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PCA and DCT Based Approach for Face Recognition

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ABSTRACT

Recognizing the identity of the target. The research of face recognition has great theoretical value involving subject of pattern recognition, image processing, computer vision, machine learning, and physiology and so on, and it also has a high correlation with other biometrics recognition methods. In recent years, face recognition is one of the most active and challenging problems in the field of pattern recognition and artificial intelligence. Face recognition has a lot of advantages which are not involved in biometrics recognition methods such as nonaggressive, friendly, conveniently, and so on .Therefore, face recognition has a prospective application foreground, such as the criminal identification, security system, file management, entrance guard system, and so on . Research in the field of face recognition knew considerable progress during these last years. Among the most evoked techniques we find those which employ the optimization of the size of the data in order to get a representation which makes it possible to carry out the recognition. For these methods, the images of faces are seen like points in a space of very great dimensions. The face space is defined by Eigen face which are eigenvectors of the set of faces. In the DCT approach we take transform the image into the frequency domain and extract the feature from it. For feature extraction we use two approach. In the 1st approach we take the DCT of the whole image and extract the feature from it. In the 2nd approach we divide the image into sub-images and take DCT of each of them and then extract the feature vector from them.

KEYWORDS: *PCA, DCT, Face Recognition, Eigen Face, Frequency Domain, MATLAB*

I. INTRODUCTION

During the past two decades, Face recognition bound its importance as the necessity of security levels increasing. This makes the researchers to work for an efficient system of face recognition. The methods of face recognition is mainly divided into two major categories, appearance based (PCA, LDA, IDA etc.,) and feature based, in which the former one is more popularized.

The information age is quickly revolutionizing the way transactions are completed. Human's day to day actions are increasingly being handled electronically, instead of face to face or with pencil and paper. This type of electronic transactions has resulted in a greater demand for fast and accurate user identification and authentication for establishing proper communication, access codes for buildings, banks accounts and computer systems for more secure transactions, PIN's for identification and security. By stealing other's ATM or any other smart cards, an unauthorized user can guess the correct personal information. Even after warnings, many people continue to choose easily guessed PIN's and passwords e.g. birthdays, phone numbers and social security numbers, horoscopes. Present cases of identity theft have heightened the need for methods to prove that someone is truly who he/she claims to be. Face recognition technology may solve this problem since a face is undeniably connected to its owner expect in the case of identical twins. It's non-transferable. The system can then compare scans to records stored in a central or local database or even on a smart card.

II. PRINCIPAL COMPONENT ANALYSIS (PCA)

PCA was invented in 1901 by Karl Pearson. It is a linear transformation based on statistical technique. It is used to decrease the dimension of the data or to reduce the correlation between them. It is a way of identifying patterns present in data, and expressing the data in such a way that their similarities and differences are highlight. Since patterns present in data can be hard to find in data of high dimension, where it cannot be represented graphically, PCA is a powerful tool for face detection which is multi- dimensional. The purpose of PCA is to reduce the large dimension of data space to a smaller intrinsic dimension of feature vector (independent variable), which are used to describe the data cost effectively. The first principal component is the linear combination of the original dimension along which the variance is maximum. The second principal component is the linear combination of the original dimension along which the variance is maximum and which is orthogonal to the first principal component. The n-th principal component is the linear combination with highest variance, subject to being orthogonal to n-1 principal component.

The images of the faces we have are in two dimension, let us say of size NXN. Our aim here is to find the Principal components (also known as Eigen Faces) which can represent the faces present in the training set in a lower dimensional space.

For all our calculations we need the input data i.e. the faces is a linear form so we map the NXN image into a $1XN^2$ vector. Let every linear form of the image in our training set be represented by I_n. Let the total no. of faces in the training set be represented as M.

- We first compute the mean of all the faces vectors
- Next we subtract the mean from the image vector I_i.
- We compute the covariance matrix C:
- Our next step is to compute the Eigen vector of the matrix C or BB^T, let it be u_i. But BB^T has a very large size and the computation of Eigen vector for it is not practically possible.
- So now we have the M best Eigen vector of C. From that we choose N1 best Eigen vectors i.e. with largest Eigen value.
- The N1 Eigen vector that we have chosen are used as basis to represent the faces. The Eigen vectors should be normalized. The Eigen vectors are also referred to as Eigen faces because when it is transformed into a N X N matrix it appears as "ghostly faces" consisting features of all the training faces.

