

# A Survey Based on the Face Recognition Techniques

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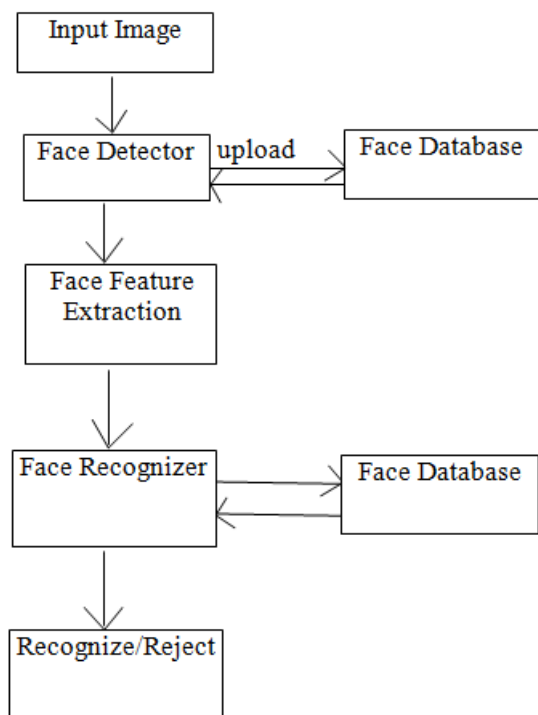
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**Abstract:** Over the decades there has been accumulation of data and information in abundance which also includes in the field of computer vision and image analysis. Thus, face recognition has achieved great attention to solve challenging problem as well as various applications which contains surveillance, user identification and human computer interaction. Due to which various methods have been evolved in the recent years. In this paper, we provide an overview of some known methods and their benefits and drawbacks in face recognition. Finally the face recognition results are compared and analyzed.

**Keywords:** Face Detection, Face Recognition, PCA, LDA, Gabor, Neural Network, Machine Learning

## 1. Introduction

Face Recognition has achieved quite a lot of attention in the recent few years and thus has become one of the most prominent biometric authentication systems. Face Recognition can be applied to various fields including access control, identity authentication and so on [1]. Basically face recognition consist of two methods. The first approach is on facial feature which includes eyes, nose and thus many feature extraction method are used to identify feature vectors of the facial features.



**Figure 1:** Overview of Face Recognition System

method that consists of an neural network that is used to identify feature vector. The another approach extracts characteristics by statistic methods which is taken directly from training samples of image which include feature of eyes, mouth or nose separately. Face recognition mainly consist of two tasks: verification and identification. Face verification does 1:1 match that is a face image is compared with a template of images until the identity is claimed. Face identification consists of 1:N that compare a face image with all set of image template in the database. Thus, Machine recognition of face has gradually become an important domain in various application range from commercial to law enforcement, such application include access control, surveillance, identification, forensic and so on. The biggest advantage of face recognition system with other biometric recognition like fingerprint, palm print, hand geometry etc. is that it does not require an active cooperation of an person whereas face recognition is based on non-procedure method as compared to various biometric recognition. The General overview of face recognition system is shown in Fig 1.

## 2. Literature Survey

There have been various developments in the area of face recognition which also include technological advancements in face detection, image classification, biometric identification, pattern matching etc. This section briefly gives the method and techniques of face detection, face recognition.

### 2.1 Face Detection Techniques

There are four basic approaches of face detection namely [2], [3], [4]:

The second approach is the traditional pattern recognition

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#### A) Knowledge Based Method

This method is based on the rules of facial features that means it uses the knowledge of the faces and converts them into rules. These rules give the relationship of face features and their location of the face. In 2002 [5], a new system based on energies was proposed for images having simple background. It gave a basic approach about the geometry of the face and the facial design. The rules are built on the measures for appropriate set of rules. The rules are quite general hence it is false positives. The rules are detailed are stated as false negatives. The solutions to this problem are hierarchical knowledge based methods. In case of complex set of images, color of human skin or textures are considered [6]. There are general rules for face detection from simple or complex background image. First, features are extracted from image and then set of rules for face recognition. Natural symmetry of the face helps to describe the rules of the nose, eyes, chin etc..

#### B) Template Based Method

This method works by storing the patterns of the facial features onto the database and the detecting of the face is achieved by forming an relationship between the image and the stored patterns. However, the template matching method does not give better results for variation in the position of the nose, eyes etc. Basically this method finds the edges of the face. Then the edges of the facial features are extracted through energy function and the features are stored in predefined templates. The concept of deformable templates was proposed by Yuille et.al [7] which describes parametrized features to detect face.

#### C) Feature Invariant Method

This method is used to determine the invariant features of the face irrespective of the shape or position of the face. This method mainly focuses on the structure features irrespective of the changes in nose, mouth, cheek bones etc. The algorithm for this method by finding the structural features of the nose, chin irrespective of the various lighting conditions, viewpoint or pose. David.G. Lowe [8] proposed a system that uses the method of structural features for detection.

#### D) Appearance Based Method

This method works by the training the images and understanding the variability of the image. It works by depending on techniques such as Machine Learning and statistical analysis for the features of the face. This method two pattern classification one which is based on the face and another is a non face. In [9] M A Rabbani and C. Chellappan proposed a method that uses median to find better results for an complex image. The various techniques which is based on Appearance method are PCA, Eigenface, LDA, SVM etc.

