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Face Recognition Based on PCA and DCT Combination Technique

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***Abstract*—Face recognition is one of the most successful applications of image analysis and understanding and has gained much attention in recent years. Face Recognition is a computer based application which detects the faces of different persons for authentication and various other purposes. It has separate applications from the fingerprint and iris recognitions. There are various successful techniques are purposed so far as Holistically methods and Discrete Cosine Transform (DCT). In this paper, we purpose a simple and fast face recognition system on the basis of feature extraction using Principal Component Analysis (PCA) is a classical and successful method of dimension reduction and the discrete cosine transform paper (DCT) is a well know compression technique. This paper proposes for improving the recognition rate of the face recognition system. The main advantage of this technique is increase the efficiency and implementation easier, high speed and better recognition rate .**

Keywords -(PCA , DCT , Face Recognition , FACES 94 databases ,AT&T databases ,recognition rate).

I.INTRODUCTION

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, 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 [1].

II.FACE RECOGNITION

A face recognition (FR) system is simply an attempt to emulate the typical human face recognition task that a human performs routinely, effortlessly, and frequently along his life. Thus face recognition defined as the ability of a computer to receiving and interpreting of face image input. Such face recognition system is supposed to identify faces presented in images and videos automatically. It can operate in either a single or dual mode. Like other biometric systems. A typical face recognition system usually consists of four steps, as shown in Figure (1) [2]: face detection, face preprocessing, feature extraction and feature matching.

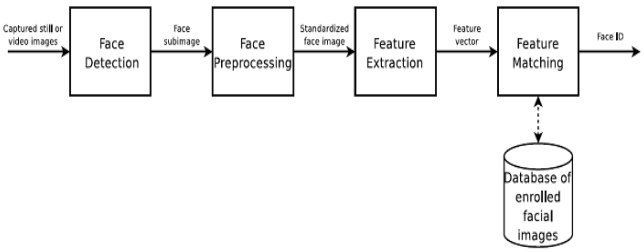


Figure (1) The four general steps in face recognition .

Face recognition techniques can be divided into two groups based on the face representation they use:

A.Appearance based, which uses holistic texture feature and is applied to either whole-face or specific regions in a face image .

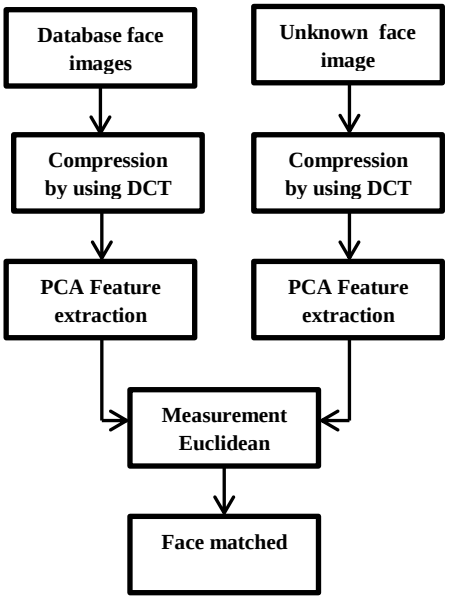
B.Feature based, which uses geometric facial feature (mouth, eyes, brows, cheeks etc.) and geometric relationships between them[3].

In this paper we have done the face recognition using statistical and frequency domain approach. We have applied hybrid method combining principle components analysis (PCA) and the discrete cosine transform(DCT) as show in figure(2). Main objective of proposed work are as follows:

A.To design a model for an ideal facial recognition system .

B.To enhance the model for a high speed facial recognition system.

C.To decrease a face recognition training time and increase recognition rate by combining DCT and PCA.



Figure(2) flow chart of face recognition system based on PCA&DCT

III.DATABASE OF FACE IMAGES

The database are used FACES94 database and AT&T (the ORL database).In FACE94 there are 153 number of individuals,180 by200 pixel 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[10,12]. The AT&T database is made up of 10 different images of 40 distinct subject. the image were taken at different times, varying lighting, facial expression(open/close eyes, smiling/not smiling), and facial details (glasses/no glasses) [11]as shown in figure(3).