III. Discrete Cosine Transform (DCT)

A transform is a mathematical operation that when applied to a signal that is being processed converts it into a different domain and then can be again is converted back to the original domain by the use of inverse transform. The transforms gives us a set of coefficients from which we can restore the original samples of the signal. Some mathematical transforms have the ability to generate decor related coefficients such that most of the signal energy is concentrating in a reduced number of coefficients. The Discrete Cosine Transform (DCT) also attempts to decor relate the image data as other transforms. After decor relation each transform coefficient can be encoded independently without losing compression efficiency. It expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. The DCT coefficients reflect different frequency component that are present in it. The first coefficient refers to the signal's lowest frequency (DC component) and usually carries the majority of the relevant information from the original signal. The coefficients present at the end refer to the signal's higher frequencies and these generally represent the finer detailed. The rest of the coefficients carry different information levels of the original signal.

IV. BASIC ALGORITHM FOR FACE RECOGNITION

The basic Face Recognition Algorithm is discussed below. Both normalization and recognition are involved in it. The system receives as input an image containing a face .The normalized (and cropped) face is obtained and then it can be compared with other faces in the training set, under the same normalized condition conditions like nominal size, orientation and position. This comparison is done by comparing the features extracted using the DCT. The basic idea here is to compute the DCT of the normalized face and retain a certain subset of the DCT coefficients as a feature vector describing this face.

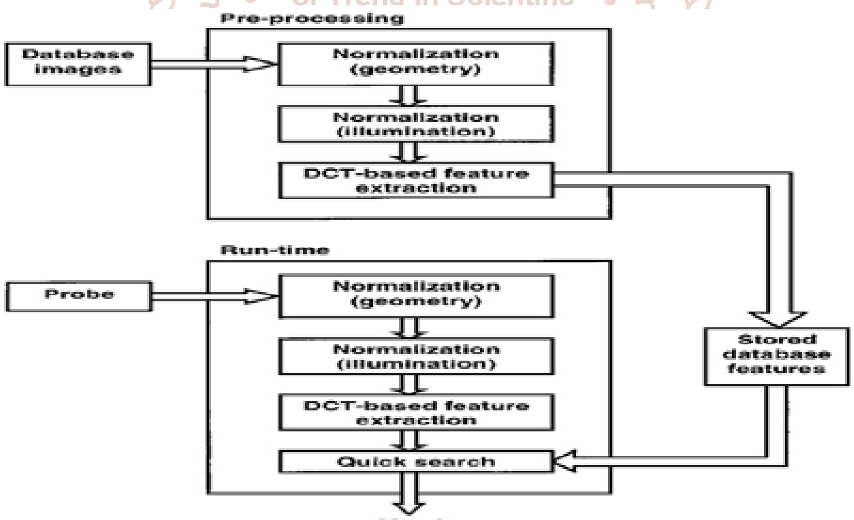


Figure 1 Basic flow chart of DCT

V. IMPEMENTATION

Matlab 2011a is used for coding. The face images are cropped and converted to grey scale images as grey scale images are easier for applying computational techniques in image processing.

Figure 2 few of the images from the database.

We have conducted five sets of experiments by considering 5, 10, 20, 40 and 60 each time. For each person we have taken a few no photos with different orientations and expressions. In each experiment we have used the algorithm discussed in the previous chapter and have found out the principal components. Then by taking certain no of principal components at a time we have formed the face space.

Fig. 3 shows the image of 10 person in different pose

Fig.4 mean of the above 40 faces

After the face space is formed we take a unknown face from the data base, normalize it by subtracting the mean from it .Then we project it on the Eigen vectors and derive its corresponding components.

Next we evaluate the Euclidian distance from the feature vector of other faces and find the face to which it has minimum distance. WE classify the unknown image to belong to that class (provided the minimum distance is less than the defined threshold).

Fig 5 Eigen faces

We have used Matlab 2011a is used for implementation. We use the same data base as the above case. The face images are cropped and changed grey level. Next we convert the image to DCT domain for feature extraction. The feature vector is dimensionally much less as compared to the original image but contains the required information for recognition. The DCT of the image has the same size as the original image. But the coefficients with large magnitude are mainly located in the upper left corner of the DCT matrix.

Low frequency coefficients are related to illumination variation and smooth regions (like forehead cheek etc.) of the face. High frequency coefficients represent noise and detailed information about the eddies in the image. The mid frequency region coefficients represent the general structure of the face in the image.

Hence we can't ignore all the low frequency components for achieving illumination invariance and also we can't truncate all the high frequency components for removing noise as they are responsible for edges and finer details.

We take DCT of the image. Here our image size is 480 x 480. Next we convert the DCT of the image into a one dimensional vector by zigzag scanning. We do a zigzag scanning so that in the vector the components are arranged according to increasing value of frequency.

