International Conference on Recent Innovations in Engineering and Management
Dhananjay Mahadik Group of Institutions (BIMAT) Kolhapur, Maharashtra (ICRIEM-16)
23rd March 2016, www.conferenceworld.in ISBN: 978-81-932074-5-1

# COMPARATIVE ANALYSIS OF FACE RECOGNITION TECHNIQUES

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## ABSTRACT

*Face Recognition is one of the major techniques which can be used for security of personal information from stealing. Face Recognition is a top priority application for image analysis, commercial security and law enforcement. It also used in video conferencing, crowd observation, video coding and human computer interaction. But loopholes in current system still needs to be worked upon like ambient light, face possess, surface orientation with respect to source light etc. This paper is a review on different face recognition approaches and technologies developed, like knowledge based, feature based, template based and image based with their advantages and limitations, so that it will help for the development of more effective approach. The purpose of the survey is to help the researches going on in this field to improve the existing technologies.*

***Keywords: Ambient light, Face Possess Surface Orientation, Face Recognition.***

## I. INTRODUCTION

Users hate passwords [1]! In modern world, the fear of losing personal information and valuables like money urge user to use passwords. But due to complexity rules and different passwords for different purposes, leads user to forget one or more of them.

Ideally, account authentication is based on one or more of these three things:

- Something a user has like ATM card etc.
- Something a user know like ATM Pin, password etc.
- Something a user is example his fingerprint, his face etc.

Biometric system is used to identify a person based upon his physical and behavioral characteristics. Some of the familiar methods of biometric are fingerprint recognition, iris scanner, face recognition, handwriting verification and palm geometry. Among all these technology, a rapidly growing technique is face recognition and it is one of most popular application of image analysis. Face recognition plays a vital role in accessing personal information, security and human machine interaction. Although, human are quite good to identify known faces but when it comes to identify a large amount of unknown face they fail. This is a human limitation, to overcome this we use computer system running efficient and robust algorithm to do the work. The performance of many face recognition application in controlled environment reached to satisfactory level, but still research is going on for face recognition technique which can deal the uncontrolled environment. Some challenges of uncontrolled environment is to deal with variation in illumination which can drastic change in face recognition, other challenges are face pose, expression etc. [2].

Currently available method for face recognition are mainly I) feature based full texture feature extraction II) image based feature extraction. It is difficult to robustly extract feature of a face of low and poor resolution, so image based feature extraction (Hybrid approach) like color space with SVM method have an upper hand against these two method.

So, in this paper we review different kinds of approaches in face recognition.

## II. FACE RECOGNITION

Face recognition method involves various techniques like pattern recognition, computer vision, computer graphics, image processing etc.

Generally, face recognition method consist of following steps:

- Capturing image, magnify and segmenting.
- Detection of face boundary and facial features.
- Extracted facial features are matched against the trained set of templates in database.
- Recognition of face is done.

In Fig 1 shown below, the first step is to capture image either on line or off line then preprocessing is done, after that feature extraction is carried out by different image processing algorithm used for features extraction and then extracted feature are matched with database using classifier like SVM and finally final result is obtained.

