

## CHALLENGES IN FACE RECOGNITION SYSTEMS

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**ABSTRACT:** : Face recognition has received tremendous significance in current scenario due to its wide range of applications such as social media, surveillance, security etc. It is a widely used biometric recognition process used in both online and offline applications. But the complexity of the system expands as the application widens. Even though many face recognition methods have been introduced, but it still remains a challenge in real life applications. There is no technique which stands at par with the human ability to recognize faces in spite of variations in appearances. In this paper we have discussed various challenges a face recognition system faces. This challenges can be due to variation in illumination, ageing, difference in poses, Variation in expressions, oclusions etc.

**Key Words:** Image processing, Face recognition, Face detection, Biometrics, Feature extraction

### I INTRODUCTION

Face recognition by definition can be explained as the computer application that can be used for identifying or verifying an individual using their faces. It can be considered as one of the efficient biometric methods present today. As the importance of security is growing day by day, such biometric systems play an important role. The first face detection system was introduced in the year 1970. Since there were limitations with the computation and the system could not meet the user requirement to identify the real-time passport photographs, it was not a successful system then. The field expanded not just among engineers, it had wide applications in other branches of science as well, especially in the automatic access control areas. [3]

It is a very challenging system as it is very difficult to implement due to different situations that a human face can be found. Since face detection is the primary step required for an automatic face recognition system and face detection is not an easy process as there are a variety of image appearances like variation in illumination conditions, oclusions, variation in pose, change in expressions, ageing. An efficient face recognition system is supposed to detect and recognize the face in spite of any variations in the environment. In face recognition system the important factor is the face, and in the day to day life as well face plays an important role in identifying and conveying the emotions of an individual. [5]

### II. FACE RECOGNITION SYSTEM

Before going into the details of the challenges and issues of face recognition system it is important to understand a face recognition system in deep. As we know this system is used to identify an individual from an image, let's discuss how it works. Firstly, a face image or an image sequence is given as the input to the system. The image can be acquired in real time as well using camera and sensors. Following this step the face recognition system applies the proposed methods for processing the image. In this step the FRS will do processes such a feature extraction and matches it with the images in the stored database.

Two processes are very important, they are:

1. **Verification:** It generally is the process known as a 1-to-1 matching system because the system tend to match the biometric given by the individual with a reference biometric already on file. In this case the biometric will be the face. [2]
2. **Identification:** It generally is the process also known as a1-to-many matching system. The system tends to identify an unknown person, or unknown biometric. In this case the biometric will be the face.

In the fig. 1, we can see a basic face recognition system. As we can see as the face image is given as the input to the system, pre-processing step involves noise removal and other unnecessary elements are also eliminated from the image. The next would be to find, to which subject in the database the input image matches with and the output would be the system shows whether the subject in the input image is present in the database or not present in the database.

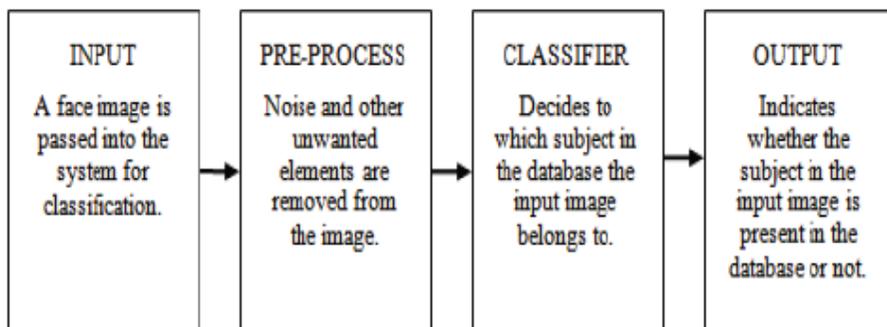


Fig. 1 Basic face recognition system

This system has been used in many applications and few of them are mentioned below.

- a) Security: One important application of face recognition in airports, ATM machines, border checkpoints etc. It is also widely used in automatic home security systems nowadays. [2,3]
- b) Surveillance: The use of face recognition techniques come handy in detecting criminals in public areas using CCTV cameras and authorities can be notified. [6]
- c) General Identity Verification: This is the most widely used application of FRSS. We can see this in the areas such as banking, electoral registration, passport identification, Attendance systems in industries as well as in educational institutions. [7]
- d) Multi-media environments with adaptive human computer interfaces. This can be seen in places where continuous monitoring is required, for example childcare centers, hospitals, prison, old age homes etc. [8,11]
- e) Video indexing: Labeling faces in a video. Most social media application has this feature. Automatically identifying faces in an image based on your friend list. [1,4]

In addition to these, currently FRSS are also used for variety of applications such as gender identification, facial expression identification and tracking. Automobile companies are coming up with smart cars that can identify its owner and the engine only initiates if the individual belong to the stored database. In all these we can see how wide the application is for face recognition system and hence the accountability and performance of the system comes into question.

