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RESEARCH ARTICLE

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ANALYSIS AND COMPARISON OF DWT AND LBP TECHNIQUES FOR FACE RECOGNITION

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ABSTRACT

Face recognition method is the one of the biometric methods, to identify and verify the face image. It is an important area which is used in many applications such as video surveillance, Security Monitoring, Access control, human computer interface and image database management. Basically, it is the research topic which is allied to the three fields of the research: machine learning, computer vision and image analysis. The face recognition system has various phases- face detection, normalization, feature extraction, classification and face recognition. The feature extraction phase plays a vital role in the face recognition as it affects the recognition rate. The recognition rate depends upon the illumination, pose, facial expressions, ageing, occlusion, low resolution and imaging conditions etc. This recognition rate helps us to configure whether the face is same or not. But if any of these factors are present in the image then the recognition rate decreases to an extent. This paper analyses and compares the two feature extraction techniques DWT and LBP which compares the face images of a person having different facial expressions on the basis of recognition rate, accuracy and time

Keywords- Face Recognition, Face Verification, Face Identification, DWT, LBP, Euclidean distance, cross correlation, standard deviation.

I. INTRODUCION

Our primary focus of attention in social intercourse is a face which plays a major role in conveying identity and emotion of people. The human ability to recognize faces is outstanding. We can recognize hundreds or thousands of faces throughout our lifetime and after many years of separation, human can still identify familiar faces. It has been an active research area and studied by scientists from different areas of science and those from diverse areas of computer sciences in last 30 year. Engineers studying on machine recognition of human faces whereas psychologist and neuroscientists deal with the human perception of face recognition. The main reason of active research in the area of face recognition is due to its applications in various fields. Face recognition application has been categorized in law enforcement and commercial application. Face recognition technology is firstly used in law enforcement, especially in video surveillance, base portal control and CCTV control. Under the commercial applications: matching of photograph on ATM cards, passports, credit cards, driver's licenses, National ID. Face Recognition System can be classified into two types: (i) Face verification System (ii) Face Identification system.

(i) *Face Verification* ("Am I who I say I am?") is a one-to-one match that compares a query face image against a face image whose identity is being claimed. To evaluate the verification performance, the verification rate vs. false accepts rate is plotted.

(ii) *Face Identification* ("Who am I?") is a one-to-many matching process that compares a query face image against all images in a face database to determine the identity of the query face. The identification of the test image is done by locating the image in the database that has the highest similarity with the test image. The test subject's features are compared to the other features in the system's database and a similarity score is found for each comparison. These similarity scores are then numerically ranked in a descending order.

A typical Face Recognition system has mainly six functional blocks which explains the main working strategy of the Face Recognition system is given below:

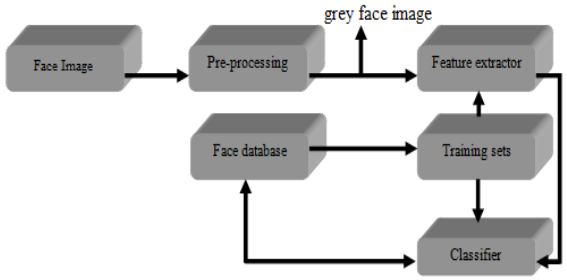

Fig1- Basic Face Recognition System

II. METHODS USED

A. *Discrete Wavelet Transform*

By applying 2-D DWT on an image, the image is decomposed into four equal sub-bands each is (1/4) that of the original image: the LL, HL, LH, HH sub-bands, equivalent to approximate, vertical, horizontal and Diagonal Features respectively as shown in figure 2, where the LL corresponds to the low frequency components in both horizontal and vertical directions, LH corresponds to the low frequency components in the horizontal direction and high frequency components in the vertical direction, HL corresponds to the high frequency components in the horizontal direction and low frequency in the vertical direction and the last HH corresponds to high frequency in the horizontal vertical directions.

