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On The Design Optimization for Enhanced Face Recognition

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ABSTRACT: Face Recognition is one of the problems which can be handled very well using Hybrid techniques or mixed transform rather than single technique. This paper deals with using of Particle Swarm Optimization techniques for Face Recognition. Feature selection (FS) is a global optimization problem in machine learning, which reduces the number of features, removes irrelevant, noisy and redundant data, and results in acceptable recognition accuracy. It is the most important step that affects the performance of a pattern recognition system. This paper presents a novel feature selection algorithm based on PCA [1] [2] Subspace using Accelerated Binary Particle Swarm Optimization. ABPSO is a computational paradigm based on the idea of collaborative behavior inspired by the social behavior of bird flocking or fish schooling. This paper proposes a novel method of Binary Particle Swarm Optimization called Accelerated Binary Particle Swarm Optimization (ABPSO) by intelligent acceleration of particles. Together with Image Pre-processing techniques such as Resolution Conversion, Histogram Equalization and Edge Detection, ABPSO is used for feature selection to obtain significantly reduced feature subset and improved recognition rate. The performance of ABPSO is established by computing the recognition rate and the number of selected features on ORL database. For the implementation of this propose work we use the Image Processing Toolbox under Matlab software.

KEYWORDS: Face Detection, Face recognition, pattern recognition, PSO, PCA

I. INTRODUCTION

In the present paper we propose a novel face recognition algorithm that is able to locate frontal faces in a given image, in the two-dimension search space. This is the case in most applications that use face recognition. For example, most of the state-of-the-art face recognition and facial expression recognition methods consider that the face has been correctly and precisely located in the image and that it is in frontal view. The most competitive face detection algorithms are searching exhaustively in the test image for localizing the face. To avoid the exhaustive search of all possible locations in the image, we propose a face recognition algorithm based on swarm intelligence and more specifically the accelerated binary particle swarm optimization (ABPSO) method. Each particle is equipped with a very fast and accurate classifier and cooperates with the other particles in order to form an intelligent swarm that is able to detect faces. Applying a nature-inspired intelligent method not only has the advantage of searching the 2D solution space in an efficient way but also an exhaustive search in all possible combinations on the 2D coordinates can be avoided. Indeed, approximately only 5% of the possible image positions had to be examined. Face recognition [1] is one of the most important biometrics which seems to be a good compromise between actuality and social reception and balances security and privacy well. It has a variety of potential applications in information security law enforcement and access controls. Face recognition systems fall into two categories: verification and identification. Face verification is 1:1 match that compares a face images against a template face image. On the other hand face identification is 1: N problem that compares a probe face image against all image templates in a face database. Face recognition is a very difficult problem due to a substantial variations in light direction (illumination) , different face poses , diversified facial expressions , Aging (changing the face over time) and Occlusions (like glasses, hair, cosmetics). So the building of an automated system that accomplishes such objectives is very challenging. In last decades many systems with recognition

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rate greater than 90% has been done however a perfect system with 100% recognition rate remains a challenge. Face recognition algorithms are divided by into three categories as follows:

1. Holistic methods: These methods identify a face using the whole face images as input and extract the overall features.
2. Feature [3] based methods: these methods used the local facial features for recognition (like eyes, mouths, fiducial points. etc.).
3. Hybrid methods: these methods used both feature based and holistic features to recognize a face. These methods have the potential to offer better performance than individuals.

Face Recognition System is one of the most successful applications of enhanced computational ability and image processing. Automatic face recognition is intricate primarily because of difficult imaging conditions, ageing, facial expression, occlusion etc. Thus, image preprocessing is used to resize (to reduce the dimensionality of feature subset), adjust contrast, brightness and filter the noise in an image. Face Recognition (FR) has evolved drastically over the last decade and has found innumerable applications in various fields. Major advancements in the recent past have propelled FR technology into the spotlight. FR is used for both verification and identification. In this paper we propose Accelerated Binary Particle Swarm Optimization (ABPSO) algorithm [8] based on an intelligently updated velocity equation. We apply ABPSO for feature selection and establish its improved performance over the basic Binary PSO algorithm. The set of selected features are found to be significantly reduced. This causes a reduction in the memory space required for storing face features in the face feature gallery of the propose FR system. The experiments are conducted for ORL databases.

