

DCT Based Face Recognition

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Abstract — A typical automatic face recognition system is composed of three parts: face detection, face alignment and face recognition. Conventionally, these three parts are processed in a bottom-up manner: face detection is performed first, then the results are passed to face alignment, and finally to face recognition. In this paper we will see the face recognition using DCT. The face recognition algorithm is based on appearances of Local facial regions that are represented with discrete cosine transform coefficients. This system exploits the feature extraction capabilities of the discrete cosine transform (DCT) and invokes certain normalization techniques that increase its robustness to variations in facial geometry and illumination. The method is tested on two databases first the standard database and second database of real images. High percent of recognition is achieved by varying the threshold.

Keywords — Face Recognition, Face Detection, Discrete Cosine Transform (DCT), Threshold.

I. INTRODUCTION

Face recognition has been an active research area over the last 30 years. It has been studied by scientists from different areas of psychophysical sciences and those from different areas of computer sciences. Psychologists and neuroscientists mainly deal with the human perception part of the topic, whereas engineers studying on machine recognition of human faces deal with the computational aspects of face recognition. Face recognition has applications mainly in the fields of biometrics, access control, law enforcement, and security and surveillance systems. Biometrics is methods to automatically verify or identify individuals using their physiological or behavioral characteristics. Biometric technologies include face recognition, finger print recognition, iris recognition etc. The necessity for personal identification in the fields of private and secure systems made face recognition one of the main fields among other biometric technologies. The importance of face recognition rises from the fact that a face recognition system does not require the cooperation of the individual while the other systems need such cooperation. Thus, it should not be surprising that a face recognition system is placed in the Statue of Liberty in US. Face recognition algorithms try to solve the problem of both verification and identification. When verification is on demand, the face recognition system is given a face image and it is given a claimed identity. The system is expected to either reject or accept the claim. On the other hand, in the identification problem, the system is trained by some images of known individuals and given a test image. It decides which individual the test image belongs to.

II. DISCRETE COSINE TRANSFORM

The mathematical theory of linear transforms plays a very important role in the signal and image processing area. They generate a set of coefficients from which it is possible to restore the original samples of the signal. In many situations, a mathematical operation generally known as a transform – is applied to a signal that is being processed, converting it to the frequency domain. With the signal in the frequency domain, it is processed and, finally, converted back to the original domain. A mathematical transform has an important property: when applied to a signal, i.e., they have the ability to generate de-correlated coefficients, concentrating most of the signal's energy in a reduced number of coefficients. The Discrete Cosine Transform (DCT) is an invertible linear transform that can express a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. The original signal is converted to the frequency domain by applying the direct DCT transform and it is possible to convert back the transformed signal to the original domain by applying the inverse DCT transform. After the original signal has been transformed, its DCT coefficients reflect the importance of the frequencies that are present in it. The very first coefficient refers to the signal's lowest frequency, known as the DC-coefficient, and usually carries the majority of the relevant (the most representative) information from the original signal. The last coefficient refers to the signal's higher frequencies. These higher frequencies generally represent more detailed or fine information of signal and probably have been caused by noise. The rest of the coefficients (those between the first and the last coefficients) carry different information levels of the original signal. In the image processing field, it is interesting to use a two-dimensional DCT (2D-DCT), because images are intrinsically two-dimensional elements. The standard JPEG, for example, establishes the use a 2D-DCT at the de-correlation step. Figure 2.1 shows the application of the DCT on one of the face images obtained from the database. Figure 2.1.a displays the original image, and Figure 2.1.b displays the result of applying the DCT on the original image. At Figure, it is possible to verify that most of the image's energy is concentrated in the upper left corner. This is the region that represents the DCT lowest frequency coefficients.



Fig.2.1. (a) Image from database (b) DCT of the image

To perform the attribute extraction, the approach used is the selection of the lowest DCT frequency coefficients. This approach is fast and simple, as it neither evaluates the DCT coefficient of the image, nor performs calculations or any kind of comparison. As the DCT of an image is a 2D signal, the selection of the lower frequency coefficients consists simply in defining a geometric region at the beginning of the 2D signal. An example of such masks for attribute selection using four square regions is shown in Figure 2.2, illustrating this selection approach for low frequencies. It shows the result of applying the 2D-DCT on an image, followed by a normalization stage for easy viewing. As can be seen, the largest energy concentration occurs in the low frequency coefficients region. Thus, this approach is suitable to capture the most important coefficients of the image.



