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Face Recognition Using BBDCT and BPSO For Feature Extraction and Selection

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Abstract- Face Recognition (FR) is the process of matching the train image and test image. There is different number of techniques and algorithms are used for Face Recognition Process. Because of this process with minimum number of feature extraction and matching is challenging task and also have unsatisfied efficiency in the system and process. Therefore the energy based feature extraction is most widely used and effective approach to overcome this problem. Here we proposes Block-Based Discrete Cosine Transform (BBDCT) for feature extraction and Binary Particle Swarm Optimization (BPSO)-based feature selection algorithm to search the feature vector space for optimal solution.

Keywords :Discrete Cosine Transform, Face Recognition, Feature Extraction, Feature Selection, Particle Swarm Optimization.

I INTRODUCTION

Face recognition is a task that humans perform routinely and effortlessly in their daily lives. Wide availability of powerful and low-cost desktop and embedded computing systems has created an enormous interest in automatic processing of digital images and videos in a number of applications, including biometric authentication, surveillance, human-computer interaction, and multimedia management. Research and development in automatic face recognition follows naturally [1].

The process of face recognition comprises of face detection ,feature extraction and verification or identification. Here we illustrate the extraction and identification steps in Face recognition process.

There are many different algorithms have been developed. But the success rate of these algorithms is not satisfied due to position, pose, illumination variations in the input image [4].

Therefore we applying the method for feature extraction using Block Based DCT. Here we dividing the image into same sized blocks and extracting the most useful and related features of each bock.

Face recognition, as one of the primary biometric technologies, became more and more important owing to rapid advances in technologies such as digital cameras, the Internet and mobile devices, and increased demands on security. Face recognition has several advantages over other biometric technologies: It is natural, nonintrusive, and easy to use [1].

In DCT the DC low frequency component having more correlated information which is useful for face recognition , where as the high frequency components related to fine details like edges and expressions which are vulnerable to pose and expression variations. Therefore the analysis of input image using block based DCT is applied and the relevant features are grouped together to represent the extracted features.

In the next consequent stage the BPSO technique based on swarm intelligence is applied to minimize the feature subset, and increases the performance analysis of the system .

For efficient Face Recognition, the following new idea is proposed:

1. Block Based DCT for optimal feature extraction.
2. Optimal features selected based on Energy Pruning levels which are further reduced through Binary Particle Swarm Optimization (BPSO) Technique.

This paper organized face recognition process as follows:

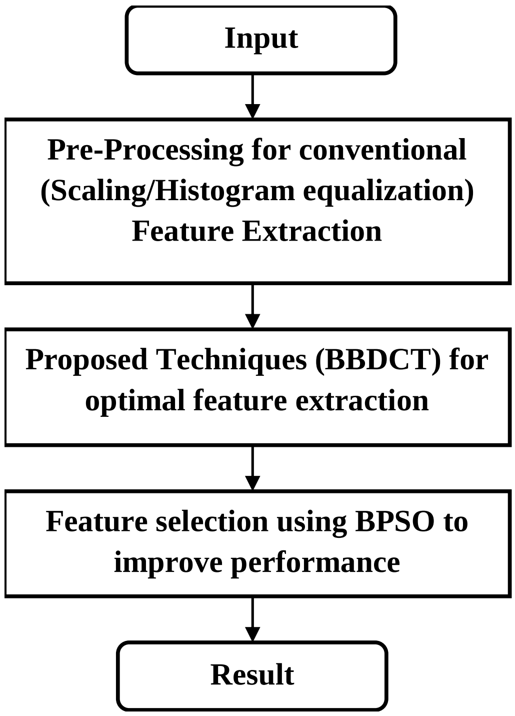


Figure 1: Face Recognition Process

II PRE-PROCESSING TECHNIQUES

The image pre-processing is used to modify the images more suitable for the applications of algorithm. These are techniques are situation specific and they increases the success rate.

The following are the image pre-processing techniques applied in algorithm:

1]*Scaling:* For recognition of images the test image and train image to be scaled to the same size as the correlation between the images of the same size is maximum.
The theme of the technique of magnification is to have a close view by magnifying or zooming interested part of imagery. By reduction, we can bring the unmanageable size of data to manageable limit. For resembling an image nearest neighborhood ,linear or cubic convolution technique are used.

2]*Histogram Equalization:* Histogram is the graphical representation of the intensity distribution of an image and equalization is the method for adjusting image intensities to enhance contrast[6].
It is mathematically given by, equation 1**:**

$$h(v) = \text{round}\left(\frac{cdf(v) - cdf\ \min}{(MxN) - cdf\ \min} x(L-1)\right) - - - (1)$$

Where , M, N = is the width and the height of the image respectively.
cdf = is the Cumulative Distribution Function.
L = is the number of gray levels used.

