ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 5, May 2013

DCT Based Fast Face Recognition Using PCA and ANN

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Abstract: This paper proposed a noble face recognition algorithm which integrates the principal component analysis; back propagation neural network (BPNN) and discrete cosine transform (DCT) to improve the performance of face recognition algorithms.PCA is used to reduce the dimensionality of face image and the recognition is done by the BPNN for efficient and robust face recognition. DCT is an accurate and robust face recognition system used in compression due to its compact representation power. Various faces images are considered in this research work to evaluate the performance of the proposed algorithm. The proposed algorithm is efficient and fast because DCT reduce the amount of time required to recognize a face.

Keywords: Face recognition, Eigen faces, principal component analysis, back propagation neural network, discrete cosine transform

I. INTRODUCTION

The face is the key center of consideration in the public, playing a foremost function in conveying uniqueness and emotion. Face recognition has become a significant matter in many applications such as security systems, credit card verification, criminal identification, biometric systems, banks etc.

Face recognition [1] can be partitioned into Face identification, Face classification, sex determination, people surveillance in crowded areas, video content indexing, Personal identification (e.g. Driver's License) and Entrance security. Developing a computational model of face recognition is quite difficult, because faces are complex, multi-dimensional visual stimuli. Therefore, face recognition is a very high stage computer visualization task, in which many early visualization techniques can be implicated.

There are three major research groups [2], which recommend three different approaches to the face recognition problem. The major group deals with facial characteristics, which are used by human beings in recognizing Individual faces. The second group performs human face identification based on feature vectors extracted from side view. The third group uses feature vectors extracted from a frontal view of the face.

The most widely and commonly used algorithm for face recognition is the Principal Component Analysis (PCA) [3]. PCA technique provided by Kirby and Sirovich not only resulted in a technique that efficiently represents pictures of faces, but also laid the foundation for the development of the "eigenface" technique of Turk and Pentland. Principal Component Analysis proves to be the most robust and novel algorithm for face recognition and this can be verified by the fact that almost every other face algorithm such as the Linear Discriminant Analysis and the Gabor filter approach make use of the Principal Component Analysis for dimensionality reduction.

II. RELATED WORK

Agarwal et al. [1] has proposed a methodology for face recognition based on approach of coding and decoding the face image. Proposed methodology is connection of two stages : Feature extraction using principle component analysis and recognition using the feed forward back propagation Neural Network. The space dimension can be reduced from 2576 to 50 by choosing PCA as a feature selection method. Test results of the algorithm gave a recognition rate of 97.018%.

Dashore et al. (2012) [2] has proposed an algorithm for real-time human face tracking. The system functions by

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 5, May 2013

projecting face image onto a feature space that spans the important variations among known face images. These features are known as "Eigen faces", because they are the eigenvectors (Principal Component) of the set of faces they do not necessarily correspond to the features such as eyes, ears, and noses. The projection operation distinguish an individual face by a weighted sum of the Eigen faces features and so to recognize a particular face it is necessary only to compare these weights to those individuals.

Mamta Dhanda (2012) [3] has presented an overview of the design and development of a real-time face recognition system .The design of the face recognition system is based upon "eigenfaces". The original images of the training set are transformed into a set of eigenfaces E. Then, the weights are calculated for each image of the training set and stored in the set W. Upon observing an unknown image Y, the weights are calculated for that particular image and stored in the vector WY. Afterwards, WY is compared with the weights of images, of which one knows for certain that they are facing. [3]

Kashem et al.(2011) [4] in their paper presented a face recognition system for personal identification and verification using Principal Component Analysis with Back Propagation Neural Networks .The dimensionality of face image is reduced by the PCA and the recognition is done by the BPNN for efficient and robust face recognition.

Prasad et al. (2011) [5] has proposed a Neural and PCA based algorithm for efficient and robust face recognition. Holistic approach is used in which the whole face region is taken as input data which is based on Principal Component Analysis technique to simplify a dataset into lower dimension while retaining the characteristics of dataset. Pre-processing, Principal component analysis and Feed Forward Neural Algorithm are the major implementations of the paper of Prasad et al.

