# Face Recognition Techniques: A Survey

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***Abstract*- Nowadays research has expanded to extracting auxiliary information from various biometric techniques like fingerprints, face, iris, palm and voice . This information contains some major features like gender, age, beard, mustache, scars, height, hair, skin color, glasses, weight, facial marks and tattoos. All this information contributes strongly to identification of human. The major challenges that come across face recognition are to find age & gender of the person. This paper contributes a survey of various face recognition techniques for finding the age and gender. The existing techniques are discussed based on their performances. This paper also provides future directions for further research.**

**Keywords— Face Recognition, Age and gender identification.**

## I. INTRODUCTION

Biometrics is the unique measurable characteristics of automatically recognizing an individual identification based on their physical and behavioral characteristics. The Physiological parameters are physique of the body such as fingerprint, face, palm, iris and DNA. On the other hand behavioral involves the behavior of a person such as signature, keystrokes, and voice.

In the last 51 years, the face recognition system has been researched as a low-cost tool and is reliable in the diverse fields such as forensic, commercial, health-care, entertainment, government, traveling and immigration etc. Nowadays the biometric driven systems are proliferating exponentially all over the world. The biometrics market was $4 hundred million in the year 2000 which grew to $5 billion in the year 2011. It is expected that the biometrics business would grow up to $23 billion in the year of 2019 . Due to their intrusive property, the success of some biometrics systems (i.e. fingerprint, palm, and iris) depends on user cooperation but face recognition systems are non-intrusive as it doesn't require the physical interaction of users to be identified, once the input is acquired. One more important characteristic is Passive Identification which means the person is not required to be subjected to physical verification. This is why personal authentication face recognition is considered as friendly among all biometrics. The face biometric system can identify various attributes from the image such as gender, age, beard, mustache, scars, height, hair, skin color,glasses, weight, facial marks, tattoos etc as shown in Fig-1. From these attributes, a biometric system can extract some information from the data and compares this information with the templates in the database to determine an identity.

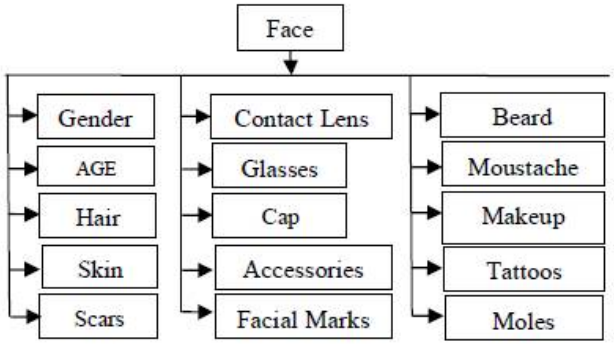


Fig-1: Auxiliary information from the face

In 1960 Woody (et al.) gave the first semi-automated facial recognition technique. This technique required some features such as mouth, nose, eyes and nose on the image. The year 2001 onwards, the biometric techniques proliferated rapidly indication of which are the increased number of publication of research papers in this field (refer Fig-2). A detailed literature survey was carried out by the authors of this paper to justify the constantly increasing scientific interest in face recognition biometric technique. The authors analyzed the publication of the last 51 years related to the face through the database extracted from the well known and qualified sources of Scopus. The mentioned database includes enough information for our analysis hence; it would be acceptable to the research and scientific community. The analysis was carried out by applying the keyword 'face recognition'. The face recognition database has been obtained from the different type of publications, the broad classifications of which are shown in Fig-3. Moreover, the increased publications of research papers in the past decade are the testimony of the importance of face recognition techniques. The analysis of Fig-3 reveals that the number of books and autographs published in the field of face recognition is a small percentage compared to the research papers published during the past 15 years.

