Journal of Theoretical and Applied Information Technology
20th February 2013. Vol. 48 No.2
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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

A NEW ALGORITHM OF IMPROVING FACE RECOGNITION BASED ON JPEG

[1]HANGLIN ZENG,[2]LI CAO,[3]XUEFEI TANG

[1] Prof., Coll. of auto. and Electr. Eng., SiChuan University of Tech. and Eng. ZiGong, 643000， China

[2]Assoc. Prof., Coll.of Computer,University of Electr Sci. and Tech of China, Chengdu, 610054， China

E-mail: zhl@suse.edu.cn, caoli51future@126.com, ucit@vip.163.com

ABSTRACT

This paper proposes a new algorithm to improve face recognition on Joint Photographic Experts Group (JPEG). An imagine compression on face recognition is realized by discrete cosine transform (DCT), and improved compression coding and two dimensions principal component analysis (2DPCA). A new approach to improve the face recognition based on JPEG reduces the effect of class scatter matrix maximized of diagonal average face image can be divided into basic sub-image, and this paper sets up a relationship of rows and columns of face image. An integrated BP neural network is proposed to be used for face recognition. Experiment simulation showed that the method proposed can effectively improve face recognition rate and reduce the time of feature extraction.

Keywords: *Face Image Recognition, JPEG, DCT, 2DPCA, BP Neural Network*

1. INTRODUCTION

The use of face recognition for solving state-of-the-art scientific exploration, pattern recognition etc. has increased steadily over the last 20 years. Within this growing trend, it relies heavily on developing a new method to improve the quality of face recognition. Kirby and Sirovich used PCA method for face recognition to reduce data dimension, which has achieved good results in face recognition [1-4]. However, PCA method cannot deal with posture changes, such as facial expression change. The method of 2DPCA is proposed to extract face feature to improve quality of image recognition, then on the basis of 2DPCA, some improvements have been got, such as, average face method, weighted average face method, DiagPCA method, combining Wavelet transform and PCA method, and so on [5-12].

This article is intended to improve image processing for face recognition. The remainder of this paper is structured as follows. In section 2, we will propose a new approach for solving of compression of face recognition with discrete cosine transform (DCT) and two dimensions principal component analysis (2DPCA). In section 3， we will put forward an integrated BP neural network for face recognition. In section 4， some experiment results and analysis are given to validate the feasibility of a new approaches proposed for face recognition. Finally, some of conclusion about a new algorithm of improving face recognition based on JPEG is given.

2. A NEW APPROACH FOR SOLVING OF COMPRESSION OF FACE RECOGNITION WITH DCT AND 2DPCA

A new approach of improving face recognition based on JPEG is realized by image data compression with discrete cosine transform (DCT) and feature extraction with two dimensions principal component analysis (2DPCA) [4,6,10].

An image is divided into some basic sub-image with size of $N_1 \times N_2$, which is carried out DCT Wavelet packet decomposition pyramid-like multi-variable-rate feature extraction.

DCT Wavelet decomposition is defined as following

$$X_{k_1,k_2} = \sum_{n_1=0}^{N_1-1}\left[\sum_{n_2=0}^{N_2-1} X_{n_1,n_2}\varphi_2\right]\varphi_1 \quad (1)$$

$$\varphi_1 = \cos\left[\frac{\pi}{N_1}\left(n_1+\frac{1}{2}\right)K_1\right] \quad (2)$$

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$$\varphi_2 = \cos\left[\frac{\pi}{N_2}\left(n_2 + \frac{1}{2}\right)K_2\right] \quad (3)$$

Where N_1, N_2 is size of basic sub-image.

The low frequency coefficients of a image are concentrated in the left corner of the chart, and high frequency coefficients of image are concentrated in the right corner of the chart after DCT. DCT of a face image is shown as in Figure 1.

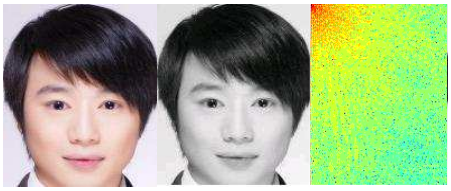

Figure 1 DCT Of A Face Image

An improved compression coding on JPEG is realized as follows: quantization of the transform coefficient of DCT Wavelet decomposition is based on JPEG standard, then forecast coding is based on DC coefficient of basic sub-image, and entropy coding is based on AC coefficient of basic sub-image with Huffman code table standard [3,6]. Since Huffman coding is a kind of difference coding which encoded between adjacent elements of an image, data of Huffman coding will use difference values to replace the original quantized coefficient of a sub-image. Moreover, for a 8×8 sub-image, in case of 16 coefficients continuously are zero or 63 coefficients are zero, a variable-length coding will be done [9].The output of a compression image is a bit sequence.

