Problems in Facial Recognition: Analysis

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Abstract : 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. Now-a-days as we all know facial recognition is everywhere. It is in video game consoles, video conferencing applications, smart-phones, surveillance networks, and social media. So far numerous methods have been proposed for face recognition, Current facial recognition technology far surpasses the early attempts, 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.

I. INTRODUCTION

Face recognition has been one of the most interesting and important research fields in the past two decades for object recognition, shape matching, and pattern recognition in the field of computer vision. The reasons come from the need of automatic recognitions and surveillance systems, the interest in human visual system on face recognition, and the design of human-computer interface, etc. These researches involve knowledge and researchers from disciplines such as neuroscience, psychology, computer vision, pattern recognition, image processing, and machine learning, etc[1]. A human being can be identified with the help of different face features, fingerprint, eye/iris, body structure, spot mark and so on. Face is one of the important parts of the body, which plays an important role in recognizing humans. Face recognition is always an interesting area and one of the challenging tasks in computer vision and image retrieval. It is applicable in variety of domain such as in ATM, healthcare system, driving license system, railway reservation system, surveillance operation, forensic investigation and passport authentication[2].

However, face detection is not straightforward because it has lot of variations of image appearance, such as pose variation (front, non-front), occlusion, image orientation, illuminating condition and facial expression[3]. A bunch of papers have been published to overcome these variation and achieve better recognition rate, while there is still no robust technique against uncontrolled practical cases which may involve kinds of factors simultaneously. Many Face Recognition systems based on numerous methods to recognize faces but not equal human ability to recognize faces despite many variations in appearance that a face can have in a scene. 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. Hence, the human ability to recognize faces is remarkable.

II. HISTORY

The first system of face recognition was introduced by Alphonse Bertillon(French) in 1882 which uses photography(Anthropometry) which now a days also known as mugshots. In this system five measurements that is head length, head breadth, length of the left foot, and length of the cubit of the criminal is taken which help them to identify them[4].
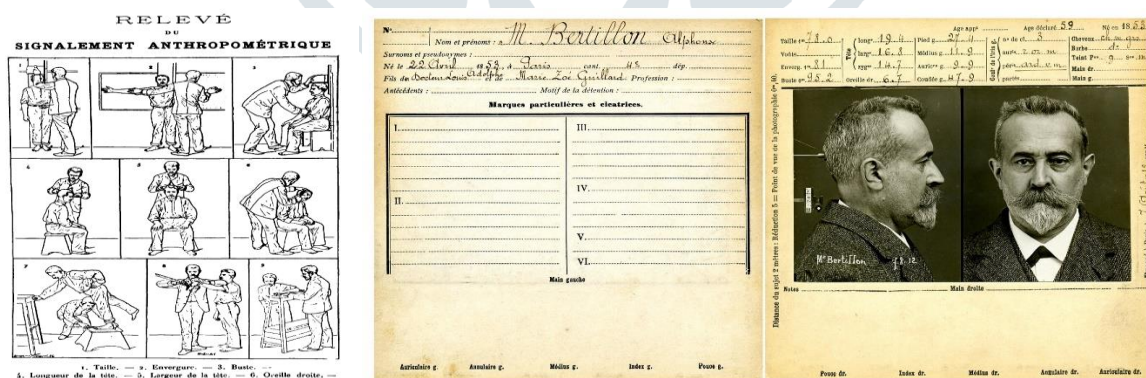

Fig-1. The Habitual Criminal Act, U.K., 1869, recognized value of photographing prisoners[4]
(Source: Internet World- https://www.google.com/search- Habitual criminal act)

In 1960s the processing power and system used for face recognition is limited, so many researches and developments were made by the researchers of Bell Labs in which they focused on the features of the face like ear protrusion, eyebrow weight or nose length as they can used to identify a particular person[6]. Finally in 1973 a Japanese researcher, Takeo Kanade achieved 75% of accuracy as he successfully build a fully automated system to recognize the face by analyzing the facial features which is the basic idea of researchers of Bell Labs using pattern classification. He achieve 75% of accuracy on a specific collection of few hundred digitized photographs. But one of the major drawback of the is that slightly change in any facial feature reduce the accuracy to less than 3% which is great fall with very few change [7].