Fig.2.2. Pattern for selection of coefficients.

One of the major contributions of this work is basically on the way to select the most important of the DCT coefficients. This is done by defining a new geometric shape that is to be used to select the attributes. A previous work used square regions on the coefficient selection stage, as in Figure But, in the current study, regions with square, rectangular, triangular, and elliptical shapes were tested. In Figure we can see that an elliptical shape selects the coefficients of greater amplitude (white dots of the image) better than a square shape, thus selecting the most relevant coefficients of the DCT 2D signal. After selecting the DCT coefficients for the face to be compared its Euclidian distance is calculated with the DCT coefficients of the images present in database. Image is identified as the face of particular image with which it gives minimum distance. If no match is there then the image is stored as new image in database.

III. IMPLEMENTATION

1. Input Image:

Input to the system is an image in jpeg format. The figure 3.1 shows the two images which are used as inputs for the system. Image (a) is an image from the database and it is of size 200×180 , and the image shown in figure (b) is an image taken from real time database and it is of size 1200×1640 .

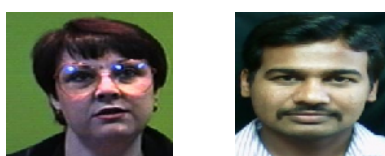


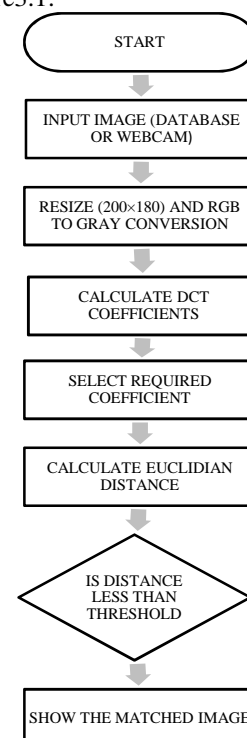
Fig.3.1. Input Images

2. Resizing and RGB to Gray Conversion:



Fig.3.2. Resizing and RGB to Gray Conversion

The properties of the image given system will vary according to the device used for capturing an image. The next part of the system converts the given image to gray format and resizes the image to 200×180 . So each time system will have the image input in similar format. Figure 3.2 shows the resized and gray images of the input images shown in figure3.1.



3. Calculation of DCT Coefficients:

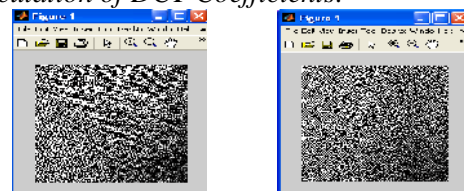


Fig.3.3. DCT of the images.

In next step we calculate the DCT of the image which is converted into suitable form. Figure 3.3 shows the DCTs of the images shown in figure 3.2. After the calculation of DCT we select the number of coefficients required in rectangular manner from the low frequency area of the DCT distribution. For the system we have kept number of coefficients equal to 10.

4. Euclidian Distance Calculation:

Coefficients for given images are calculated and store. The DCT of image to be compared is calculated and

Euclidian distance between this image and images stored in a database is calculated as

$$d = [(f_0 - v_0)^2 + (f_1 - v_1)^2 + \dots + (f_{M-1} - v_{M-1})^2]^{1/2}$$

Where

$v = [v_0 \ v_1 \ \dots \ v_{M-1}]^T$ = Input image DCT coefficients vector

$f = [f_0 \ f_1 \ \dots \ f_{M-1}]^T$ = DCT coefficients vector of image to be compared.

5. Finding Match in Database:

Euclidian distance with all the images present in database is calculated now the image will match to the image in database for which minimum Euclidian distance is obtained. Euclidian distance obtained will vary for different images. It will be equal to zero if exactly identical images are there but if there is some variation then it will give some finite value. So it becomes necessary to decide threshold. Threshold is decided by observing Euclidian distance for few images with their variable images. Here we are taking threshold of $4e+07$ for standard database and $8e+07$ for real time database.

IV. TESTING

The implemented system is applied to the images shown.

