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Efficient Face Recognition Method Using Multi Algorithm and Average Half Face

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***Abstract* – Face recognition has received much attention in recent years due to its many applications such as human computer interface, video surveillance and face image database management. It is a challenging technique due to under different lighting conditions, facial expressions and changes in head pose. Single class of feature is not enough to capture all the available information in face. Multi algorithm approach of face recognition improves the accuracy using feature level fusion. This paper proposes an efficient technique for identification of an individual by using Average Half Face (AHF). We propose feature fusion technique using Principal component Analysis (PCA) and Discrete Wavelet Transform (DWT). For classification, distance classifier is used. The proposed method was tested using the cropped extended Yale B database, where the images vary in illumination and expression. High recognition performance has been obtained by fusion of PCA and Wavelet features at feature level for average half face compared to full face.**

Keywords: **Face Recognition, PCA, Wavelet, Multi Algorithm, Average Half Face**

I. Introduction

Biometrics be the most secure and convenient method to satisfy the need for identity recognition of individual in the society. For that physiological or behavioral characteristics of person are used for automatic identification of an individual [1]. In the field of Biometrics, facial recognition is one of the most acceptable biometrics. Because one human face is always bare and human beings often use them in their visual interactions. The automatic recognition of human face presents a significant challenge for researcher. Human faces are very similar in structure with minor difference from person to person It is a convenient biometric mode for human identification for more than two decades. For the past several decades Face recognition be a great deal of attention from scientific and industrial sections having is wide range of applications in information security and access control. Considerable research efforts have been given to the face recognition problem.

Nowadays, wavelets have been used quite frequently in image processing. They have been used for feature extraction, de-noising, compression, face recognition, and image super-resolution. Wavelet transformations are a method of representing signals across space and frequency [2]. The decomposition of images into different frequency ranges permits the isolation of the frequency components introduced by "intrinsic deformations" or "extrinsic factors" into certain sub-bands. This process results in isolating small changes in an image mainly in high frequency sub-band images. Hence, discrete wavelet transform (DWT) is a suitable tool to extract the feature vector of a face image.

Multi biometric systems combine information from multiple biometric traits. Single biometric traits may not be sufficient because the security needs to increase and criminals gain more expertise in biometric technology. A well planed and designed multi biometric system is potentially more accurate than best single biometric traits system [1]. Multi algorithm approach uses a single biometric sample form single sensor. More than one algorithm processes the acquired sample and increases the system performance. Fusion is an effective approach that may increase the accuracy of the biometric system. Fusion can be performed in three levels, sensor level, feature level and decision level. The selection and combination of features to remove redundant features at feature level fusion.

In nature human face is inherently symmetry, using this concept we would like to exploit this symmetry in face recognition. This paper demonstrates the effectiveness of using the average-half-face as an input to face recognition algorithms and it is based on multi algorithm approach that combined DWT and PCA.

II. Related Works

Many face recognition algorithms have been developed and each has its own strengths. In PCA method, also known as Eigen face method, face images are projected onto the Eigen space, that encodes the variations among the known facial classes and recognition is achieved by carrying out match of these projected feature vectors [3]. Real time recognition is the advantage of this method, but it is sensitive to change in illumination, facial orientation and its size. LFA method of recognition is based on analyzing the face in terms of local features, e.g., eyes, nose etc by which what is referred to as LFA kernels [4]. LFA technique offers better robustness against local variations on the facial image in carrying out a match but does not account for global facial attributes. Another popular method for face recognition is the Fisher Linear Discriminant, which maximizes the ratio of the trace of the between class scatter to the trace of the within-class scatter matrix [5]. However, this method suffers from small sample size problem.

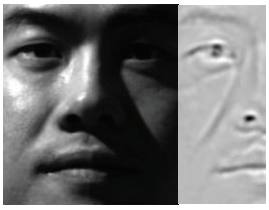
The Gram-Schmidt Orthogonalization based Face Recognition using DWT is presented in [6]. The DWT is applied on face images of Libor Spacek database. The LL sub-band is considered and Fast Principal Component Analysis using Gram-Schmidt orthogonalization process is applied to generate feature coefficient vectors. Two feature extraction methods based on PCA and Wavelets on the ORL face database using support vector machine and nearest neighbor classifier is described in [7]. The automatic recognition of human faces is presented in [8] based on a set of measurements called the pattern vector. The prototype system in [9] built in lab finds facial match by utilizing multi algorithmic multi-biometric technique, combining gray level statistical correlation method with PCA or Discrete Cosine Transform techniques. The fusion of LDA and PCA in the field of the face verification with good results is proposed in [10]. The fusion at the feature level by considering two biometric modalities face and hand geometry is proposed in [11].

Josh *et al* introduces the concept of the 'average-half-face', motivated by the Symmetry Preserving Singular Value Decomposition [12]. A Multi-Manifold Discriminant Analysis method for image feature extraction and pattern recognition based on graph embedded learning and under the Fisher discriminant analysis framework is proposed in [13]. A comparison by using the average-half-face and the original full face is performed with 6 different algorithms applied to two-dimensional and three-dimensional databases [14], the rank 1 accuracy of recognition is improved for average half face. A face detection method based on half face-template is discussed [15]. According to the character of density of the feature organs such as eye, ear, nose, mouth, part of cheek in the face images, the obverse average full face-template is constructed. And the obverse average half face-template is constructed directly based on density symmetry of face-template.