Kekre et al. (2010) [6] has proposed an algorithm based on Principal Component Analysis and verify the results of this algorithm on a training database of images. This algorithm is also used to recognize the gender of the test image by evaluating the Euclidian distance of the test image from the images in the database.

Karim et al. (2010) [7] has presented a paper to implement a reliable PCA-based face recognition technique and study its performance using standard face databases. MATLAB based programs are implemented to identify the faces using Indian databases and the Face recognition data, University of Essex, UK.

Tungathurthi et al.(2009)[8] has presented a paper in which face recognition system detects the faces in a picture taken by web-cam or a digital camera, and these face images are then checked with training image dataset based on descriptive features. Descriptive features are used to characterize images. For the analysis, the main focus is on principal component analysis and the implementation is done in free software, Scilab

Sandhu et al. (2009) [9] has presented a paper in which PCA features for Feature extraction are used and matching is done for the face under consideration with the test image using Eigen face coefficients. The crux of the work lies in calculating Euclidean distances between the projected test image and the projection of all centered training images and paving the way to test the same algorithm using Matlab which is an efficient tool having powerful user interface along with simplicity in representing complex images.

Ruprah et al. [10] has proposed the face recognition system using PCA with neural network back propagation learning algorithm in the context of face verification and face recognition using photometric normalization for comparison. For recognition, E.D. (Euclidean Distance) classifier gives the highest accuracy using the original face image.

Shaik et al. [11] examined the PCA appearance-based (holistic) approach for face recognition observed by using Eigen vectors. The features are extracted from the original image to represents unique identity used as inputs to the system to measure similarity in classification and recognition. The principal components have proven the capability to provide the significant features and reduce the input size of the images.

Chadha et al. [12] have examined Face Recognition using Discrete Cosine Transform (DCT) for Local and Global Features that involves recognizing the corresponding face image from the database. Discrete Cosine Transform (DCT) will be applied to each of the local features (left eye, right eye, nose and mouth) individually and also to the global features. Finally, the results obtained in both cases will be

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 5, May 2013

compared and the false acceptance rate for DCT can be minimized.

Shermina.J [13] has presented a methodology on illumination invariant face recognition using Discrete Cosine Transform (DCT) and Principal Component Analysis (PCA) through the process of normalization, compensation and recognition of face images that proves good recognition rate.

III. PROBLEM DEFINITION

In this paper a new improved approach to find the optimum learning rate that increases the recognition rate and reduces the training time of the BPNN as well as single layer feed forward Neural Network is considered. PCA [1, 2,4and 9] is a multivariate technique that analyzes a face data in which observation are described by several inter-correlated dependent variables. The goal is to extract the important information from the face data, to represent it as a set of new orthogonal variables called principal components. This paper integrates the PCA face recognition algorithm with well known DCT compression algorithm to reduce the amount of time to finish up the recognition. The algorithm has been tested on 250 images (non faces, faces and faces with noise).

A. Problem Definition

We run our algorithm for face recognition application using Principal Component Analysis and neural network and demonstrate the effect of number of hidden neurons and size of feature vector on training time and recognition accuracy for given numbers of input patterns. This algorithm can achieve 98.7% and higher performance. Successful results are obtained in different situations where images have taken under different lighting conditions. The proposed method reduces the computational load. In comparison with the traditional use of PCA, the proposed method gives better recognition accuracy, discriminatory power and use minimum time.

IV. RESEARCH METHODOLOGY

The complete process of face recognition system is described in the following steps-

A. Preprocessing

This module automatically reduces every face image to X*Y pixels, can distribute the intensity of face images in order to improve face recognition performance.

