Diagonally Assisted DCT Technique for Face Recognition: DA-DCT

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ABSTRACT
Face is a multidimensional intricate structure that demands good computing technique for recalling it. This paper proposes a new diagonally assisted face recognition technique using Discrete Cosine Transform (DCT). Proposed work divides an image into matrix to apply DCT. Working scheme i.e. DA-DCT selects diagonal coefficient to retain low, moderate and high frequency coefficients for each block. Proficiency of the proposed work has been checked for self-created database using MATLAB. Experimental results prove that DA-DCT performs much better than PCA.

Keywords
Discrete Cosine Transform, Face recognition

1. INTRODUCTION
Face recognition is an inherent part of biometric technology whereas the applications of biometrics are generally associated with the security. A biometric system usually deals with any person's verification or identification by their unique physical characteristics. Increase of uncertainty and negative happenings around the globe gives the terrific hike to the face recognition research [1]. Various application areas of the face recognition are entertainment, smart cards, information security, law enforcement and surveillance etc. A human brain can keep retention of more than thousands number of faces in a complete lifecycle and can easily recall a familiar face in different perspective variations such as illumination, age and pose variations [2]. In face recognition technology facial traits of individual is matched with the existing database to get the results. Many researchers have been proposed lots of work in this field and their various proposed methods can be classified in two global categories i.e. holistic based and featured based [3]. In holistic approach, faces are recognized using global features from faces i.e. entire raw face image has been considered as input whereas in featured based method, recognition held on the basis of extracting local facial features [4]. In featured based method, first local features i.e. eyes, nose and mouth etc. has been extracted then classifier takes retrieved statistics as input. The proposed method is based on holistic approach i.e. entire images have been taken as input. This paper proposes a new diagonally assisted face recognition technique using Discrete Cosine Transform (DCT). Proposed work divides an image into appropriate matrix to apply DCT. Working scheme selects diagonal coefficient to retain low, moderate and high frequency coefficients for each block. Proficiency of the proposed work has been checked for self-created database using MATLAB. The organization of the paper is as follows. In section2, work related to face recognition is described; proposed scheme is explained in section 3. Experimental results are presented and discussed in section 4, followed by conclusion in section 5.

2. LITERATURE SURVEY
In face recognition technology mathematical transforms such as Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT) has been used to generate facial feature image. DCT method has been used to balance illumination variations. In [5], authors implements Principal Component Analysis (PCA) with Singular value decomposition (SVD) for Feature Extraction to determine emotions. Block based DCT is used to extract local features and to mitigate the effects of expression, illumination and occlusion in paper [6]. Numerous approaches have been proposed in the literature as a holistic method such as Eigenface [7] which is basically used to reduce high dimensional data, linear (Fisher) discriminant analysis (LDA)-based [8] methods, neural network-based methods [9–11], etc. among all of the above said approaches LDA based methods seems more effective but still this method is suffers from two major problems. The first is that LDA cannot deals with nonlinear problems and second is small sample size [12]. To overcome from above said problems some methods have been proposed such as kernel Fisher discriminant (KFD) [13,14], direct LDA [15,16] and PCA + LDA [17], etc. now the another problem has been originated from above solutions that is these methods are designed in the sub-feature space, instead of full feature space which may results loss of some important information. After that in [18] authors have been proposed three parameters RDA method to solve such type of problems but here system has to pay high computational cost.

3. PROPOSED SCHEME
3.1 Overview
The proposed scheme implemented DCT assisted statistical analysis on self created database for the purpose of recognizing face from the database. subject matter of statistic is basically depend upon the idea that there is a big set of data and its essential to analyze it to understand the relationships between the individual element in that data set. Fig.1 shows the block diagram of DA-DCT which represents the complete idea behind the working model.

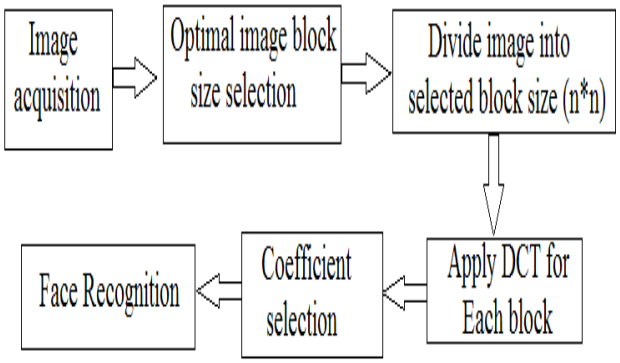

Fig1: Block Diagram of DA-DCT

3.2 Selection of Appropriate Image Block Size

Selection of Image block size for applying Discrete Cosine Transform (DCT) is very important; to obtain best possible results. Here the proposed scheme first performed an analysis for 8-block, 16-block and 32-block for different perspective variations of faces and the result shows that 8-size block is the most suitable one as depicted in Fig.2.

