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Improvement of Face Recognition Algorithm Based on Neural Network

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Abstract: **Face recognition is constructed based on facial feature extraction and classification, the facial feature extraction is taken in the face region according to different parts of the characteristic, it is prone to confuse the issue, this paper proposes a face recognition algorithm based on neural network. In order to reduce the interference of background noise. Reduce the post feature point location and recognition of the complexity of the binarization image denoising method for face image denoising, image noise reduction of output for feature extraction, extract the face value of the peak and valley of two-dimensional features, can get the edge face regions around the border, BP neural network classifier method is used for information facial features batch read, differences and classify facial features are constructed to achieve accurate face recognition. The simulation results show that the calculation face recognition method can accurately extract facial features, the accuracy of face recognition is better, the anti-interference ability is stronger, and the operation speed is higher, it can effectively obtain fast and efficient face recognition.**

Keywords: **neural network; face recognition; image denoising; classification; feature extraction**

I. INTRODUCTIONS

Face recognition is a biometric identification technology based on facial features of people's information. With the acquisition of the camera or the camera with face image or video stream, and automatically detecting and tracking human faces in the image, a face and then to detect face column technology, also commonly known as face recognition. Face recognition. Face recognition technology is the traditional visible face recognition based on image, this is the people familiar with the identification, has 30 years of development history. But in this way it is difficult to overcome defects, especially in the light of environmental changes, the recognition result will decline sharply, unable to meet the actual needs of the system solve the problem of light. The scheme has a three-dimensional image of face recognition, face recognition and thermal imaging. But these two kinds of technology are far from mature, the recognition effect is unsatisfactory. The rapid development of a solution is more active source of face recognition technology based on near infrared images. It can overcome the influence of illumination change, has achieved recognition performance, excellent in accuracy, stability and speed of the whole system performance over the 3D image of face recognition. This technology has developed rapidly in the past two or three years, the face recognition technology gradually to be practical.

The process of face recognition includes three parts such as face image acquisition, face feature extraction and classification, the face image acquisition is different face images can be obtained by the camera acquisition, such as static image, dynamic image, different positions, different expressions and other aspects can be well when the acquisition. Users in the acquisition equipment shooting range, acquisition device will automatically search and shoot the user's face image. The face detection in practice is mainly used for the pretreatment of face recognition, which is in the image accurate calibration of face location and size. Pattern features contained in face images is very rich, such as histogram, color feature template features, structural features and Haar features. Face detection is to pick out the useful information, and use these features to achieve face detection. Human face detection method is the mainstream based on the above characteristics of the Adaboost algorithm, Adaboost algorithm is used as a classification method, it has some weak classification methods together, a combination of new classification method is very strong. In the process of face detection using Adaboost algorithm to select the most representative face rectangle features (weak classifiers), in accordance with the weighted voting of weak classifiers constructed as a strong classifier, and then some strong classifier trained in series to form a cascade classifier cascade structure, effectively improve the detection rate of the classifier. At present, domestic and foreign scholars have put forward a lot of facial feature extraction and recognition method, according to the basic

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types of positioning information the mainstream method of automatic positioning of the existing feature point can be divided into the following four types: the transcendental method based on rules and methods based on geometry information, based on color The method of color information, method based on statistical model. This method has many shortcomings, in face recognition, face recognition method based on a priori rules are easily affected by the illumination and image acquisition equipment, poor robustness. The method based on statistical model has better robustness, but the algorithms are too complex, calculation a large, low efficiency.

Aiming at the above problems, this paper proposes a face recognition algorithm based on neural network. Firstly, the binarization image denoising method for face image denoising, image noise reduction of output for feature extraction. Then extract the face value of the peak and valley two-dimensional features, can get the edge face regions around the border. The BP neural network classifier method for information of facial features batch read, differences and classify facial features, to achieve accurate face recognition, and the simulation experiments show the superior performance of the proposed method.

II. FACE IMAGE ACQUISITION AND PREPROCESSING

A. Face image acquisition and edge detection

Face image acquisition and detection is the basis of face recognition, image acquisition using 3D laser scanning method or infrared scanning method, using laser detection method face to get the dynamic information of massive data, and then the laser image scanning for coarse and fine registration, to remove the noise in the image acquisition, the key points of motion information sampling. The realization of face reconstruction based on face recognition, the overall design diagram is shown in Figure 1.

