International Journal of Engineering Research and General Science Volume 2, Issue 4, June-July, 2014
ISSN 2091-2730

Face Recognition using Principal Component Analysis with DCT

Kiran D. Kadam[1]

[1]E&TC Department, Dr.D.Y.Patil College of Engineering, Pune University, Ambi-Pune

E-mail- kiran3181kk@gmail.com

Abstract—Face recognition (FR) is a challenging issue due to variation in expression, pose, illumination and aging etc. In this paper hybrid combination of principal component analysis (PCA) and discrete cosine transform (DCT) is used is used to represent accurate face recognition system. Face recognition system used for many applications such as security access to video indexing by content. This method is useful to increase the efficiency by extracting meaningful features and also increase in recognition rate of system which is easy to implement. This paper proposes a methodology for improving the recognition rate of face recognition system. Standard databases such as FACES 94 and ORL are used to test the experimental results which proves that proposed system achieves more accurate face recognition as compared to individual method.

Keywords: DCT, FACES 94 databases, face recognition, feature extraction, Mydatabase, ORL database, PCA, recognition rate

INTRODUCTION

In recent years, automatic face recognition has become a popular area of research. An excellent survey paper on the topic appeared recently in [l]. Recognition, verification and identification of faces from still images or video data have a wide range of commercial applications including video indexing of large databases, security access and other multimedia applications. As one of the most successful applications of image analysis and understanding, face recognition has recently received significant attention, especially during the past several years.

Generally, feature extraction and classification are two fundamental operations in any face recognition system. In order to improve the recognition performance it is necessary to enhance these operations. Feature extraction is used for reducing the dimensionality of the images using some linear or non-linear transformations of face images with successive feature selection, so that exacted feature representation is possible. However, there are some problems such as lightning condition, illumination, various backgrounds, aging and individual variation with feature extraction of human face.

In this paper PCA is used for identification and pattern recognition. Since pattern recognition is very difficult, particularly when input data (images) are with very great dimensions. In such a case PCA can be seen as a very powerful tool to explore the data since it operates by reducing their dimensions in a considerable way. Advantages of using PCA are data can be compressed without losing useful information and dimensions can be reduced.

At least two reasons are accounted for this trend: first it is widely used in real life applications and second, is the availability of feasible technologies after many years of research. The range of face recognition applications is very assorted, such as face-based video indexing and browsing engines, multimedia management, human-computer interaction, biometric identity authentication, surveillance, image and film processing, and criminal identification. In face recognition method is based on biometric study to identity authentication. As compared with existing identification technologies such as fingerprint and iris recognition, face recognition has several characteristics which are useful for consumer applications, such as nonintrusive and user-friendly interfaces, low-cost sensors and easy setup, and active identification. This method can be divided in the following categorization: holistic matching methods, feature-based matching methods and hybrid methods. The holistic methods used the whole face as input. Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) and Independent Component Analysis (ICA) belong to this class of methods.

First time PCA algorithm used for face recognition by Mr. Turk and A. Pentland [2] in 1991 with MIT Media Labs. Applying Principal component analysis (PCA) includes evolution of covariance matrix and computing the eigenvalues for covariance matrix.

The proposed method is based on hybrid combination of PCA and DCT and face recognition is done by feature extraction using PCA and DCT. The redundant information interference is eliminated by using normalization. Principal Component Analysis (PCA) was used for feature extraction and dimension reduction. In general for PCA based face recognition by increasing in the number of signatures there is increase the recognition rate. However, the recognition rate saturates after a certain amount of increases.

Classification is done using different algorithms such as Euclidian distance, hamming distance etc. After these algorithms final recognition result will be displayed whether face is match or not. And percentage of recognition rate is calculated.

Presently, there are two types of face detection technique, geometrical face detectors and holistic-based face detectors. Geometric face detector extracts local features such as location and local statistics of the eyes, nose and mouth. Holistic-based detector extracts a holistic representation of the whole face region and has a robust recognition performance under noise, blurring, and partial occlusion. Principal component analysis (PCA) is holistic based approach

2. FACE RECOGNITION

Face recognition technique is a research hotspot in the fields of computer vision and pattern recognition, which is widely used in human-computer interaction, security validation and etc. Up to now, almost all the techniques are based on multi-sample. But in some special situations, such as passport verification and ID card verification, only one image can be obtained for one person, and these techniques may failed.
Principal Component Analysis (PCA), proposed by Turk [2], is one of the most important single sample face recognition methods, which can exactly express every face image via linear operation of eigenvector.
Most currently DCT is used in the field of face recognition field. It uses the discrete transformation into a cosine to eliminate the redundancies in an image and extract from them the most significant elements (i.e. coefficients) in order to use them for recognition. In discrete cosine transform (DCT) special domain signal is transformed to frequency domain.