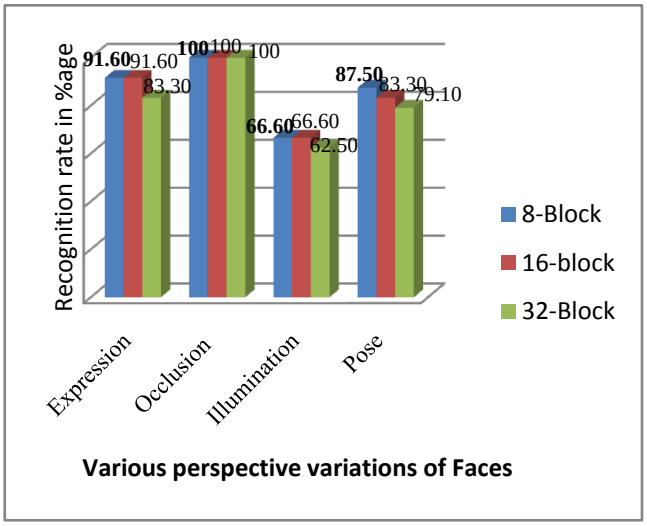

Fig.2 Comparative analysis of different block sizes for various perspective variations of faces

3.3 Discrete Cosine Transform (DCT)

DCT is precise and robust face recognition system and using certain normalization techniques, its robustness to variations in illumination and facial geometry can be improved [C1], [C2]. The working scheme followed a procedure which is divided into two main parts: in first part image is divided into 8*8 blocks and in second part DCT is applied to each block and face recognition has been done on the basis of statistical analysis of DCT coefficients. Let an image is acquired. Image will be of size m x n. This m x n image is divided into 8*8 blocks. After dividing the image into 8*8 blocks DCT is applied to each block of an image separately and then the image is represented as the matrix of DCT coefficients. Below shown equation 1, 2 and 3 are representing DCT encoding.

DCT Definitions:-

$$D_{xy} = \delta_x \delta_y \sum_{m=0}^{M-1} \sum_{n=0}^{N-I} A_{mn} \cos\frac{\pi(2m+1)x}{2M} \cos\frac{\pi(2n+1)y}{2N},$$

$$0 \le x \le M-1$$

$$0 \le y \le N-1$$

Where $$\delta_x = \begin{cases} \frac{1}{\sqrt{M}}, x = 0 \\ \sqrt{\frac{2}{M}}, 1 \le x \le M-1 \end{cases}$$

$$\delta_y = \begin{cases} \frac{1}{\sqrt{N}}, y = 0 \\ \sqrt{\frac{2}{N}}, 1 \le y \le N-1 \end{cases}$$

In above equations m, n are spatial coordinates in the image block and x, y are coordinates in DCT coefficients block and δ_x , δ_y are the base functions of DCT. After applying DCT an image will be represented as DCT coefficients. Then Select the diagonal DCT coefficient from each block. Now find mean and standard deviation of diagonal coefficients of each image. Minimum the standard deviation will represent the recognized image

3.4 Coefficient selection-

The selection of DCT coefficient is somewhat different here. It is known that each DCT block contain information of all the three bands i.e. low frequency band, high frequency band, middle frequency band. Low frequency coefficients tells about the illumination variation and smooth region, middle frequency coefficients gives information of the basic structure of the face and high frequency coefficients represent detailed information of edge and noise. All the information of these bands is important and cannot ignore any band-information completely, so to extract important features by preserving the different band information DA-DCT chooses only diagonal coefficients from each block.