3]*Edge Detection:* It refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of object in an image. LoG [7] is applied after histogram equalization. There are various edge extraction techniques like `Canny', `Sobel' etc., out of which Laplacian of Gaussian (LoG) is used here for illumination invariant database. The edge techniques work their best in the illumination normalized images.

III Discrete Cosine Transformation

It is the widely used transformation in the image processing for feature extraction. In this technique whole image transformation is done for extracting the relevant feature and values of coefficients.DCT performs the energy compaction[8].The transformed image contains three frequencies called low, middle, and high containing information of an image. The average intensity of an image is generally stored in low frequency components which is the main component in recognition of an image[9]. Mathematically, the 2D-DCT of an image is given by:

$$F(u,v) = a(u)a(v)\sum_{x=o}^{N-1}\sum_{y=o}^{M-1} COS\left[\frac{\pi u}{2N}(2x-1)\right] COS\left[\frac{\pi v}{2M}(2y-1)\right] f(x,y) - - (2)$$

$$a(u)a(v) = \begin{cases} \sqrt{\frac{1}{N}} & for\ u,v \neq 0 \\ \sqrt{\frac{2}{N}} & for\ u,v = 0 \end{cases} - - - - - (3)$$

where, f(x, y) = is the intensity of the pixel at coordinates (x,y), u varies from 0 to M-1, and v varies from 0 to N-1.and M x N=size of the image.

IV Block-Based DCT (BBDCT) For Feature Extraction

Block based DCT (BBDCT) is an efficient approach in feature extraction over the conventional DCT. In the proposed system architecture as shown in Fig. 2, the image is divided into blocks of 8x8. The three reasons for selecting the block-size to be 8x8 are:

1. It is an adequate size in order to collect the information from all the regions of the face without a compromise [6].
2. Useful image contents vary gracefully within an 8x8 image block.
3. To favor the hardware implementation of the algorithm as this size is best suited for meeting both the processing and timing constraints of most of the real time processors.

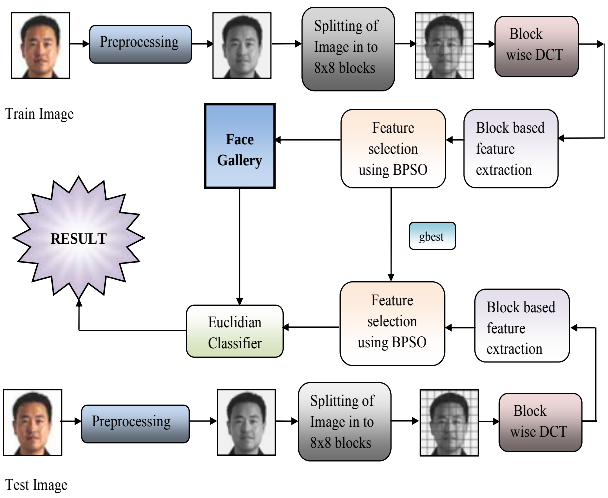
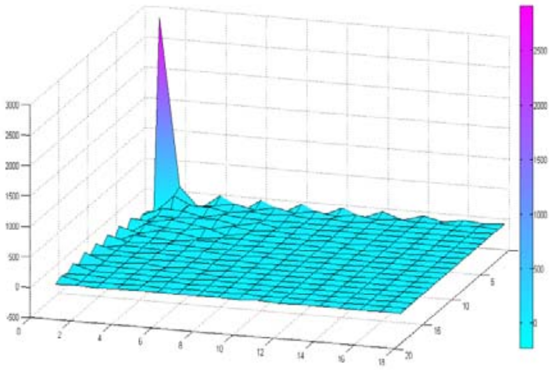