From 1980s there was an explosion in the development, research and practical applications of face recognition system using machine learning to solve the problems. In 2014, Facebook published a research paper on 'DeepFace', a Benson 5 facial recognition system which is based on the methodology of deep learning rather than the earlier one that is focusing on the facial features. Whole problem of face recognition is divided into some sub-problems which play a crucial role in the whole process. The first, the basic step detecting the face from a stationary or from the moving clip, after that face is to be aligned to a standard portrait and the final step is to convert it into the representational form other than pixels.

III. TYPES OF FACE RECOGNITION

A face recognition system (FRS) is used to identify and verify the face or more than one face in still image or in the sequence of images that is also called as video picture. Mainly this is done on three basic methods i) color-image-based (2D) face recognition, ii) video-based (3D), iii) thermal-based method and iv) infrared face recognition.

3.1 2D FACE RECOGNITION:

2D face recognition process include matrix which contain the computed value of pixels of the face under the different lighting conditions or illumination. The computed value of pixels is of different position and corner of the face under different illumination condition [7]. Techniques based on color, intensity and illumination are adopted for detection of 2D face which involve three basic steps. The first step is face detection, the main function of this step is to detect and locate the position of the human face, second step is feature extraction in this human face patches are extracted from images and after that transformed into a vector with fixed dimension and their corresponding locations, the third step is face recognition, the last step to identity the faces by comparing the feature of image to each face stored in the database. There are factors which affect the performance and accuracy of the system like head orientation, lighting conditions, partial occlusion, facial expressions. The two most significant factors which effect the overall performance are pose (change in the orientation of the head or position of the head) and illumination (different lighting conditions at different places).
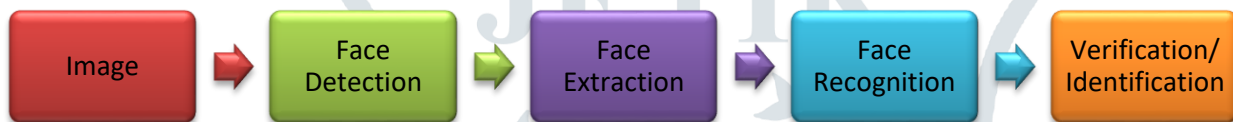

Fig- 2. Configuration of a general face recognition structure
(Source: Article- "Face Recognition", Wei-Lun Chao GICE, National Taiwan University.)

3.2 2D-3D FACE RECOGNITION:

In this approach of face recognition, the head moves through the space therefore there is a pose angle estimation and illumination compensation since multiple poses will be available which is one of the major problem in 2D face recognition. The information of different angles and positions are combined together into a single image to produce more accurate results. In 2D-3D face recognition is performed using both 2D and 3D approaches. The data set or face to be recognized is a 2D face and that will be processed by 3D recognition algorithms. This approach also have some significant challenges-
(i) It becomes difficult to build a composite image when the quality of the video is low with a lot of clutter in the scene that makes face detection very difficult[8].
(ii) The size of the images of face are often very small (15 by 15 pixels), so obviously accurate detection and normalization is challenging with such small images[8].

3.3 3D FACE RECOGNITION:

3D face recognition technology provide more accuracy and performance than 2D face recognition system as 3D system ought more information than a 2D recognition system. 3D face technology enables device to read overall surface geometry of the human face very deeply, that it reads each point on the face surface so that it can be viewed very clearly from every position and from every angle[8]. His system is logical way to overcome the problems faced by 2D recognition system. There are three approaches: passive stereo, structured lighting and laser. In both passive stereo and structured lighting it is very important that there is a known (and fixed) geometric relationship between the subject and the sensing devices. There is also involve a matrix calculation which is used for finding out similarity scores and concept of pose and light normalized signatures for face verifications applied frequently and this matrix is called Correlation matrix[9]. Illumination also have a great affect on the performance and accuracy of the 3D face recognition system.

