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DCT-BASED REDUCED FACE FOR FACE RECOGNITION

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ABSTRACT: In this paper, face recognition technique using Discrete Cosine Transform (DCT) is proposed. The local information of the face is extracted using block-based (DCT). The coefficients selected in each DCT block are fused to generate the feature image. This feature image is used for classification process. The face, recognition is then performed using Mahalanobis distance. The advantage of this technique is the reduction in the dimension of the face space retaining low, mid and high frequency coefficients. The technique is validated using standard ORL and YALE face datasets. The experimental results outperform traditional methods like PCA, LDA and DCT normalization.

Keywords: Block-Based Discrete Cosine Transform, Diagonal Selection, Mahalanobis Distance.

1. INTRODUCTION

Face appearance is a compelling biometric since it is used to recognize individuals. Facial scan is more acceptable than other biometrics, such as fingerprints. In Face recognition we recognize an individual by matching the input face image with face images of all users in the training dataset and finds the best match. It is used as an attempt to identify a person or verify a person's claimed identity [4]. It is an unsolved problem under the conditions of pose and illumination variations [14]. The reasons for the research are: the increased need for identification for authentication, Law enforcement and surveillance, smart cards, access control, for perceptual user interfaces, and the lack of robust features and classification schemes for the face recognition.

Popular recognition algorithms are Eigenface [10], Fisherface [13], Hidden Markov Model [12], Component-based and Morphable Models Method [2, 9]. Normalization techniques like DCT-normalization, Wavelet-Denoising, etc. perform normalization on face recognition algorithms providing solution to illumination and pose problem [16].

Discrete cosine transform (DCT) is used for feature extraction step in various studies of face recognition [1, 3, 5, 8, 11, and 20]. DCT features have been used in a holistic appearance-based or local appearance-based sense which ignores spatial information during the classification. In order to reduce the effect of illumination variation and pose variation many works has been done [18]. Chen, W, Meng Joo Er and Shiqian Wu States that the DC or the first three low frequency coefficients have been truncated in order to decrease the effects of the illumination variation [5]. Polynomial coefficients are derived from the 2D-DCT coefficients from the spatially neighboring blocks [1]. Removal of DC element enables the reconstructed facial image to be robust to lighting changes and removal of high-frequency DCT coefficients to be robust against scaling variations [8]. A discriminated band (a group of coefficients) has been found in the transformed space [17]. Their approach searches the discriminator coefficients in the transformed space group by group. The DCT based normalization technique (DCT) was proposed by Chen et al. [5]. Chichizola, F. [6] improved the recognition rate by transforming face images into smaller ones in order to allow working directly with the covariance matrix instead of using an approximation of it.

The purpose of this work is to show that local appearance based face recognition is more robust against variations on facial appearance than the traditional holistic approaches (PCA, LDA, and ICA). In this paper we utilize local information by using block-based discrete-cosine transform (DCT). To eliminate the effects of expression, illumination, poses and occlusion variations we performed local analysis and then by fused the outputs of local features extracted.

The organization of the paper is as follows. In Section 2, the different methodologies used in the paper are described. The fusion of different band selection and proposed technique is explained in Section 3. Experimental results are presented and discussed in Section 4 followed by conclusion in Section 5.

2. METHODOLOGY

The various methodology used in the present face recognition system are discussed below.

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2.1. Block Appearance DCT-Based Face Representation

DCT is a powerful transform used in image processing; applications like image coding and face recognition etc. DCT is very close to the KLT and has a strong ability for data decorrelation. In [1l] authors prove that DCT is an orthogonal transformation. DCT expresses data as the sum of cosine function for reduced size of data. Consider gray scale matrix of image as f(x, y) of size NxN, its DCT, F(u, v) of size N × N, is shown in Fig. 1:

Figure 1: Face and its DCT (Low, Mid and High) and Formation of Block Appearance DCT

DCT coefficients contain three bands, namely low frequency, middle frequency and high frequency. Fig. 1 visualizes face and its bands along with the formation of block appearance Face with DCT. The information in different bands can be used to extract meaningful information.

