# Survey on Different Approaches for Illumination Invariant Face Recognition

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Abstract—Face recognition method is the one of the biometric methods, to identify and verify the face image. It is a computer application for automatically identifying or verifying a person from a digital image. Face recognition system is an important area which is used in many applications such as video surveillance, Security Monitoring, Access control, human computer interface and image database management. Lots of research has been done on face recognition technology. However, there are some challenging problems such as different poses of faces, varied facial expression and variation in illumination in the face images which degrades the performance of face recognition system. This survey paper reviews different approaches to overcome the adverse illumination conditions.

**Keywords:** Face Recognition, Illumination Invariance, Preprocessing, Feature Extraction, Classification

## I. INTRODUCTION

Face recognition is very active research area. There has been lots of improvement achieved till now. Face recognition is used to identify and verify the person. Face Recognition became more important and competent with other biometric applications. Some biometrics like fingerprints, iris scan, or speech recognition require participation of test subject such as in fingerprint people need to place his/her hand on the system or for iris scan people need to stand in front of camera and also it cannot perform mass identification. Whereas, Face Recognition has key advantage is that it does not require cooperation of test subject to work. Face recognition can perform mass identification and it can identify individual among the crowd without people being aware of it. The performance of any Face Recognition system is adversely affected by changes in the facial appearance caused by variation in lighting, different poses of faces, varied facial expression and variation in illumination in the face images, the presence of accessories (glasses, beards, etc); finally, the rotation of a face may change many facial characteristics. Among them, harsh lighting conditions such as underexposure, overexposure and shadow, are regarded as one of the hurdle for robust face recognition.

To overcome the illumination different approaches has been proposed. Still we need some more approaches which can give satisfied result.

The rest of the paper is organized as follows: In section II face recognition system is described. In section III preprocessing approaches are described and in section IV and V approaches for feature extraction and different classifiers are described respectively and it followed by Section VI Conclusion.

II.

# FACE RECOGNITION SYSTEM

Generally Face recognition system consists of following steps as show in fig. 1



# Fig.1: face recognition steps

# A. Face Recognition steps

## *1) Face detection:*

Face detection is a technology that determines the locations and sizes of human faces in digital images. It detects facial features and ignores anything else, such as buildings, trees and bodies. It may include face edgedetection, segmentation and localization, namely obtaining a pre-processed intensityface image from an input scene, either simple or cluttered, locating its position and segmenting the image out of the background [1].

## 2) Pre-processing:

Pre-processing step is used to pre-process the image means it may remove the noise or make it clearer or efficient one. It is the important step. For illumination invariant face recognition, removing illumination is performed as preprocessing step.

#### *3) Feature extraction:*

Feature Extraction involves extraction of the features of the face which differentiate people from one to another. It is also called as dimensionality reduction. It may denote the acquirement of the image features from the image such as visual features, statistical pixel features, transform coefficient features, and algebraic features [1].

#### 4) Classification/Recognition:

In this step recognition of face is performed. Classifier is used to classify the person as recognized or unrecognized person.

## B. Applications

The main application of face recognition system is to verify and identify person. Verification involves one-one matching and identification involves one-many matching.

It is used in surveillance, general identification techniques, security, smart card application, criminal justice etc.

#### III. II. PREPROCESSING OR ILLUMINATION NORMALIZATION TECHNIQUES

These techniques attempts to make image clear or efficient

and tries to normalize the illumination. There are various techniques invented to compensate the illumination. Preprocessing method can be used before extracting the features to improve the face recognition system.

Existing approaches addressing the illumination variation problem fall into two main categories: Passive approach and Active Approach. In "passive" approaches, they attempt to overcome this problem by studying the visible spectrum images in which face appearance has been altered by illumination variations. The other category is "active" approaches, in which the illumination variation problem is overcome by employing active imaging techniques to obtain face images captured in consistent illumination condition, or images of illumination invariant modalities [2].

Haiyang et al. [3] explained some pre-processing methods such as Wavelet transform, Discrete Cosine Transform (DCT), Color normalization methods. To improve the performance we can combine more than two or more processing methods. Histogram Equalization is the most commonly used approach. By performing histogram equalization, the histogram of the pixel intensities in the resulting image is flat. It is interesting that even for images with controlled illumination; applying histogram equalization still offers performance gain in face recognition [2].

Suppressing illumination or normalizing or compensating the illumination is a pre-processing step. Many of the methods proposed for normalizing illumination. In [4] proposed method is first histogram equalization is performed for the contrast stretching and then low frequency DCT coefficients are scaled down to compensate the illumination variation. The proposed method of [4] gives better performance without any error even in worse illumination condition and it is computationally efficient and can easily be implemented for real time face recognition system.Baradarani et al. [5] described multi-resolution based method for face recognition under illumination variation. double-density dual-tree complex wavelet transform (DD-DTCWT) is used. DD-DTCWT is shift invariant and has directionality. DD-DTCWT is designed based on the use of two scaling functions and four wavelets at the same time. Chen et al. [6] proposed method discrete transformation in logarithm domain, it is based on the concept that illumination variation mainly lie on the low frequency band and by truncating appropriate number of DCT coefficient, we can compensate the illumination. DCT in logarithm domain gives efficient result compared to other method. Abbas et al. [7] used the same method as proposed in [6] but skipped the inverse DCT step so it improved the speed. In [8] pre-processing is done using different techniques combined together which are histogram equalization, discrete cosine transform (DCT) and steerable gaussian filters. By combining these techniques it resulted in improving the performance. The steerable filter based normalization technique (SGF) uses steerable filters for removing illumination induced appearance variations from the facial images [8].

