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# A Review on Face Recognition Approaches

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***Abstract*— Face recognition is a type of biometric software application that works on "Verification" and "Identification", which is very strong in authentication field because of its accuracy, reliability, and capability of keeping information's safe and well maintained. Face recognition applications recognizes a person based on face. The system will capture the image of a person and store it and then will try to recognize the person based on some unique features of human face that are previously present in the dataset. This paper explains review of Face Recognition Work Flow, Existing systems and results that are given by authors are shown. Face Recognition techniques such as Principle Component Analysis and Neural Networks are explained.**

***Key Words: Face recognition, Eigen face, Eigen vectors, PCA.***

## I. INTRODUCTION

Maintaining the security and confidentiality is a very big challenge in today's world. In recent time biometric system has been very popular and also found effective by many organizations like bank, forensic to maintain the confidentiality and security. Face recognition (FR) is more successful and effective authentication techniques than finger print and iris scan as being more natural and non-intrusive [5]. Being non-intrusive, FR can be easily implemented in an uncontrolled environment and without any knowledge of the subject. This is making FR most effective in applicable for applications like human behavior identification and analysis, identification of law enforcement, matching automated identification of criminals/terrorists at airport, video surveillance, credit card verification, authorization and authentication of personnel many organizations like military, bank etc. However designing a robust FR is a very big challenge due to various factors like illumination, age, appearance and orientation of face to the camera, human emotion like sad, happy, angry etc.

The purpose of FR system is to detect or identify a person from images or videos. This is accomplished by matching with a set of images which are already stored in a database. Working of FR system is very much similar to how human brains identify faces. But the problem here is the performance of the system which cannot be compared with human brain. Many researchers are working in this area to come up with a good accuracy rate.

FR techniques can be mainly grouped into photometric approach which uses various statistical parameters extracted from the images and geometric approach where features of individuals like eyes, mouth, nose trails etc are taken into consideration.

In this paper we present a review on some recently developed techniques. The rest of the paper is organized as follows: section II describes briefly the general FR model, section III presents some of the state of art techniques used in pattern recognition, section IV gives review of some existing works, section V is for the conclusion and then the references.

## II. FACE RECOGNITION MODEL

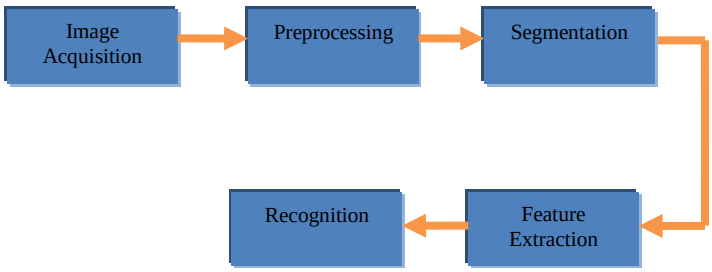


Figure 1: General Face Recognition Structure

In this section we present the structure of general FR model. This model undergoes through various stages. The stages are as follows.

Stage I: Image Acquisition
Stage II: Preprocessing
Stage III: Segmentation
Stage IV: Feature Extraction
Stage V: Recognition

*Stage I: Image Acquisition:*

Image acquisition is the first step of Face Recognition process. Images can be generated with the help of a camera (Webcam). A special measure like proper lighting, background etc. has to be taken while capturing the images as this matter a lot during recognition stage.

*Stage II: Preprocessing:*

After Image Acquisition next step is preprocessing. Preprocessing is required to improve the quality of the image, to remove low-frequency background noise, to normalize the intensity of the individual particles images. This is also important to highlight most important part of the face by removing reflections and masking other portions of the image. Some preprocessing techniques are listed as follows:

i. Smooth: Spatial smoothing for images.
ii. Background Subtraction (Flat field): Rolling-ball background subtraction for images.
iii. Max: Max value over neighboring pixels.
iv. Median: Median value over neighboring pixels.
v. Mean: Mean value over neighboring pixels.
vi. Min: Min value over neighboring pixels.