TABLE I.Datebase images.

Database Name	Sample No	Total images
AT&T	40	400
FACES94	153	3040

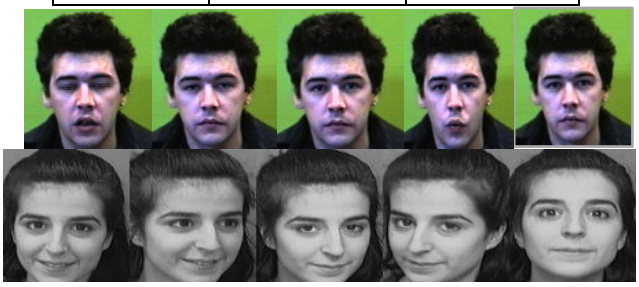


Figure (3) database image FACE94,AT&T.

IV. DISCRETE COSINE TRANSFORM (DCT)

Compression is an important process by which the description of computerized information is modified so that the capacity required to store or the bit rate required to transmit it is reduced. The DCT is a transform which transforms a signal or image from the spatial domain to the frequency domain. Lower frequencies are more obvious in an image than higher frequencies an image is transferred into its frequency components and higher frequency coefficients are discarded, the amount of data needed to describe the image without sacrificing too much image quality will reduce[6]. For mostimages, much of the signal energy lies at low frequencies[7]. These appear in the upper left corner of the DCT as shown in figure(4). The 2D-DCT was applied to the face image to obtain the DCT coefficients. A block size of 32×32 and 64×64. We are chosen 64×64 block to transformed using PCA. Where the 64×64 perform better than the 32×32 block. The result are illustrated in table 5. The reconstructed face images from these block sizes are shown in figure(4) (c) and (d).

The general equation for 2D DCT is defined as follows:

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

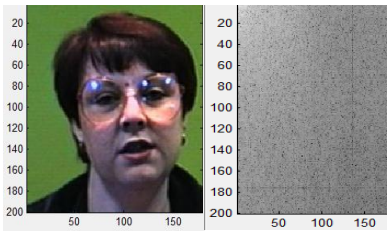
$$cos[\frac{\pi(2x+1)u}{2N}](1)$$

For k ,u=0,1,2…….N-1.

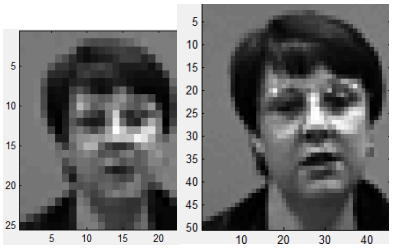
The inverse transform is defined as:

$$f(x,y) =$$

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



(a) (b)



(c) (d)

Figure(4)(a) Sample Face image. (b) DCT of face image (c) reconstructed face image from 32× 32 block(d) reconstructed face image from 64× 64 block.

V. PRINCIPAL COMPONENT ANALYSIS ALGORITHM (PCA)

Principal component analysis is standard technique used in statistical pattern recognitionand signal processing for data reduction and featureextraction. As the pattern often contains redundantinformation, we map it to a feature space of lower dimensionality.PCA algorithm flow chart as shown in figure(6)

A face image of size N×N pixels can be considered as a one dimensional vector of dimensioned N^2. The main idea of the principal component is to find the vectors that best account for the distribution of face images within the entire image space. Because these vectors are the eigenvectors of the covariance matrix corresponding to the original face images, and because they are face like in appearance, we refer to them as 'eigenfaces' as figure(5)[4].

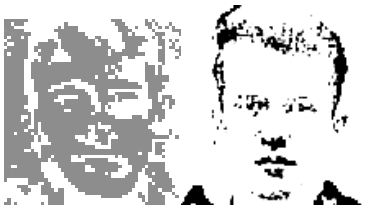
1-Let the training set of face images be, г1 г2…… гM.