After obtaining the suitable block size i.e. 8*8, in the proposed work face image is divided into 8*8 blocks. Then each block is represented by its DCT coefficients. DCT coefficients of both training and test images are used as a data set. Recognition will be based on the statistical analysis of these selected coefficients. In DA-DCT diagonal coefficients of all the blocks of all the training and test images are chosen and then mean, standard deviation is calculated for all train and test images. On the basis of mean and standard deviation, correctly matched face image will be identified i.e. Image having the minimum standard deviation will be the recognized face.

4. DATABASES

To prove the robustness of the scheme the experimentation has been done on self-structured dataset. Train and test dataset contain face images of different perspectives i.e. Illumination, Occlusion, Expression and Pose. Train dataset contain 5 images per person so total of 12x5=60 images are considered as Fig.3 shows the sample images of train data set.

Fig 3: Sample Images Train Database

For the purpose of testing 4 different test datasets has been considered, first dataset contain images of individual in different Expressions as shown in Fig.4, second contain face images in different Illumination conditions (e.g. left light and bottom light) as shown in Fig.5.

Fig 4: Sample Images of Expression Varied Test Database

Fig 5: Sample Images of Illumination Varied Test Database

Third dataset contain face images in different Occlusions conditions as shown in Fig.6 and last dataset contain face images in different Poses (e.g. left and right) as shown in Fig.7.

Fig 6: Sample Images of Occlusion Varied Test Database

Fig 7: Sample Images of Pose Varied Test Database

As the result will be evaluated for four different cases so in case of Expression and Occlusion, 12 face images of 12 different individual is considered. Similarly for Illumination and Pose, 2 face images of each person i.e. total of 24 images in both the datasets has been considered.

5. EXPERIMENTAL RESULTS

To validate the results; the proposed technique has been implemented in MATLAB 2012. For the purpose of graphical representation we assume value 1 in graph for recognized images and value 0 for un-recognized image.

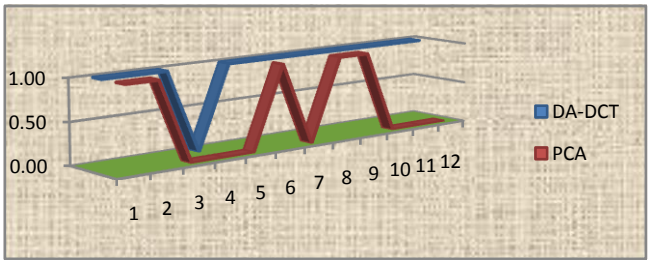

Fig 8: Comparative analysis of PCA and DA-DCT for Expression

When database containing face images of different Expression, checked with PCA then only 5 images are recognized correctly, out of 12 images whereas DA-DCT has been recognizes 11 images correctly, out of 12 images. As Fig.8 depicts the performance of PCA and DA-DCT for Expressions and makes very clear that DA-DCT performs better than PCA.

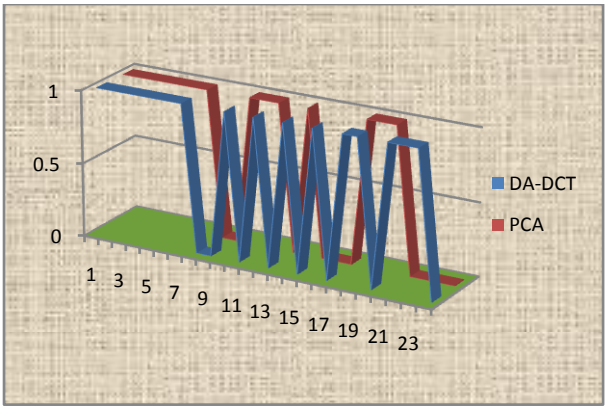

Fig 9: Comparative analysis of PCA and Proposed Scheme for Illumination.

When database containing face images of different Illumination, checked with PCA then only 14 images are recognized correctly, out of 24 images whereas DA-DCT has been recognizes 16 images correctly, out of 24 images. As Fig.9 depicts the performance of PCA and DA-DCT for Illumination and makes very clear that DA-DCT performs better than PCA.

