A Survey On Various Problems & Challenges In Face Recognition

Sonia Ohlyan, M.Tech (CSE)
Shri Baba Mast Nath Engineering College,
Rohtak(India),

Ms. Sunita Sangwan, H.O.D. (CSE)
Shri Baba Mast Nath Engineering College,
Rohtak(India)

Mr. Tarun Ahuja, Assistant Professor (CSE)
Shri Baba Mast Nath Engineering College,
Rohtak(India),

Abstract

Face is one of the most important human's biometrics which is used frequently in every day human communication and due to some of its unique characteristics plays a major role in conveying identity and emotion. So far numerous methods have been proposed for face recognition, but it is still remained very challenging in real life applications and up to date; there is no technique which equals human ability to recognize faces despite many variations in appearance that the face can have in a scene and provides a robust solution to all situations. The aim of this paper is to present the problems & issues that occur in a face recognition system in detecting & recognizing faces accurately due to light, aging, expressions, similarity in faces and other systematic problems like noise, image-acquisition, video camera distortion etc.

Keywords: Face Recognition, Biometrics, Image Processing

1. Introduction

Face recognition has recently become a very active research area, partly because of the increased interest in biometric security systems in general, but also because of recent advances that have taken the state-of-the-art far beyond the initial attempts of using direct image comparison. The first of face detection system has been developed since in early 1970. Due to the limitation of computation, system can't be satisfied the requirement of users, which is identify passport photograph real time. At the beginning of 1990's techniques are proposed focused on the face recognition on and increase the need of face detection. Face recognition has attracted much attention and its research has rapidly expanded by not only engineers but also neuroscientists, since it has many potential applications in computer vision communication and automatic access control system. It is a specific and hard case of object recognition. It has always been a very challenging problem in the field of image processing and computer vision, and as such has received a great deal of attention over the last few years. On the one hand, its applications are very useful in various domains. On the other hand, it has always been very difficult to implement due to all different situation that a human face can be found.

Especially, face detection is an important part of face recognition as the first step of automatic face recognition. However, face detection is not straightforward because it has lots of variations of image appearance, such as pose variation (front, non-front), occlusion, image orientation, illuminating condition and facial expression. The aim of face detection is detect faces in any images or videos. The face is our primary focus of attention in a face recognition system as well as in social intercourse of our day to day life and plays a major role in conveying our identity and emotion. Although, there have been developed so many Face Recognition systems based on numerous methods to recognize faces but not equals human ability to recognize faces despite many variations in appearance that a face can have in a scene. The human ability to recognize faces is remarkable. We can recognize thousands of faces learned throughout our life time and identify familiar faces at a glance even after years of separation despite large changes in the visual stimulus due to viewing conditions, expression, aging and distractions such as glasses or changes in hairstyles or facial hair.

2. What a Face Recognition system do?

A *face recognition system (FRS)* is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. A face image or image sequence is given as input to the FRS, and then FRS applies proposed methods to match the given input with face images stored in the database.

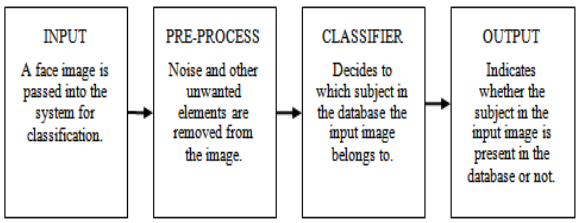

Fig. 1. Generic representation of a face recognition system

It is used for two primary tasks:

1. Verification (one-to-one matching): When presented with a face image of an unknown individual along with a claim of identity, ascertaining whether the individual is who he/she claims to be.
2. Identification (one-to-many matching): Given an image of an unknown individual, determining that person's identity by comparing (possibly after encoding) that image with a database of (possibly encoded) images of known individuals.

There are numerous application areas in which face recognition can be exploited for these two purposes, a few of which are outlined below.

• Security (access control to buildings, airports/seaports, ATM machines and border checkpoints [2, 3]; computer/ network security [4]; email authentication on multimedia workstations).