B. DCT Compression [11, 12, 13]

The discrete cosine transform (DCT) is used to transform a signal from the spatial domain into the frequency domain. The reverse process, i.e. transforming a signal from the frequency domain into the spatial domain, is called the inverse discrete cosine transform (IDCT). A signal in the frequency domain contains the same information as that in the spatial domain. The order of values obtained by applying the DCT is coincidentally from lowest to highest frequency. This feature and the psychological observation that the human eye and ear are less sensitive to recognizing the higher-order frequencies leads to the possibility of compressing a spatial signal by transforming it to the frequency domain and dropping high-order values and keeping low-order ones. When reconstructing the signal and transforming it back to the spatial domain, the results are remarkably similar to the original signal.

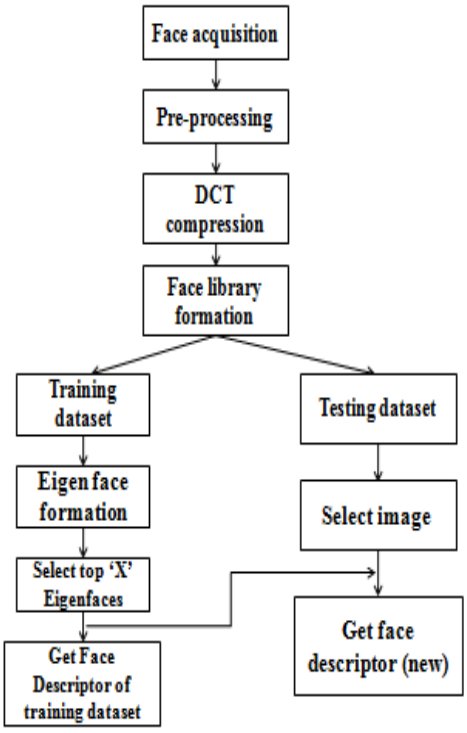

Fig 1: The complete process of face recognition system

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C. Face Library Formation

Face images are stored in a face library in the system. Every action such as training set or Eigen face formation is performed on this face library. The face library is further

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 5, May 2013

divided into two sets – training dataset (60% of individual image) and testing dataset (rest 40%images).

D. Get the Face Descriptor Using Eigen Face [3, 8, 9]

The face library entries are normalized. Eigenfaces are calculated from the training set and stored. An individual face can be represented exactly in terms of a linear combination of eigenfaces. The face can also be approximated using only the best M eigenfaces, which have the largest eigenvalues. For calculating the eigenface PCA algorithm was used. It includes the calculation of the average face (φ) in the face space and then further computes each face difference from the average. Only M eigenfaces (U_i) of highest eigenvalue are actually needed to produce a complete basis for the face space. A new face image (Γ) is transformed into its eigenface components by a simple operation,

$$W_K = U_K^T(\Gamma - \varphi)$$

for k = 1,2,……M'

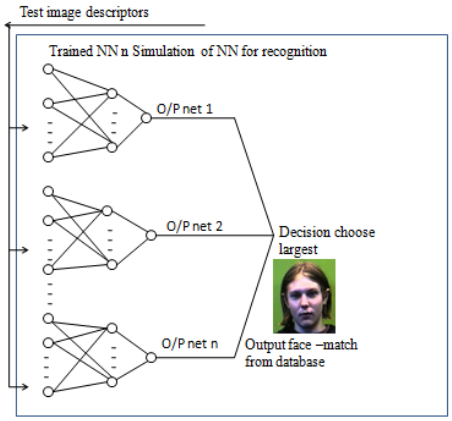
The weights W_K formed a feature vector or face descriptor,

$$\Omega^T = [W_1 W_2 \ldots\ldots W_M']$$

Ω^T describes the contribution of each eigenface in representing the input face image, treating the eigenfaces as a basis set for face images. The feature vector/ face descriptor is then used in a standard pattern recognition algorithm.

E. Training of Neural Networks [4, 5]

One ANN is used for each person in the database in which face descriptors are used as inputs to train the networks. During training of the ANN's, the person's network gives output 1 for face descriptors that belong to same person and other networks give 0 for that face descriptors.