*Stage III: Image Segmentation:*

Segmentation divides the pixels of a digital image into regions that are strongly associated with the objects and boundaries (lines, curves etc.) in an image. In FR system the segmentation module partitions the face image into different parts depending on what kind features or technique are to be used during recognition. Segmentation makes a digital image more useful and easy to analyse. Some segmentation Techniques:

*i. Segmentation based on edge detection:*

Edge helps in segmentation by detecting object boundaries in a digital image. Whenever there is a rapid change in brightness or intensities of a digital image some points can be identified with the help of edge detection. There are many Edge detection techniques; however two most used techniques are given below:

**a)** Gray Histogram Technique
**b)** Gradient Based Method

*ii. Threshold Method:*

Based on characteristics of the image, segmentation using threshold is simple but very powerful. Basically threshold method used for Images that consist of dark object on light background or vice versa. Threshold method assigns an appropriate threshold value T, which separates image pixels into various classes and divides image objects from the background. Based on threshold value there are two types of thresholding:

**a) Global Thresholding:** In this method a single threshold value is used to the entire image.
**b) Local Thresholding:** Here the image is divided into different parts and thresholding is performed for each part separately with different threshold value.

*Stage IV: Feature Extraction:*

As a face image consists of many redundant data feature extraction transforms the large sized input into a reduced set of featured vectors. Those extracted data consists of important or applicable data which will be useful to pursue further face Recognition operations. Feature Extraction techniques:

**a)** *Geometry –based Technique:* In this technique, features are extracted with the help of size or geometrical shape of positions of the objects of the image.

**b)** *Template Based Techniques:* In this technique, facial feature are extracted on the basis of templates i.e. designed previously using suitable energy function and the least amount of energy is give away by the templates which have best match in facial image.

*Stage V: Recognition:*

In Recognition, after feature extraction the processed image is compared with the image in the test dataset by selecting the extracted features. If the test image is matched with the processed image the person is recognized otherwise error message will be displayed.

## III. STANDARD TECHNIQUES USED IN FACE RECOGNITION

*i. Principle Component Analysis (PCA)*

PCA was invented by Karl Pearson in 1901. PCA is the simplest of the true eigenvector-base analysis. For extracting global structures from high-dimensional data set, PCA technique is very useful. This technique is widely used for dimensionality reduction while handling highly redundant data [11]. Apart from these PCA can be used as a pattern recognition tool. PCA is a mathematical procedure that uses an orthogonal transformation to convert a set of M face images into set of K uncorrelated variables called Eigen

faces. It assures that the number of Eigen faces always lees than or equal to the number of original images i.e. K<M [10].

*Eigen face:*

The goal of feature Extraction is to increase the efficiency and reduce redundancy. One simple method to have this goal is using alternative orthogonal bases rather than the natural bases. One such basis is the Karhonen-Loeve (KL). KL bases are found by the eigenvectors of the covariance matrix of the face vector X. In the high dimensional face space, only the first few Eigen values have large values. Therefore, a compression can be achieved by letting those eigenvectors with large Eigen values to represent the face vector X,

$$X \cong \sum_{i=1}^{M} \hat{x}_i u_i \qquad (1)$$

Where u is the Eigenvector and M is the dimension which is smaller than the original vector dimension N.

The Eigen face representation is well known as the principal component analysis in statistics. It is optimal in the terms of efficiency for any M<N. KL representation gives a minimum mean square error among all possible approximations of X that uses M orthogonal vectors. However, it does not signifies that the KL representation is optimal in terms of discriminating power as it relies more on the separation between different faces rather than the spread of all faces[5].

*Working principal of PCA:*

Step 1:

- Loaded all M images of size NXN from the dataset
- Each image matrix is now converted into $N^2$x1 vector
- All such image vectors are combined and formed a matrix say A of size $N^2$xM.

Step 2:

- Calculate the average face say ψ
- Normalize each face vector, I by subtracting the average face from each. So the normalized face vector of $I_k$ say $\Phi_k$ is calculated as $\Phi_k = I_k - \psi$
- So now A is $[\Phi_1, \Phi_2, \Phi_3, \ldots\ldots\ldots\ldots\Phi_N]$

Step 3: Calculate the covariance matrix C as, $C=A^T.A$

Step 4: Calculate the Eigen face from the C

Step 5: Choose K best Eigen faces that can represent the entire training set.