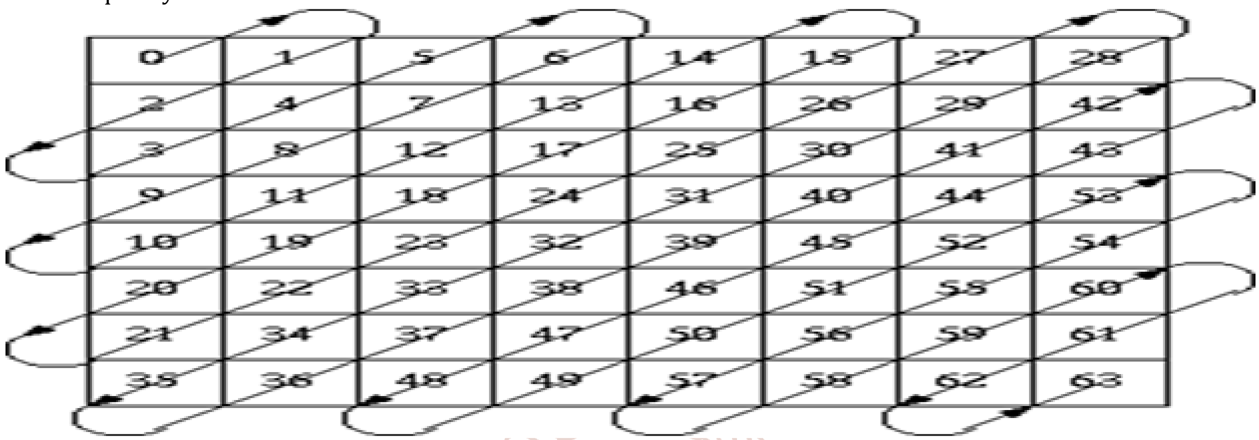


Figure 6. Show the manner in which zigzag scanning is done

VI. RESULT AND DISCUSSIONS

From the plot of the vector we observe that the low- frequency components have high magnitude high frequency component have very less magnitude (i.e. much less than 1).