F. Simulation of ANN for Recognition

New test image from test dataset is taken for recognition and its face descriptor is calculated from the eigenfaces (M) found before. These new descriptors are given as an input to every network; further these networks are simulated. The simulated results are compared and only that maximum output values are considered which are higher than some predefined threshold level and confirmed that this new face belongs to the recognized person with the maximum output.

V. Parameters for Performance Analysis

a) Hits

It is defined as the no of faces detected in the experiment.

b) Misses

It is defined as the no of faces which are not detected in the experiment.

c) Hit Ratio

It is defined as the number of faces detected to the total number of faces in the image.

$$\textbf{Hit Ratio} = \frac{Nooffacesdetected}{Totalnooffacesinimage}$$

d) Miss Ratio

It is defined as the number of missed faces to the total number of faces in the image

Miss Ratio = 1-Hit Ratio

e) Accuracy $= \frac{Hits}{Total} * 100$

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 5, May 2013

VI. Results and Performance Analysis

The experiment is performed on 50 non-faces, 100 face and 100 noisy images. The results show that the proposed method gives better results as compared to the existing method. The existing method gives 97 hits while the proposed method gives 98 hits. The existing method gives 3 misses and proposed method gives 2 misses. We have concentrated on single face images. The table illustrates face recognition performance. As a result of this hit ratio of proposed method is more as compared to that of existing method.

Table1: For non-face images

Eigen faces	Hits	Misses	Accuracy (%)
10	**10**	**0**	**100**
20	**18**	**2**	**90**
30	**29**	**1**	**96.67**
40	**38**	**2**	**95**
50	**48**	**2**	**96**

Table 1 is showing that different samples of eigenfaces up to 50 are taken for recognition. From the samples taken, the no. of hits are calculated which gives the number of times the recognition of faces is done. It is clearly shown in the table that the accuracy rate is highest when the no of eigenfaces taken are 30.

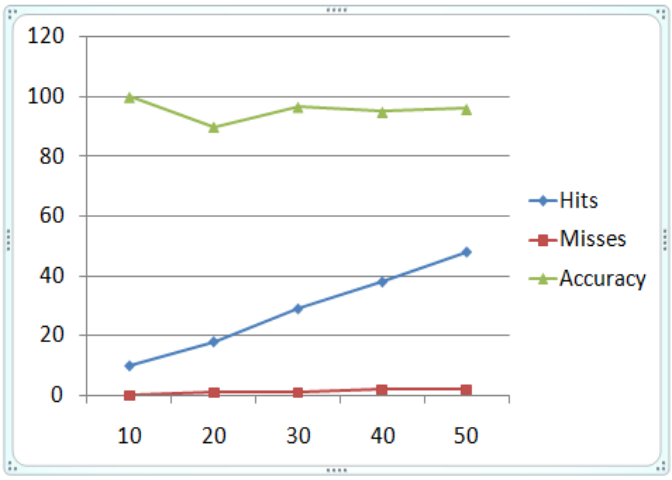


Fig 2: For non-face images

It is demonstrated in the Figure 1 that the no. of misses are almost close to 0 and no. of hits are correspondingly increasing which makes the accuracy rate close to 90.

Table 2: For face images

Eigen faces	Hits	Misses	Accuracy (%)
10	**10**	**0**	**100**
20	**19**	**1**	**95**
30	**28**	**2**	**93.33**
40	**38**	**2**	**95**
50	**49**	**1**	**98**
60	**58**	**2**	**96.66**
70	**68**	**2**	**97.14**
80	**79**	**1**	**98.75**
90	**88**	**2**	**97.77**
100	**98**	**2**	**98**

Table 2 is showing that 100 samples of eigenfaces are taken for recognition and the noise and disturbance is calculated from the samples which gives the no. of hits when the faces are matched with the input images. It is clearly shown in the table that the accuracy rate is highest when the no of eigenfaces taken are 10.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 5, May 2013