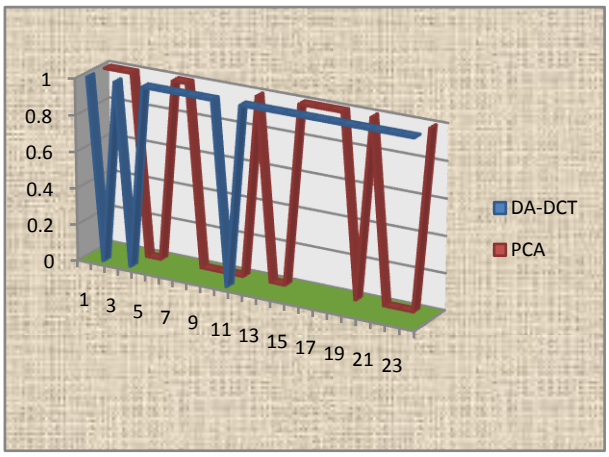

Fig 10: Comparative analysis of PCA and Proposed Scheme for Pose.

When database containing face images of different Poses, checked with PCA then only 12 images are recognized correctly, out of 24 images whereas DA-DCT has been recognizes 21 images correctly, out of 24 images. As Fig.10 depicts the performance of PCA and DA-DCT for Pose and makes very clear that DA-DCT performs better than PCA.

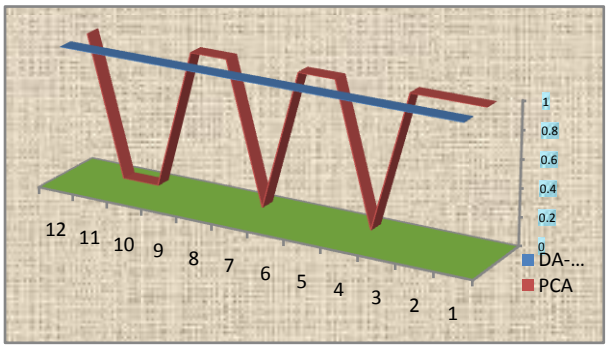

Fig 11: Comparative analysis of PCA and Proposed Scheme for Occlusion.

When database containing face images of different Occlusions, checked with PCA then only 12 images are recognized correctly, out of 24 images whereas DA-DCT has been recognizes 21 images correctly, out of 24 images. As Fig.11 depicts the performance of PCA and DA-DCT for Occlusion and makes very clear that DA-DCT performs better than PCA.

Table 1 summarizes the face recognition rate of the proposed technique with the PCA in different conditions. Experimental analysis shows that proposed scheme perform better than PCA.

Table 1: Performance of PCA and Proposed Technique

Scheme	Pose	Expression	Illumination	Occlusion
PCA	50.00%	41.66%	58.33%	66.66%
DA-DCT	87.5%	91.66%	66.66%	100.00%

Fig.12 depicts the performance of PCA and DA-DCT and shows that proposed scheme gives overall better performance than PCA and proves itself much effective in Occlusion conditions i.e. it successfully recognizes all occluded images and gives 100 % recognition rate.

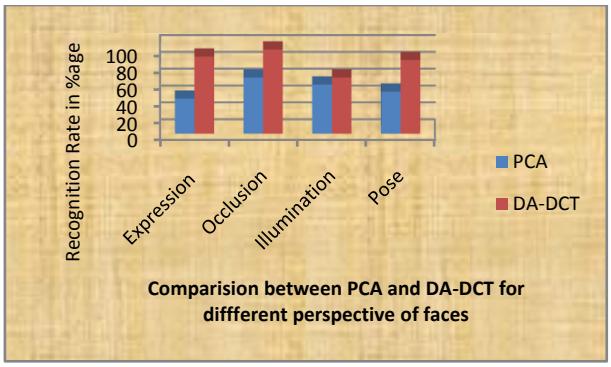

Fig.12: Comparative Analysis of PCA and DA-DCT

6. CONCLUSION

Face recognition is an unsettled problem under the conditions of pose, illumination etc. so a technique based on statistical analysis of DCT coefficients has been proposed and a set of experiments has been performed on self-structured database, to demonstrate the efficiency of the proposed scheme. The performance of the proposed scheme i.e. DA-DCT is compared with the PCA. For Expression varied dataset PCA performed unexpectedly worst with 0.58 error rate and DA-DCT gives much better results i.e. only 0.08 error rate. PCA performs well in Occlusion conditions i.e. with 0.33 error rate whereas DA-DCT performs best i.e. 0% error rate. For other two conditions i.e. illumination and Pose, DA-DCT proves itself better in performance than PCA. Looking forward with future work, further improvements can be made in this technology in terms of training examples, execution speed, and dynamism in database and colour variances.

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