Research on Face Recognition Access Control System in Universities Based on Convolutional Neural Network

Hui Xiong1,*

1Department of Computer Science, Software Department, Sichuan Vocational and Technical College, 629000

*Corresponding author e-mail: xionghui04@ucas.edu.cn

Abstract. With the development of technology, Internet technology can be seen everywhere in people’s lives. Of course, advanced technology is not only used for things that are conducive to social development. Some people also use technology to do some illegal things, such as robbery or theft. Therefore, in order to make the anti-theft system more secure at home, people have developed a face recognition technology, which depends on the Internet technology. This technology uses facial features to determine whether a person is a resident or a stranger. This technology protects people’s safety and property more effectively. This paper makes research and analysis on face recognition, which is based on convolutional neural network.

Keywords: Hog, Convolutional Neural Network, Face Recognition, Feature Extraction

1. Introduction

Face recognition is one of the research contents in the field of biometrics. Relatively speaking, the traditional biometric technology depends on skin contact, for example, fingerprint unlocking. If we want the computer to identify accurately, we must contact it. Although touch recognition still has its shortcomings, it is more secure than traditional combination locks. Face recognition does not require skin contact any more, it just needs a short distance. This technology is more interactive, safer and more convenient. The application of face recognition is very extensive, such as: foreign mobile phone manufacturers apply Apple’s face recognition technology to their mobile phones to unlock; we use Alipay to pay with face recognition on the domestic payment platform; the face recognition system of the public security department can detect criminal suspects; face recognition is also widely used in access control systems. At present, face recognition technology has become a hot spot in the field of computer vision and artificial intelligence.

2. The composition of the human face system

The face recognition system based on BP neural network in this study is composed of three parts: preprocessing, PCA feature extraction and BP neural network classifier [1]. The specific research system process design is shown in Figure 1.
Figure 1. Face recognition system based on BP neural network

As shown in Figure 1, the functional research of the various components of the face recognition system based on BP neural network proposed in this paper can be described as follows.

2.1. BP neural network classifier

BP neural network classifier refers to the use of BP neural network to classify and recognize the principal component features extracted by PCA [2]. BP neural network is a multi-layer neural network composed of input layer, hidden layer and output layer. Through the linear calculation of the weighted sum of the input value and the parameters of each layer and the nonlinear mapping of the activation function between the layers, it not only has a strong ability to fit and approximate arbitrarily complex nonlinear functions, but also can be used for nonlinear classification. It is the preferred classifier commonly used in pattern recognition [3].

2.2. PCA feature extraction

The two-dimensional discrete wavelet transform (DWT) can decompose the original facial image into low-frequency components containing facial contours and facial features, and high-frequency components containing some high-frequency noise and edge details [4]. The system uses two-dimensional discrete wavelet transform to suppress high-frequency features and enhance low-frequency features, which not only retains the main features of the original face image, but also effectively eliminates noise under conditions. Set a certain image quality. At the same time, as shown in Figure 2, the two-dimensional discrete wavelet transform changes the decomposition of the original face image for the second time to retain a quarter of the low-frequency components in the original image after the image size, thereby reducing the image The resolution, that is, the size of the original face image, is more conducive to the use of the PCA method to extract features in the next study [5,6].

Figure 2. Facial image is decomposed and reconstructed by second-level wavelet
3. Research method design of face recognition system
The research and realization of this article will go through three stages in sequence: the acquisition of PCA feature extraction matrix, the design of BP neural network and the selection of wavelet basis function of image wavelet transform. The design is discussed below [7].

3.1. Obtain PCA feature extraction matrix
The face image comes from the ORL face database. The face database contains 40 people of different ages, genders and races. Each person extracts 10 images, a total of 400112*92 grayscale images, and involves facial expressions, posture changes, wearing or not wearing glasses, etc. 7 images of facial image training samples are randomly selected from each person, a total of 280 images, and the remaining images are used as system simulation test data[8]; the mean value of X refers to the zero mean value of row expansion, that is, subtracting each row of the matrix The mean value of the elements; the calculation formula of the covariance matrix C is shown in publicity (1):

\[ C = \frac{1}{m} x x^T \]  

(1)

The larger the eigenvalue of the covariance matrix, the greater the influence of the corresponding eigenvector on the image. Therefore, the choice of k value is more important for facial feature extraction [9,10]. The PCA feature extraction matrix P can be obtained by introducing the parameter \( \beta \). The calculation of parameter \( \beta \) can be seen from formula (2):

\[ \beta = \frac{\text{The sum of the eigenvalues corresponding to the eigenvectors of the first k rows}}{\text{Sum of all features}} \]  

(2)

Finally, the principal component feature Y of the facial image can be calculated by equation (3). The mathematical form is as follows:

\[ Y = PA \]  

(3)

Among them, A is the \( (n \times 1) \) column vector after stretching the face pixel matrix. It can be seen that by multiplying the P of \( (k \times n) \) by A, the principal component feature vector Y of \( (k \times 1) \) can be obtained [11].

3.2. BP neural network design
The number of neurons in the input layer is consistent with the PCA feature dimension, namely K. The number of neurons in the output layer is 40. The number of neurons in the hidden layer is set according to the empirical formula, that is, the smallest integer greater than \( \sqrt{nm} \); the activation function after each layer uses modified linear elements, so the feature of nonlinear sparse activation will help fast Optimize the BP neural network [12]. The formula definition of ReLU is shown in public announcement (4):

\[ \text{ReLU}(x) = \max(0, x) \]  

(4)

The output function of the output layer adopts the Softmax function, and its mathematical expression is shown in publicity (5):

\[ P_j = \frac{e^{f_j}}{\sum_i e^{f_i}} \]  

(5)

3.3. Selection of wavelet basis function
Wavelet transform uses wavelet basis functions of finite length and attenuation, which can effectively analyze the signal locally. It has the advantages of frequency change and limited duration, so it has the advantages of multi-resolution and multi-scale analysis [13]. In image processing, two-dimensional wavelet transform is the scale factor and continuous translation parameter of discretized basic wavelet. Many wavelet basis functions that can implement two-dimensional wavelet transform on facial images have been introduced [14]. For example, Haar wavelet, Daubechies wavelet and so on.

4. Conclusion

The face recognition system is already an advanced recognition system, which is based on neural network. It will accurately recognize a person's face whether it is wearing glasses or makeup. The face recognition application scene with uniform ambient light has high recognition accuracy. With the development of our face recognition system, I believe that our science and technology will be more stable and rapid [15].

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