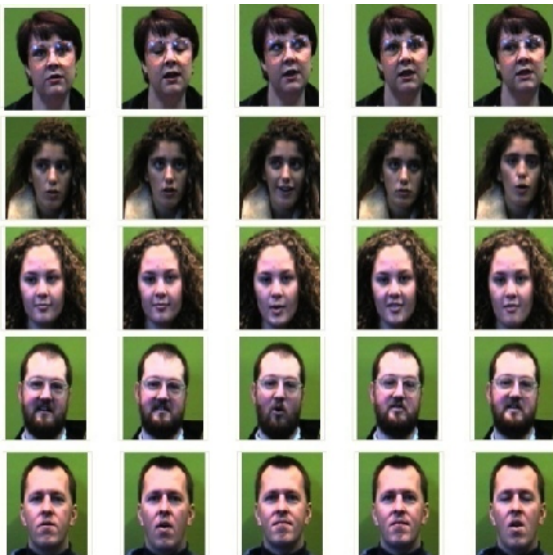


Fig.4.1. (a) Reference images from standard database. (b), (c), (d), (e) images with facial variations

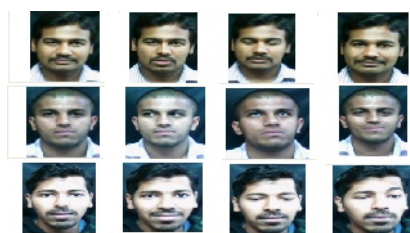


Fig.4.2. (a) Reference images from Real database. (b), (c), (d) images with facial variations.

The graph shows the Euclidian distance variation of images with respect to images for both databases.

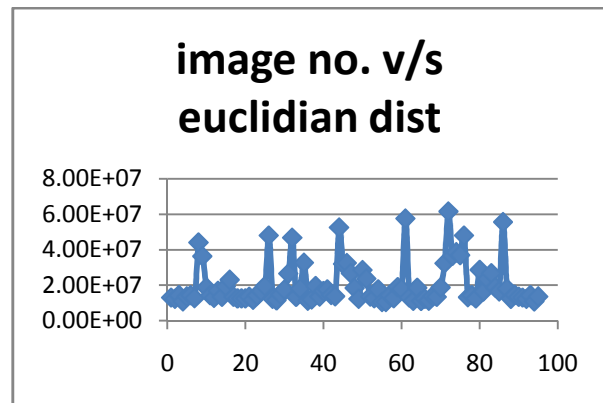


Fig.4.1. Graph of image Number v/s Euclidian distance for Standard Database

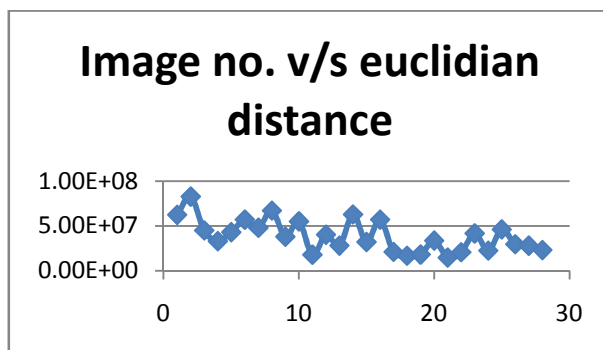


Fig.4.2. Graph of image Number v/s Euclidian distance for Real Time Database

Table 4.1 shows percentage of finding match for different thresholds for both standard as well as real time database following are the plots showing percentage match verses thresholds. Here we can see the percentage of match increases with increase in the threshold value.

Table 4.1 Percentage of finding match for different thresholds

For Standard Database				
Threshold	1.5e+07	2e+07	3e+07	4e+07
% match	55	75	85	92
For Real Time Database				
Threshold	4e+07	5e+07	6e+07	7e+07
% match	52	73	83	94

V. CONCLUSION AND FUTURE WORK

The proposed face recognition method has proved to be valid in the performed tests, achieving good results in several evaluation categories as recognition accuracy, robustness and computational cost. Without any pre-processing step, the proposed method achieves a high recognition accuracy of 95% when using only 10 coefficients using the leave-one-out approach.

Testing of the proposed algorithm was done on the database available which contains images with facial variations. And the results achieved for these variations are very good. It is seen from testing that the result goes on increasing if threshold is adjusted properly. Testing done is on both real time and standard database and it was observed that the real time database has more variation so requires larger thresholds in order to obtain good results. Future developments to the method will focus on improving the processing time on very large databases, and integrate the system with a face detector method. Additionally, tests must be done on other face databases.

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AUTHOR'S PROFILE



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