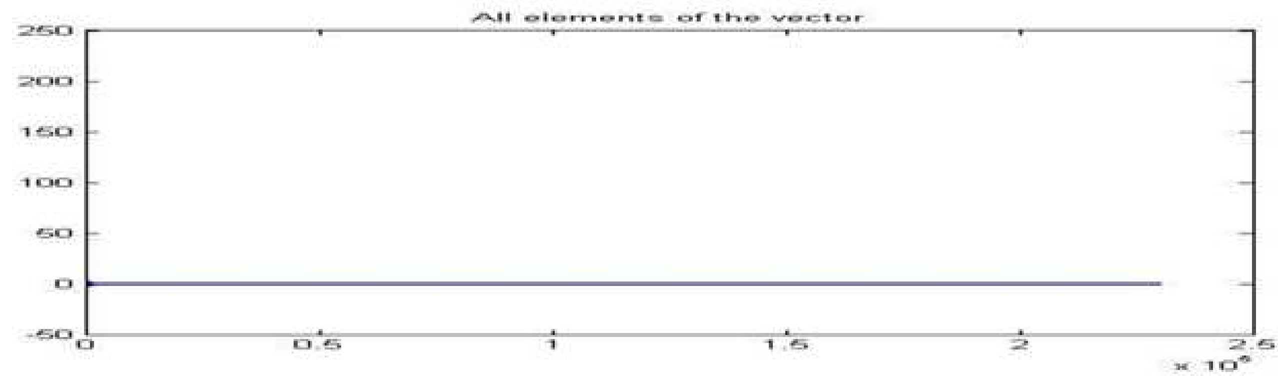


Fig: 7 showing all the elements of the vector

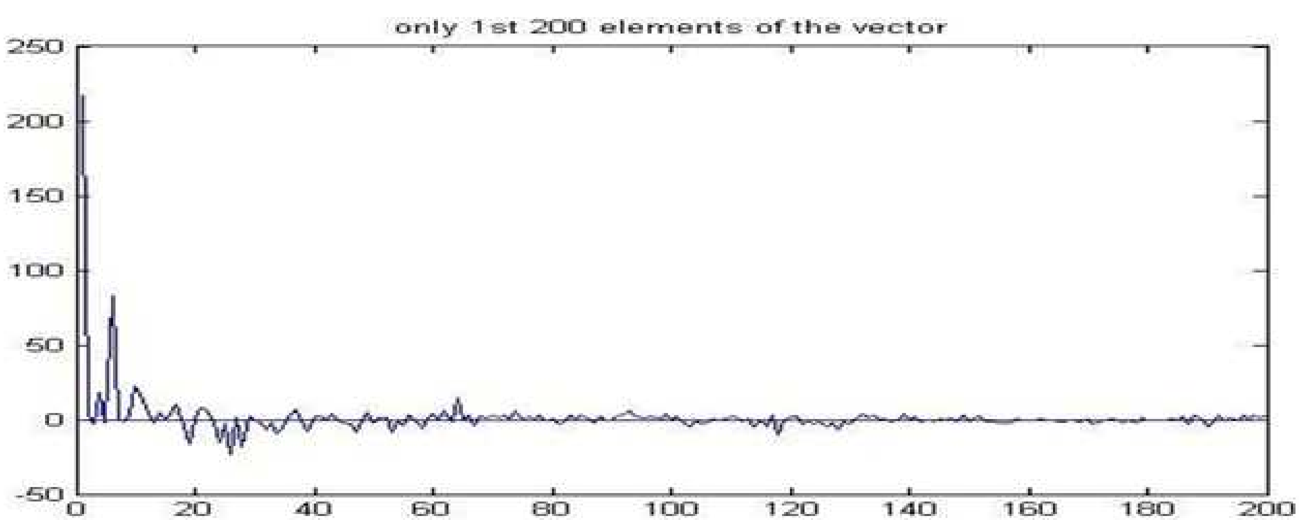


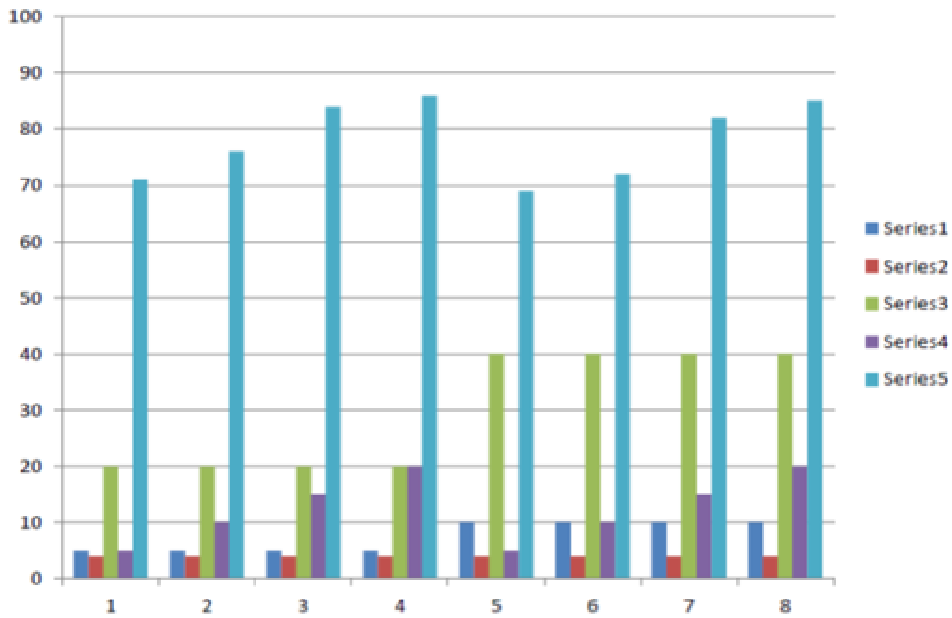
Fig 8 showing only the 1st 200 components

Threshold value of the test face image to Eigen face space which is Euclidean distance is taken as 7.6 which classifies the face as known or unknown. The values are compiled in a tabular form.

Table 1: Comparison between different experimental Results of PCA approach

No. of Person	No. of Photos Per Person	Total no. of Test faces	Total no. of Eigen face Taken	Success Rate PCA Approach
5	4	20	5	71%
5	4	20	10	76%
5	4	20	15	84%
5	4	20	20	86%
10	4	40	5	69%
10	4	40	10	72%
10	4	40	15	82%
10	4	40	20	85%

Series 1: No. of Person
Series 2 No. of Photos per Person
Series 3: Total no. of Test faces
Series 4: Total no. of Eigen face Taken
Series 5: Success Rate



VII. CONCLUSION

In this thesis we implemented the face recognition system using Principal Component Analysis and DCT based approach. The system successfully recognized the human faces and worked better in different conditions of face orientation up to a tolerable limit. But in PCA, it suffers from Background (deemphasize the outside of the face, e.g., by multiplying the input image by a 2D Gaussian window centered on the face), Lighting conditions (performance degrades with light changes), Scale (performance decreases quickly with changes to the head size), Orientation (performance decreases but not as fast as with scale changes).

In block DCT based approach our results are quite satisfactory. But it suffers from its problem that all images should align themselves in the center position minimizing the skewness of the image to lower level.

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