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Literature Survey on Various Face Recognition Techniques under Varying Illumination and Pose

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Abstract: **Face Recognition is one of the important biometric and as a successful application of image analysis and understanding it has gained a significant attention. Face recognition aims at capturing and using the behavioral and physiological characteristics for unique verification and identification. Face recognition is applicable to wide range of applications like security etc. Even though the face recognition is an important biometric method it is challenging task due to the large variations in pose, illumination, scale, occlusion etc. Pose and illumination may change the occurrence of face image from one to another and variations in the pose and illumination may also hinder correct face recognition, so these are the major two challenges in the recognition process. Face recognition achieves better accuracy compared to some of the biometric recognition like finger print analysis etc. In this paper we will be discussing about the various methods on pose and illumination for face recognition.**

Keywords: **Face Recognition, Biometrics, Illumination, Pose, Identification, verification.**

1. INTRODUCTION

Face recognition is a type of biometric application that will automatically verify or identify an individual in an digital image or a video source by comparing and analyzing the patterns in the database. Face recognition has two main task identification and verification. Verification is a process of comparing the face image with the given face image template and gives yes or no decision. Identification is the process it compares the face image with the entire face image template in the database and produces a ranked list of matches.

We choose the face recognition for the following reasons:

- No physical interaction is required.
- It provides high accuracy
- Experts are not required to interpret the recognition results.
- It works on existing hardware configurations.
- It provides passive identification

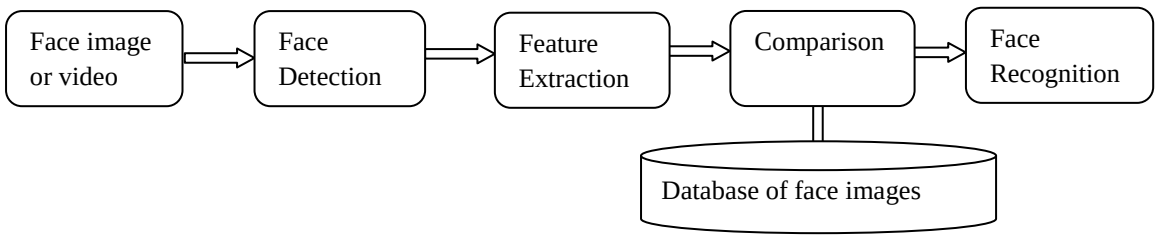

Fig 1: Face recognition process

In the Fig 1, the first step in the face recognition process is capturing the image using camera. The next step is *face detection*, the objective is to find are there any face image in the captured image if an face image is present it returns its location. This is followed by and *normalization* in order to remove noise and standardize the image in terms of pose, illumination, size etc. This is followed by *feature extraction*, the objective is the mathematical representation of the image is generated which is called has biometric representation of the image and is stored in the database. This is followed by *face recognition*; the biometric representation of the captured image is generated and compared with the template in the database.

There are three basic approaches in face recognition:

- **Feature-based approach-** In the featured base approach the local features of the face like eyes, nose etc is used for face segmentation and is used as input for face detection step.
- **Holistic approach-** The entire face is used as an input in the face detection step and used as input for face recognition.
- **Hybrid approach-** it is the combination of feature and holistic the local features of the face image as well as the entire face images is used as input to the face detection.

Applications:

- Child base protection
- Identification solutions
- Homeland defense
- Airport security
- Access control
- Financial services

2. LITERATURE SURVEY

Timo Ahonen et.al [1] has proposed a method; in which preprocessing stage the face images are registered using the eye co-ordinates and elliptical mask has used in order to exclude the non face area from the image. This image is divided into several facial regions and LBP are extracted for each facial region and global feature histogram is constructed, the nearest neighbor classifier for face recognition. The FERET database is used and the face recognition accuracy is 79%.This method can easily extract in single scan, but speed of recognition decrease due to the length of feature vector.

Peng Yang et.al [2] has proposed a method, in which only the small amount of the gabor features of the image are selected by Adaboost from large set features and then an strong classifier that is learnt by the adaboost has been used to combine the gabor features which will evaluate the similarity between the face images. FERET database is used and face recognition accuracy is 95.2%.This method is low dimensional and discriminant and achieves good performance and recognition rate has to be improved.