## 2.2 Face Recognition Techniques

#### A) Eigen Face

Eigen Face [10] is one of the most prominent face recognition techniques. It is also known as Eigen vector or Principal Component Analysis (PCA). Multiple Faces are made distinct by eigen vectors [11]. Eigen Vectors are calculated using co-variance vectors [12]. Eigen Face was proposed by Sirovich and Kirby in 1987 [13]. Turk and Pentland [14] proposed a method which works by calculating the principal components for the data by reducing the dimensionality. The dimensions of the data are reduced and new spaces are obtained. Eigen Face method work best on frontal face image but researchers have done research on various pose of the face [15], [16]. A Hybrid Approach for Eigen Face using ANN for face recognition [17] has provided better results. An optimized threshold values are selected for better optimization and also to improve the performance of the face recognition using Eigenface [18].

#### B) Linear Discriminant Analysis

Linear Discriminant Analysis is also called as Fisher Discriminant Analysis which is yet another dimensionality reduction method. It based on class specific method where between the class scattering measure are maximized while class scattering measure within are minimized [19]. Lih-Heng Chan proposed a method which is combination of LDA as well as PCA method. It works such as first by reducing the dimensionality of the original image followed by LDA process to determine a better discriminant. The Euclidean distances are then calculated for the benchmark. In 1930 Fisher developed a better face recognition for better results. The Fisher method minimizes the within class scatter problem by the LDA.

#### C) Gabor Wavelet

Gabor Wavelet is also known as Gabor Filter [20]. This method was introduced by Dennis Gabor in the year 1946. Gabor filters were used to present 1-D filters by Dennis Gabor, Later Daugman into 2-D filters [21]. Gabor method has been used for face recognition such that the Gabor wavelets for the input image are processed followed by the output images are also similarly processed along with it. Gabor Wavelet [22] uses local features for face recognition. Gabor Wavelets can extract Multi-Orientational features of face image. These Features are extracted by Gabor Wavelets [23] are called Gabor Features [24] and these features are present in local regions at different scales [25], [26]. Gabor Features are redundant because of the high dimensional data [27]. The Feature reduction can be done by Gabor wavelet transformation [28]. The basic two approaches for Gabor filter are:

i) Analytic Approach: In this approach the feature points are calculated and these points are used for face recognition.

ii) Holistic Approach: In this approach, Features of the entire face are selected. Eigen face as well as LDA are holistic approach.

#### D) Support Vector Machine

The Support Vector Machine was introduced by Bernd Heisele, Purdy Ho and Tomaso Poggio [29] which consists of SVM classifiers that are used to train people in the database. Classification problems are solved by SVM. This method is applied for spaces after the process of feature extraction. The unseen patterns are classified by SVM considering the weight combination of the trained vectors. Multi face recognition can be done by binary tree integration with SVM [30]. Thus to combat Fast Face Recognition by Fast Least Squares with SVM [31] locates the hyperplane by using training sample with bigger values. Global approaches as well as component based approaches are based on SVM that solves problem of face recognition [32].

#### E) Neural Network

Neural Network is collection of artificial neurons that form a computational model to solve the problem related to artificial intelligence. In most scenarios neural network is quite flexible to the external as well as internal according to flow of the network. Neural network is based on the multi layer feed forward algorithm. ANN (Artificial Neural Network) [33], [34] recognizes faces through previous learning. Neural Network is based for recognize faces. It is based on Incremental Learning Ability based on face recognition purpose [35], [36]. The Probabilistic Neural Network (PNN) [37] proposed by Vinitha and Santosh detects and recognizes face from the grayscale images having frontal face. The main advantage of PNN is that requires less training. Self-Organizing Map Neural Network (SOM) also known as Kohonen Map [38-41] preserves the topological for face recognition. Radial Basis Function

(RBF) Network [42-45] is also an neural network for face recognition.

#### F) Machine Learning

Machine Learning has become of the most important research areas in the recent times. Machine Learning consist of training large number of images and along with that classifier are trained and it is then added to the model k-nearest algorithm, Naives bayes classifier [46]

### 3. Challenges of Face Recognition

#### 3.1 Variation in the pose

The changes in the pose mainly happen due to the angle variation in the camera or due to the random movement of the person.

#### 3.2 Changes in the Lighting conditions

The angle of the light that falls on the person does create a huge difference in the face of the person such further analysis on the same picture of the person show as two different pictures.

#### 3.3 Resolution

Resolution plays an important role in the face recognition as low resolutions are unsuitable for face recognition hence high resolution images are needed.

#### 3.4 Age

The Aging process greatly affects in recognition of the person face features are altered over time.

**Table 1: Merits and Demerits of Face Recognition**

Methods	Merits	Demerits
PCA	Data Compression has low dimensional space and also prior knowledge about geometry of face is not needed	Preprocessing at scale normalization is needed
LDA	Most discriminant features are optimized by the low dimension	Singular matrices with scales are failed and main issue it has small sample size problems.
SVM	SVM performs better generalization	Feature vector with missing entries cannot be used.
Neural Network	Less statistical training is required can detect independent as well as independent variables and detects interaction with variables and training algorithms	Computation training increase as fitting and execution time taken is quite more.

### 4. Conclusion

In this paper we have discussed about the various face recognition and detection methods. The study shows the merits and demerits of the face recognition methods. The challenges of the face recognition are also included in this study.

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