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An Efficient Face Recognition under Varying Image Conditions

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***Abstract*— Performance of the face verification system depends on many conditions. One of the most problematic is varying illumination condition. Making recognition more reliable under uncontrolled lighting conditions is one of the most important challenges for practical face recognition systems. Our paper presents a simple and efficient preprocessing method that eliminates most of the effects of changing illumination and shadows while still preserving the essential appearance details that are needed for recognition. This preprocessing method run before feature extraction that incorporates a series of stages designed to counter the effects of illumination variations, local shadowing, and highlights while preserving the essential elements of visual appearance.In this paper, proposed a robust Face Recognition System under uncontrolled illumination variation. In this Face recognition system consists of three phases, illumination insensitive preprocessing method, Feature-extraction and score fusion. In the preprocessing stage illumination sensitive image transformed into illumination-insensitive image, and then to combines multiple classifiers with complementary features instead of improving the accuracy of a single classifier. Score fusion computes a weighted sum of scores, where the weight is am measure of the discriminating power of the component classifier. In this system demonstrated successful accuracy in face recognition under different illumination condition. The method provides good performance on three sets that are widely used for testing under difficult lighting conditions: Extended Yale-B, Face Recognition Grand Challenge Version 2 experiment (FRGC-204), FERET datasets. The results obtained from the experiments showed that the illumination preprocessing methods significantly improves the recognition rate and it's a very important step in face verification system.**

***Index Terms*— Face recognition, uncontrolled image, normalization, smoothing, fusion, gradient, reconstruction, feature extraction, multiple face model, frequency band selection.**

I. INTRODUCTION

Face recognition has been growing rapidly in the past few years for it's many uses in the areas of Law Enforcement, Biometrics, Security, and other commercial uses. While face recognition has increased in reliability significantly it is still not accurate all the time. The ability to correctly categorize the image depends on a variety of variables including lighting, pose, facial expressions, and image quality. Face is one of the most commonly used by people to recognize each other. Over the course of its evolution, the human brain has developed highly specialized areas dedicated to the analysis of the facial images.

In the past decades, face recognition has been an active research area and many types of algorithms and techniques have been proposed to equal this ability of human brain. It is however questioned whether the face itself is a sufficient basis for recognizing, a person from large population with great accuracy. Indeed, the human brain also relies on much contextual information and operates on limited population.

The most problematic perturbation affecting the performance of face recognition systems are strong variations in pose and illumination. Variation between images of different faces in general is smaller than taken from the same face in a variety of environments.

The face verification system authenticates a person's claimed identity and decides that claimed identity is correct or not. In this case we have limited user group and in the most cases we can forced or demand frontal pose orientations. Unfortunately we still have problems with illumination condition. Face recognition tests revealed that the lighting variant is one of the bottlenecks in face recognition/verification. If lighting conditions are different from the gallery identity decision is wrong in many cases.

There are two approaches to this problem. Model- based , and preprocessing-based. Model-based attempt to model the light variation. Unfortunately, this requires large amount of training data and sometimes fall when we have complicated lighting configuration. The second approach using preprocessing methods to remove lighting influence effect without any additional knowledge. So these methods are not practical enough for recognition systems in most cases.

The proposed system is used to match two face images of the same person under different illumination condition. In the preprocessing stage illumination sensitive image transformed into illumination-insensitive image, and then to combines multiple classifiers with complementary features instead of improving the accuracy of a single classifier. Score fusion computes a weighted sum of scores, where the weight is a measure of the discriminating power of the component classifier. In this system demonstrated successful accuracy in face recognition under different illumination condition.

Illumination variation is the main obstacle for face recognition. since face image appearances of the same person change under different illuminations. Sometimes, the changes in terms of different illuminations among the same person are greater than those of different persons among the same illumination.

Preprocessing algorithms to minimize the effect of illumination changes for face recognition have been developed, and many developments and advantages have occurred within the 3-D face model training stages. In presented an image-based technique that employed the logarithmic total variation model to factorize each of the two

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aligned face images into an illumination-dependent component and an illumination-invariant component.