3.4 INFRA-RED (THERMAL) FACE RECOGNITION:

In infrared recognition technology, infrared thermal image of face is given as an input. IR scanner only scan the heat pattern emitted by the object[9] and is not effected by any other kind of lighting. Every human have their own unique body heat pattern so infrared scanner scans the thermal human face image which are independent of ambient lighting conditions. The cause of these unique heat pattern of the body is the flow of blood in the tissue structure which is unique of every human therefore the IR images are also unique[10]. Fig. 2 shows a thermal image corresponding to its visual one. Various approaches which have been proposed in an attempt to overcome the limitations like illumination, face expression and poses, the infrared recognition technology have no effect of ambient lighting conditions.

Fig- 3. Developments in infrared technology (camera) over the last decade have given computer vision researchers a whole new diversity of imaging options, particularly in the infrared spectrum.
(Source: Internet world- https://www.google.com/search?q=infrared+face+recognition)

IV. CHALLENGES

Human face have a great degree of variations so face recognition is not an easy task. There are two main concern in this field are speed (time required to recognize the face) and accuracy (correctness of the results). Basically this system have application in the security field but there still a question-Is it really improves the security or put it at a greater risk? There are some issues which are need to be solved to get the desired results. 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.
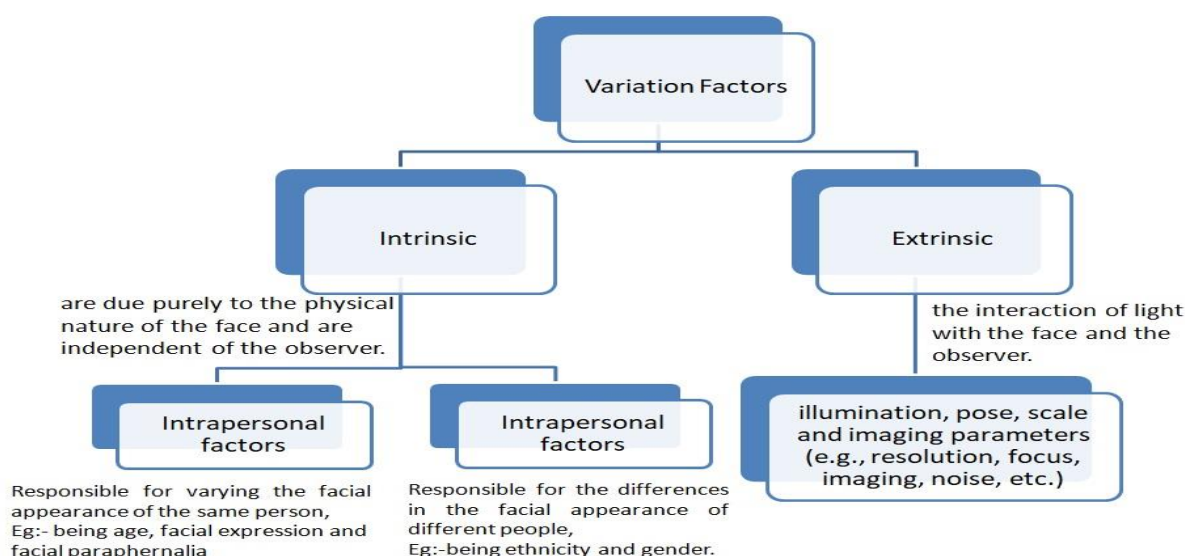

Fig-4. Factors affecting face recognition

Intrinsic properties of the domain specific data are considered along with the general structure of pattern recognition when there is a need to focus on a specific application.