Local appearance based face representation is a generic local approach and does not require detection of any salient local regions, such as eyes, nose, mouth, or any distinguishing features of an individual face as in the modular or component based approaches for face representation. In the proposed technique we used Block appearance based face representation. It can be obtained as follows: A face image is divided into 8 × 8 blocks. Each block is then represented by its DCT coefficients. The reason for choosing a block size of 8 × 8 pixels is to have small-enough blocks to collect information in the individual blocks so that we acquire information from important regions of face.

3. PROPOSED TECHNIQUE

In the proposed work a feature image is generated from a set of images. For this face image is divided into 8*8 blocks. Each block is then represented by its DCT coefficients. An individual Block of Block Appearance DCT-Based Face representation contains three bands information, namely low frequency, middle frequency and high frequency. Low frequency coefficients are related to illumination variation and smooth regions. High frequency coefficients represent noise and detailed information of edge. The middle frequency coefficients represent the basic structure of image. It shows that each band contains important information. Without losing any band information we want to generate the feature coefficients. So we could not ignore all the low frequency components to compensate for illumination variations if the image is not so much affected by lighting conditions. Similarly we could not ignore all the high frequency coefficients to remove noise as they contain details and edge information of the block image.

To extract important features by retaining different band information, we considered only diagonal coefficients from individual DCT blocks. Diagonal selection from Block based DCT coefficients not only retains different band information but also reduces the space complexity. Feature image is then generated by fusing the selected diagonal coefficients. It is observed that if the size of face image is 112* 92 then the generated feature image has size of 112*12. Fig. 2 shows the overall proposed technique.

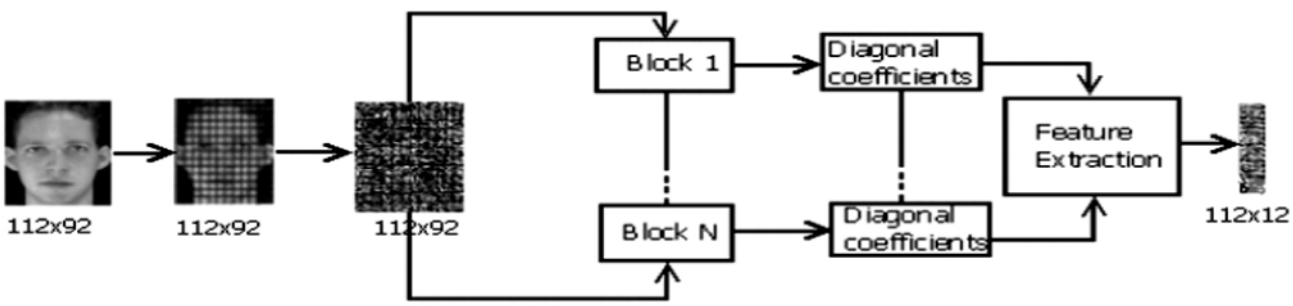

Figure 2: Proposed Technique

To recognize the unknown face, feature image is generated for the test face using proposed technique. Distance calculation between the generated feature images of training set and the feature image of the test image is calculated using Mahalanobis distance [15]. The minimum distance will give recognized face.

4. EXPERIMENTAL RESULTS

To validate the results we implement the proposed technique in MATLAB 2010. The experimentation is carried out on standard ORL and YALE face dataset. To prove the robustness of the technique, we considered only two poses of each individual (out of 10 poses of each individual in the training dataset) i.e., 80 images of 40 individuals [7] and 30 images of 15 individuals in case of YALE dataset [19] are considered. Test dataset contains poses that are different than the training dataset.

4.1. Experimental Result Analysis Based on ORL Face Dataset and YALE Face Datasets

We implement our technique by using DCT Transform as shown in Fig. 2. The set of feature images are generated using training dataset. The different test images are given as input to check the recognition rate of the proposed technique. Recognition is done on the generated feature images by Mahalanobis distance. Fig. 3 shows test image and its correctly recognized image. Table1 summarizes the face recognition rate of proposed technique with the other standard techniques using ORL datasets and YALE face datasets.