Features to be used for person classification are extracted to identify any invariance in the face images against environmental changes. In this paper, we extend the AFD [6] to handle a large number of uncontrolled face images effectively. This learning process is done independently from various selected frequency bands using a 2-D discrete Fourier transform.

This feature extraction framework is introduced in order to remove unnecessary frequency parts as the occasion demands for face recognition. Three types of Fourier feature domain, concatenated real and imaginary components, Fourier spectrums, and the phase angle, are represented. The information each classifier extracts is well summarized in the score each classifier produces.

Hence, combining the classifiers can be achieved by processing the set of scores produced by component classifiers and generating a new single score value. We call this process "score fusion." Previous methods for score fusion include sum rule, product rule, weighted sum, Bayesian method, and voting . In this paper, we consider a score fusion method based upon a probabilistic approach, namely, log-likelihood ratio (LLR) for face recognition.

II. Proposed Face Recognition System

The proposed face recognition system consists of a novel illumination-insensitive preprocessing method, a hybrid Fourier-based facial feature extraction, and a score fusion scheme. First, in the preprocessing stage, a face image is transformed into an illumination-insensitive image, called an "integral normalized gradient image," by normalizing and integrating the smoothed gradients of a facial image. Then, for feature extraction of complementary classifiers, multiple face models based upon hybrid Fourier features are applied.

The hybrid Fourier features are extracted from different Fourier domains in different frequency bandwidths, and then each feature is individually classified by linear discriminant analysis. In addition, multiple face models are generated by plural normalized face images that have different eye distances. Finally, to combine scores from multiple complementary classifiers, a log likelihood ratio-based score fusion scheme is applied. The proposed system consists of three stages,

- Illumination-insensitive pre-processing method
- Hybrid Fourier-based facial feature extraction
- Score fusion scheme

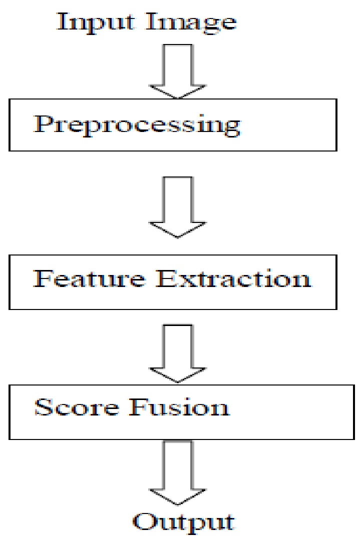

Fig.1. Flow of Design

III. Illumination Insensitivity Preprocessing Method

Compared to the controlled illumination changes in the studio (indoors, same day, overhead), achieving high recognition accuracy in an uncontrolled illumination situation (outdoors, different day) is hard. The main reason is that the image distortion caused by illumination changes makes images of different persons in the same illumination conditions more similar rather than images of the same person under various illumination changes.

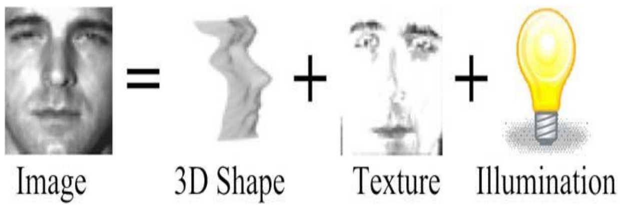

Fig. 2. Under the assumption of the Lambertian reflectance model, an image consists of a 3-D shape, texture, and illumination.

Before going to illumination normalization the image analysis technique will be performed.Here it considers the two factors. The intrinsic factor is illumination free and represents the identity of a face image, where as the extrinsic factor is very sensitive to illumination variations, and only partial identity information is included in the 3-D shape.An illumination-insensitive image could be obtained by enhancing the intrinsic factor and depressing the extrinsic factor in the input image.

Illumination insensitivity preprocessing method is first stage of in this system. In this stage the input image get decomposed into low frequency component image and high frequency component image. Smoothing is performed on high frequency component image , and normalizing is performed on low frequency component image. Reconstruction is performed by combining the processed low and high frequency component image. This is called Integral Normalized Gradient Image.

