An improved 3D intelligent dynamic face recognition algorithm based on computer vision

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Abstract: In order to improve the ability of 3D intelligent dynamic face recognition, a classification and location recognition algorithm for 3D intelligent dynamic face in computer vision based on Harris corner detection is proposed. The Harris corner detection algorithm is used to calibrate the information of 3D intelligent dynamic facial miniscule feature points. The accurate classification and location is realized. Simulation results show that this algorithm has high accuracy for 3D intelligent dynamic face classification and location recognition, and has a good effect on feature extraction and location recognition of 3D intelligent dynamic face. It has high application value in 3D intelligent dynamic face recognition and computer vision monitoring.

1. Introduction

With the development of image processing technology, face visual feature analysis is carried out by using image processing method. By extracting and analyzing face information features, face recognition will be realized in criminal investigation, security monitoring, and so on. Image database information retrieval and the construction of multimedia visual expert database have high application value. As one of the important technologies of identity recognition, face recognition has become a hot topic in the field of pattern recognition and computer vision[1]. Face recognition includes the key feature extraction and recognition classification of face detection 'pre-processing', in which feature extraction is an important part of recognition technology. The key problem to be solved in face recognition is to extract the features which are robust and representative and easy to classify and recognize under all the influencing factors. Different areas of face images contain different amounts of information, and also have different importance in face recognition. The human eye can quickly capture key information in complex environment, which depends on visual selective attention mechanism[2].

Face recognition involves many subjects such as image processing, information processing, pattern recognition and data classification. It covers a wide range of knowledge[3]. The common face recognition algorithms mainly include face recognition algorithms based on Harris corner detection. Face recognition algorithm based on subspace Eigen decomposition, particle swarm (PSO) training algorithm, fuzzy decision scheduling, SVM algorithm, chaotic mapping recognition algorithm and so on[4]. The common feature of the above algorithms is that through feature sampling and information retrieval of face training sample set, intelligent training algorithm is used to realize face feature classification, and some research results are obtained. In reference [5], a face recognition algorithm based on face motion directional feature clustering is proposed. The image compression is realized by image vector quantization coding, and the gradient difference feature extraction of face image is realized. Using BP neural network classifier to realize face classification and recognition, classify and mark the difference features of face, and realize high precision recognition. However, the computation cost of this algorithm is large, and the accuracy of face recognition is not good. In reference [6], a face recognition algorithm based on Splines biorthogonal wavelet analysis and corner feature detection is proposed to extract the edge features of the face and serialize the face image according to the associated features through wavelet multi-feature decomposition.

2. 3D intelligent dynamic face data acquisition and feature preprocessing based on computer vision

2.1. 3D intelligent dynamic face data acquisition based on computer vision

In order to realize the classification, location and recognition of 3D intelligent dynamic face in computer vision, the collection of target data and 3D intelligent dynamic face vision image is the basis. $u^{(n)}(x,y;d)$ is used to represent the features of texture and structure of computer vision sequence subspace. It is necessary to detect the contour edge of 3D intelligent dynamic face vision image. The fuzzy membership function is extended by Atanassov, and the intuitionistic fuzzy set is given. In the superpixel plane of computer vision sequence, the 3D intelligent dynamic face image data acquisition and feature extraction preprocessing are carried out, and in the computer vision 3D intelligent dynamic face column, the feature analysis model of 3D intelligent dynamic face is constructed. The optimization equation of feature extraction is expressed as follows:

$$\begin{aligned} I_{GSM} &= I(C^N;D^N \mid s^N) \\ &= \sum_{i=1}^{N} I(C_i;D_i \mid s_i) \\ &= \sum_{i=1}^{N} (h(D_i \mid s_i) - h(D_i \mid C_i, s_i)) \\ &= \sum_{i=1}^{N} (h(g_i C_i + V_i \mid s_i) - h(V_i)) \end{aligned} \tag{1}$$