A restored image is got by Huffman entropy decoding, DC coefficient and AC variable-length decoding, inverse DCT and inverse quantization. Reconstruction of JPEG compression of an original image is shown in Figure 2.

Figure 2 Reconstruction Of Image On JPEG (A) An Original Image (B)Reconstruction Of Image

Changing the quantization matrix, coding bit rate and different compression rate. Reconstruction of JPEG compression of an original image is shown in table 1.

TABLE 1 Reconstruction Of Face Image With Different Quantization Matrix, Coding Bit Rate And Compression Image.

quantization Q	Coding bit rate (bpp)	Comression rate	SNR（db）
$Q\times9$	0.16	5.20	27.88
$Q\times4$	0.20	28.60	30.26
$Q\times2.5$	0.36	22.36	32.12
$Q\times1$	0.6	16.8	34.2
$Q\times0.5$	0.8	8.24	37.56
$Q\times0.3$	1.36	5.90	39.45

Changing coding bit rate, the signal noise rate (SNR) curves of reconstruction of image is shown in Fig. 3.

It is shown that reconstruction of image signal to noise rate is more than 30dB in a large range of compression.

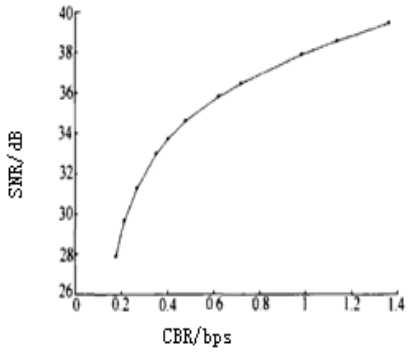

Fig. 3. The Relationship Of Signal Noise Rate (SNR) Vs Coding Bit Rate (CBR)

A new approach to improve face recognition based on JPEG is that diagonal 2DPCA method is proposed to improve face recognition accuracy in which reconstruction image is firstly diagonalized based on DigPCA, then identification of the image diagonalized is based on the average face method. The concrete steps performing of face recognition based on JPEG given as following:

Step 1 Diagonalization of a training sample. Where n is a total number of training sample, N_c is classes of face images, C is a number of sample belonged to the class C, A_{ci} is the i sample belonged to the class C, A_d is a face image

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diagonalized to be recognized. An average face image $\overline{A}$ and an average face class are calculated as following

$$\overline{A} = \mathrm{E(A)} = \frac{1}{n}\sum_{c=1}^{C}\sum_{i=1}^{N_c} A_{ci} \quad (4)$$

$$\overline{A_c} = (A_c) = \frac{1}{n}\sum_{i=1}^{N_c} A_{ci} \quad (5)$$

Step 2 Constructing of a between-class scatter matrix of a training sample. a between-class scatter matrix G_t is calculated as following

$$G_t = E\left[(A-\bar{A}_c)^T(A-\bar{A}_c)\right] = \frac{1}{N}\sum_{c=1}^{C}\sum_{i=1}^{N_c}(A_{ci}-\bar{A})^T(A_{ci}-\bar{A}) \quad (6)$$

Step 3 Eigenvalue decomposition of a between-class scatter matrix of a training sample. A feature space is defined as following

$$Y = [Y_1, Y_2, \cdots, Y_d] \quad (7)$$

Step 4 A_{ci} and A_d is projected to a feature space and difference of sample face image and face image to be recognized are calculated as following

$$\hat{A}_{ci} = A_{ci} - \overline{A_c}, \hat{A}_d = A_d - \hat{A} \quad (8)$$

Step 5 A face image is recognized based on the rule of minimum distance classifier.

3. AN INTEGRATED BP NEURAL NETWORK FOR FACE RECOGNITION

A new approach of improving face recognition based on JPEG is firstly realized by image data compression with discrete cosine transform (DCT), then image reconstruction is made on coding of different compression rate. Feature extraction is made on reconstruction image based on diagonal 2DPCA method. Finally, face recognition is realized by an integrated BP neural network.

A system of an integrated BP neural network for face recognition is shown in Fig. 4.