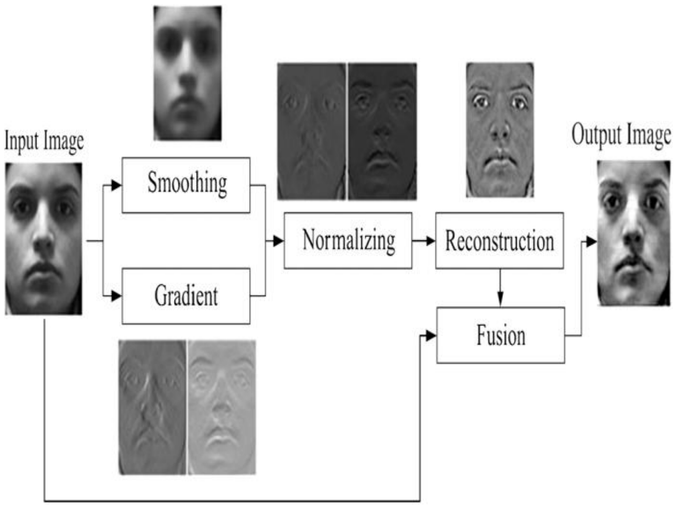

Fig.3. Structure of the integral normalized gradient image

As complete removal of the illumination variations can lead to loss of useful information for face recognition, we fuse the reconstructed image with the original input image.

IV. Feature Extraction

In this face recognition system with selective frequency bandwidth and multiple face models based upon different eye distances . To gain more powerful discriminating features, extract the multi block Fourier features.

First divide an input image into several blocks and then apply a 2-D discrete Fourier filter to each block. The Fourier features extracted from blocks by band selection rules are finally concatenated.

In Feature-extraction three different Fourier features extracted from the real and imaginary component (RI) domain, Fourier Spectrum (Γ) domain, and phase angle (Φ) domain in different frequency bandwidths (B1,B2,B3). All Fourier features are independently projected into discriminative subspaces by PCLDA theory. The different frequency bandwidths takes different area in our face regions. For each particular region gives one particular face model. By this method the multiple model can be created.

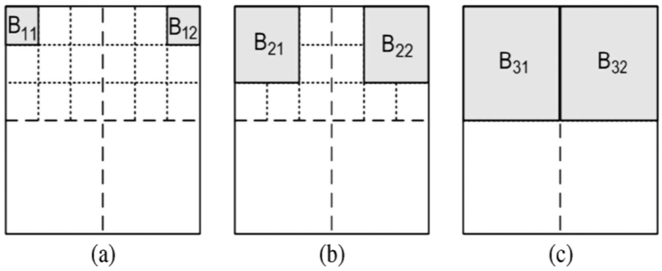

Fig. 4. Feature regions are selected according to different frequency bands in Fourier features. The upper left point of all quadrangles (0, 0) is the lowest frequency, and notations are B_1,B_2, and B_3.