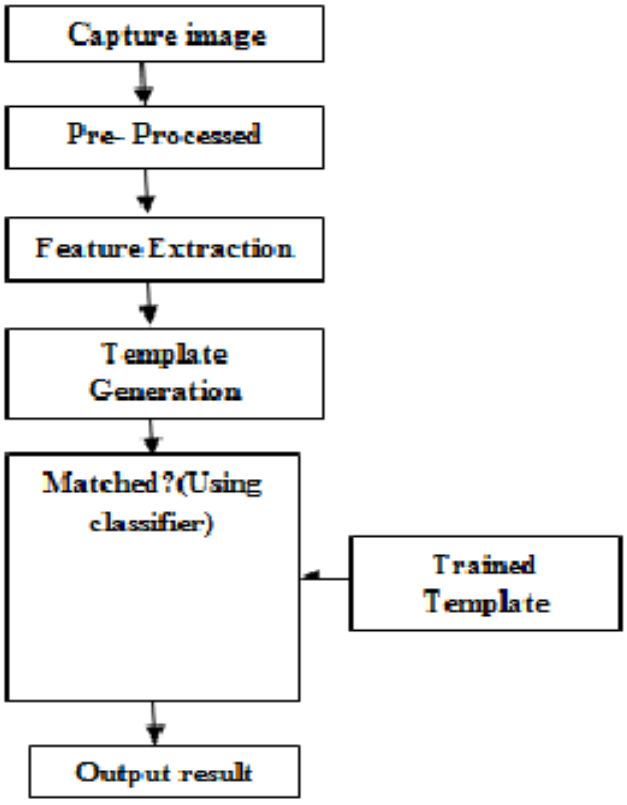


**Fig 1: Block diagram of face recognition method using classifier**

The different type of face detection and recognition methods are:

1. Knowledge Based
2. Feature Based
3. Image based
4. Template Based

These methods are further divided as shown in Fig 2.

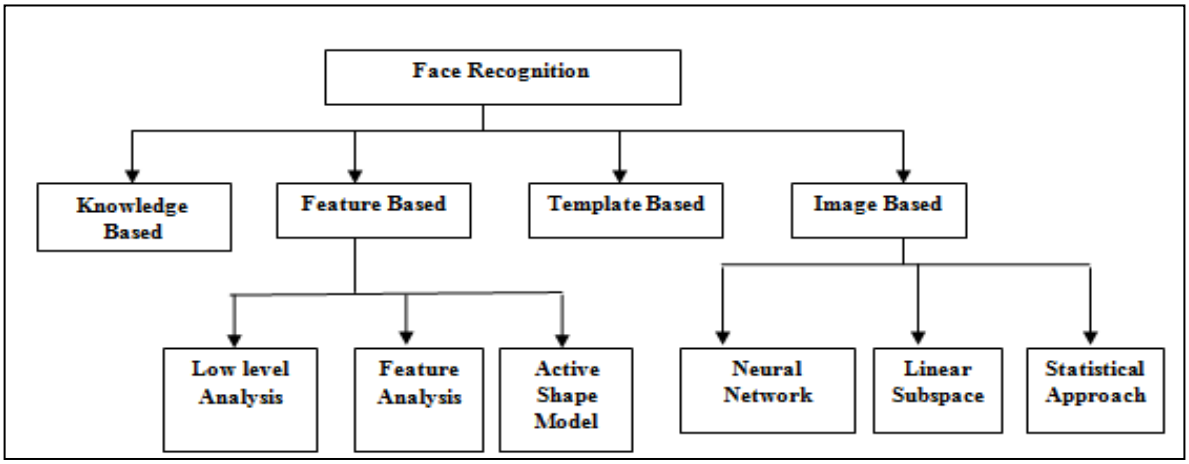


**Fig 2: Different Face Detection Techniques**

## III. ANALYSIS OF EXISTING WORKS

### 3.1. Knowledge Based Method

In this method, human facial features parameters are calculated like features of mouth, eyes, lips, face, nose etc. and their relationships like relative distance, intensity etc. After the features are detected we can reduce false detection for verification later [3]. G. Yang et al. [4] used facial features parameters to detect face in complex background. Although this method is good for face image taken from font but show variations when taken for different face poses.

### 3.2. Feature Based Method

Feature Based Method are further classified as shown in Fig 2:

#### 3.2.1. Low Level Analysis

Based on visual feature in low levels like intensity, color, edge, motion etc. it is further classified:

##### 3.2.1.1. Based on Skin Color

Human face has a vital feature know as skin color. Tracking a face using skin color as a feature has many advantages like color processing is much faster than other facial feature processing. Under favorable lightning condition, color is oriented invariant. The main problem of this color representation of face obtained by camera is that it is influenced by factors like ambient light, object movement, surface orientation relative to light source etc. Crowley and Coutaz [5] implement simple skin color algorithm for detecting skin pixel. As human face color varies relative to the illumination so pixel for skin region is detected using normalized color histogram. Here RGB color space is converted to normalized rgb color space to have fast skin detection. This algorithm fails when many skin region are presented like legs, arms etc.Cahi and Ngan [6] present color classification algorithm in YCbCr color space. Here, pixel is classified to have skin quality if values fall within the threshold

chosen. The skin color distribution gives the face portion in color image. Main constraint is that no skin region other than face should be there. Kjeldson and Kender [7] propose HSV color space to separate skin region from background. HSV is same as YCbCr color space but main component are hue (H), saturation (S), and value or brightness (V). Same as above Cahi and Ngan alogorithm and have same drawbacks.