2-computing the mean of face images average.

$$\Psi=\frac{1}{M}\sum_{n=1}^{M} \text{г}n \quad (3)$$

3-subtracting the mean from each face image.

$$\phi i= \text{г}i-\Psi \quad (4)$$



(a)averageface. (b) eigenface

Figure (5)(a)average face ,(b).eigenface.

4-Calculation of the covariance matrix.

$$C=\frac{1}{M}\sum_{n=1}^{M} \phi n\phi nT=AAT \quad (5)$$

5-Obtaining the eigenvectors and eigenvalue of covariance matrix $A=[v1, v2, v3,\ldots..,vd]$, $\Lambda=\begin{bmatrix} \lambda 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \lambda d \end{bmatrix}$ (6)

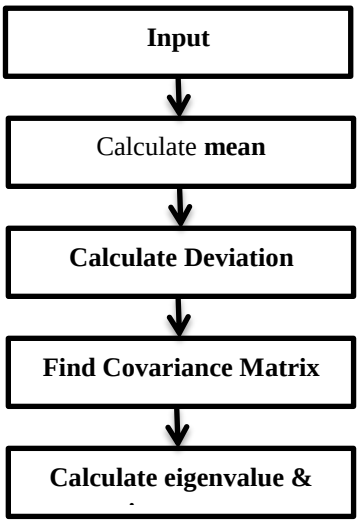


Figure (6).PCA algorithm flow chart[5].

VI. EXPERIMENTAL WORK

The experiment work of proposed system consist the several steps ,all face image are preprocessed by MATLAB to convert it into grayscale image and size 180 by200. DCT compression technique is then applied to all face images and extract features using PCA was applied all images for dimension reduction. The system matches the input test image with all the training images and measures the minimum distance between them using the Euclidean Table 3.training time.

distance[8]. If the feature vector of the input test image is v and that of the database is f, then the Euclidean distance is given by :

$$D=\sqrt{\sum_{t=1}^{n}(ft-vt)2} \quad (7)$$

where n is number of used feature. A match is found by minimizing D .

VII. RESULT ANALYSIS

The experimental result have been developed by taking all the test image which includes the frontal faces as well as the rotated face image. All the test image are gone through the PCA and PCA&DCT. In this experiment we tested the recognition rate for PCA and PCA&DCT .We used two type of database FACES94 and AT&T databases. The recognition result as shown in figure(7).

Figure (7). the recognition result of FACE94 and AT&T.

The recognition rate is calculated by the formula :

$$\text{Recognition rate} = \frac{\text{No of image recognition correctly}}{\text{Total no of test imeges}} \times 100 \quad (8)$$

Recognition rate and training time of the PCA&DCT are better than PCA and PCA&LDA as shown in tables below.

TABLE II. Eigen face time and recognition time.

Database type	Methods type	Eigen face time (sec)	Recognition time (sec)
AT&T	PCA	12.725	0.86657
AT&T	PCA+DCT	9.8032	0.7030
FACES94	PCA	8.07715	0.6679
FACES94	PCA+DCT	6.5924	0.6321

TABLE III.training time.

Training time PCA+DCT(sec)	Training time PCA(sec)	No selected images	Database type
7.223	13.366	130	AT&T
11.056	13.551	160	FACES94

TABLE IV. recognition rate of PCA & DCT block size 64×64.

Database name	Recognition rate(PCA)	Recognition rate (PCA&DCT)
AT&T	94.97	98.7
FACES94	96.5	99.9

TABLE V. recognition rate of PCA & DCT block size 32×32.

Database type	The recognition rate(%)
AT&T	96.5
FACES94	98.25

TABLE VI. recognition rete of different methods by using AT&T.

Recognition method	The average recognition rate (%)
PCA	94.97
LDA [9]	93.82
PCA+LDA [9]	94.06
PCA+DCT	98.82

VIII. CONCLUSION

This paper has present face recognition technique that uses DCT for compression and PCA as dimensionality reduction and recognition. The system was evaluated in MATLAB 2014 and using data base FACES94 and AT&T with different facial expressions and different illumination and lightening condition. The system is less computational requirement this make system well suited for low cost hardware implementation, the system achieved better recognition rate and training time.

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