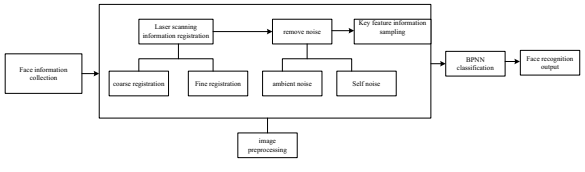

Fig. 1 Overall block diagram of face recognition

According to Figure 1 design process, the dynamic information of face image sampling, the coordinates of 3D laser scanning hypothesis of face image sampling value is expressed as $\{(z_k, a_k)\}$, $\mathbf{P}_n$ and $\mathbf{P}_{n+1}$ represent the key points with posture change n times and $n+1$ times of the 3D laser scanning face, a number of key points to characterize the face pattern of laser scanning face, the face closed contour is $T(m,n)$, the edge contour is a dimension of $M \times N$ high-dimensional matrix. When the center pixel neighborhood determined, grid model laser scanning as $k = 1,2,.....,n, z_k \in w^s$, , to adjust the pixel matching point, each layer $a_k \in \{1,2,...,R\}$ of the dynamic information of graphics rendering, get face images are recorded as output:

$$\overline{x_T} = \frac{1}{T}\sum_{i=1}^{T} x_i \tag{1}$$

Among them: $x_1, x_2, x_3 ... x_T$ is the key position point X attitude information parameter, T is the number of marker points. According to the above image scanning results, the edge contour amplitude N_l is obtained:

$$N_l = \begin{cases} 1 & l = 0, L \\ \left[2\pi \cdot \frac{D}{2} \cdot \sin\eta \Big/ l_{triangle} \right] & l = 1,...,L-1 \end{cases} \tag{2}$$

Wherein, $l_{triangle} = \pi \cdot D / 2L$ is the four neighborhood pixel seeds value $M \times M$ for face contour line of gray value differences, to minimize the Euclidean distance as a criterion for face image segmentation, segmentation of $f(x,y)$, before segmentation, the pixels in the SFF image information enhancement, the face of dynamic information is enhanced to a maximum value for:

$$P(\lim_{T\to\infty} \overline{x_T} = K) = 1 \tag{3}$$

Wherein, $\overline{x_T}$ is the pixel average, K deformation error correction value iteration, said contour initial error, image $Q(x_i, y_i)$, read into the face of dynamic information, the $V(s)$ along the s enhanced into s points, the image edge enhancement, the output results:

$$E_{S\,n\,a}\overline{\pi}_e \sum_{0}^{N-1}[\,E_{\Gamma\,n}(\,v\,)\}\quad E_{e}(x_i \tag{4}$$

Wherein, V_i is Laplasse sharpening operator, i=0, 1, $\cdots N-1$, with the image enhancement, the edge contour segmentation of face image is obtained:

$$E_{\text{int}}(vi) = \frac{1}{2}(\partial i \left| d - \left| v_i - v_{i-1} \right| \right|^2 + \beta i \left| v_{i-1} + 2v_i + v_{i+1} \right|^2) \tag{5}$$

Where, $d = \frac{1}{n}\sum_{i=0}^{n-1} \left| v_i - v_{i-1} \right|$, it is the average distance between the control points of the initial

contour.

B. Image denoising processing

The binarization image denoising method for face image denoising, face image edge contour feature points are mapped to the two-dimensional space, for facial feature information, face image as the effective frame in the landscape to meet:

$$\sigma(Z;D_X)=\sum_{i>j}\left|d_{ij}(Z)-d_X(x_i,x_j)\right|^2 \quad (6)$$

In the formula, $d_{ij}(Z)$ is the Euclidean distance of pixels, the distribution characteristics of the state vector $d_X(x_i,x_j)$ and uniform distribution in the grid, the rough registration method of interpolation fitting, T pixels $x_1,x_2,x_3...x_T \in R$, mapping the feature points after the coarse registration to two-dimensional space, fine registration, dynamic facial feature points accumulation s divided into N points along the gradient direction, the snake function of facial feature representation for dynamic information registration:

$$E_{Snake}=\sum_{0}^{N-1}[E_{\text{int}}(vi)+E_{ext}(vi)] \quad (7)$$

Where V_i is the fine registration of face target image control point, i=0, 1,$\cdots N-1$, defining the boundary range model, get the results for the registration of facial features:

$$d_{mn}^{ij}(x,y)=\begin{cases}\dfrac{\sum_{k=-s}^{+s}\left|\theta_m^{ij}(x+k,y+k)-\theta_n^{ij}(x+k,y+k)\right|}{(2s+1)^2}, & m\neq n\\ 0, & m=n\end{cases} \quad (8)$$

In the formula, *m* and *n* based on dynamic image information registration, noise processing, face motion dynamic information output for noise reduction:

$$m_{pq}=\sum_{m=1}^{M}\sum_{n=1}^{N}x^p y^q f(x,y) \quad (9)$$

Wherein, x^p is pixel abscissa of region block of face target image, y^q is ordinate.

The noise reduction processing, the feature was more clearly, which will reduce the impact of the threshold of feature points separating effect, enhance the efficiency and accuracy of feature point positioning, but also compensate for the feature points of the face information, so we can take the high pass filter as a way of image enhancement.

III. IMPROVED IMPLEMENTATION OF FACE RECOGNITION ALGORITHM

A. Feature extraction

This paper proposes a face recognition algorithm based on neural network. The peak and valley value of two-dimensional feature extraction of face, can get the edge face regions around the border, in the YCbCr space, the pixels around the eye region relative people face in other parts of the pixel point has the following characteristics:

(1) On the chromaticity component, the Cb component value is larger, while the Cr component value is smaller;

(2) On luminance component, not only contains brighter pixels, but also contains darker pixels. Based on the above characteristics, the chromaticity model function can be constructed:

$$EyeMapC=\frac{1}{3}\left\{C_b^2+\overline{C}_r^2+C_b/C_r\right\} \quad (10)$$

Wherein, C_b^2, $\overline{C}_r^2$, C_b/C_r need to be normalized to the [0,1] interval. In order to satisfy the chromaticity characteristics of the eye region and highlight the higher pixel values in the eye region, $\overline{C}_r=1-C_r$. Colorimetric model function is improved as follows:

$$EyeMapC^*=((C_b-C_r)/C_r)^2 \quad (11)$$

In the formula, $EyeMapC^*$ is maximum, it can well meet the Cb component of eye area is larger, smaller component characteristics of Cr. At the same time compared with the original formula significantly reduces the computational complexity.

Characteristic based on luminance brightness function model can be constructed, expressed as:

$$EyeMapL=Y(x,y)\oplus g(x,y)/Y(x,y)\otimes g(x,y) \quad (12)$$

The Y (x, y) is the luminance component, g (x, y) is a structural element. The molecular $Y(x,y)\oplus g(x,y)$ said Y gray expansion operation with the structural elements, the Y value becomes large, the image is lightened; the denominator $Y(x,y)\otimes g(x,y)$ said gray corrosion operation of Y with structural elements, the Y value is smaller, the image dim.

According to characteristics of construction of mouth model function are as follows:

$$MouthMap=Cr^2*(Cr^2-n*Cr/Cb)^2 \quad (13)$$

$$n=0.8\frac{\sum Cr(x,y)^2}{\sum Cr(x,y)/Cb(x,y)} \quad (14)$$

Where Cr^2 and Cr/Cb are normalized to

[0,1], it can accurately locate the rectangular mouth feature region according to the outsourcing model function in the formula.

According to the characteristics of the regional nose prior knowledge to determine the feature by the eyes and mouth features of regional feature area to locate the nose. The nose area in the horizontal direction should be in the right and left eyes of the regional horizontal line perpendicular bisector range, vertical direction should be around the eye area on the inside corner of the eye as the midpoint of vertical line. The mouth area above the 10 pixel position as boundaries. Thus the face feature extraction.