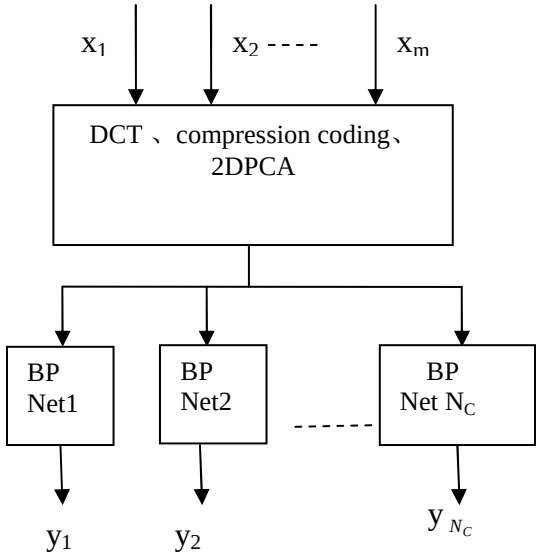

Fig. 4. . A System Of An Integrated BP Neural Network For Face Recognition

An integrated BP neural network is a classifier of a three-layer BP network with multiple-input, single-output structure. An integrated BP neural network transforms the N_c -class classification issue into N_c isolated 2 problems. In an integrated BP neural network, every BP network is used to identify one of pattern in N_c -class face image classification. Input of system of an integrated BP neural network for face recognition is a vector of input image. Input of an integrated BP neural network is a feature of input image with compression coding and 2DPCA. Number of nodes of the hide layer of the network is determined by some experiments. Number of nodes of the output layer of the network is equal to N_c . An input-output function of a neuron is defined by a hyperbolic tangent function

$$u = \frac{1-e^{-kv}}{1+e^{-kv}} \quad (9)$$

The concrete steps performing of training neural network is based on BP [7,11]. A mean error function is defined as

$$J_k = \frac{1}{2}\sum_{k=1}^{n}(t_k - z_k)^2 = \frac{1}{2}\|t-z\|^2 \quad (10)$$

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Where t_k is an expectation value of the output, z_k is a practical value of the output.

Based on the gradient method, it yields

$$g_k = \frac{\partial J_k}{\partial w} \quad (11)$$

$$\Delta w_k = a_k g_k \quad (12)$$

$$a_{k+1} = \begin{cases} k_{inc} a_k & J_{k+1} < J_k \\ k_{dec} a_k & J_{k+1} > J_k \end{cases} \quad (13)$$

$$w_{k+1} = w_k + \Delta w_k \quad (14)$$

An initial weight of neural network is stochastic value, then adjustment of weight of neural network is based on formula (14). Where Δw_k is a change weight of neural network at the k time, a_k is a study rate of neural network at the k time, g_k is a training gradient of neural network at the k time, k_{inc} is a training factor of neural network.

4. EXPERIMENT RESULTS AND ANALYSIS

An experiment simulation of image is based on database of ORL standard people face library [13].

Input: a database of ORL standard people face library. 5 site images of per person are taken as training sample, 5 site images of per person are taken as testing sample. 200 face images are used in this experiment simulation.

Output: N_c -class of face image classification. The output of a neural sub-network is 0.9 which is regarded as a target image, -0.9 is regarded as a anti-cases.

Some comparison of face recognition is made based on normal 2DPCA, diagonal average face 2DPCA [14,15] and the method proposed here. Some comparison results of face recognition are given in the Table 2.

Table 2. Some Comparison Results Of Face Recognition With Normal 2DPCA, Diagonal Average Face 2DPCA And The Method Proposed Here

Methods of face recognition	correct rate of face recognition (%)	time of feature extraction (s)
normal 2DPCA	93.5	15.450
diagonal average face 2DPCA	94.1	7.213
the method proposed here	96.4	4.326.

It is shown that the method proposed here combine diagonal average face 2DPCA with JPEG, not only increase the correct rate of face recognition, also decrease the time of feature extraction. A new approach of face recognition based on JPEG has greatly improved face recognition.

5. SUMMARY

The main issue what we are interested is effective improvement of face recognition. JPEG compression can be implemented in a large range, and JPEG compression image can be reconstructed very well. Diagonal average face 2DPCA can reduce the impact on two-dimensional PCA class scatter matrix maximized, and set up the relationships of rows and columns. A new approach of face recognition takes advantages of JPEG and Diagonal average face 2DPCA to process data of face image, then an integrated BP neural network is used for face image recognition. The effectiveness of the proposed approaches of improvement of face image recognition is supported by some comparison of simulation experiments.

ACKNOWLEDGMENTS

This work was supported by a grant from Foundation of major applied science project of Science and Technology Department of Sichuan Province under No**.** 2011JY0051 and Foundation of major special project of Key Laboratory of Sichuan Province of Liquors and Biotechnology under No**.** NJ2010-01

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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

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