• Surveillance (a large number of CCTVs can be monitored to look for known criminals, drug offenders, etc. and authorities can be notified when one is located; for example, this procedure was used at the Super Bowl 2001 game at Tampa, Florida [5]; in another instance, according to a CNN report, two cameras linked to state and national databases of sex offenders, missing children and alleged abductors have been installed recently at Royal Palm Middle School in Phoenix, Arizona [6]).

• General identity verification (electoral registration, banking, electronic commerce, identifying newborns, national IDs, passports, drivers' licenses, employee IDs).

• Criminal justice systems (mug-shot/booking systems, post-event analysis, forensics).

• Image database investigations (searching image databases of licensed drivers, benefit recipients, missing children, immigrants and police bookings).

• "Smart Card" applications (in lieu of maintaining a database of facial images, the face-print can be stored in a smart card, bar code or magnetic stripe, authentication of which is performed by matching the live image and the stored template) [7].

• Multi-media environments with adaptive human computer interfaces (part of ubiquitous or context aware systems, behavior monitoring at childcare or old people's centers, recognizing a customer and assessing his needs) [8, 9].

• Video indexing (labeling faces in video) [10, 11].

• Witness faces reconstruction [12].

In addition to these applications, the underlying techniques in the current face recognition technology have also been modified and used for related applications such as gender classification [13-15], expression recognition [16, 17] and facial feature recognition and tracking [18]; each of these has its utility in various domains: for instance, expression recognition can be utilized in the field of medicine for intensive care monitoring [19] while facial feature recognition and detection can be exploited for tracking a vehicle driver's eyes and thus monitoring his fatigue [20], as well as for stress detection [21].

Face recognition is also being used in conjunction with other biometrics such as speech, iris, fingerprint, ears and gait recognition in order to enhance the recognition performance of these methods.

However, the human brain has its limitations in the total number of persons that it can accurately "remember." A key advantage of a computer system is its capacity to handle large numbers of face images

3. Problems & Challenges

Over the last decade, academic computer vision researchers and commercial product developers have improved the performance of automated face recognition algorithms on a variety of challenging face recognition tasks. Because humans currently perform face recognition tasks in most real-world security situations, it is unclear whether the use of algorithms improves security or puts it at greater risk. The real challenge in face detection and recognition technologies is the ability to handle all those scenarios where subjects are non-cooperative and the acquisition phase is unconstrained. There are numerous factors that cause the appearance of the face to vary. These sources of variation in the facial appearance can be categorized into two groups: Intrinsic factors and Extrinsic ones [22].

A) Intrinsic factors: - are due purely to the physical nature of the face and are independent of the observer. These factors can be further divided into two classes: intrapersonal and interpersonal [23]. Intrapersonal factors are responsible for varying the facial appearance of the same person, some examples being age, facial expression and facial paraphernalia (facial hair, glasses, cosmetics, etc.).
Interpersonal factors, however, are responsible for the differences in the facial appearance of different people, some examples being ethnicity and gender.

B) Extrinsic factors: - cause the appearance of the face to alter via the interaction of light with the face and the observer. These factors include

illumination, pose, scale and imaging parameters (e.g., resolution, focus, imaging, noise, etc.).

Following are the common problems and challenges that a face recognition system can have while detecting and recognizing faces:

3.1 Automatically locate the face

Locating or detecting a face in an image or video is the first step in a face recognition system. It is not always possible that in an image sequence the position of the head is stationary. For example, in a Video Surveillance System at a crowded place, it is a difficult task to detect a face as there is always some motion. Second, the background is very complex that makes detection more challenging.

Fig. 2 Face Detection

3.2 Illumination

Illumination means light variations. Illumination changes can vary the overall magnitude of light intensity reflected back from an object, as well as the pattern of shading and shadows visible in an image. Indeed, varying the illumination can result in larger image differences than varying either the identity or the viewpoint of a face. The same individual imaged with the same camera and seen with nearly the same facial expression and pose may appear dramatically different with changes in the lighting conditions. The problem of face recognition over changes in illumination is widely recognized to be difficult for humans and for algorithms. The difficulties posed by variable illumination conditions, therefore, remain a significant challenge for automatic face recognition systems. It is found that the difference between two images of the same person taken under varying illumination is greater than the difference between the images of two different persons under same illumination. The variation in illumination changes the appearance of the face drastically as shown in figure.