Considering the geometric structure of the neighborhood of the whole contour wave domain and the pixel values of each point, the 3D intelligent dynamic facial feature information multidimensional search iterative equation is obtained and described as:

$$u^{(n+1)}(x,y) = u^{(n)}(x,y) + \delta u_1^{(n)}(x,y) \tag{2}$$

$$u_1^{(n)}(x,y) = M\Delta_s u^{(n)}(x,y) + N\Delta_t u^{(n)}(x,y;d) \tag{3}$$

In the above expression, $n = 1,2,...,T$, represents the number of iterations, and the subspace feature information texture structure is expressed as:

$$v_i = \frac{\sum_{k=1}^{n}(1-(1-u_{ik}{}^{\alpha})^{1/\alpha})^m (x_k + \beta \overline{x_k})}{(1+\beta)\sum_{k=1}^{n}(1-(1-u_{ik}{}^{\alpha})^{1/\alpha})^m} \tag{4}$$

In this formula, $u_{ik}{}^{\alpha}$ is the diversity factor of computer vision, β is the fuzzy membership matrix, and d_{ki}^2 is the parameter of neighborhood information. The contour edge features of 3D intelligent dynamic face vision image are represented as follows:

$$p(x,t) = \lim_{\Delta x \to 0}[\sigma \frac{u-(u+\Delta u)}{\Delta x}] = -\sigma \frac{\partial u(x,t)}{\partial x} \tag{5}$$

In the above formula, σ is represented as the fuzzy heat flux density of the texture structure of 3D intelligent dynamic face vision image in a unit time, and Δx represents the poor vision of edge information of 3D intelligent dynamic face vision image. In order to solve the dark primary color of computer vision, $t(x) = e^{-\beta d(x)}$, $t(x)$ represents the transmissivity of edge detection and segmentation of computer vision. Based on the above processing, the 3D intelligent dynamic face data acquisition of computer vision can be realized[7].

2.2. Corner feature extraction preprocessing

On the basis of the above 3D intelligent dynamic face image data acquisition and analysis, the feature extraction pretreatment is carried out[8], and the face image section map is constructed in affine invariant region as shown in figure 1.

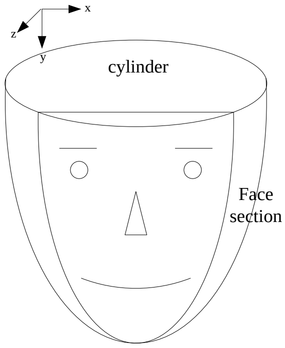

Fig. 1 Section view of face image

Face features are decomposed and extracted in multi-dimensional scale space. The dynamic feature information of face changes is analyzed[9], and the angle of face image transformation is assumed to be θ_1. The feature equation of the feature point information of the human face in the rotation transformation coordinate system is described as:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos(-\theta_1) & -\sin(-\theta_1) & 0 \\ \sin(-\theta_1) & \cos(-\theta_1) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} \tag{6}$$

In order to make the feature position clearer, the face image with vertical rotation angle is corrected by high-order invariant moments, and the feature point correction equation of human face is described as follows:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos(\theta_1) & -\sin(\theta_1) & 0 \\ \sin(\theta_1) & \cos(\theta_1) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} \tag{7}$$

Wherein, x, y are the two-dimensional coordinates of each feature point of the attribute of the face image, and the two-dimensional coordinates of the facial feature information of the face are matched by the template by x', y' respectively. The coordinate value in the marked shape region is determined by x', y', and the facial expression information at the x and y coordinates is determined[10].