Ermioni Marami and Anastasios Tefas [1] in 2010 present Face Detection Using Particle Swarm Optimization and Support Vector Machines. In this paper, a face detection algorithm that uses Particle Swarm Optimization (PSO) for searching the image is proposed. The algorithm uses a linear Support Vector Machine (SVM) as a fast and accurate classifier in order to search for a face in the two-dimension solution space. Using PSO, the exhaustive search in all possible combinations of the 2D coordinates can be avoided, saving time and decreasing the computational complexity. Moreover, linear SVMs have proven their ef- ficiency in classification problems, especially in demanding applications. Experimental results based on real recording conditions from the BioID database are very promising and support the potential use of the proposed approach to real applications. P.V. Shinde, B.L. Gunjal and R. G. Ghule [2] in 2012 proposed Face Recognition Using Particle Swarm Optimization. In this paper, a novel PSO-based feature selection algorithm for FR is proposed. The algorithm is applied to feature vectors extracted by two feature extraction techniques: DCT and the DWT. The algorithm is utilized to search the feature space for the optimal feature subset. Evolution is driven by a fitness function defined in terms of class separation. The classifier performance and the length of selected feature vector were consider for performance evaluation using the ORL face database

The remainder of this paper is organized as the following. At first, in Section II we illustrate the various components of our proposed technique to face recognition. Further, in Section III we present some key experimental results and evaluate the performance of the proposed system. At the end we provide conclusion of the paper in Section IV and state some possible future work directions.

II. PROPOSED TECHNIQUE

This section illustrates the overall technique of our proposed image compression. In our propose work we present “Gradient-Orientation-Based PCA Subspace using Accelerated Binary Particle Swarm Optimization for Enhanced Face Recognition”. In previous purposed work, the Face Recognition was proposed using PSO but we propose using PAC with ABPSO. The first step in any face recognition system is the extraction of the feature matrix. A typical feature extraction algorithm tends to build a computational model through some linear or nonlinear transform of the data so that the extracted feature is as representative as possible. In this paper DCT and DWT were used for feature extraction. When ABPSO is used to solve an optimization problem, a swarm of computational elements, called particles, is used to explore the solution space for an optimum solution. Each particle represents a candidate solution and is identified with specific coordinates in the 2-dimensional search space. The task for the binary ABPSO algorithm is to search for the most representative feature subset through the extracted DCT or DWT feature space. Each particle in the algorithm represents a possible candidate solution (feature subset). Evolution is driven by a fitness function defined in terms of class separation (scatter index) which gives an indication of the expected fitness on future trials. The experiments

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showed that the Schurfaces has the high discriminate power and consistently outperformed the standard face recognition methods. There are no face detection so error rate is about 18%.But, in our purpose method we use PSO for optimization and use face detection also. In our purpose method there are no limits for dataset and we can use any dimension of image, processing time will be very less by the use of PSO matching is more accurate.

A. Discrete Cosine Transform (DCT)

DCT has emerged as a popular transformation technique widely used in signal and image processing. This is due to its strong "energy compaction" property: most of the signal information tends to be concentrated in a few low-frequency components of the DCT. The use of DCT for feature extraction in FR has been described by several research groups. DCT was found to be an effective method that yields high recognition rates with low computational complexity. DCT exploits inter-pixel redundancies to render excellent de-correlation for most natural images. After de-correlation each transform coefficient can be encoded independently without losing compression efficiency. The DCT helps separate the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality). DCT transforms the input into a linear combination of weighted basis functions. These basis functions are the frequency components of the input data. DCT is similar to the discrete Fourier transform (DFT) in the sense that they transform a signal or image from the spatial domain to the frequency domain, use sinusoidal base functions, and exhibit good decorrelation and energy compaction characteristics. The major difference is that the DCT transform uses simple cosine-based basis functions whereas the DFT is a complex transform and therefore stipulates that both image magnitude and phase information be encoded. In addition, studies have shown that DCT provides better energy compaction than DFT for most natural images.

B. Discrete Wavelet Transform (DWT)

Wavelets have many advantages over other mathematical transforms such as the DFT or DCT. Functions with discontinuities and functions with sharp spikes usually take substantially fewer wavelet basis functions than sine-cosine functions to achieve a comparable approximation. Wavelets have been successfully used in image processing since 1985. Its ability to provide spatial and frequency representations of the image simultaneously motivates its use for feature extraction. The decomposition of the input data into several layers of division in space and frequency and allows us to isolate the frequency components introduced by intrinsic deformations due to expression or extrinsic factors (like illumination) into certain sub-bands. Wavelet-based methods prune away these variable sub-bands, and focus on the space/frequency sub-bands that contain the most relevant information to better represent the data and aid in the classification between different images. There exists a large selection of wavelet families depending on the choice of the mother wavelet. In this paper FR using the DWT is based on the facial features extracted from a Haar Wavelet Transform. The Haar wavelet transform is a widely used technique that has an established name as a simple and powerful technique for the multi-resolution decomposition of time series. Earlier studies concluded that information in low spatial frequency bands play a dominant role in face recognition.