Fig.3 Variations in illumination

3.3 Pose

Pose variations in an image is also a matter of concern in face recognition. The pose of a face changes with viewing angle of the observer &rotation in the head position. These changes in the posture strike a serious problem for the identification of the input image. A Face Recognition System can tolerate cases with small rotation angles, but it becomes a challenge when rotation angle goes higher and the available image in the database may have only the frontal view of the face which may differ in pose with the input image and that misleads the system result in faulty identification or no recognition.

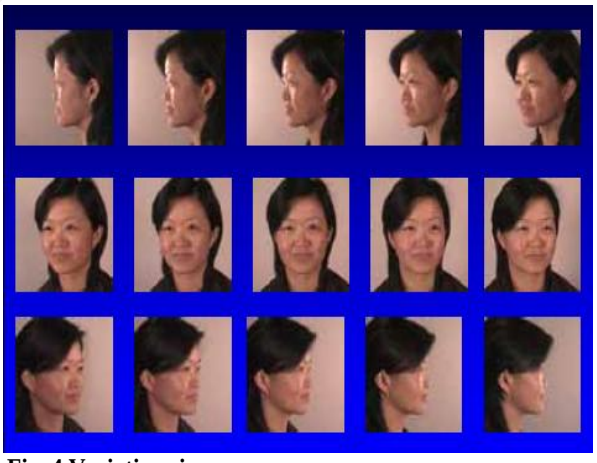

Fig. 4 Variations in pose

3.4 Expressions

Face is one of the most important human's biometrics which due to its unique characteristics plays a major role in conveying human identity and emotion. Because of these emotions human mood varies and results in different facial expressions. With this make-up and hair style also changes the facial expressions. These differences in facial expressions change the appearance of the face and it becomes difficult for a Face Recognition System to match the accurate face stored in the database as shown in figure.

Fig. 5 Variations in expressions

3.5 **Ageing**

The human face is not a unique, rigid object. Everything changes with time, so with the increasing age the appearance of a person also changes which affect the face recognition system as shown in figure.

Fig. 6 Ageing variations [30]

3.6 **Occlusion**

Occlusion means blockage. When in a Face Recognition System the whole face is not available as input image or image sequence, then it is termed as Occlusion. It is one of the important challenges of the face recognition as shown in the figure. This is due to presence of various occluding objects such as glasses, beard, moustache etc. on the face and when an image is captured from a surveillance camera; the face lacks some parts. In real world applications also it is very common situation to acquire persons talking on the phone or wearing glasses, scarves, hats, etc. or for some reasons having their face covered with hands. Such a problem can severely affect the classification process of the recognition system.

Fig. 7 Partial occlusion in images [29]

3.7 Low Resolution

Low resolution problem occurs in a face recognition system when resolution of the face image to be recognized is lower than 16x16. This problem happens in many surveillance applications, such as small scale stand alone camera applications in supermarkets and banks, CCTV in public streets, etc. where images taken from a surveillance camera generally consists of very small face area and cannot provide enough resolution of face for recognition. As the person face is not close to the camera, the face region will be smaller than 16x16. Such a low resolution face image consists of very limited information as most of the details are lost. This can drop down the recognition rate drastically.

Fig. 8 Typical frame from a surveillance video (CAVIAR database)

3.8 Identify similar faces

Different persons may have similar appearance that sometimes it is impossible for a human to identify them.

So, it is very difficult for a recognition system to identify them.

Fig. 9 Similar Faces

3.9 Other systematic problems

These problems can be due system faults used in face recognition, such as camera distortion, background noise, inefficient storage, improper techniques etc. More than that there can be network problems due to environmental conditions.

4. Conclusion

Face recognition is one of the most difficult problems in the research area of image recognition. A human face is not only a 3-D object; it is also a non-rigid body. Moreover, facial images are often taken under natural environment. That is, the image background could be very complex and the illumination condition could be drastic. Camera distortion and noise are standard variations in image recognition problems. Evaluations of state-of-the-art recognition techniques conducted during the past several years, such as the FERET evaluations [7, 24], FRVT 2000 [25], FRVT 2002 [26] and the FAT 2004 [27], have confirmed that age variations, illumination variations and pose variations are three major problems plaguing current face recognition systems [28].

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