### III CHALLENGES IN FACE RECOGNITION

As the range of application is expanding day by day, the complexity of the system is increasing as well. This in fact affects the efficiency of the system. In this section of the paper we shall discuss the different challenges of face recognition systems that are present today. These challenges are related to the face image which is given as the input to the system. The algorithms used or this process varies from application to application. There are many reasons that are responsible for variation in faces. These sources of variation are classified into two main factors. They are:

1. Intrinsic factors: It is due to the physical nature of the face and not dependent on the observer. Intrinsic factors are further divided into intrapersonal and interpersonal. Intrapersonal is caused due to variation in face appearance of an individual, for example ageing, facial expression and facial paraphernalia (facial hair, cosmetics, glasses etc.)
2. Extrinsic factors: This is caused due to the variation in face appearance due to the interaction of light with the face and the observer. This will include illumination, pose, scale and imaging parameters (resolution, focus, imaging, noise etc.).

Following are the common challenges seen in face recognition system can have while detecting a face.

#### 2.1 Pose variation

Variation in pose causes significant problems in detecting a face. Pose variation can be due to change in observing angle of the observer and also due to rotation in the head position. These variations can cause a serious problem in identifying the input image. Many of the systems can tolerate small variations such as small rotations in angles. But it will be difficult when it comes to large rotational angles. The database usually consists of face images of frontal view of the faces. Since the existing FRSS are very sensitive to pose variation, pose correction is essential and could be achieved by means of efficient techniques aiming to rotate the face and/or to align it to the image's axis.[7]



Fig. 2 Variation in poses

### 2.2 Variation in illumination

Variations of illuminations could reduce the efficiency of FRS. For moderate levels of lighting of the background, face detection and recognition are much difficult to perform. Variation in illumination can vary the total magnitude of light intensity being reflected back from an object. On the other hand, higher light levels could lead to over-exposure of the face and (partially) undetectable facial patterns. There have been many algorithms such as equalization techniques that are available now to get rid of this problem to an extent. Sometimes even multiple algorithms can be used in a face recognition system to tolerate the issue of illumination. But in case of extents, it is not desirable to depend on these techniques. [8, 10]



Fig. 3 Variation in Illumination

### 2.3 Variation in expression

Some variation in the face images can be caused due to difference in expression influenced by the individual's state of emotion. Therefore, it is important to recognize different facial expressions for evaluating the emotional state. Human expressions consist of macro-expressions such as, disgust, anger, happiness, fear, sadness or surprise, and other involuntary, rapid facial patterns. These facial changes can be computed with the help of dense optical flow. Cosmetics and hair styles can also be included in this challenge as changing hair style and putting make-up can also cause variation in facial expression. [9]



Fig. 4 Variation in Expression

## 2.4 Ageing

Another reason for the changes in the appearance of the face could be the aging of the human face and could affect the entire process of face recognition; if the time between each image capture is large, there will be significant changes in the person. As per various study conducted by scientists, in every 10 years there will be significant changes in an individual's face appearance. The fig. 5 shows the change in an individual's face at different ages. It is not just the shape and lines of a face that gets modified over time; there will be changes in hairstyles as well. [7]



Fig. 5 Ageing

## 2.5 Occlusions

Variation in facial appearance can also be caused due to presence of objects that such as occlusion that partially cover the face. This makes it a difficult task for the system to classify the image. Although the face is found, it may be difficult to recognize it due to some hidden facial parts, making it difficult to recognize features. This challenge can be seen in real world application where acquiring persons talking on the phone, wearing glasses, scarf, hats etc or having their faces covered with hands. [7]



Fig.6 Occlusions

## 2.6 Similar Faces

This is usually a not so common challenge. But we have seen that even humans find it difficult to identify people with similar faces. Hence we can imagine the difficult situation for computer to identify similar face individuals. Especially identical twins with similar facial features, shape etc. this becomes a difficult task for the face recognition system to identify the individual. This will cause an increase in false recognition rate (FRR) as well.



Fig. 7 Similar Faces

## 2.7 Image Resolution

Another important issue with face recognition system is the varying quality and resolution of the images given as input. Many factors can affect the resolution of an image. The environment, the performance quality of the acquiring system and many other reasons can be mentioned as factors that are responsible for varying resolution of the image. If the resolution is good, then the recognition process will be much easier and efficient. So we can say that resolution is directly proportional to the efficiency of the face recognition system. [10]



Fig. 8 Variation in resolution

#### IV CONCLUSION

In this paper we discussed in detail about the different challenges that exists in a face recognition system. Since face recognition is one of the widely used biometric systems, the efficiency of the system needs to be taken care of. Moreover, facial images are often taken under natural environment. The image backgrounds can be complex, illumination variation could be extreme. Here we have discussed challenges such as ageing, occlusions, variation in illumination, variation in resolution, variation in expression and poses. Some of them can be to an extent controlled by using appropriate algorithms. Various algorithms have been developed to tackle problems of illumination, variation in expression and poses. But when these problems are experienced in large, it is difficult to recognize the face. In addition, in this field of face recognition there are a number of challenges ahead and plenty of space for innovation.

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