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AN IMPROVED TECHNIQUE OF FACE RECOGNITION UNDER LIGHT VARIATION BY UTILIZING ITS PRINCIPAL COMPONENTS

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Abstract: Face recognition is a computer based person identification technique based on arithmetical and numerical features obtained from face images. In a face recognition system, illumination has been a great problem. In this work, light variation is tried to dominate to increase recognition rate. Face database used is Extended Yalle Face Database B+. This database consists of images of 38 different persons and 64 illumination variant facial images of each person. Out of these, 5 images are taken for training and remaining are kept for testing purpose. Image based face recognition system is designed by different dimension reduction techniques, which are Dimensional PCA and Differential 2-Dimensional PCA. Recognition rates achieved by 2DPCA and D2DPCA are 36.93% and 72.79% respectively. To improve the face recognition rate further, a novel technique is adopted, where facial images are vertically divided into two equal halves and D2DPCA dimension reduction technique is applied in each halves. Then Euclidean Distance is calculated between test images and training images for each halves, which are then normalized and hence normalized score of each halves are fused together to find the matched face from training database. Normalization is performed by four different techniques, which are Min-Max and Z-Score and recognition rates achieved by them are 95.76% and 95.90%respectively. Also, on comparing proposed technique with conventional technique, result of D2DPCA based system has been found increased by 23.24%. Hence it is shown that proposed technique works well for illumination variant images and D2DPCA is better dimension reduction tool than 2DPCA.

Keywords: PCA, 2DPCA, D2DPCA, Fusion Technique, Normalization Technique

1. Introduction

Biometrics refers to the use of physiological and behavioral characteristics for an automatic human recognition system [1, 2]. Human recognition deals with two different tracts: person identification and person authentication. Identification is the determining the individuality of a person from a scene including different background, while authentication deals with recognizing a person from a group of persons which is termed as database. An automatic human recognition system must be capable of successful acceptation of truth and rejection of false data which is not registered in the database. Such automatic authentication system has wide area of application such as human computer interface, security system, banking sector, network security, database management, office and building access, e-commerce, teleconferencing etc. Now a day biometrics has entered in security system of various digital equipments also like cell phones, laptops, cars, etc. Out of various biometrics, the most commonly used six of them

are face recognition, finger print, signature verification, iris recognition, lip reading and hand gesture recognition technologies.

The face is one of the most acceptable biometrics because of its visual interactions. Unlike other biometrics, face recognition is non-intrusive and can be used even without having subject's sufficient knowledge. In other biometrics like fingerprint, voice, iris and DNA, there always persists the problem of data acquisition. Illumination variation has been a big challenge in achieving good recognition rate in security system like ATM's, Banking sectors, Scanners etc. The work proposed in this thesis is to provide robustness against illumination variation. It is extension of face recognition system, as proposed by Sang Heon et. al. [3]. In their work, they designed a face recognition system to counter problem in identification during dim light conditions.

The block diagram of a face recognition system is shown in Fig.1. It consists of four components viz face detection, face alignment, feature extraction and classification.

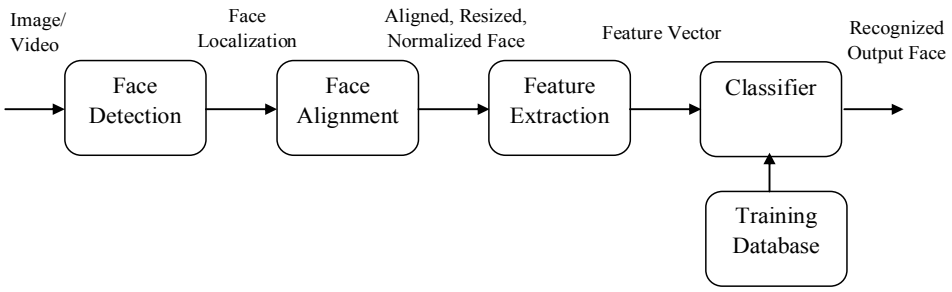

Figure 1. Block Diagram of Face Recognition System

First stage is face detection, where human faces are found out in an input image. After detection, faces are aligned centrally to extract facial features like eyes, brows, cheeks, ears, nose, or the facial contour. Face image are then preprocessed like rotated, masked, resized and normalized. Feature extraction is performed on a normalized facial image. The extracted features in the form of mathematical data are sent to a classifier and compared with the database.

2. Related Works

Various numbers of research papers from different journals and conferences, related to, face recognition techniques has been studied [3, 5-16]. It is observed that there are still lots of problems, prevailing in this technique, which are needed to be counter. Below is a report of related research survey in the proposed area of research. Two widely used feature extraction techniques, Principal Component Analysis and Linear Discriminant Analysis, have been deeply reviewed.

