IOSR Journal of Engineering (IOSRJEN)
ISSN: 2250-3021 Volume 2, Issue 7(July 2012), PP 119-122
www.iosrjen.org

Face Recognition based on Diagonal DCT Coefficients and Image Processing Techniques

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ABSTRACT : - *The presented paper presents the statistical analysis of the diagonal dct coefficients of facial images in order to identify the face from the data base. The dct coefficients matrix contains the frequency variations of facial images in three parts; the lower half of the matrix that contains the low frequency elements that make up the flashy part of the face, the upper half that contain the high frequency elements in form of noise and diagonal elements that contain the maximum information about the features of the facial image. The diagonal elements or dct coefficients are then analyzed statistically in terms of mean deviation, standard deviation and covariance to identify the given face. The statistical analysis of dct coefficients gives the freedom of face variations among the same face images. The dct coefficients do not vary much if the same person's face is photographed at different conditions.*

I. INTRODUCTION

The face is our primary focus of attention in social intercourse, playing a major role in conveying identity and emotion. Although the ability to infer intelligence or character from facial appearance is suspect, the human ability to recognize faces is remarkable. We can recognize thousands of faces learned throughout our lifetime and identify familiar faces at a glance even after years of separation. This skill is quite robust, despite large changes in the visual stimulus due to viewing conditions, expression, aging, and distractions such as glasses, beards or changes in hair style.

Face recognition has become an important issue in many applications such as security systems, credit card verification and criminal identification. For example, the ability to model a particular face and distinguish it from a large number of stored face models would make it possible to vastly improve criminal identification. Even the ability to merely detect faces, as opposed to recognizing them, can be important. Detecting faces in photographs for automating color film development can be very useful, since the effect of many enhancement and noise reduction techniques depends on the image content.

II. BRIEF LITERATURE SURVEY

There are three major research groups which propose three different approaches to the face recognition problem. The largest group [4, 5, 6] have dealt with facial characteristics which are used by human beings in recognizing individual faces. The second group [7, 8, 9, 10, 11] performs human face identification based on feature vectors extracted from profile silhouettes. The third group [12, 13] uses feature vectors extracted from a frontal view of the face. Although there are three different approaches to the face recognition problem, there are two basic methods from which these three different approaches arise.

The first method is based on the information theory concepts, in other words, on the principal component analysis methods. In this approach, the most relevant information that best describes a face is derived from the entire face image. Based on the Karhunen- Loeve expansion in pattern recognition, M. Kirby and L. Sirovich have shown that [4, 5] any particular face could be economically represented in terms of a best coordinate system that they termed "Eigen faces". These are the Eigen functions of the averaged covariance of the ensemble of faces. Later, M. Turk and A. Pentland have proposed a face recognition method [14] based on the Eigen faces approach.

The second method is based on extracting feature vectors from the basic parts of a face such as eyes, nose, mouth, and chin. In this method, with the help of deformable templates and extensive mathematics, key information from the basic parts of a face is gathered and then converted into a feature vector. L. Yullie and S. Cohen [15] played a great role in adapting deformable templates to contour extraction of face images.

III. DCT COEFFICIENTS

Variations in facial images can be identified by analysing DCT coefficients. For, the image is spitted into 8x8 blocks and DCT coefficients of each block are stored in single column a matrix. For a 8x8 block matrix, we get 8x8matrix of DCT coefficients. However, the maximum information is available in the diagonal elements of 8x8 dct coefficients matrix. This is because, only diagonal elements of dct coefficients matrix have the maximum frequency variation components and they are design or patterns in the fabric image. Therefore, by making the statistical analysis of the diagonal elements of the dct coefficients Matrices of test and reference facial image, variation in faces may be checked.

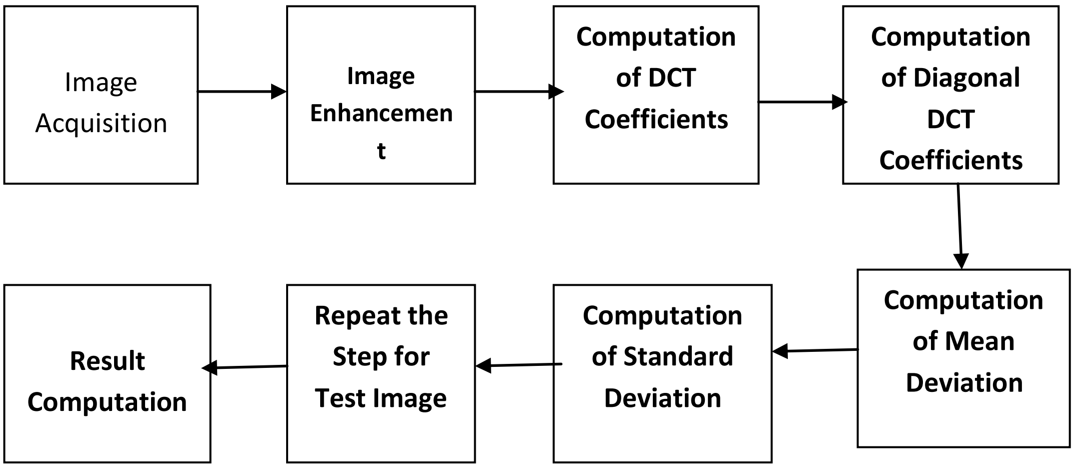
The discrete cosine transform (DCT) represents an image as
a sum of sinusoids of varying magnitudes and frequencies. The dct2 function computes the two-dimensional discrete cosine transform (DCT) of an image. The DCT has the property that, for a typical image, most of the visually significant information about the image is concentrated in just a few coefficients of the DCT. For this reason, the DCT is often used in image compression applications. For example, the DCT is at the heart of the international standard lossy image compression algorithm known as JPEG. (The name comes from the working group that developed the standard: the Joint Photographic Experts Group.) The two-dimensional DCT of an M-by-N matrix A is defined as follows.