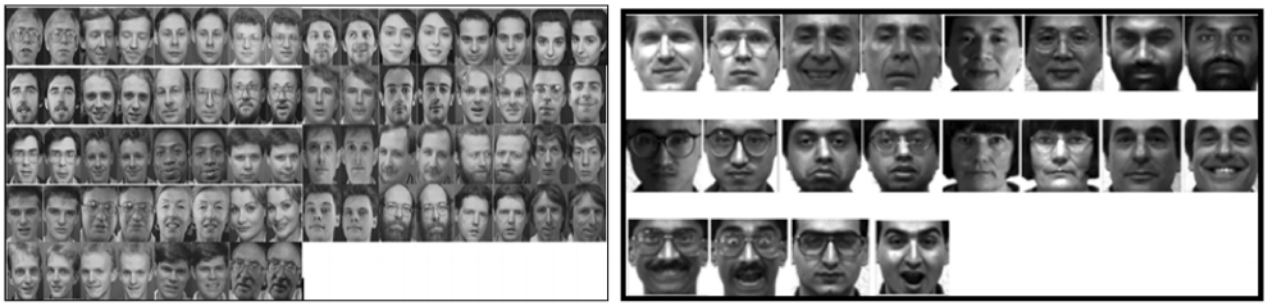

Figure 3: Test image & correctly recognized image

Table 1
Face Recognition Rate Using ORL Dataset and YALE Face Dataset

Technique	Training Images (ORL)/(YALE)	Test Images (ORL)/(YALE)	Correctly Recognized Correctly Recognized
Eigenface technique (PCA), DCT Normalization and Wavelet-Denoising	80/30	40/15	33/7
Proposed technique (Mahalanobis distance)	80/30	40/15	35/10

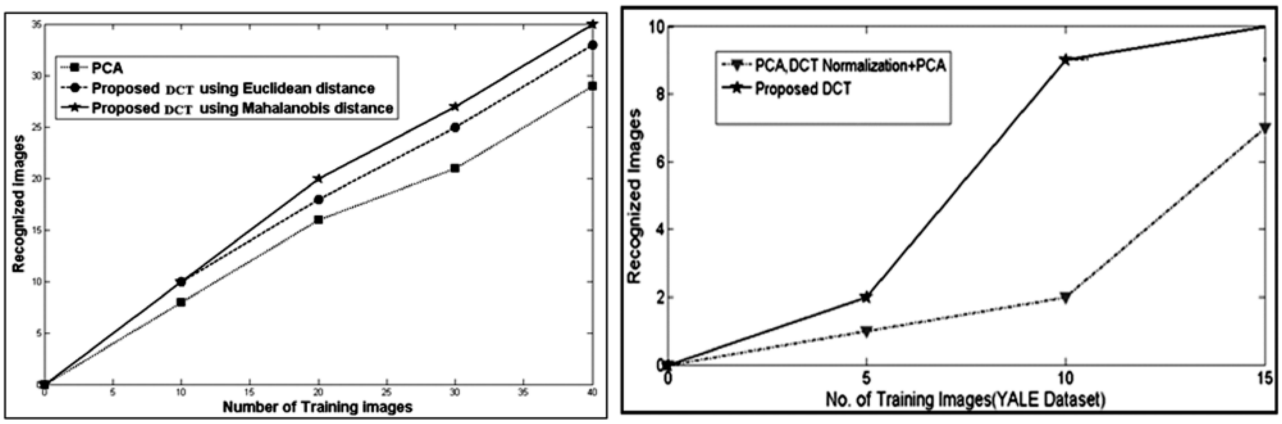

Figure 4: Plot of No. of Training Images Tested Vs. Recognition Rate

Fig. 4 shows the comparison of different face recognition technique in terms of plots of correctly recognized faces.

5. CONCLUSION

In this paper we have presented an approach for dimension reduction by generating DCT-based feature images. This technique is motivated by the desire to combine the advantage of dimension reduction and the advantage of maximizing class separation by feature image generation. The experimental results show that the proposed method is very promising in terms of face recognition rate as compared to other methods such as PCA, DCT-normalization and Wavelet-Denoising. One of the major advantages of DCT-based face recognition using Mahalanobis distance is that, recognition is performed directly without using PCA. Furthermore, no knowledge of geometry or specific feature of the image is required and only a small amount of work is needed for preprocessing. Changes in the emotions and poses did not cause a major problem to the proposed technique.

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