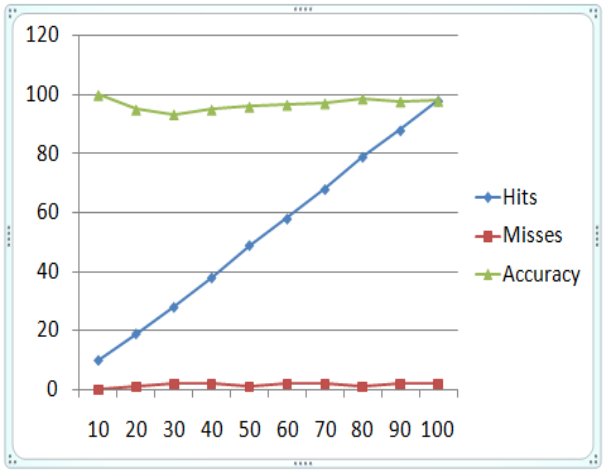


Fig 3: For face images

It is clearly shown in Figure 2, the accuracy rate is almost close to 100 due to continuous increase in no. of hits and the no. of the faces not detected i.e. misses are close to 0 .

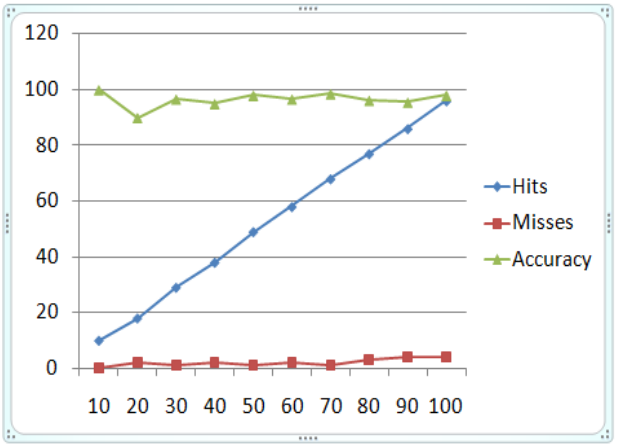


Fig 4: for blurred images

As illustrated in the figure 3 there is a small rise above 0 in the miss ratio i.e. no. of misses are between 0 to 4 and no. of hits are continuously increasing which makes the accuracy rate close to 100.

Table 3: For blurred images

Eigenfaces	Hits	Misses	Accuracy (%)
10	10	0	100
20	18	2	90
30	29	1	96.66
40	38	2	95
50	49	1	98
60	58	2	96.66
70	68	2	98.57
80	77	3	96.25
90	86	4	95.55
100	96	4	96

According to table 3, 100 samples of eigenfaces are taken for recognition and the noise is calculated from the samples. The no. of hits can be calculated from the faces recognized with the input sample which gives the number of times the recognition of faces is done. It is clearly shown in the table that the accuracy rate is highest when the no of eigenfaces taken are 10.

Table 4: Existing method vs. proposed method

	Eigen faces	Existing method	Proposed method
Non-Faces	50	97.2	98.8
Faces	100	97.018	98.71
Blurred Faces	100	72.1	98.23

Recognized Output Image:

Fig 5: Test image and equivalent output image

Figure 5 is showing the input test image and the corresponding equivalent image. It is clearly visible from the

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
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figure that equivalent image is almost similar to input image. The test image is matched with the database of images and the recognized image is generated as a result of the use of the proposed algorithm.

VII. CONCLUSION

In this paper, we have represented anew fast DCT based face recognition method based on PCA.PCA can be regarded as a very fast algorithm with a more or less high robustness and DCT is used for time reduction of recognized output images .The performances of DCT are almost comparable with those of PCA but with a higher computing time. So finally we conclude that the combination of PCA with DCT offers higher rates of recognition .This face recognition method verifies improvement in parameters in comparison to the existing method. Future work includes the use of filtering to reduce the miss ratio and improve the hit ratio of recognized face images.

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BIOGRAPHY

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