P_8	P_1	P_2
P_7	P_0	P_3
P_6	P_5	P_4

$$B_{pq} = \alpha_p \alpha_q \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} A_{mn} \cos\frac{\pi(2m+1)p}{2M} \cos\frac{\pi(2n+1)q}{2N}, \quad \begin{matrix} 0 \le p \le M-1 \\ 0 \le q \le N-1 \end{matrix}$$

$$\alpha_p = \begin{cases} 1/\sqrt{M}, & p = 0 \\ \sqrt{2/M}, & 1 \le p \le M-1 \end{cases} \quad \alpha_q = \begin{cases} 1/\sqrt{N}, & q = 0 \\ \sqrt{2/N}, & 1 \le q \le N-1 \end{cases}$$

The values Bpq are called the DCT coefficients of A.



IV. NOISE REMOVAL

Salt and Pepper noise are removed by applying the following algorithm:
If (P0 = BLACK) & P1= P2 = P3 = P4 = P5 P6 = P7 = P8 = WHITE)
Then P0 is the Background Pixel.
If (P0 = WHITE) & P1= P2 = P3 = P4 = P5 P6 = P7 = P8 = BLACK)
Then P0 is the Object Pixel.

The intensity values of pixels in a small region within the size of the filter are examined, and the median intensity value is selected for the central pixel. Removing noise using the median filter does not reduce the difference in brightness of images, since the intensity values of the filtered image are taken from the original image.

V. ALGORITHM

In DCT based approach for face recognition, it is proposed to determine the dct coefficients of the facial images. For a MxN face image, we get a MxN dct coefficients matrix. The lower half of the DCT coefficients matrix contains the frequency variation of the background image or flashy parts i.e. the background, while the upper half of the DCT coefficients matrix contains the high frequency part i.e. noise.

The diagonal elements of the DCT coefficients matrix contain the maximum information of the face image. The diagonal DCT coefficient of the matrix is rearranged in a single column matrix to find out the mean deviation, standard deviation and covariance. By analysis of the standard deviation of the dct coefficients, the variations in textile images are computed.

The computation of the proposed algorithm is implemented in following steps:

Step-1: Compute the dct coefficients of facial images in data base.
Step-2: Determine the diagonal dct coefficients of each of the facial image and arrange in a single column matrix.
Step-3: Repeat the above two step for test image.
Step-4: Compute the difference of diagonal dct coefficients of test image form data base images. Here, we get N column matrix for N data base images.
Step-5: Compute the mean of each of the column.

$$Mean = \sum Diff / D_n$$

Where Diff = Difference of DCT coeff. Of test and data base images and D_n is no. of diagonal dct coefficients.
Step-6: Compute the standard deviation of each of the column. SD is given by:

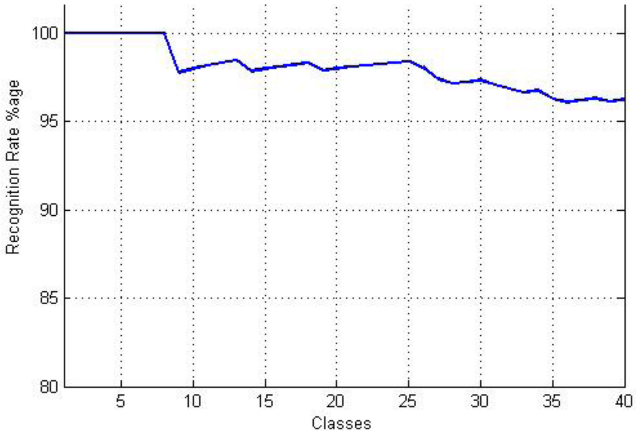
$$SD = \sqrt{} \sum(Di - Mean) / 2xD_n^2$$

Step-7: Find out the minimum standard deviation value column and that is the equivalent face to the test image.

VI. RESULTS

The presented algorithm has been tested on 100 persons test images. The data base has the five no. of images of the same person in different poses like open mouth, with and without spaces, smiling and normal. The performance of the algorithm found to be satisfactorily in the range of 98-100%.

The below graph shows the performance of the algorithm:



VII. CONCLUSION

The presented approach of statistical analysis of diagonal dct coefficients of facial images gives strong face detection approach as the standard deviation of the dct coefficients does not vary much if there is slight variation in the facial images of the same person. Therefore, it is advantageous if there is some variations in the same persons image from that of the data base image, then even the person can be identified, Also if there is background variation in the facial images from that of the data base, even that does not poses any threat to accurate identification of the facial image as back ground dct coefficients fall under the lower half of the dct coefficients matrix and that are not considered in the presented approach.

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