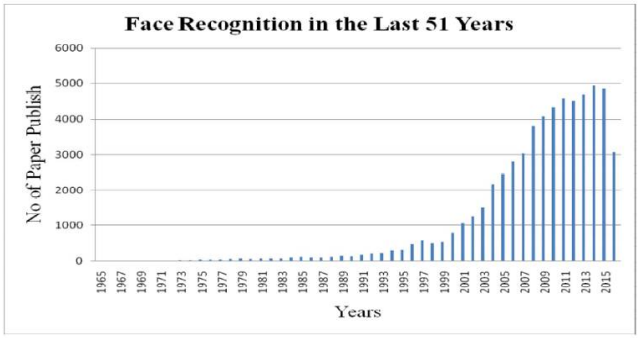


Fig-2: Face Recognition related publications for the past 51 years

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However during the same period publications of research papers have been more productive. The stated analysis indicates the heavy leaning of the research in the field of face recognition and thus, the highest evolution in this field so far. Such a high degree of research activities in the field of face recognition is creating high pre-knowledge that must favor the discovery and development of the next generation frameworks in the face recognition and applications.

## II. FACE RECOGNITION TECHNIQUES

***Local Region Principle Component Analysis***

Local Region PCA (LRPCA) is a refined implementation of the standard method based on principle component analysis (PCA) face recognition algorithm, also known as Eigenfaces. It first extracts a cropped and geometrically normalized face region from an original face image. The original image is assumed to be a still image whose pose of the face is close to frontal. The face region in the original is scaled, rotated and cropped to a specified size and the centers of the eyes are horizontally aligned and placed on standard pixel locations. In the baseline algorithm, the face chip is 128 by 128 pixels with the centers of the eyes spaced 64 pixels apart. The PCA representation is conducted on thirteen local regions cropped out of a normalized face image and the complete face chip. The local regions are centered relative to the average location of the eyes, eyebrows, nose and mouth. Figure 3 shows a cropped face and the thirteen local regions. All the 14 face regions are normalized to attenuate variation in illumination. First, self-quotient normalization is independently applied to each of the 14 regions. The self-quotient normalization procedure first smooths each region by convolving it with a two dimensional Gaussian kernel and then divides the original region by the smoothed region. The influence of illumination can be reduced by self-quotient normalization. A final normalization step adjusts the pixel values in each region to have a sample mean of zero and a sample standard deviation of one. During training, PCA is computed for each of the 14 regions and the 3rd through 252th eigenvectors are retained to represent the face. As a result, a face is encoded by concatenating the 250 coefficients for each of the 14 regions into a new vector of length 3500. Therepresentation is whitened by scaling each dimension to have a sample standard deviation of one on the training set. Then the weight on each dimension is further adjusted based on Fishers criterion. The Fishers criterion weight emphasizes the dimensions along which images of different people are spread apart according to the training.

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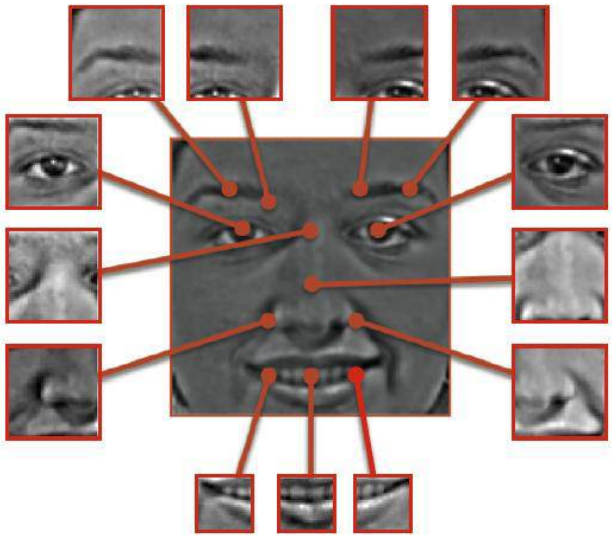

Figure 3: A cropped face and the thirteen local regions.

***Cohort Linear Discriminant Analysis***

Cohort Linear Discriminant Analysis (CohortLDA) is a Linear Discriminant Analysis (LDA) algorithm with color spaces and cohort normalization. The main differences between CohortLDA and standard LDA are two-fold. One is the preprocessing step and the other is that CohortLDA introduces a cohort set to normalize the score. Specifically, CohortLDA uses both the R channel from RGB color space and the I channel from YIQ color space to conserve the structure of the face and reduce the influence of strong illumination. Since the red channel is similar to the gray-scale image, it usually does not work well with large lighting variation. Therefore, logarithm transformation and z-normalization are applied after extracting the R channel. During training, it seeks a projection that maximizes the ratio of between-class scatter and within class scatter in order to make the data belonging to the same cluster more similar and the data belonging to different clusters more different.