Wenchao Zhang et.al [3] has proposed a method, in which an input image is normalized and transformed in order to obtain the multiple GMP, Each GMP, is converted into LBP map. Each local gabor binary pattern map is divided into an non overlapping rectangle regions and then for each region histogram is computed. These histograms are concatenated with the final histogram sequence as face model, nearest neighborhood classifier is used for face recognition. FERET database is used and the recognition accuracy is 96%. This method doesn't require learning process but it will not work for different pose and occlusion.

Faith Kahraman et.al [4] has proposed a face alignment method, AAM model will mark n land mark points on the image and these marked points are analyzed based on both texture and shape. The input face image is divided into left part and the right part and histogram for each window is generated and independently fitted into mean face histogram. The AAM based pose normalization will generate different poses for the available frontal image, this will improve the training dataset. Yala B database is used and the recognition accuracy is 95%.This method will handle pose and illumination variations and can model same identity under different illumination and pose, but recognition rate has to be improved.

Linlin shen et.al[5] proposed a method, in which boosting algorithm selects only the 200 gabor features, gabor wavelet are used for feature extraction, these gabor features are combined with SVM classifier for face recognition FERET database is used and the recognition accuracy is 92%. This method improves the computation cost but down sampling will result in loss of information.

Hasan Demirel et.al [6] has proposed a method, in which Histogram equalization in each color channel is used in order to equalize color image in RGB color space. SVD is used in order to describe the intensity matrix of each color channel in RGB color space to eliminate illumination problem. The SMQT method will segment the image and will eliminate the uninterested background. The minimum KLD between the PDF of the face image and PDF of the image in the database is used for face recognition. FERET database is used and the recognition accuracy is 97.78%.In this method PDF calculation is computationally cheaper than PCA, but Repetition of decision procedure in different color channels has higher computation cost.

Jawal Nagil et.al [7] has proposed a method, for feature extraction DWT-DCT domain coefficients and the SVM classifier is for classifying the feature vectors obtained using DWT and DCT into the separate groups and the input image is compared with the database during the classification.ORL database is used and the recognition accuracy is 98.9%. This method improves recognition rate, low cost, but it works only for frontal images.

Hasan Demirel et.al [8] has proposed method, in this approach the color PDF in HSI and Ycbcr color spaces of the face image is used as face descriptors, histogram equalization will remove the illumination problems. The minimum KLD between the face image and the database face image is used as the statistical feature vector for face recognition. Data fusion methods like median rule, max rule etc. are used to combine the PDF in different color channels. FERET database is used and the recognition accuracy is 99.33%.This method improves the performance, but the computational cost is high.

Paul Nicholl et.al [9] has proposed method, in this MVC extracts the features using DWT. Each face image is horizontally segmented into an overlapping horizontal segments and each horizontal segment is vertically further segmented into blocks each block is decomposed using wavelet filter and normalized The vector produced by MVC will be optimized using multiscale vector optimization. This final feature vector is then classified using the PCA. AT & T database is used and the accuracy of recognition is 97.5%.This method eliminates the need for manual segmentation, but it works only with PCA classifier and small databases..

PAN Hong et.al [10] has proposed method, in this illumination normalization is achieved using DMQI, the normalized image is divided into number of local regions by applying the LBP operator and the LBP descriptors are independently extracted from each of the region and then the histogram of the local regions is concatenated to form the global description of the face image. The Yale database is used and recognition accuracy is 83% to 91%.This method is computationally simple, but it has to be tested with different dataset and sever illumination variations.

Hafiz Imtiaz et.al [11] has proposed a method, in which an entropy based local band selection is, defined which will select horizontal segments of the face image that will contain high information. For each of local region that is residing in the horizontal segments dominant wavelet coefficient are selected as features. PCA is used for dimensionality reduction in the feature space. The recognition process is performed using distances of the feature vector of training face images and test images. The database used is Yale and ORL. The corresponding recognition accuracy is 98.71% and 99.75.This method works with simple classifier, partial occlusions, expressions and non liner lighting conditions, but it is not applicable for ORL database.