We already proposed for face identification of individual using average half face based on DWT and SVM classifier in [16]. The experiments were performed with full face and average half face got good recognition rate and better result in substantial savings in storage and computation time. And also discussed in [17] for the recognition of individual using average half face and selective palm print based on DWT and SVM classifier with score level fusion. Previously, Euclidian distance, Mahalanobis distance, nearest neighbor, the probabilistic decision-based neural network, Hidden Markova model [18-21] is used as a face classifier. Based on the better performance, we combine DWT and PCA for multi algorithm approach with distance classifier.

III. Proposed System

The average half-face is inspired by the symmetry preserving singular value decomposition which is used to reduce the dimensionality of data while simultaneously preserving symmetry that is present in the data [12]. To take into account, the proposed system uses average half face for individual identification with less memory and less computation time. To represent the data as symmetric, initially the image is centered about the nose, so that the two spatial halves of the data are similar. Among the two spatial halves, column of the one halve is reversed and averaged with the other halve to get the average half face. Then the wavelet and PCA features are extracted from the average half face. Before feature extraction, the input image is preprocessed to eliminate the various lighting condition by applying gamma correction, DoG filtering and normalization [22]. Figure 1 shows Input Full face Image and Average Half Face Image.



(a) (b)

Fig. 1 (a) Full face (b) Average half face

The preprocessed average half face image is decomposed by using 2-level Haar wavelet transform. Only 2nd level sub-bands coefficients are used as features for the recognition problem. PCA features also extracted from the average half face and fused with wavelet features to form the feature vector of the corresponding image. The proposed features are normalized using z-score before fusion. This is normally essential for the raw features getting from different modalities or algorithms can be merged in the fusion stage. The same procedure is applied to all training images and the feature vectors are stored in the Fusion Database (FD) for classification.

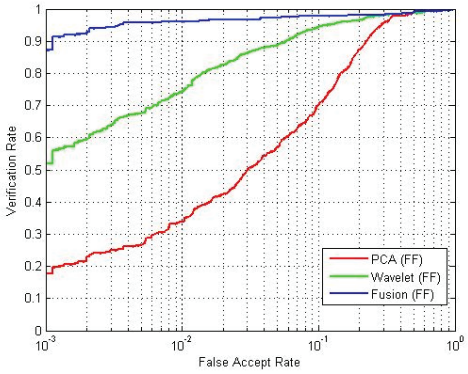
To recognize the user, the proposed wavelet and PCA features are extracted from the average half face and tested with the nearest neighbor classifier with cosine distance. The classifier gives the class i.e. index of the retrieved image. For two vectors x and y, the cosine distance measure is defined by

$$cosine = -\frac{x.y}{\|x\|.\|y\|} \quad (1)$$

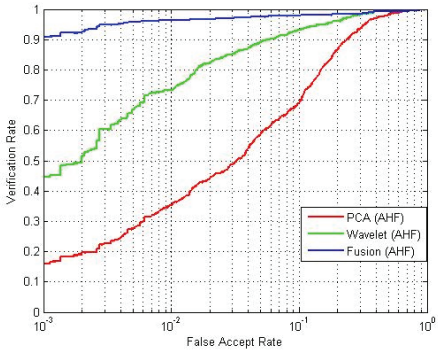
IV. Experimental Results

Extended Yale database B is used to evaluate the performance of the proposed system. This database [23] contains 38 human subjects under 9 poses and 64 illumination conditions. Among the 38 subjects, 15 subjects are randomly selected for the performance evaluation. For training the classifier, 50% of images in each poses are randomly selected and the remaining images are used for testing. To assess the performance of the proposed system, many computer simulations and experiments is performed. The performance measures False Acceptance Rate (FAR) and False Rejection Rate (FRR) are calculated. The system is implemented in MATLAB version 7.6.

In the proposed system, multi algorithm approach is developed by using wavelet and PCA features. Initially, the experiments are conducted for full face images in the database and compared with the proposed average half face images. A fair comparison is made between classification results of PCA, Wavelet and fusion approaches for full face and average half face. Figure 2 shows the ROC plot for full face and average half face respectively.



(a)



(b)

Fig. 2 ROC Plot for (a) Full face (b) Average half face

Table I Recognition Rate of The Proposed Techniques

Algorithm	Recognition rate (%)	
	Full Face	Average Half Face
PCA	84.00	85.39
Wavelet	86.26	92.52
Proposed approach	92.87	95.48

V. Conclusion

In this paper, we proposed a multi algorithm technique for identification of individual using average half face. The wavelet and PCA features are fused at feature level for identifying the individual and distance classifier is used for the classification purpose. The experiments were performed with full face and average half face. We utilize the symmetry of the face for face recognition which gives good recognition rate and better result in substantial savings in storage and computation time. As the test data, the cropped extended Yale B database is used for face recognition. The experimental results show that the recognition rate of the proposed approach is 95.48% for average half face and 92.87% for full face. In future, the proposed approach can be combined with different modalities.

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