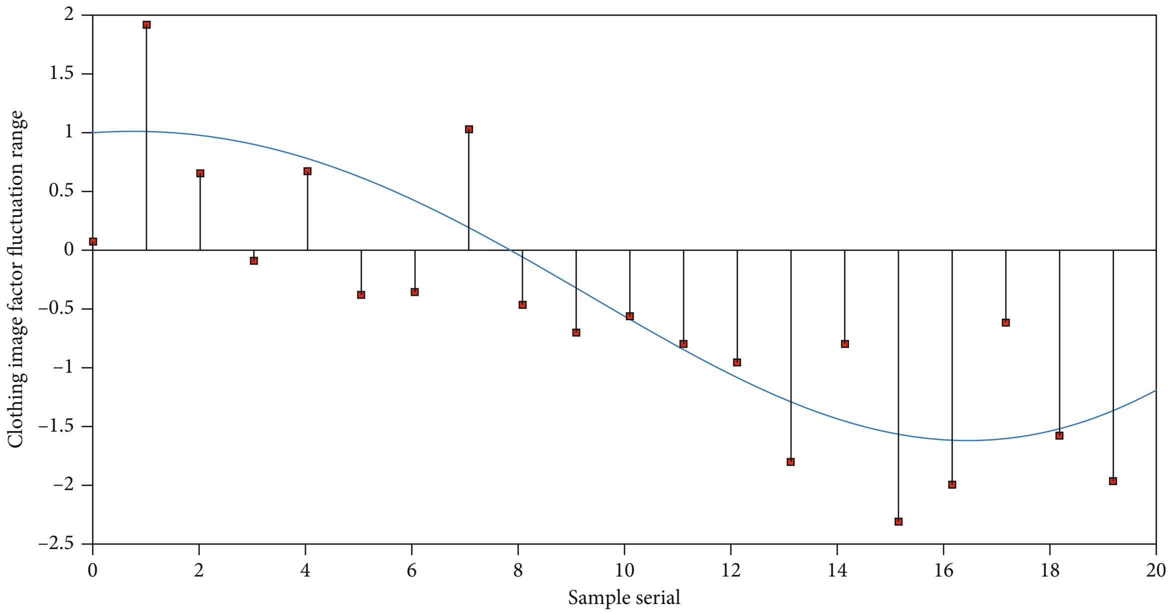

Figure 7: The distribution of the fluctuation range of clothing image factors.

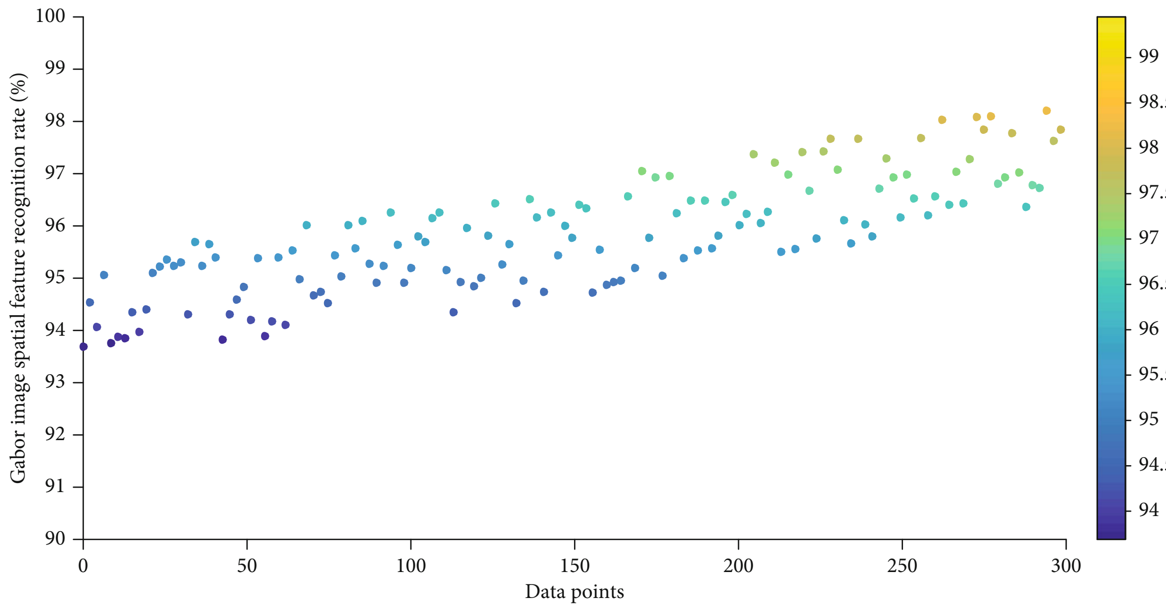

Figure 8: Gabor image spatial feature recognition rate two-dimensional scatter point distribution.

samples and test samples. For the accuracy of the experiment, the image was reduced to 30 ∗ 24 before any processing was performed, and the experiment was performed with different numbers of principal elements. Figure 8 shows the two-dimensional scatter point distribution of Gabor image spatial feature recognition rate. It can be found that when the number of samples increases from 60 to about 160, the speed of improvement of the recognition rate is the fastest; then as the number of samples increases, the speed of improvement of the recognition rate starts to slow down; when the number of samples is 280, the recognition rate is the highest, reaching 96.6%. In order to avoid that the marking line does not extend to the edge of the image, starting from the first pixel in the 10th column of the image, the detection is done point by point. Considering the interference of noise, the difference range between the RGB value of the pixel and the RGB value of the background color is judged to determine whether the first red marking line is found. It can be seen that the correct recognition rate of the nearest neighbor classifier based on PCA, Fisher face, and Gabor features is reduced by 0.85%, 2.8%, and 0.55%, respectively, and the error correction is reduced by 0.55%, and the secondary classifier is reduced by 0.25%, 0.7%, and 0.45%. It can be seen that no matter which feature is used, the reduction of the feature dimension has the least impact on the secondary classifier. When the number of training samples is greater than 280, the recognition rate also decreases.

5. Conclusion

Based on the study of several image recognition algorithms, the principle of Gabor wavelet transform, and its application in image feature extraction, this paper uses Gabor wavelet transform to construct an image elastic map to determine the image feature template; then, a simple image recognition system was designed in combination with PCA, and corresponding experiments were carried out on image databases. After the Gabor wavelet transform, the dimensionality will become very high, which is not conducive to image recognition. Therefore, a simple image recognition system based on Gabor+PCA is designed. In terms of clothing style recognition, this paper extracts the width of each segment on the image and uses the ratio of the width of the segment to propose the concept of profile coefficient, which is used to characterize the closeness of the clothing style to various common clothing silhouettes. The contour lines on both sides of the section are analyzed, and the concept of direction sequence is proposed, which reveals the characteristics of the shoulder-neck point and the shoulder height point on the shoulder line. Based on the analysis of the time-frequency characteristics of the Gabor filter, an elliptical multiscale and multidirectional Gabor filter bank is designed for the plain grey fabric defect image, and the filter bank is used to filter the fabric defect image in the frequency domain. At the same time, the method of identifying and quantifying clothing visual elements was explored, forming a relatively complete recognition and evaluation system, and on this basis, software and hardware design was carried out, and the clothing visual element collection and analysis system was realized by using computer programming and automation technology. It provides a theoretical foundation and a practical platform for the automatic evaluation of clothing visual effects, the tracking, and prediction of clothing fashion trends. Through experimental verification, PCA can solve the learning problem in image recognition and careful selection of the dimensionality after dimensionality reduction.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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