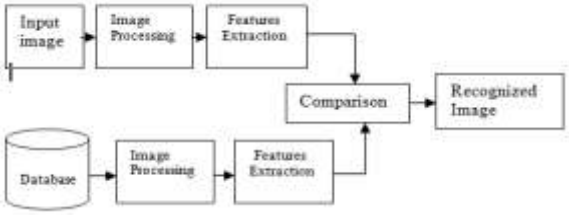

Fig.1 Face recognition system

2.1 Face recognition problem

The challenges of face recognition are the rapid and accurate identification or classification of a query image [3].There are some difficulties in face recognition are identifying similar faces (inter-class similarity) and intra-class variability as head pose, illumination condition, facial expression and aging effect. The performance of a face recognition technique should be able to produce the results within a reasonable time [4]. In human-robot interaction, real-time response time is critical [10]. Besides, it also enables computer systems to recognize facial expressions and infer emotions from them in real time [11].

2.2 Feature extraction

In the field of pattern recognition and data mining technology feature extraction is very important. It extracts the meaningful feature subset from original dates by some rules, to reduce the time of machine training and the complexity of space, in order to achieve the goal of dimensionality reduction. In feature extraction input data is transformed into set of features and new reduced representation contains most of the important information from the original data [5].In any face recognition system feature extraction is key step. Feature extraction is a process which is used to transfers the data from primary spaces into feature space and represents them in a lower dimensional space with less effective characters. Many methods of feature extraction are proposed till now such as knowledge-based methods, feature invariant approaches, template matching methods, and appearance-based methods. Among all these methods the algorithm of Eigen face, the most widely used method of linear map based on PCA (Principle Component Analysis) useful for face recognition.

3. PRINCIPAL COMPONENT ANALYSIS (PCA)

The technique used to reduce the dimensionality which can be used to solve compression and recognition problems is Principal Component Analysis (PCA). PCA is also known as Hotelling, or eigenspace Projection or Karhunen and Leove (KL) transformation [6]. In PCA the original data image is transformed into a subspace set of Principal Components (PCs) such that the first orthogonal dimension of this subspace captures the greatest amount of variance among the images. The last dimension of this subspace captures the least amount of variance among the images, based on the statistical characteristics of the targets [7].
Principal Component Analysis (PCA) is a popular transformation system whose result is not directly related to a single feature component of the original sample. PCA has the potential to perform feature extraction, that able to capture the most variable data components of samples, and select a number of important individuals from all the feature components. In the field of face recognition, image denoising, data compression, data mining, and machine learning PCA has been successfully used. Implementation of the PCA method in face recognition is called eigenfaces technique [12].

Calculation and subtraction of the average

Average image Ψ is calculated and subtracted from all the images.

$$\Psi = \frac{1}{M}\sum_{i=1}^{M} \Gamma_i$$

$$\Phi_i = \Gamma_i - \Psi \quad (i = 1, 2, \ldots M)$$

Where M is number of images, Γ is the input image and Φ indicates difference from average.

Calculation of the covariance matrix

Covariance matrix of the data file is calculated using the following formula:

$$C = \frac{1}{M}\sum_{i=1}^{M} \Phi_i \Phi_i^T = AxA^T$$

$$\Phi = [\Phi 1\ \Phi_2, \ldots\ \Phi_M]$$

Calculation of the eigenvectors and eigenvalues

Only M eigenfaces (Ui) of highest eigenvalues are actually needed to produce a complete basis for the face space. A new input face image (Γ) is transformed into its eigenface components by a simple operation

$W_k = U^T_K (\Gamma - \Phi)$ For K= 1, 2,…M'

The wk are called weights and form a vector ΩT:

ΩT = [w1, w2, w3…, wM']

The feature vector descriptor is then used in a standard face recognition algorithm.

4. DISCRETE COSINE TRANSFORM (DCT)

The discrete cosine transform (DCT) is used to transform a signal from the spatial domain into the frequency domain. A signal in the frequency domain contains the same information as that in the spatial domain.

$$C(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos\left[\frac{\pi(2x+1)u}{2N}\right]\cos\left[\frac{\pi(2y+1)v}{2N}\right],$$

IDCT is expressed as,

$$C(u,v) = \sum_{u=0}^{N-1}\sum_{v=0}^{N-1} \alpha(u)\alpha(v)C(u,v)\cos[\frac{(2x+1)\pi u}{2N}]\cos[\frac{(2y+1)\pi v}{2N}]$$

5. HYBRID METHOD

Hybrid method is the combination of two individual methods which is useful to improve the performance. Recognition rates are slightly more as compared with individual methods. In this paper two technologies are PCA and DCT are combined. Two methods PCA and DCT have certain mathematical similarities since that they both aim to reduce the dimensions of data. Initially we will use DCT which is useful to compress the input image, then PCA is entered to reduce the dimensions and the final recognition or classification is done using the Euclidian distance formula. It should be noted that it requires less memory what makes its use advantageous with bases of significant size.