**3.2.1.2. Based on Motion**

When use of video sequence is valuable then motion information can be used to locate moving objects.

Moving shadows like face and body parts can be extracted by simply frame differences gathered thresholding.

**3.2.1.3. Based on Grayscale**

Facial features like eyebrows, pupils and lips appear generally darker than its surrounding facial region. Some algorithms search for local gray minima within segmented facial region. These algorithms first enhanced by contrast stretching and gray scale morphology to improve quality of local dark patches and makes detection easier. Dark patches are extracted by low level gray scale thresholding. Yang and Huang [4] uses faces gray scale behavior in pyramid images and utilizes hierarchical face location consisting of three levels. Higher two level of pyramid image are at different resolution and in lower level, edge detection is done. This algorithm gives good response for unknown face size in complex background.

**3.2.1.4. Based on Edge Detection**

Sakai et al. [8] proposed face detection based on edges. Here, his work is based on analyzing line drawing of faces from photographs, and aiming to locate facial features. Craw et al. [9] introduced hierarchical framework to trace human head outline based on Sakai et al. work. Anila and Devarajan [10] proposed framework based on median filtering, noise removal, histogram equalization and a edge tracking algorithm and finally they used Back propagation Neural Network (BPN) for classification.

**3.2.2. Active Shape Model**

Active Shape Model (ASMs) focuses on complex non rigid features and aimed to automatically locate landmarks points that define the shape of any statistically modeled object in an image. Training stage of ASM involves building statistical facial model a set containing images with landmarks which is manually marked. ASM is classified into following.

**3.2.2.1. Snakes**

Snakes are a generic active contour introduce by Kass et al. in 1987 [11]. First, Snakes are initialized at proximity around a head boundary. It then locks onto nearby edges and assume the shape of the head. Snake is progressed by minimizing energy function. Snakes are used to identify head boundary.

Selection of energy terms and energy minimization are two key considerations. Energy minimization process is done by optimizing techniques like steepest gradient descent. Chen [12] and Lam and Yan [13] uses greedy algorithm to produce fast iteration method. Main drawback is outline often become locked in onto false image feature and another is that snakes are not suitable in extracting non convex features.

**3.2.2.2. Deformable Templates**

Deformable templates is introduced by Yuille et al. [14], he incorporated global information of the eye to improve the reliability of extraction process. Deformation is based on local valley, edge, peak and brightness, other than face boundary, facial features like eyes, nose, mouth and eyebrows extraction is a great challenge here.

#### 3.2.2.3 PDM (Point distribution model)

The statistical model of shape which is represent as a vector to which statistical methods can be applied and by training examples and use of principle component these model can learn allowable set of shapes, this is called Point Distribution Model. Cootes and Taylor [15] presented parametric statistical shape model for image analysis based on principal components of inter landmark distance.

### 3.2.3 Feature Analysis

These algorithms find structural features that exit when pose, viewpoint and lighting conditions can change and use these to locate faces. These methods are also called face localization method.

#### 3.2.3.1. Viola Jones Method

Paul Viola and Michael Jones [16] presented a fast and robust method for face detection and minimum computation time with high accuracy at that time when they presented their paper. This technique uses Haar like feature that evaluated quickly through use of new image representation.

#### 3.2.3.2. Gabor filters

Sharif et al. [17] presented an Elastic Bunch Graph Map (EBGM) algorithm that implements face detection using Gabor filters. The presented algorithm used 40 different Gabor filters on an image and produce 40 images with different angles and orientation as output, then maximum intensity points in filtered image is calculated and then by using distance formula distance between those points are calculated and finally distance is compared with database, if match then face is detected.