Muzhir Shaban Al-Anil et.al [12] has proposed a method, in this approach wavelet curvelet technique is used for feature extraction and nearest mean classifier is used for face recognition. MAFD and ORL database is used and the corresponding recognition accuracy is 93.6% and 98%.This method reduces the computational power and memory size, but this method doesn't work for occlusion variations.

Behzad Bozorgtabar et.al [13] has proposed a method, in this approach during the illumination normalization step two methods are applied first the lower end and upper end of the histogram are truncated and then the homomorphic filtering is used on the face image. The required features are extracted from the normalized image using the Fuzzy LDA. The extracted features are classified using the feed forward neural network.ORL database is used and the recognition accuracy

is 95.5%. This method is insensitive to the large illumination variations and has good recognition rate, but recognition rate has to be improved.

Dong-Ju Kim et.al [14] has proposed method using Local directional pattern. In this approach, the LDP feature at each pixel position is obtained by computing edge response values for the image in the 8 different directions then this LDP image is used as input to the 2D-PCA for feature extraction and representation and the nearest neighbor classifier is used for the face recognition. Yale B database is used and the recognition accuracy is 70.77% to 96.43%.This method has better recognition accuracy under varying illumination environments, but it works for only frontal images.

Wu FengXiang [15] has proposed a method, in this approach during the preprocessing wavelet transformation is applied to obtain the series of different resolution sub images and wavelet decomposition to obtain different scale of components. DW-LBP histogram for the different weighted sub regions of face image is calculated after the wavelet decomposition. Chi-Square is used for histogram sequence matching. ORL and AR database is used and the corresponding recognition accuracy with noise is 95.2%, without noise is 98.7% and with noise is 97.3%, without noise is 98.4%. This method reduces calculation complexity and improves recognition rate, but it does not work for different poses.

Table 1: Comparison of various face recognition approaches

Method	Database	Accuracy (%)	Author	year
LBP + NN classifier [1]	FERET	79	Timo Ahonen et.al	2004
Gabor features + Adaboost [2]	FERET	95.2	Peng Yang et.al	2004
Gabor filter + LBP + LGBPHS [3]	FERET	96	WenchaoZhang et.al	2005
Active appearance model [4]	Yala B	95	Faith Kahraman et.al	2007
Gabor features + SVM + OG-SVM	FERET	92	Linlin shen et.al	2007
SVD + SMQT + PDF in different color channels [6]	FERET	97.78	Hasan Demirel et.al	2008
DWT-DCT + SVM [7]	ORL	98.9	Jawal Nagil et.al	2008
SMQT + PDF + Data fusion methods [8]	FERET	99.33	Hasan Demirel et.al	2009
DWT + PCA [9]	AT&T	97.5	Paul Nicholl et.al	2010
DMQI + LBP [10]	Yale	83 to 91	PAN Hong et.al	2011
2D-DWT + PCA + Euclidean distance [11]	Yale and ORL	98.71 and 99.75	Hafiz Imtiaz et.al	2011
2D-DWT + Curvelet transform + NMC[12]	MAFD and ORL	93.6 and 98	Muzhir Shaban Al-Anil et.al	2012
Homomorphic filter + Fuzzy LDA + FFNN [13]	ORL	96.5	Behzad Bozorgtabar et.al	2012
LDP + 2D-PCA + NN classifier [14]	Yale B	70.7 to 96.43	Dong-Ju Kim et.al	2013
HCPP + RDW-LBP + Chi-square [15]	ORL and AR	95.2 with noise, 98.7 without noise and 97.3 with noise, 98.4 without noise	Wu FengXiang	2014

3. CONCLUSION

In this paper we have discussed different methods or approaches for detecting the face image, extraction of required features and recognition of face. Recognition of a face image under the different lighting conditions and poses are the major challenges. Various face recognition methods has been discussed here for solving the illumination and pose variation problem, and also discussed about the accuracy of the recognition rate and database used for the different face recognition approaches. Face recognition has become one of the important application in the recent years because it will allow the unique identification of the human face without any contact to machine and it also provides better recognition accuracy than other methods like finger print, palm print etc. for interpretation of face recognition results does not require an technical expert and the face recognition software works under existing configurations. Face recognition can be applied either on the video or the still images. More efficient techniques can be developed to enhance the results.

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