3. 3D intelligent dynamic face recognition optimization

3.1. 3D intelligent dynamic facial minutiae calibration

On the basis of the pre-processing model of feature extraction, the mid-3D intelligent dynamic face classification and location recognition algorithm based on computer vision is improved. The traditional dynamic face recognition method adopts single-layer square mesh generation method. The recognition effect of randomly calibrated 3D intelligent dynamic face points is not good. In order to overcome the problem, this paper proposes a classification and location recognition algorithm for 3D intelligent dynamic face in computer vision based on Harris corner detection. The second-order cumulative Taylor expansion algorithm is used to extract the edge contour features of infrared micro-target 3D intelligent dynamic face vision image model in computer vision:

$$L(a,b_m) = \sum_{V_m \in P^{res}} \sum_{V_n \in P^{true}} \frac{|V_m \cap V_n|}{|V|} \log\left(\frac{|V||V_m \cap V_n|}{|V_m||V_n|}\right) \tag{8}$$

The phase-weighted 3D intelligent dynamic face vision image information (amplitude and definition domain change) can be obtained. The Harris corner information vector can be obtained by substituting t_0:

$$L(a,b_m)=\sum_{V_m\in P^{res}}\frac{|V_m|}{|V|}\log\left(\frac{|V_m|}{|V|}\right)+\sum_{V_n\in P^{true}}\frac{|V_n|}{|V|}\log\left(\frac{|V_n|}{|V|}\right) \tag{9}$$

Wherein, $I(x,y)$ represents a gray value of a 3D intelligent dynamic human face visual image at (x,y), $L(x,y,\sigma)$ represents a Gaussian scale space, and the 3D intelligent dynamic face visual image is edge-detected and segmented to obtain a 3D intelligent dynamic face scope, and the definition range of the 3D intelligent dynamic face scope is expressed as follows:

$$SP=\sqrt{\frac{1}{|PS|-1}\sum_{i=1}^{|PS|}(\bar{d}-d_i)^2} \tag{10}$$

With ray filtering, the edge information of 3D intelligent dynamic face vision image is obtained along the gradient direction, and the phase weighting of the (a,b_m) point on the scale translation plane is obtained as follows:

$$L(a,b_m)=\log\left(\frac{|V||V_m\cap V_n|}{|V_m||V_n|}\right) \tag{11}$$

With the above processing, we can calibrate the spatial position information of the dynamic face.

3.2. Optimized output of face recognition

The tiny 3D intelligent dynamic face vision image in computer vision is copied to a new curve with the basic properties of convex envelope symmetry and so on. The edge contour calculation formula of 3D model based on computer vision 3D intelligent dynamic face feature reconstruction is obtained as follows:

$$MHF=\frac{\sum_{i=1}^{TC}M_i\left(C_i\right)}{\sum_{i=1}^{TC}M_a\left(C_i\right)} \tag{12}$$

$$M_a\left(C_i\right)=M_d\left(C_i\right)+M_i\left(C_i\right) \tag{13}$$

Where, $A_i\left(C_i\right)$ represents the attributes of 3D intelligent dynamic face image texture structure information $C_i\left(i=1,2,...,n\right)$, $A_a\left(C_i\right)$ is the number of attributes of rotation translation scale in $C_i\left(i=1,2,...,n\right)$, and $A_d\left(C_i\right)$ is the number of multi-rotation compensation attributes of $C_i\left(i=1,2,...,n\right)$. Based on the above-mentioned processing, the corner feature extraction of 3D intelligent dynamic face of computer vision is realized, and the classification and accurate location of face are carried out.

4. Simulation experiment and result analysis

In order to verify the performance of the proposed algorithm in 3D intelligent dynamic face classification and recognition in computer vision, simulation experiments are carried out. The simulation experiment samples are from the computer vision data provided by the OpenFligh 3D intelligent dynamic face vision image library. Through the Raster to DED tool of Creator, the computer vision data are converted into the required DED data, and the 3D imaging simulation is carried out. 10, 100, 1000, 5000, 10 000 random points are selected to carry on the experiment, respectively. In order to avoid the error of a single measurement, when an object is measured, the group of experiments is measured four times, and the loading results of the sample test set are shown in Fig. 2.

Fig. 2 Face database sample test set loading

In order to compare the performance of the algorithm, this algorithm and the traditional algorithm are used to classify and recognize the 3D intelligent dynamic face of the same sample, and coordinate calibration method is used to carry out the face recognition and feature location. The simulation results are shown in figure 3. As can be seen from figure 3, using this algorithm, the classification and location recognition of 3D intelligent dynamic face is more accurate, and it can effectively calibrate the 3D intelligent dynamic face micro-unit which cannot be calibrated by the traditional method. The performance of this algorithm is better than that of the traditional method.