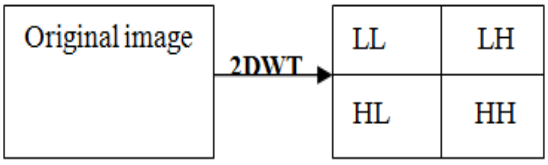

Fig2: Features of DWT

B. *Linear Binary Pattern*

LBP is very popular procedure which is mainly used for face representation. LBP is a function which either never decreases or never increases to gray scale transformations. The basic idea is that each 3x3 neighborhood pixels in an image is threshold by the value of its center pixel and a decimal value/representation is then obtained by taking the binary sequence as a binary number such that LBP $\epsilon[0,255]$.

$$LBP(x_c, y_c) = \sum_{n=1}^{8} 2^n \, s(i_n - i_c)$$

Where i_c corresponds to grey value of center pixel(x_c, y_c), i_n the grey values of the 8 neighbor pixels. s(x) is defined as:

$$s(x) = \begin{cases} 1 \; if \; x \geq 0 \\ 0 \; if \; x < 0 \end{cases}$$

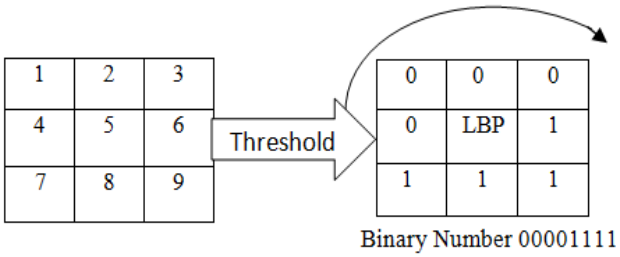

Fig3: An example of basic LBP operator

A local binary pattern is called uniform if it contains two bitwise transitions from 0 to 1 or vice versa when the corresponding bit string is consider circular.

C. *Local Ternary Patterns*

LTP is extended version of LBP. Instead of two value codes, we use three values i.e. 9, 0, 1 and also the binary LBP code is replaced by a ternary LTP code. The equation is same as the LBP but the value of s(x) is changed to:

$$s(x) = \begin{cases} 0 \; if \; i_n < i_c - t \\ 9 \; if \; i_n > i_c + t \\ 1 \; if \; otherwise \end{cases}$$

Where, t is any small positive value.

D. *Cross correlation*

Cross-correlation is a measure of similarity of two series as a function of the lag of one relative to the

other. If we have two images and r(x) and s(x) are two patterns of test image and reference image respectively then the cross correlation can be calculated as follows:

$$-1 \leq \frac{\int r(x)s(x)dx}{\sqrt{\int |(rx)|^2 dx \int |(sx)|^2 dx}} \leq 1$$

Normalized correlation between r(x) and s(x) lies between -1 and +1; but reaches +1 if and only if r(x) = s(x) i.e. both the images are same.

E. Euclidean Distance Method

Euclidean distance is the most common recognition rule which calculates the shortest distance from the query face image and the reference image.

$$E = \sqrt{\sum |F_i - Fr_i|^2}$$

Where, F is the feature space of query image and Fr is the feature space of reference image.

F. Chi square Method

Chi Square is proposed as a simple dissimilarly metric in finding the minimum quadratic difference normalized between samples of the feature vector of query image to be evaluated, S, with samples of a given features vector of reference image, M;

$$\chi^2(S,M) = \sum_i \frac{(S_i - M_i)^2}{|S_i + M_i|}$$

G. Recognition Rate

Recognition performance has many measurement standards. It is simply the rate of number of recognized images by the number of testing images. The formula can be written as follows:

Recognition rate= the number of recognized images/the number of testing images

III. PROPOSED METHODOLOGY

A. For DWT

Step1: Select a representative face from each group as the reference face, and carry out the k^{th} level DWT on them where k is the decomposition level.

Step2: For a test faces, perform the step 1

Step3: Match the circular shift obtained from test face image with the corresponding reference face image.

Step4: Compute the Cross Correlation and Euclidean distance between the test image and the reference image.

Step5: Evaluate the recognition rate, accuracy, time, and min and max value of cross correlation and Euclidean distance.

The value of k is used 4 with the various families of DWT.

B. For LBP, LTP

Step1: Select a representative face from each group as the reference face, and carry out the LBP and LTP on them.

Step2: For test faces, perform the step 1

Step3: Compute the Euclidean distance and chi square between the test image and the reference image.

Step4: Evaluate the recognition rate, accuracy, time, and min and max value of Euclidean distance and chi square.

IV. EXPERIMENTAL RESULTS

The experiments are done on YALE database. It is predefined database which contains the 165 grayscale face images of 15 different people under 11 different lightening, facial expression and illumination on each person. Each image is of dimension 320X243.