5.1 The complete process of face recognition system

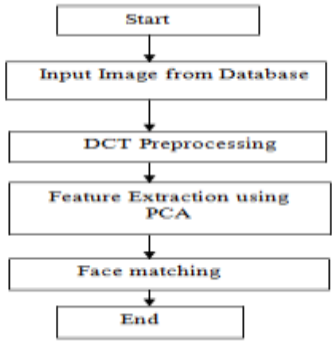

Fig.2 Algorithm flowchart

Distance Matching (Detection)

In this paper, the nearest neighbour classifier with Euclidean distance was used for classification. The Euclidean distance is used to measure the distances from the probed feature vector to the reference feature vectors in the gallery. The two vectors are close to each other when distance between them minimum. It is defined as:

$$d(X,Y) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2}$$

6. EXPERIMENTAL RESULTS

Some experiments are performed. These experiments were performed to evaluate the performance of PCA with DCT as a face recognition system on standard database such as FACES 94 and ORL. In FACES 94 there are 153 Number of individuals, 180 by 200 pixels image resolution, Contains images of male and female subjects in separate directories, the background is plain green, Head turn, tilt and slant with very minor variation in these attributes, no image blurring. The ORL database consists of 400 images of 40 individuals; there are 10 different images of each person. The ORL database includes variations in facial expression, illumination. Mydatabase is created there are 60 images of 6 individuals, 180 by 200 pixels image resolution.

Fig.3 FACES 94, ORL and Mydatabase database

6.1 Experimental setup

In order to evaluate the performance of PCA and DCT, a code for each algorithm has been generated using Matlab. These algorithms have been tested using standard such as FACES 94 and ORL and Mydatabase etc [9].After testing results on standard database we tested it on database created by author.

6.2 Result discussion

The result of the overall experiments shows that Combination of PCA with DCT gives better recognition rates than using simple PCA. We have tested PCA with DCT on standard databases FACES 94 and ORL which achieve level of accuracy 99.90% and 94.70%.We have also tested this one on Mydatabase which gave recognition rate 95%. This method is useful especially to recognize face with expression disturbance.

Table1. Dataset Description

Database Name	Sample Number	Total Images
ATT	40	400

FACES94	153	3040
Mydatabase	10	60

Table 2. Recognition Rate

Dataset name	PCA	PCA+DCT
ATT	91.30%	94.70%
FACES94	99.90%	99.90%
Mydatabase	87.00%	95%

7. CONCLUSION

In this paper, we have represented a new rapid method which is the combination of DCT and PCA.PCA is considered as a very fast algorithm with a more or less high robustness and DCT is used for time reduction of recognized output images. So finally we can conclude that combination of PCA and DCT it will offers higher rates of recognition .This face recognition method verifies improvement in parameters in comparison to the existing method.

ACKNOWLEDGEMENTS
This work is supported in part by Electronics department of a Dr.D.Y.Patil college of Engineering Ambi-Pune. The author would like to thank the anonymous reviewers and the editor for their constructive comments.

REFERENCES:
[1] Dashun Que, Bi Chen, Jin Hu "A Novel Single training sample face recognition algorithm based on Modular Weighted $(2d)^2$ PCA" *School of Information Technology, Wuhan University of Technology, Wuhan 430063, P. R. China.*
[2] M. Turk and A. Pentland. Eigenfaces for recognition. *Journal of Cognitive Science*, pages 71–86, 1991.
[3] K.E. Gates, "Fast and Accurate Face Recognition Using Support Vector Machines," Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2005, pp.163-163.
[4] S. Palanivel, B.S. Venkatesh, and B. Yegnanarayana, "Real Time Face Recognition System Using Autoassociative Neural Network Models," 2003
[5] L. Xie and J. Li, "A Novel Feature Extraction Method Assembled with PCA and ICA for Network Intrusion Detection," 2009 International Forum on Computer Science-Technology and Applications, vol. 3, 2009, pp. 31-34.
[6] M. Karg, R. Jenke, W. Seiberl, K. K, A. Schwirtz, and M. Buss, "A Comparison of PCA , KPCA and LDA for Feature Extraction to Recognize Affect in Gait Kinematics," 3rd International Conference on Affective Computing and Intelligent Interaction and Workshops, 2009, pp. 1-6.
[7] Ö. Toygar and A. Acan, "Face Recognition Using PCA , LDA and ICA Approaches on Colored Images," Journal of Electrical & Electronic Engineering, vol. 3, 2003, pp. 735-743.
[8] Z. M. Hafed and Martin D. Levin, "Face Recognition Using the Discrete Cosine Transform", *International Journal ofComputer Vision*, 43(3), 2001, pp 167-188.
[9] Available at: http://www.cl.cam.ac.uk/research/dtg/attarchive/facedatabase.html
[10] C. Cruz, L.E. Sucar, and E.F. Morales, "Real-Time Face Recognition for Human-Robot Interaction," 2008 8th IEEE International Conference on Automatic Face & Gesture Recognition, Sep. 2008,pp. 1-6.
[11] P. Michel and R. El Kaliouby, "Real Time Facial Expression Recognition in Video Using Support Vector Machines," Proceedings of the 5th international conference on Multimodal interfaces - ICMI'03, 2003, p. 258
[12] C. Li, Y. Diao, H. Ma, and Y. Li, "A Statistical PCA Method for Face Recognition," Second International Symposium on Intelligent Information Technology Application, vol. 3, Dec. 2008, pp. 376-380