On the basis of study it is found that, PCA performs generalization of data by reducing the feature space dimension through variance of the input data. Features are selected in such a way that maximum information is retained in a small feature space. While PCA performs generalization of the input data, LDA performs discrimination of the input data through dimension reduction. LDA projects the input data on a lower dimensional space such that it has discriminated pattern. Hence LDA maximizes the scatter between

different classes and minimize the scatter between the input classes. Both of these techniques have advantages over each other. PCA might outperform LDA, when the number of samples per class is small and LDA outperforms PCA with a large number of samples in training dataset. LDA is better than PCA, when training datasets are different. However, PCA is better than LDA, when dimension of face images is high. As Illumination had been a great problem in face recognition system, Differential 2-dimensional PCA is an effective tool to dominate light variation effect. This enhanced technique followed by normalization and fusion can be implemented on the light variant images to increase the accuracy.

Various Problems are listed out on the basis of literature survey [3, 17-21]. The sources of deviation in the facial appearance can be classified as two factors. Intrinsic factors are due to the physical properties of the face, but independent of the observer. It is subdivided into intrapersonal and interpersonal. Intrapersonal include variation in the facial appearance of an individual, such as being ageing effect, facial expression variation and occlusions. Interpersonal factors are due to differences in the facial appearance of different people, such as unevenness, identity deviation. Extrinsic factors are due to external effects.

Out of these entire problems, illumination variation and large dimensionality are generally faced in security systems, which are being worked out in this work.

3. Problem Identification

Facial images are divided into two vertical halves. 2DPCA and D2DPCA are separately applied on both halves. Euclidean distance measures are calculated between test and training half images. These distances are then normalized by sigmoid function followed by their fusion. Finally minimum value of these fused scores is used to recognize identity of test. Four different types of normalization techniques are used over Euclidean distance; these are Min-Max, Z-Score normalization.

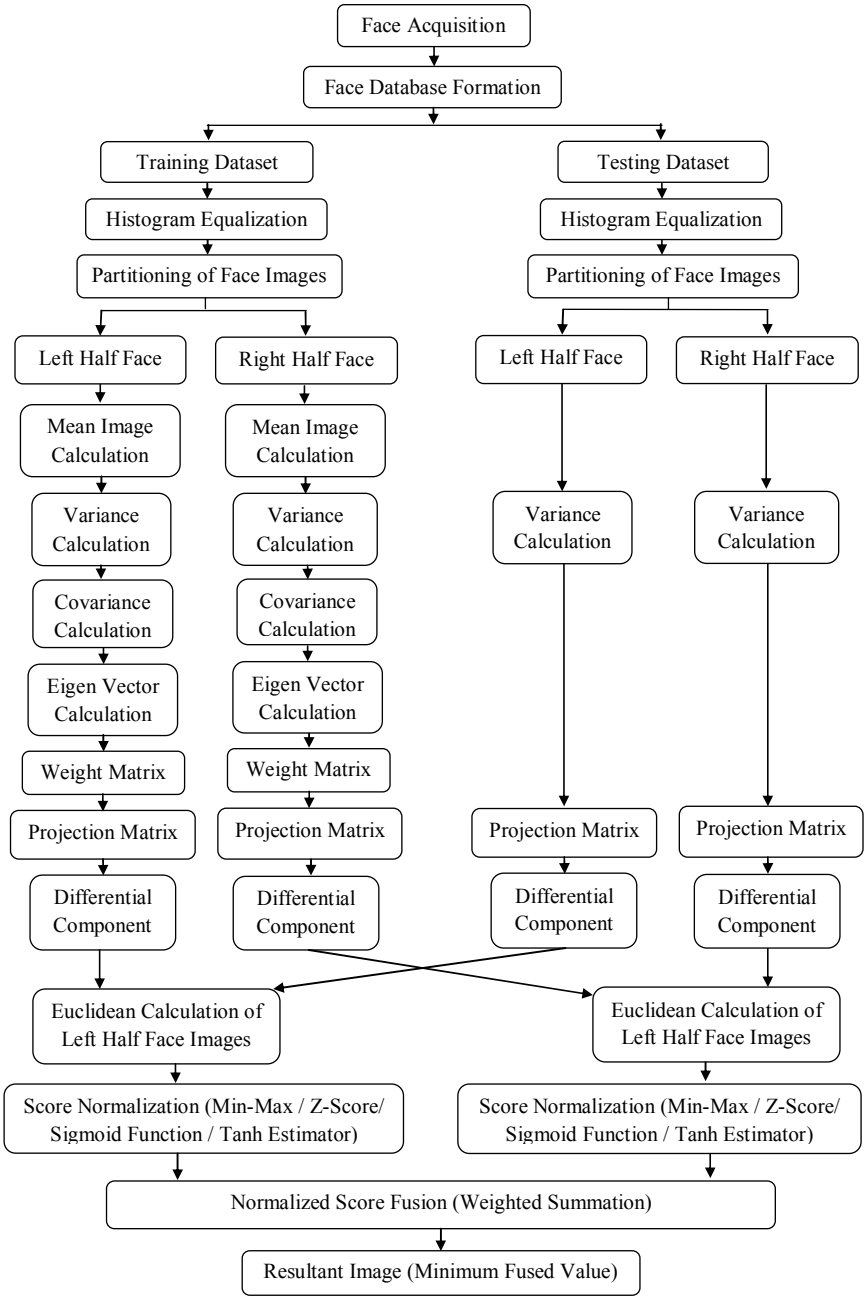

Figure 2 Flowchart of Proposed Method

The face recognition system adopted in this work is having five phases-

1. Face Image Database Acquisition- The size of each image is 168x192 pixels, with 256 grey levels per pixel are resized to 48x42 pixels. Training images have more or less same illumination intensity. After which they are divided into two equal halves by vertical line passing through nose tip. Both of these half images are then histogram equalized.