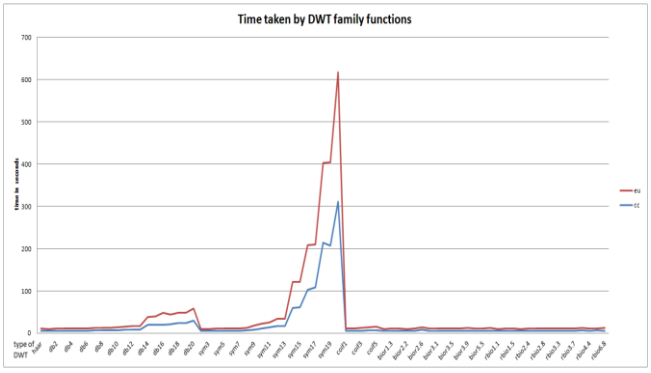

Fig4: Graph showing time taken by DWT family by cross-correlation method and Euclidean method

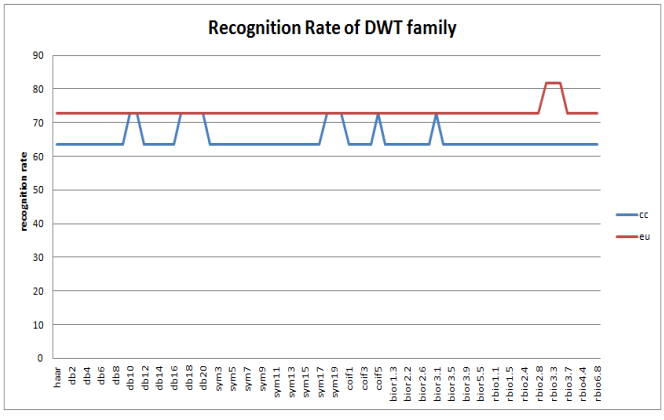

Fig5: Graph showing recognition rate of DWT family by cross-correlation method and Euclidean method

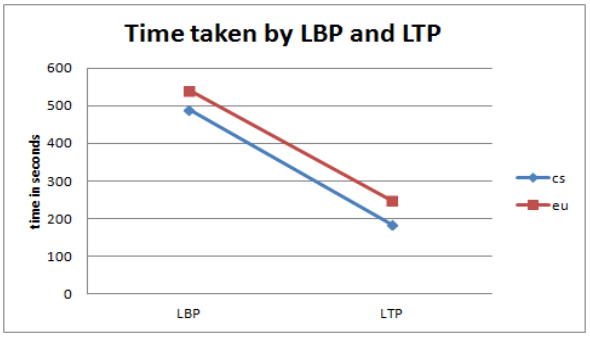

Fig 6: Graph showing time taken by LBP and LTP using chi square method and Euclidean method

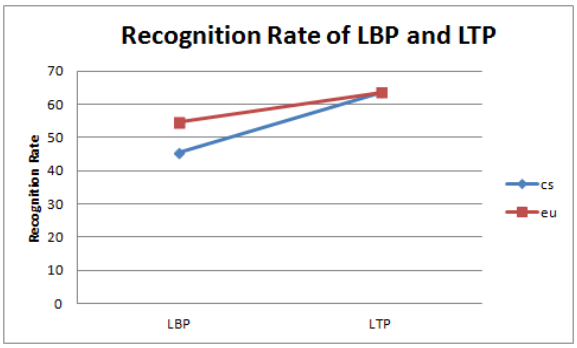

Fig7: Graph showing recognition rate of LBP and LTP by chi square method and Euclidean method

After comparing and analyzing, the experimental results show that in case of DWT, the function "rbio3.1" takes less time with the highest recognition rate among all. But it gives far better result with Euclidean distance method rather than cross correlation method. While in case of LBP and LTP, they take more time with less recognition rate with both chi square and Euclidean distance method.

V. CONCLUSION

Face recognition of people is a challenging problem which has received much attention during recent years due to its many applications in different fields. There are various hurdles that come during face recognition like skin color, age's effect, color and gender. In case of face verification, both the techniques give correct result but DWT is faster than the LBP and its derivative LTP. Also, in the case of face identification, from DWT and LBP feature extraction methods, DWT performs better in both the recognition rate and the time. DWT takes less time with high recognition rate.

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