Step 6: Convert each K lower dimensional Eigen faces into original dimension.

Step 7: Represent the entire training dataset as a linear combination of K Eigen Faces

.

*Neural Network:*

Artificial neural networks are one of the popular tools used for face recognition. They have been used extensively in pattern recognition and classification. Probabilistic Decision-based Neural Network (PDNN) is one of the neural classifier .As it does not contain fully connected network topologies so it divides the network into K subnets which helps to recognize a person in a dataset. PDNN uses the Gaussian activation function for its neurons, and the output of each face subnet is calculated by summing up all the weights of the neuron outputs. In other words, the face subnet uses the mixture of Gaussian model to estimate probability density of face space. Mixture of Gaussian gives more approximate and flexible face space densities rather than AWGN mixture [5].

*Gabor Filter:*

Gabor Filter is a linear filter which is use for Edge Detection. Gabor Filter's frequency and orientation is same as of human visual system.

In this process, first feature extraction is done. Then each face image's feature vector is obtained. Face feature vector is classified based upon the minimum average distance. This results in face identification process. A threshold value is assigned for recognition [9].

## IV: Literature Review

*A.* Wei-Lun Chao explains in [1] the general structure and ideas of recognition, important issues and factors of human faces. In this work a discussion on some critical techniques and algorithms along with a comparison are presented. Techniques that are used here are Hierarchical knowledge based, Horizontal/vertical projection, feature invariant approach, Holistic based method, Eigen face and principal component analysis.

*B.* This paper is about unraveling the classical problem of human face recognition. The problem of automated face recognition by functionally dividing it into face detection and face recognition is stated here. The Techniques used are Kohonen Feature Maps, PCA, deformable template,

Eigen face, Pose invariant face recognition. The systems do not have accuracy over 90%, due to the limited number of eigen faces that they have used for the PCA transform [2].

*C.* The goal of this paper is to present a critical survey of existing literatures on human face recognition. Techniques used in this paper are Geometrical Method, Motion-Based Method, Eigen face-Based Method, Neural Networks Method, Knowledge-Based Method, and Feature Matching Approach [3].

*D.* This paper deals with various methods that are used to solve the problems which are related to occlusions. This paper also visualizes a classification among parts based method, fractals based method and feature based method. In parts based method, the face images are divided into some non-overlapping blocks and are analyzed individually by using parts based method. Less importance is given to fractal-based approach. Occlusion is based on the appearance of an image where similar pixels are deformed, so as a result part based methods are used for its effectiveness . Feature based methods deal with the occlusion problems considering the individual features, e.g. distance between eyes, shape of the nose and mouth region and discards the other common features of individuals. Above mentioned approaches are effective as spatial domain of images is affected by occlusion [4].

*E.* In this paper, an introduction of the face recognition technology is given. The paper covered the general structure of face recognition, the various components that may arise during recognition which affects the performance of the recognizer and about various face recognition algorithms. This paper explains about Face recognition algorithms such as: Eigen face, Neural Networks [5].

*F.* In paper surveyed segmentation, feature extraction and recognition and various aspects of face recognition from image sequences including basic techniques used in video based face processing, modeling and tracking. Two key problems for any face recognition system: the illumination problem and the pose problem. Here an attempt has been made to categorize proposed methods of solving these two problems [6].

*G.* In this paper, they started with a discussion on the one sample problem and its affects in the current face recognition algorithms. To recognize from one sample per person they had used holistic method, local method and hybrid method and reviewed the relative recognition performance of current algorithms and discussed several issues that need to be carefully considered when deciding how to evaluate a proposed method [7].

*H.* In this paper they have presented an extensive review of recent research development on face recognition, also they had focused on face recognition systems, feature extraction, detection recognition and localization. They had used FERET protocol and XM2VTS protocol, which has a significant role in the development of face recognition algorithms [8].

## V CONCLUSION

Face recognition is a both challenging and important recognition technique. As comparison to other authentication systems Face recognition system works on individuals unique facial features instead of patterns, keywords or swap cards, which make accessibility more secure and reliable. Many techniques have been developed so far but due to various factors like camera distortion, noise, complex background, illumination, translation, rotation, scaling, occlusion, facial expression

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