## III. COMPARATIVE ANALYSIS OF VARIOUS FACE RECOGNITION TECHNIQUES

Whenever there is large number of techniques available to achieve a single specific purpose, it often becomes very complex and time consuming to properly study and understand all the techniques one by one. Thus it is relevant to analyze all the techniques in more precise way. Following is the description of various techniques used for face recognition and feature extraction and their performance analysis graphically such as PCA, LDA, ICA, SVM.

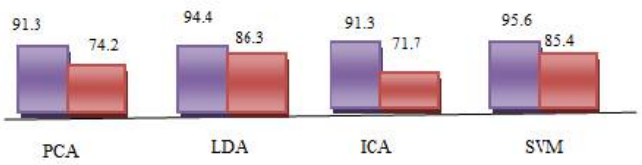

Fig.4. Comparison among different techniques

It is reviewed that different techniques shows different accuracy rates. Here in the above figure, blue bar shows the accuracy rate of ATT database which is higher than the accuracy of IFD database represented by red bar for different techniques. Its one of the reason is the nature of images in database. SVM classifier can be considered as the best one here in this case.

Thus we can analyze that there are numerous methods for face recognition and feature extraction. Now, the choice of a good and robust technique heavily depends upon certain parameters such as their advantages, disadvantages, performance rate, etc. and further performance of face recognition system depends upon certain factors such as pose, illumination conditions, expression, occlusion, etc A detailed overview of all the techniques in the tabular form showing their relative comparison is as:

## IV. CHALLENGES OF FACE RECOGNITION

Most of the applications such as computer security, human crowd surveillance, face processing, AI driven applications content-based image retrieval and video surveillance etc. require face detection for identification and verification of the enrolled users. The major challenges which any face recognition techniques face are the skin color segmentation and the facial segmentation accuracy. The facial segmentation accuracy depends on the pose, noise, lighting conditions and distance between the object and the camera. The various types of challenges that are faced during face detection are described below:

*A. Pose*

The most challenging situation is that the human face varies with respect to the relative camera-face pose (45 degrees, profile, frontal and upside down).

*B. Facial Expression*

The facial expression such as anger, fear, disgust, happiness, sadness and surprise is most influential temperaments for human beings to communicate their feelings.

*C. Illumination*

Illumination is a major challenge during face recognition. This factor is related to the lumn value and angle of the light.

*D. Occlusion*

Occlusion is one of the typical challenges during face recognition because sometimes the face is partially covered and occluded by others objects.

*E. Imaging Condition*

During the face image capture, some factors such as different illumination conditions and camera characteristic (lenses, sensor response) affect the face recognition accuracy.

*F. Different Facial Features*

Different type of facial features such as glasses, beard, hair, mustache, scars, moles, tattoos, skin colors and makeup affect the face recognition accuracy.

*G. Face Size*

This factor poses another typical challenge because face size can vary a lot from a person to another person. Not only different people have different sized faces but the face closer International Conference on Computing, Communication and Automation (ICCCA2017) 1003 to the camera and far away from the camera also pose a challenge.

*H. Rotation of Optical axis of the camera*

This factor depends on the nature of the images i.e. face images vary at different camera rotations about its optical axis.

## V. CONCLUSION

This paper presents a comprehensive survey of face recognition and various challenges in the last 51 years. This literature analysis showed continuously increasing interest in the field of face recognition. During face recognition some well-known problems such as pose, facial expression, illumination, occlusion, different facial features etc. have attained a lot of attention in the research community of computer vision and pattern recognition. Various types of techniques have been proposed to compensate for all these challenges but still, there are some unsolved challenges, so there is a scope of optimization. All these analyses will give a right direction to the researcher in future to resolve the unsolved challenges.

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