B. Neural network classification

The characteristics of facial feature pixels on the extraction of classification learning, the training method of BP neural network for feature classification, neural network structure model is shown in Figure 2. The figure, the structure of the BP neural network model based on BP neural network model based on neural network is divided into three layers structure, the upper layer is the output network contact (for SFF), the input layer is the information processing center, the input quantity of the input face layer.

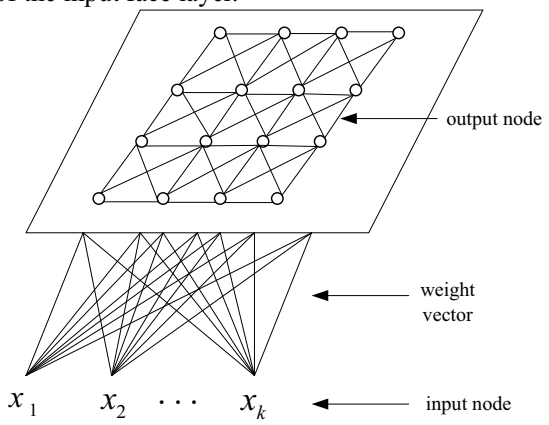

Fig. 2 BP neural network structure model

In the BP neural network classifier constructed in Figure 2, the facial feature intelligent recognition is carried out, and the extracted pixel feature points are trained by BP neural network:

Step 1: The neural network input layer initialization vector mode and each vector element k, given the number of input nodes of $x(t)$, $t=0,1,\cdots,n-1$, smooth region image pixel traversal, a face value of the image of SDF, SDD, a given pixel feature training sequence, the time counting $t=0$;

Step 2: In the neural network with exponential function $\alpha(c_{j^*})=A_3e^{-c_{j^*}/T_3}$ for face feature training, $x(t)=(x_0(t),x_1(t),\cdots,x_{k-1}(t))^T$ training new input vector mode in neural network, BP neural network as input training vectors;

Step 3: Adaptive weighted set a response frequency counter to the neural network, the input vector $x(t)$ face pixel feature vector ω_j and hidden layer distance:

$$d_j=\sum_{i=0}^{k-1}(x_i(t)-\omega_{ij}(t))^2,\quad j=0,1,\cdots,N-1 \qquad (15)$$

Wherein, $\omega_j=(\omega_{0j},\omega_{1j,}\cdots,\omega_{k-1,j})^T$;

Step 4: The pixel level visual difference feature of face is obtained as N_{j^*}, $d_{j^*}=\min\limits_{0\le j\le N-1}\{d_j\}$;

Step 5: According to the information classification differences in facial features, the neural network classifier, and adjust the output node N_{j^*} connection weights, determine the classification weights belonging according to the face contour line of SFF and $NE_{j^*}(t)$ have a geometric neighborhood, iterative classification for face feature:

$$\omega_{ij}(t+1)=\omega_{ij}(t)+\alpha(t)(x_i(t)-\omega_{ij}(t)) \qquad (16)$$

Wherein, $N_j\in E_{j^*}(t)$, $0\le i\le k-1$ $0\le\alpha(t)\le 1$ is a variable learning rate;

Step 6: If the termination condition is satisfied, the algorithm is terminated, otherwise, the sample data of face feature is input, $t=t+1$, go to step 2.

According to the above design, the extraction and classification of facial feature points are realized. Finally, the sampling method is used to perform the batch reading of facial feature information, and face feature extraction is used to realize face recognition.

IV. SIMULATION EXPERIMENT AND PERFORMANCE ANALYSIS

In order to test the performance of this method in face recognition, simulation experiments are carried out. The experimental computer configuration for the 2.2GHz 8 kernel memory CPU and 16GB, simulation algorithm and data statistical analysis using Matlab 2010 and Excel statistical software. The performance of the algorithm in the Extended Yale B database comparison experiment. In the experiment, I size the regularization parameter is set to 0.001, λ set

to 0.01, the smoothing parameter is 1.5, the curvature parameters of facial motion attitude is 1.25, a subset of the AR face database set for experiments, the subset contains 2599 images of 100 people, each person is about 26 images, 50 men and 50 women. The experiment first, each image size is adjusted to SFF. in the first and second subset, 799 images with expression changes, an average of 8 images as training samples.