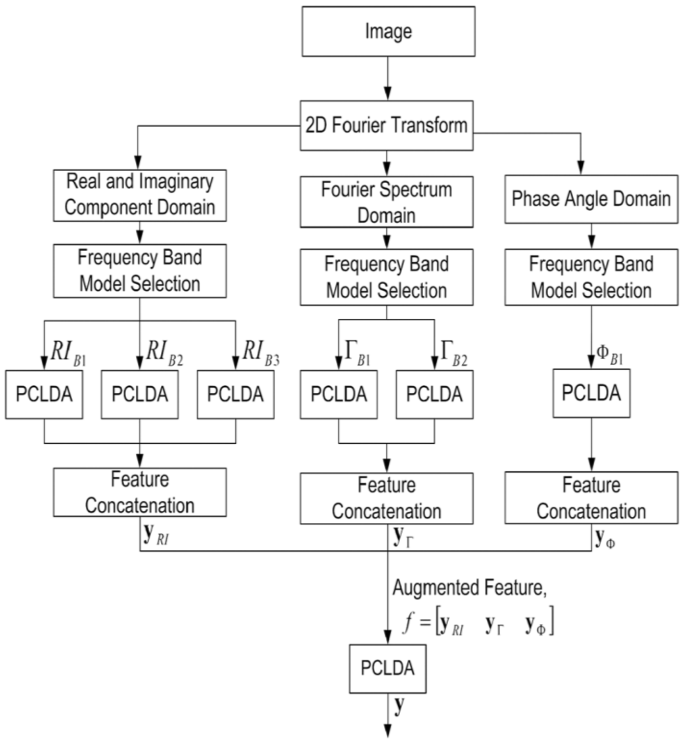

Fig.5. Structure of fourier feature

V. Multiple Face Model For Robust Face Recognition

In computer vision tasks, internal facial components have been commonly employed, because external features (e.g., hair) are too variable for face recognition. However, in the case of humans, result showed that both internal and external facial cues are important, and moreover, the human visual system sometimes makes strong use of the overall head shape in order to determine facial identity.

In this respect, here to propose a multiple face model that consists of three face models with different eye distances in the same image size. It is designed to imitate the human visual system and examines a face image from the internal facial components to the external facial shapes.

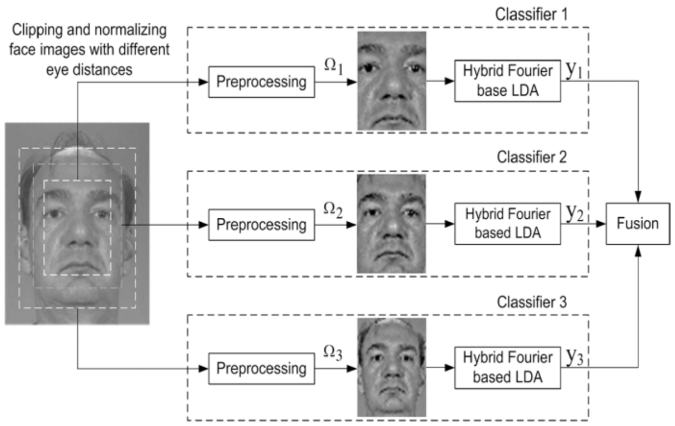

Fig.6.Structure of Fourier-based LDA with multiple face models.

The last one, the dominant face model, is a compromise between the fine model and the coarse model. Now that they all have their own individual interesting aspects for analysis, each face model can play an inherent role for the others in the face recognition system.

V. SCORE FUSION

Combining the classifiers can be achieved by processing the set of scores produced by component classifiers and generating a new single score value. This process is called "score fusion." In this system score fusion method based upon a probabilistic approach, namely, loglikelihood ratio (LLR) for face recognition.

If the ground truth distributions of the scores are known, LLR-based score fusion is optimal. However, the true distributions are unknown so we have to estimate the distributions. propose a simple approximation of the optimal score fusion based upon parametric estimation of the score distributions from the training data set.

VI. EXPERIMENTAL RESULTS AND DISCUSSIONS

The proposed system is implemented using an Matlab program with GUI where it is evaluated for compress the image. The performance of the algorithm is evaluated on several real images. These pictures are the most widely used standard test images used for face recognition algorithms.

Original image get decomposed into low frequency component image and high frequency component image. Smoothing is performed on high frequency component, and normalizing is performed on low frequency component. Reconstruction is performed by combining the processed low and high frequency component image.

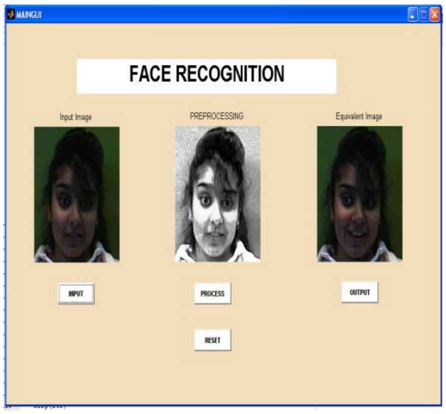

Fig.7. Face recognition process

Recognition Rate is used to evaluate the quality of various face recognition algorithms. The RR formula is defined as follows:

$$RR= \frac{\text{number of correctly identified faces}}{\text{Total number of faces}} \times 100$$