C. Image Pre-processing

Among the various pre-processing techniques, the three techniques of relevance are Bi-Cubic interpolation, Histogram equalization and Edge detection using Laplacian of Gaussian (LoG). Image interpolation provides a technique of producing high-resolution image from its low-resolution counterpart. Interpolation basically, is the process of estimating intermediate values of a continuous event from discrete samples. It is a type of approximating function whose value must coincide with the sample data at the interpolation nodes or sample points. Bi-Cubic interpolation is a resolution conversion method preserving finer details of images with increased sharpness, better than bilinear algorithm. Whenever an image is resample, there will be a loss of focus within the image, but bi-cubic interpolation, among various methods, provides maximum sharpness. Histogram equalization is a nonlinear process aimed to highlight brightness in a way particularly suited to human visual analysis. This tries to transform the distribution of pixel intensity values in the image into a uniform distribution and consequently improves the image's global contrast.

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D. Particle Swarm Optimization

Particle Swarm Optimization (PSO) [8] is a swarm intelligence technique developed by Dr. Eberhart and Dr. Kennedy in 1995. In PSO, the swarm consists of particles which move around the solution space of the problem. These particles search for the optimal solution of the problem in the predefined solution space till the convergence is achieved.

PSO algorithm:

• Initialize the particle position by assigning location p = (p0, p1…., pN) and velocities v = (v0,v1, …,vN).
• Determine the fitness value of all the particles: f (p) = (f (p0), f (p1)… f (pN)).
• Evaluate the location where each individual has the highest fitness value so far: p= ($p0^{best}$, p1best… pNbest).
• Evaluate the global fitness value which is best of all p^{best}: G (p) = max (f (p)).

The particle velocity is updated based on the p^{best} and g^{best}.

• v_i new = v1 + c1 × rand ( ) × (p_i^{best} - pi) + c2 × rand ( ) × (p_g^{best} - pi)
For 1 < i< N. (1)

• Where c1 and c2 are constants known as acceleration coefficients and rand () are two separately generated uniformly distributed random numbers in the range [0, 1].
• Update the particle location by: p_i^{new} = pi + v_i^{new} for 1 < i < N.
• Terminate if maximum number of iterations is attained or minimum error criteria is met.
• Go to step 2.

E. Accelerated Binary PSO

For binary discrete search space, Kennedy and Eberhart have adapted the PSO to search in binary spaces by applying a sigmoid transformation to the velocity component in the equation to squash the velocities into a range [0,1] and force the component values of the positions of the particles to be 0's or 1's.

F. Feature Extraction

In pattern recognition and in image processing, feature extraction [2] is a special form of dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (e.g. the same measurement in both feet and meters) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. The first step in any face recognition system is the extraction of the feature matrix. A typical feature extraction algorithm tends to build a computational model through some linear or nonlinear transform of the data so that the extracted feature is as representative as possible.

G. Feature selection using ABPSO

Feature selection is performed to reduce the dimensionality of facial image so that the features extracted are as representative as possible. Method employed here is Accelerated Binary PSO. Consider a database of L subjects or classes, each class W1, W2, W3… WL with N1, N2, N3,…NL number of samples. Let M1, M2, M3... ML is the individual class mean and M0 be mean of feature vector. Fitness function is defined so as to increase the class separation equation. By minimizing the fitness function, class separation is increased. For iteration the most important features are selected. Binary value of 1 of its position implies that the feature is selected as a distinguishing feature for the succeeding iterations and if the position value is 0 the feature is not selected.

H. Principal Component Analysis

Principal component analysis (PCA) is a technique used to emphasize variation and bring out strong patterns in a dataset. It's often used to make data easy to explore and visualize. Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it

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is orthogonal to the preceding components. The resulting vectors are an uncorrelated orthogonal basis set. The principal components are orthogonal because they are the eigenvectors of the covariance matrix, which is symmetric. PCA is sensitive to the relative scaling of the original variables. PCA is a de-correlation technique in statistical signal processing used pervasively in pattern recognition. By transforming the image data set into PCA domain and preserving only the desired components the noise and other trivial information can be removed considerably.