Fig. 3 A small part of the test sample in AR face database

In 200 wearing sunglasses without expression images as test samples, there are 200 other images scarf expressionless as the test sample, figure 3 shows a small part of the test sample of AR face database. The peak and valley value of two-dimensional feature extraction of face feature extraction, get the results shown in Figure 4.

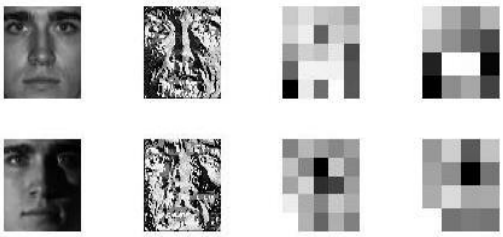

Fig. 4 Facial feature extraction results

Figure 4 shows that, using this method for face feature extraction, can effectively reflect the characteristics of different face, as the data base, input to the neural network classifier in face recognition. Table 1 shows in 0.05 of the cases I take the recognition rate of different algorithms on AR face database and the average running time. The average operation time refers to the average running time of each test image. Can be seen from table 1, for face recognition with sunglasses, RCR has the highest operation speed and recognition rate of the fastest RCR, the recognition rate of 12.5 percentage points higher than SRC, and the speed of it 40 times faster than the RCR recognition; the rate of 0.5 percentage points higher than RSC, and the speed is 98 times faster than it. For face recognition with a scarf, RCR also has the highest operation speed and recognition rate of the fastest RCR, the recognition rate of 38.5 percentage points higher than SRC, and operation 44 times faster than its RCR; the recognition rate of 1 percentage points higher than RSC, and the speed is 88 times faster than it. Table 2 shows the comparison of different recognition rate in case I wear sunglasses and average running time, can be seen from table 2, I take different values, the recognition rate remained unchanged. The speed change greatly, for example, I take the speed ratio of 0.3 I take 0.05 to 4 times faster.

Table 1 Comparison of different algorithms in AR face database as recognition rate and the average running time

Algorithms	wear sunglasses		wear a scarf	
	Recognition rate	time(s)	Recognition rate	time(s)
SRC[5]	86.0%	32.65	56.7%	33.55
RSC[8]	99.0%	79.78	96.0%	68.79
RCR	99.5%	0.82	98.7%	0.78

Table 2 Comparison of recognition rate and average running time of different ε wearing sunglasses

ε	Recognition rate	Time(s)
0.03	99.5%	0.645
0.10	99.5%	0.464
0.14	99.5%	0.345
0.22	99.5%	0.269
0.23	99.5%	0.254
0.32	98.5%	0.156

Finally, in order to compare the performance of the algorithm. By using this method and the traditional method, test of face recognition accuracy, get the results as shown in Figure 5, figure 5 analysis shows that, by adopting the method of high accuracy of face recognition, is obviously superior to the traditional method.

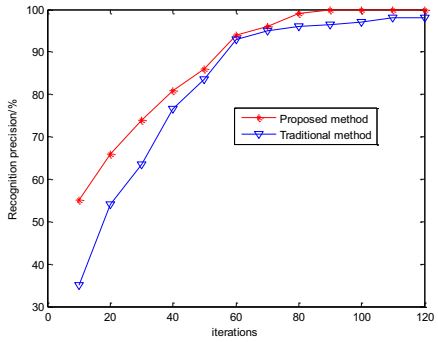

Fig. 5 Comparison of recognition accuracy

V. CONCLUSIONS

This paper studies the optimization problem of face recognition, this paper proposes a face recognition algorithm based on neural network. The dynamic information acquisition face massive data using laser detection method, and then the laser image scanning for coarse and fine registration, noise removal image acquisition the key points of motion information for face reconstruction based sampling. On the binarization image denoising method for face image denoising, image noise reduction of output for feature extraction, extract the face value of the peak and valley of two-dimensional features, the God of BP information network classifier for facial features by the method of batch read differences and classify facial features, to achieve accurate face recognition the method in this paper. The results show that the accuracy of face recognition is better, higher precision of feature extraction, the anti-interference ability is strong, and the algorithm has high computation speed, and it can recognize face effectively, quickly and efficiently.

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