(a) Before correction (b) After correction

Fig. 3 comparison of calibration results of 3D intelligent dynamic face location recognition in computer vision

In this paper, step by step processing, assuming that the face includes three cases of tilt, horizontal rotation and vertical rotation, the first choice is to correct the tilt direction of the face so that the straight line of the two eyes is parallel to the horizontal direction. This can reduce the interference caused by tilt to subsequent face correction. The correction order of the remaining two cases is different, because both face correction in different directions need to adjust the gray value of the face, resulting in a certain degree of impact on the overall effect.

Finally, in order to quantitatively analyze the algorithm and traditional methods to realize the performance of computer vision 3D intelligent face classification and location, the accuracy of location is the test index, and the result is shown in Fig. 4. With the increase of the distance, the face image is divided into equal size sub-modules, and the information entropy features of the sub-modules are extracted from the sub-modules, which have better accuracy of 3D intelligent dynamic face location with the increase of the distance, and the information entropy features of the sub-modules are extracted. In the 3 × 3, 5 × 5, 7 × 7 block mode, the recognition rate is high, which shows the superior performance.

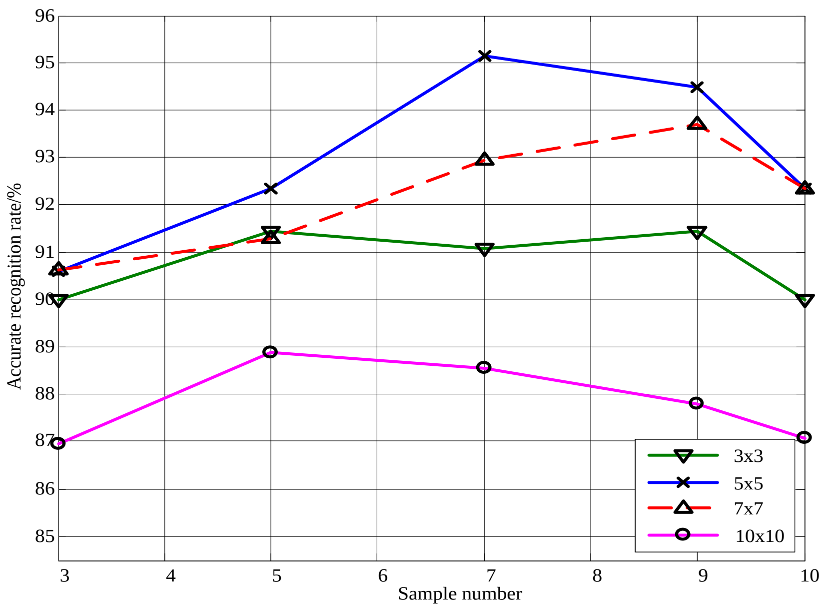

Fig. 4 Face feature localization accuracy test

By testing the recognition rate of different methods, the comparison results are shown in Table 1, and the analysis of Table 1 shows that the recognition rate of this method is higher than that of other methods.

Table 1 comparison of recognition rates

Sample number	Proposed method	Harris	SURF
100	0.974	0.745	0.845
200	0.988	0.834	0.893
300	0.992	0.912	0.904
400	0.998	0.924	0.911

5. Conclusions

In this paper, a classification and location recognition algorithm for 3D intelligent dynamic face in computer vision based on Harris corner detection is proposed. The 3D intelligent dynamic face data acquisition model of computer vision is constructed. The accurate classification and location is realized. Simulation results show that this algorithm has high accuracy for 3D intelligent dynamic face classification and location recognition, and has a good effect on feature extraction and location recognition of 3D intelligent dynamic face. It has high application value in 3D intelligent dynamic face recognition and computer vision monitoring. This method has good application value in 3D dynamic face recognition.

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