In [9] quotient image based methods are described to suppress the illumination. These are simple method and quotient image is based on lambertian model. The drawback of QI is that its performance stronglydepends on bootstrap database and known lighting conditions. New method isproposed Self Quotient Image (SQI) and also Morphological Quotient Image (MQI). In [10] for compensating the illumination dynamic morphological quotient image (DMQI) which generates the quotient image after morphological filtering.

# IV. FEATURE EXTRACTION TECHNIQUES

Facial features plays vital role in recognizing a face. There are four basic approaches for feature extraction. These are as follows [11]:

# A. Geometry-based Techniques

The features are extracted by using relative positions and sizes of the important components of face. It extracts the distinctive features such as eyes, nose, mouth etc. eyes, nose, mouth are the main features. After extracting the features, it calculates the geometric relations between the facial points. LBP [12] is geometry based technique. It divides the face image into blocks and each block is corresponds with each central pixel. it examine its pixel neighbors, based on the grayscales value of central pixel to change its neighbor to 0 or 1. Therefore, every pixel will be represented in a binary string. Since then, we build histograms for every region. Then these histograms are combined to a feature vector for the face image [11].

In [10] face texture features are extracted by the cascade of two LBP features. First, local detail texture features of the sub-block faces are obtained by the use of relatively small LBP operators. Then, global profile characteristics are obtained by the use of relatively large LBP operators. After that, two histograms are integrated together in the right order as the final identification features. Variant of LBP is weighted LBP which is described in [9].

Geometry based techniques have disadvantage that it need large number of features.

# B. Color Segmentation Based Techniques

This approach makes use of skin color to isolate the face. Any non-skin color region within the face is viewed as a candidate for eyes or mouth. By using Color models such as RGB, YCbCr or HSV with certain range of color pixels, skin region is detected. After getting the skin region, facial features viz. Eyes and Mouth are extracted [11].

Its performance is limited due to diversity of background of image. There is also discontinuity between colors.

# C. Appearance Based Techniques

PCA, ICA, LDA are some common techniques used for feature extraction. These are statistical techniques. Principal Component Analysis (PCA), Independent Component Analysis (ICA) and Linear Discriminate Analysis (LDA) are most widely used approaches. Independent component analysis (ICA) is a computational method for separating a multivariate signal into additive subcomponents supposing the mutual statistical independence of the non-Gaussian source signals [2]. PCA is common technique, it is simple method. To improve the drawback of PCA, different variants of PCA are proposed such as Kernel PCA (KPCA), modular PCA (MPCA), 2 dimensional PCA (2D PCA) etc. in [12] 2D-PCA is used for feature extraction technique, itgives better performance than the PCA. There are also variants of LDA such modular LDA (MLDA), 2 Dimensional LDA (2D-LDA).

It requires large database and also need good quality image to get the good performance.

# D. Template Based Techniques

This method group will extract feature of face such as eyes, mouth, etc. based on template function and appropriate energy function [11]. The methods have been proposed such as deformable template and genetic algorithms.

Template based techniques involves lots of computation, which is its disadvantage.

# V. CLASSIFIERS

There are different classifiers used for face recognition system. Different classifiers have their advantages and disadvantages.

Artificial Neural network (ANN) is an ideal tool for pattern recognition. ANN is powerful tool which can not only predict seen data but it can also predict unseen data. In [13] neural network is used as a classifier which gives efficient result compared to other method. It is concluded that this method has the acceptance ratio is more than 90 % and execution time of only few seconds result. Nowadays, support vector machine is emerged which gives more accurate result compared to neural network. In [14] shown the comparisons of ANN, SVM and Correlation and it concluded that SVM is better than neural network and correlation. Neural network separates classes through only single lines, while SVM separates classes through fuzzier boundary and hence SVM has less chance of miss classification compared to neural network.

Mathur et al. [15] shown the comparison of neural networks based on supervised learning and unsupervised learning. The networks used in here were feed forward back propagation neural network for supervised learning and counter propagation network for unsupervised learning. It concluded that unsupervised learning gives better accuracy than the supervised learning algorithm.

In [16] Dynamic Bayesian network (DBN) is proposed to incorporate the information from different cameras as well as the temporal clues from frames in a video sequence. It is advantageous since the dynamics in different frames for the specific person can be learned to help the recognition of the subject. It is better than different classifiers such as support vector machine (SVM), nearest neighbors (NN), linear discrete analysis (LDA). In most cases, NN and LDA are less able to discriminate the faces from the unconstrained video sequences. SVM improves the results by seeking for the maximum separation between the features of distinct subjects [16].

In [4] Nearest Neighbor classification is used as classifier for face recognition. Various variants of nearest neighbor classifiers are also there such as K-Nearest neighbor classifier (K-NNC), Nearest Mean Classier (NMC). In k-NNC, instead of 1-NN, generally, k-nearest neighboring data objects are considered. Then, the class label of unseen objects is established by majority vote. The parameter krepresents the number of neighbors involved. Tuning k as a way to regularize the NNC gives a trade-off between the distribution of the training data with a priori probability of the classes involved. When k = 1, the training data distribution and a priori probability are considered, while, when k = N, only a priori probability of the classes determines the class label. In NMC, we consider only the mean of each class, i. e. one prototype per class. In comparison to NNC, NMC has a high error on the training data and on the test data, but the error on the training data is a good prediction of the error on the test data [4].

# VI. CONCLUSION

In this paper, we have described various approaches proposed for pre-processing the image, for the feature extraction and for the face recognition. All these different approaches have their own advantages and disadvantages. Based on our requirement we can use the approach and modify the approach to meet our requirement.

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