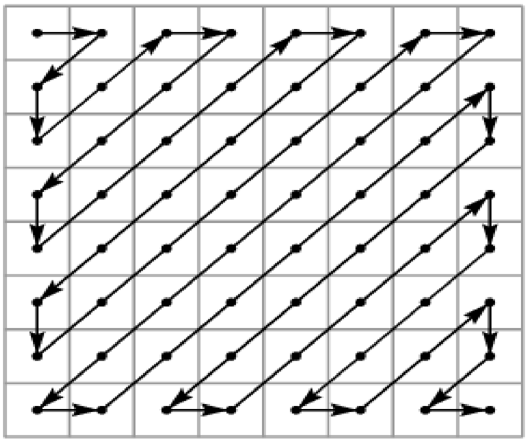
Figure 2: Face Recognition system

2D-DCT is applied and we obtain 64 coefficients from the block of 8x8. Then a matrix is formed by using these 64 coefficients. The first coefficient in matrix is called the DC component, which stores the average intensity of an image, the remaining are the AC coefficients represents the high frequency components of the image [10].Then we observe that practically the DC coefficients having average 95% of the energy. These amplitudes are directly related to the energies which carries the information of the images shown in Fig.3(a) [11].
This observation is the basis for the development of our algorithm. It is useful to take low frequencies, so that they are more uncorrelated to select the important features of each block of an image, instead of taking correlated low frequencies at the top left corner of image as a whole [12].
Then after it is more important to select optimum block size and is done by using image pre-processing techniques as mentioned earlier [13].Hence after in a grayscale image an image pixel values in the range of [0,255], therefore for a block size of 8x8, the DCT values are in the range of ±255x8x8.
Then within each DCT block the values pixels differ from low to high in a zig-zag pattern, called the raster scan order.

A typical DCT magnitude surf plot is shown in Fig. 3a and the corresponding DCT coefficients' raster scan order is shown in the Fig. 3b.



(a)DCT Magnitude plot of a single block



(b) Raster scan order
Fig 3: 8x8 operations

The raster scan is the basis for selection of number of coefficients within the block size of 8x8 as mentioned earlier consists of arrangement of DCT coefficients as a matrix is as shown in Fig. 3b.

V BINARY PARTICLE SWARM OPTIMIZATION (BPSO) BASED FEATURE SELECTION

By using BPSO technique the extracted features further reduced he extracted features are further reduced. It is introduced by Eberhart and Kennedy (1995) is used as an optimization technique in real number space [14].

It is the one of the evolutionary computation technique. It is population based search algorithm and is initialized with population of random solution called particle. Each particle is associated with velocity. Particles fly through the search space with velocities which are dynamically adjusted according to their historical behaviour.Therefore the particle have tendency to fly towards better search area over the search problem. The original PSO algorithm is discovered through simplified social model simulation, like bird flocking, fish schooling and swarm theory. It was then expanded in multidimensional search[15].

Therefore we dividing the entire problem into a set of particles where every particle represent a possible solution. The position and velocity of every particle is updated during every iteration based on the current particles best position and velocity and also the position and velocity of the best in the swarm. The PSO algorithm described by using equations Eq. 4 and Eq. 5 [13]:

$$V_i^{t+1} = w \times V_i^t + c_1 \times rand_1 \times (p_{i\_best} - X_i^t) + c_2 \times rand_2 \times (g_{best} - X_i^t) \quad (4)$$

$$X_i^t = X_i^t + X_i^{t+1} \quad (5)$$

where i is the particle index, varying from 1 to N (Number of particles), ω represents the inertia, c1 and c2 are the cognitive parameters, g_{best} is the global best position and p_{best} is the particle best position. Also rand() is a uniform random number in the range 0-1.X_i^{t+1} is the predicted position, X_i^t is the current position and V_i^{t+1} is the estimate of velocity calculated from the previous equation.

The binary variant of PSO given in Eq. 6 has the particle velocity function used as the probability function for the position update[14]. If

$$rand_3 \leq \frac{1}{1+e^{-V_i^{t+1}}} \quad (6)$$

then X_i^{t+1} =1, else X_i^{t+1} =0. A value of 1 for the position indicates the selection of the particular feature while a 0 indicates rejection from the required feature set. For our experimentation, we have chosen c_1=2, c_2=2 and ω=0.6.Each particle representing a candidate solution is evaluated based on the fitness function, which is a measure of class separation calculated using the Eq. 7[3].

$$F = \sqrt{\sum_{i=1}^{t} (M_i - M_o)^t (M_i - M_o)} \quad (7)$$

where M_i is the mean of the corresponding classes and M_o is the grand mean. Here, classes correspond to the different subjects (L).It is shown in the succeeding sections that the usage of Particle Swarm Optimization algorithm along with block based DCT technique reduces the feature vector size up to 75%, without affecting the recognition rate.

VI EUCLIDEAN CLASSIFIER

Euclidean classifier is used to find the best match between the train and test images. It is calculated as shown in Eq. 8.

$$D = \sqrt{\sum_{i=1}^{N} (p_i - q_i)^2} \quad (8)$$

Where, p_i and q_i are the coordinates of p and q in the N dimensional space, corresponding to the train and test images. Minimum distance thus corresponds to maximum correlation.

VII CONCLUSION

A new approach for flexible Face Recognition system is proposed which uses Block Based Discrete Cosine Transform (BBDCT) for feature extraction and a BPSO based feature selection. BBDCT and population based optimization algorithm such as BPSO are well suited for execution in parallel stages. This allows the algorithms to be implemented directly in the hardware and achieve much faster execution times than possible with software.

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