2. Feature Extraction - In PCA, face images are converted into a single column vectors and then all face vectors are appended column wise. To increase efficiency, D2DPCA is used where facial images are not converted into vector but they are concatenated as matrices page by page.
3. Normalization Techniques- Distance Score between each of left and right half projected training image and projected test image is then normalized. By normalization, distance scores of each of left and right half face image are mapped between 0 and 1. Normalization Techniques used here are Min-Max Normalization, Z-Score, Sigmoid Function, Tanh Estimator Normalization Technique.
4. Fusion Technique- Feature level fusion refers to combining different feature vectors [35]. For homogeneous features, a single resultant feature vector can be calculated as a weighted average of the individual feature vectors. However for non-homogeneous features, then they can be concatenated to form a single feature vector. Here fusion is being performed by weighted summation method, which is homogenous feature level fusion of pre-classification type fusion.
5. Recognition- At this stage, test image is recognized from training image database. To carry out this task, simply minimum value of fused score is found.

4. Results And Discussions

Results of various face recognition techniques utilizing different algorithms are found out and then their recognition rates are compared at varying PCA features. These face recognition systems are implemented using MATLAB version R2010a. In conventional method, training of system is performed by taking whole face image and face recognition system is applied with PCA, LDA, 2DPCA and D2DPCA. In proposed method, each training facial images are divided into two halves, classified with test image, normalized and finally fused, these images are applied with 2DPCA and D2DPCA algorithms. Recognition rate of each algorithm is represented with varying number of PCA features. As PCA and LDA are single dimension techniques, their eigenface space dimension is equal to number of facial images in training database. While 2DPCA and D2DPCA are two dimensional techniques, here eigenface space dimension is dimension of image. But in the proposed method, face images are divided into two halves and then applied with 2DPCA and D2DPCA, so in this case dimension will get halved. So dimension reduction is better in proposed method.

Table.1 Summary Of Recognition Rate Results As Various Approaches

The First Approach by Using Whole Face Image (Without Partitioning)	
Recognition Algorithms	**Maximum Recognition Rate**
PCA	29.21%
LDA	67.61%
2DPCA	36.93%
D2DPCA	72.79%
The Second Approach of Using Half Face Images (By Partitioning)	

Recognition Algorithms	Image	Maximum Recognition Rate
2DPCA	Left Face	50.93%
	Right Face	49.64%
	Fusion	52.10%
D2DPCA	Left Face	85.68%
	Right Face	79.61%
	Fusion	96.03%

Table. 2 Comparison of Recognition Rates of this work with Previous Method

System	Normalization Technique	Recognition Rate
Sang-Heon et.al.[41]	Sigmoid Function	95.59%
Our Method	Min-Max Function	95.76%
	Z-Score Function	95.90%
	Sigmoid Function	95.90%
	Tanh Estimator Function	96.03%

Table 2 is giving comparison of recognition rate of previous method and proposed method. For Cropped Extended Yale Face Database B+ [22], recognition rate by Sang Heon et. al. [3] is 95.59%, while for our method it is 95.90%, which is around 0.31% greater than previous work.

On the basis of methodology explained, class wise and features wise variation in recognition rates for various algorithms are compared. Here D2DPCA based feature extraction technique with Z-Score Function is giving maximum recognition rate of 95.90%.

5. Conclusions

Face recognition system is designed to overcome the problem due to illumination variation effect in face. On the basis of literature reviews, it is found that illumination variation is one of the great problems, which is needed to be worked upon. Cropped Extended Yale Face Database B+ [22] provided a rich database of 38 persons with each having 64 different illumination conditions. In the first part of this thesis, conventional methods such as PCA, LDA, 2DPCA, D2DPCA are applied over training face database having 5 images and 59 images in testing database for each of 38 persons. Recognition rate achieved are 29.21%, 69.61%, 36.93% and 72.79% respectively for these two feature extraction algorithm. In the second part, a technique proposed where each face images are vertically divided into two halves. 2DPCA and D2DPCA are applied on each halves separately. Euclidean distance is calculated between training and testing half images followed by normalization and fusion technique. For two different normalization techniques, which are min-max, z-score recognition rate achieved are 95.76% and 95.90% respectively. Recognition rate, on the similar database, performed by Sang-Heon et. al. [3] was 95.59% and the same is around 95.90% for this work.

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