#### 3.2.3.3. Constellation method

This uses more robust modeling approach like statistical analysis. Burl et al. [18] proposes various types of face constellation. They use statistical shape theory on features detected from multi- scale Gaussian derivative filter. Huan et al. [19] also uses Gaussian filter for pre- processing in an image feature analysis based framework.

## 3.3. Template matching Approach

Template matching methods are used to correlate between pattern in input image and stored standard patterns of a whole face or face features to determine the presence of a face or face features. Deformable and Predefined templates can be used.

## 3.4. Image Based Approach

Image based approach is further classified into

### 3.4.1. Neural Network

As, face recognition is a two class pattern recognition problem, various neural network algorithm have been proposed. Neural network for face detection is feasible for training system to capture complex class face patterns of conditional density. One drawback of neural network is that network architecture has very much number of layers, number of nodes and learning rate to get superb performance. Agui et al. [20] proposes this method, in which first stage is two parallel sub network and inputs are filtered intensity values from original image. Feraud and Bernier [21] proposed a detection method by using auto associative neural networks, in this a five layer auto associated network is able to perform nonlinear principal component analysis. One auto associative network is for detection of frontal view while other to detect face turned up to 60 degree left and

right from front view. Lin et al. [22] presented face detection system using probabilistic decision based neural network (PDBNN).

**3.4.2. Linear Sub- space method**

Eigen face Method: Kohonen [23] uses a simple neural network for performing face recognition for aligned and normalized face images. Kirby and Sirovich [24] suggested that faces of an images van be encoded linearly using modest number of basic images. Eigen face method idea first prosed by Pearson in 1901 [25] and then by Hotelling in 1933 [26]. In a collection of n by m pixel training image is represented as vector size mXn, basis vector optimal subspace are determined by mean square error between projection of training image on to this subspace and original images is minimized. They call the set of optimal vectors Eigen pictures since these eigenvector of covariance matrix computed from vectored face images in the training set.

**3.4.3. Statistical Method**

**3.4.3.1. Support Vector Machine**

Osuna et al. [27] first introduces SVMs for face detection. SVMs uses new paradigm to train polynomial function, neural networks, or radial basis function (RBF) classifiers. It uses structural risk minimization to minimize an upper bound on expected generalized error. Osuna et al. train SVM for large scale problem like face detection. SVMs in wavelet domain can detect faces and pedestrains.

**3.4.3.2. Principal Component Analysis**

Kirby and Sirivich in 1988 [24] introduced a technique based on the concept of Eigen faces known as principal component analysis (PCA). PCA is also known as KarhunenLoeve projection [28]. Turk and Pentland [29] propose PCA to face recognition field. PCA on a training set of face images is performed to generate the Eigen faces in face space. Faces area images are projected onto the clustered and subspace. Similarly, for non- face training images. To detect a face in scene, distance between an image region and face space is computed for all location in the image. The result of calculating the distance from face space is a face map.

## 3.5. Hybrid approach

This approach uses both statistical pattern recognition techniques like SVMs and Feature Analysis techniques like HSV color space.

**3.5.1. HSV Color Space and Support Vector Machine (SVM)**

Daniel F. Smith et al. [30] proposes a technique where he uses local feature and whole face region to recognize a face. It first convert the RGB captured images into HSV image and then by using feature extraction it extract the color feature and then compared with the SVM training data, if matched then face is recognized if not then not matched. It uses frame capture algorithm to improve the quality of color patterns against illumination, ambient light etc. Hybrid method considered as best because it uses both local features character as well as whole face region to detect or recognize a face.

## IV. CONCLUSION

Different approaches are developed in last few years and still no one is said to be perfect in uncontrolled environment due to illumination, face pose, surface orientation along the source light etc. This survey paper categorizes different approaches used for face recognition like knowledge based, feature based, template based

and image based. Further these approaches are subdivided according to local and global facial features of the faces. These approaches have certain limitations like illumination, face pose, ambient light etc. At last it can be concluded that the hybrid approaches like HSV color space with SVM can be used to produce more efficient and robust technique which uses local facial features as well as global features like whole face region to recognize a face. However, research is still going on to find a nearly perfect method in uncontrolled environment.

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