I. Matching

Matching is done by calculating minimum of Euclidean distances of features of the test image with feature of each image in the database using the equation:

$$\sqrt{\sum_{i=1}^{N}(FI-FT)^2}$$

Where FI and FT are the feature vectors of database image I and test image T respectively. Minimum Euclidean distance gives the closest matching image from the database.

In this paper, we propose 'Gradient-Orientation-Based PCA Subspace using Accelerated Binary Particle Swarm Optimization for Enhanced Face Recognition'. The main objective of our propose work is given below:

- Error percentage is less
- More accuracy
- Use face detection using ABPSO
- Use any dimension of image and many number of images.

III. EVALUATION AND METHODOLOGY

To verify the effectiveness (qualities and robustness) of the proposed Gradient-Orientation-Based PCA Subspace using Accelerated Binary Particle Swarm Optimization for Enhanced Face Recognition, we conduct several experiments with this procedure on several images. There are some steps of our proposed technique are given below:

Phase 1: Firstly we develop a code for the loading the face image in the database of the Matlab. This is done for the loading the face image value in the workspace of the Matlab.

Phase 2: After that we develop a code for the Accelerated Binary Particle Swarm Optimization (ABPSO). We generate the formula of the ABPSO in the Matlab using the code.

Phase 3: We develop a code for the applying the feature extraction techniques using PCA to extract the feature of the image.

Phase 4: After that we do code for the recognition of the loaded face image and develop a code for the decision on the base of the matching points for the loaded face image. For the matching purpose we develop the code.

Flow Chart of proposed method

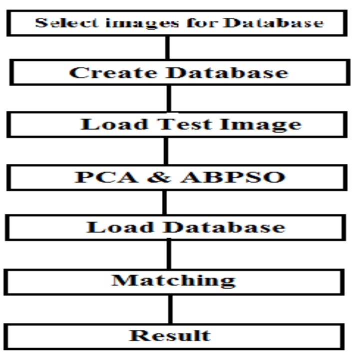

Figure: 1. Flow chart of proposed method

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IV. SIMULATION & RESULT

Fig.1. Main Figure window

Fig.2. Work Figure window

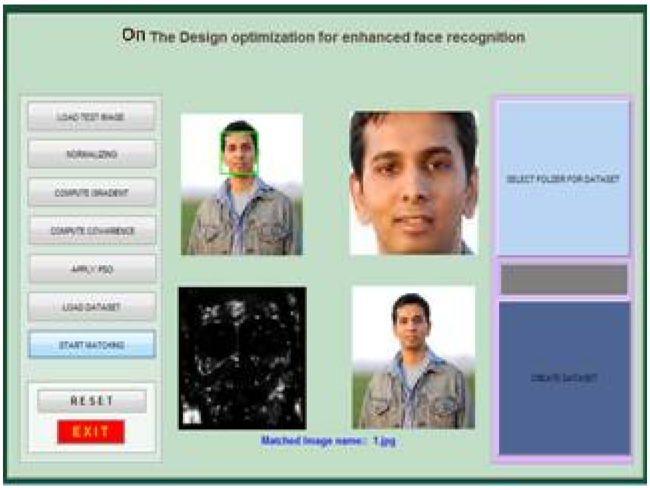

Fig.3. Running Figure window

V. CONCLUSION

This paper proposes a new ABPSO algorithm for unordered feature selection. This ABPSO differs from PSO. This paper proposes ABPSO based feature selection algorithm for Face Recognition. The algorithm is applied to feature vectors, extracted using PCA subspace and resolution conversion through Bi-cubic interpolation. The PCA subspace is used to reduce the dimension of the data produced by Radon Transform. It is also utilized to search the feature space for the optimal feature subset. Although detection performance of the proposed method is satisfactory by any means, it can further be improved with some small modifications and/or additional preprocessing of face images. Such improvements can be summarized as;

1) Since feature points are found from the responses of image to Gabor filters separately, a set of weights can be assigned to these feature points by counting the total times of a feature point occurs at those responses.

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2) A motion estimation stage using feature points followed by an affined transformation could be applied to minimize rotation effects. This process will not create much computational complexity since we already have feature vectors for recognition. By the help of this step face images would be aligned.
3) As it is mentioned in problem definition, a face detection algorithm is supposed to be done beforehand. Robust and successive face detection step will increase the detection performance. Implementing such a face detection method is an important future work for successful applications.
4) In order to further speed up the algorithm, number of Gabor filters could be decreased with an acceptable level of decrease in detection performance. It must be noted that performance of detection systems is highly application dependent and suggestions for improvements on the proposed algorithm must be directed to a specific purpose of the face detection application.

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