4.1 Domain-knowledge of human faces and human visual system

a) Aspects from psychophysics and neuroscience
Humans have great capability of identifying the faces more easily than other objects when presented in the correct orientation, but it will be difficult for the patient of prosopagnosia to recognize the human faces but they can easily identify other object which support the point that face recognition system is a dedicated process and also necessary.

b) Holistic-based or feature-based
According to the Holistic-based face recognition viewpoint, human recognize faces by global appearances, where according to the featured based viewpoint the facial features like eyes, nose, mouth and patches plays an important role in the face recognition process.

c) Thatcher Illusion

(b)

Fig- 5. The Thatcher Illusion. (a) The head is located up-side down, and it's hard to notice that the eyes are pasted in the reverse direction in the right-side picture, while in (b) we can easily recognize the strange appearance.
(Source: Article- "Face Recognition", Wei-Lun Chao GICE, National Taiwan University.)

In the fig. 6, eyes and mouth of face are inverted i.e upside down, and the result looks distorted in an upright face. But when the face is inverted it becomes difficult to notice the inverted internal features i.e. Mouth and eyes and the face look nearly normal.

4.2 .   Factors of human appearance variations

Illumination	The illumination is one the major problem and mostly discussed in the field of face detection and recognition. Different light pattern cause huge difference in the appearance of face of the same person as shown in fig.7. Because of different illumination effect it become very difficult to locate the features of the face thus it become difficult to recognize face as there can be large difference in the appearance as that of two different identities.
Pose	Pose is basically the different angles, locations and a position in which the face is to be detected. The change in the pose of the face can cause a serious distortion and problem and distortion in recognizing the face as it affect the shape and size of the features.
Expression	Face is the most expressive part of the human body which express our feelings through facial expression which can even effect the results of face recognition as the shape of the features changes for example- our lips expands in the outward direction when we smile.
Cluttering	Cluttering also cause some variation in the results of process of face recognition. Cluttering is basically the effect of the surrounding environment and the background on face that is to be recognized. It effects the accuracy of the result which diminish the performance of face detection and recognition algorithm.
Occlusion	There may be possibility that some parts of the face remains unobserved it become difficult in face detection and face recognition process.

Fig- 6: The list and description of the six general factors
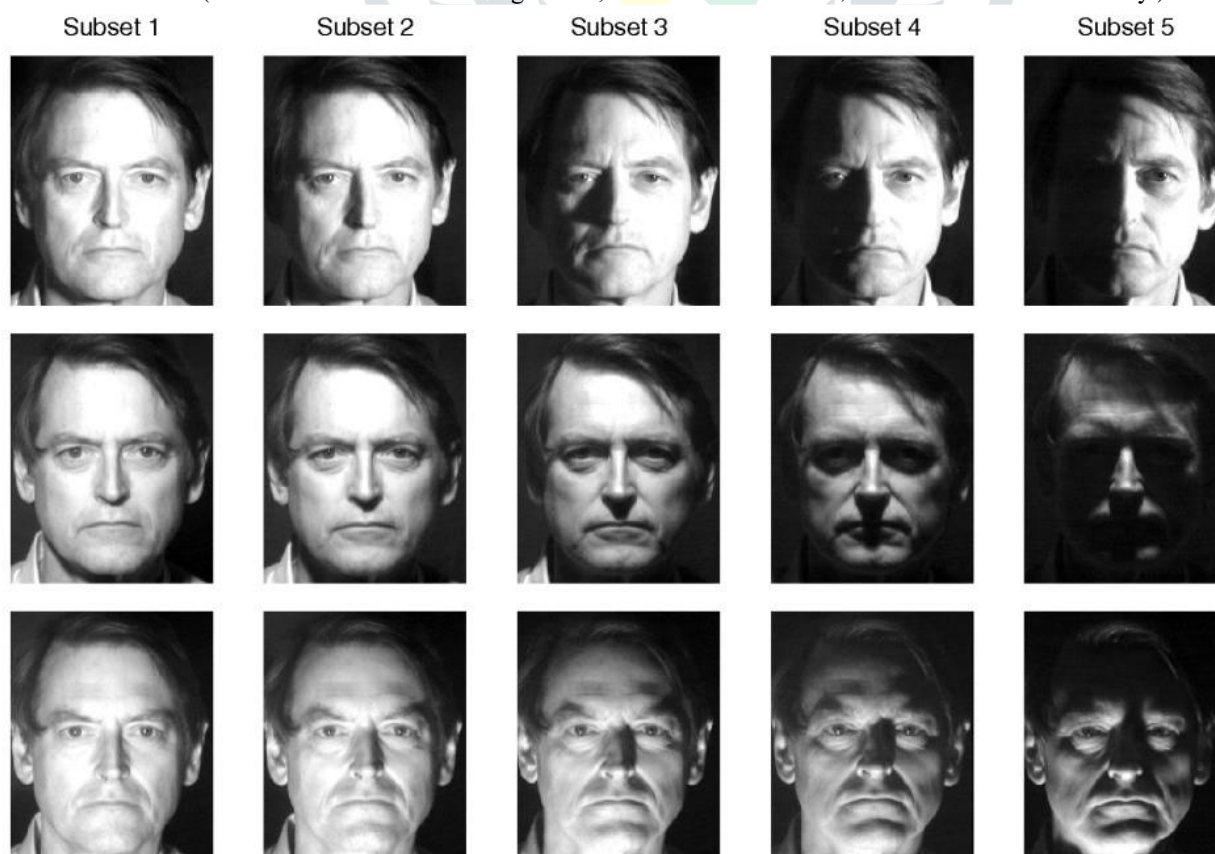(Source: Article- "Face Recognition", Wei-Lun Chao GICE, National Taiwan University.)