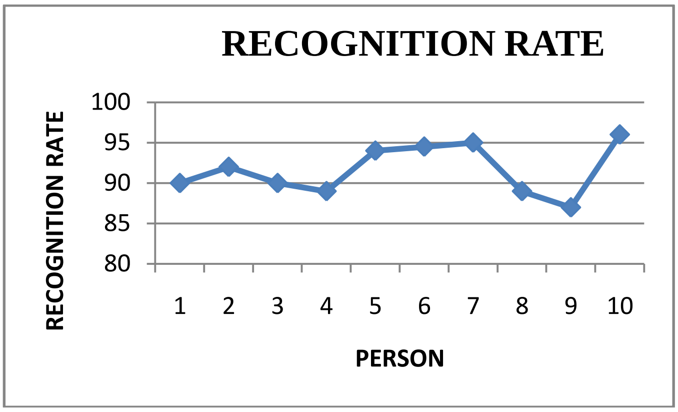

Fig.8. Recognition Rate

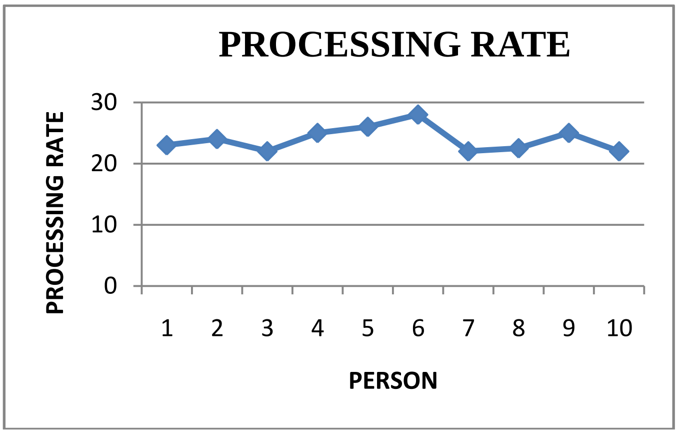

Fig.9. Processing time

The processing time is the process evaluate the computational times for the proposed method and the feature extraction stage of each local feature-based method.

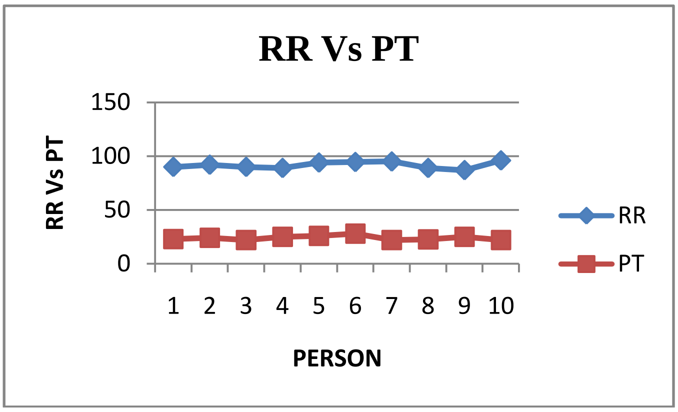

Fig.10.Processing time Vs Recognition rate

Face recognition process down with GUI implementation. Here input image condition will be normalized using preprocessing technique then the feature will be extracted classifiers are used to recognition the input image from the data base image.

VII. CONCLUSION

In this face recognition system with preprocessing, feature extraction and classifier, and score fusion methods for uncontrolled illumination situations. First, a preprocessing method, a face image is transformed into an illumination-insensitive image. The hybrid Fourier-based classifiers with multi face models, which basically consist of three Fourier domains, concatenated real and imaginary components, Fourier spectrum, and phase angle.

The Fourier features are extracted from each domain within its own proper frequency bands, and to gain the maximum discriminant power of the classes, each feature is projected into the linear discriminative subspace with the PCLDA scheme. The multiple face models, namely, fine, dominant, and coarse face models. Have the same image sizes with different eye distances.

Multiple face models always perform better than the dominant face model. Moreover, to effectively utilize the several classifiers, the score fusion method based upon the LLR at the final stage of the face recognition system.

FUTURE WORK

In this work to include the pose variation and age variation in order to increase the recognition rate in case of the uncontrolled condition images. The pose variation based on Affine Transform (pose correction with frontal pose images) and Age variation based age simulation or age Mapping.

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