Fig- 7: Face-patch changes under different illumination conditions. We can easily find how strong the illumination can affects the face appearance[11].
(Source: Internet- https://www.google.com/search?q=effect+of+illumination+on+face+recognition)

Figure 8: Face-patch changes under different pose conditions. When the head pose changes, the spatial relation (distance, angle, etc.) among fiducial points (eyes, mouth, etc.) also changes and results in serious distortion on the traditional appearance representation[12].
(Source: Internet- https://www.google.com/search?q=effect+of+pose+on+face+recognition)

4.3 Design issues

4.3.1. In early times very complex and long algorithms are used to recognize the face which could even take from few seconds to some minutes but they can accurately recognize the face. But speed is also a one of the major factor which is very much important in real-time system which is somewhere not present in early design.

4.3.2. The algorithm can be provided data of large size so that it can recognize a particular face from a group of people which improve the performance of the algorithm. However the human privacy is also an important point that is need to keep in mind along with this one thing also must be kept in mind i.e. data acquisition which should also need to be considered so the size of the database is kept small. Because of the condition of limit size of database, algorithm must be given some prior knowledge about the data.

Following are some more common problems and challenges that a face recognition system can have while detecting and recognizing faces:
    4.3.2.1. Automatically locate the face

It is not compulsory that, which is to be recognised that should always be stationary, it can be in sequence of images or can say in moving position than detection become quite challenging.

    4.3.2.2. Ageing

Everything changes with time, so as the age of the person increase with time the features and appearance of the face also changes which also affect the face recognition process.

    4.3.2.3. Low Resolution

This problem occurs when provided resolution of face is not sufficient i.e. it is less than 16x16. This problem is generally seen in the public areas where surveillance applications, such as small scale standalone 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.

    4.3.2.4. Identify similar faces

Sometimes different people have similar appearance as in case of identical twins where it becomes difficult to identify them for human as well as for recognition system.

    4.3.2.5. Other systemic problems

There may be some other kind of problems like in them system used in the face recognition such as camera distortion, background effect, storage problem, use of incorrect algorithm and technique etc.

V. CONCLUSION

During the last few decades facial recognition system has received great deals of attention in various fields. Although it faces many challenges and problems in the computer vision but many research and developments are still going on vigorously to solve these problems and challenges to develop an ideal system for face recognition. In this paper we have reviewed the current challenges and problems the facial recognition is facing and which are need to be solved to achieve the best result possible. In this paper we can see the different types and problems and why these problems are seen so that the future development can took some step to solve these types of problems for improving the performance of the face recognition system.

VI. ACKNOWLEDGEMNT

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