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Technical Challenges, Performance Metrics and Advancements in Face Recognition System

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***Abstract*—** According to the International Biometric Group, the term Biometric is defined as "Automated use of physiological or behavioral characteristics to identify and verify identity. Every individual has his/her own characteristics. The face scan, fingerprint, palm print, foot print, iris, hand scan, retinal scan, androgenic hair and DNA comes under the category of physiological characteristics. The behavioral characteristics such as voice scan, keystroke scan, gait and signature scans are better parameters. Face recognition is one of the fastest growing, emerging and interesting areas in the field of biometrics for real time applications such as image processing and film processing. This requires computational models to identify and verify the human face images. Human brain can easily detect the face but it is very difficult for computer to recognize the facial image. A lot of research work has been carried out on various algorithms for recognizing the face from past two decades. This paper provides the fundamentals of face recognition system including major components namely face detection, tracking, alignment and feature extraction. The technical issues and challenges for building a face recognition system are clearly addressed. It also provides the comparative review on existing models of face recognition. In addition to this, the applications of face recognition system are addressed to motivate the researchers for developing the novel face recognition models.

***Keywords*—** Biometrics, Authentication, Face recognition, Biometric, Physiological, Behavioral, Signature and Keystroke.

I. INTRODUCTION

The main goal of Biometric system is to design a system that can provide maximum accuracy and prevent the forgery operation. There are two main phases of Biometric systems. First is identification, which determines the person's identity and second is verification, which helps to verify a person's identity in order to distinguish the genuine and imposter candidate. Among all biometric methods for human authentication, face recognition has been used more frequently and has become more popular for the last twenty years. Automatic face recognition has many commercial and security applications in identity validation. The availability of such feasible technologies as well as the increasing request for reliable security systems has been a motivation for researchers to develop new methods for face recognition. The desirable properties of biometric traits such as universality, uniqueness, permanence, collectability, performance, acceptability and circumvention based on humans physiological and a behavioral characteristic to identify an individual is tabulated in table 1.

Table 1: Desirable properties of Biometric traits

Parameters	Descriptions
Universality	Each candidate should have characteristic.
Uniqueness	Each has separate characteristics and do not matches with other person.
Permanence	Measures how better a biometric resists aging and over time.
Collectability	Ease of acquisition for measurement.
Performance	Accuracy and robustness of techniques used.
Acceptability	Degree of approval of a technology.
Circumvention	Ease of use of a substitute.

Feature extraction and recognition systems perform well under favourable conditions even in real-time applications. But under unconstrained environments, the recognition rate is not promising enough. This is due to the various factors such as variations in age, facial expression, illuminations, camera conditions and occlusions, etc. There are large number of biometric systems and among these six attributes have been studied by Hietmeyer [47].

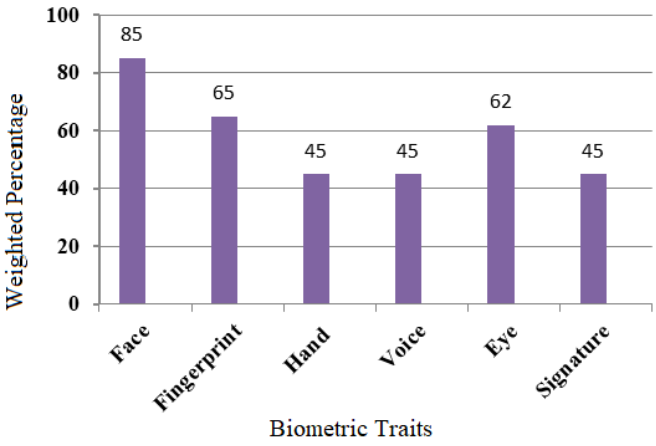

Figure 1: Comparison of various biometric traits based on MRTD

Hietmeyer studied the biometric attributes in Machine Readable Travel Documents and found that among these attributes face features had the highest compatibility which is highlighted in Fig 1.

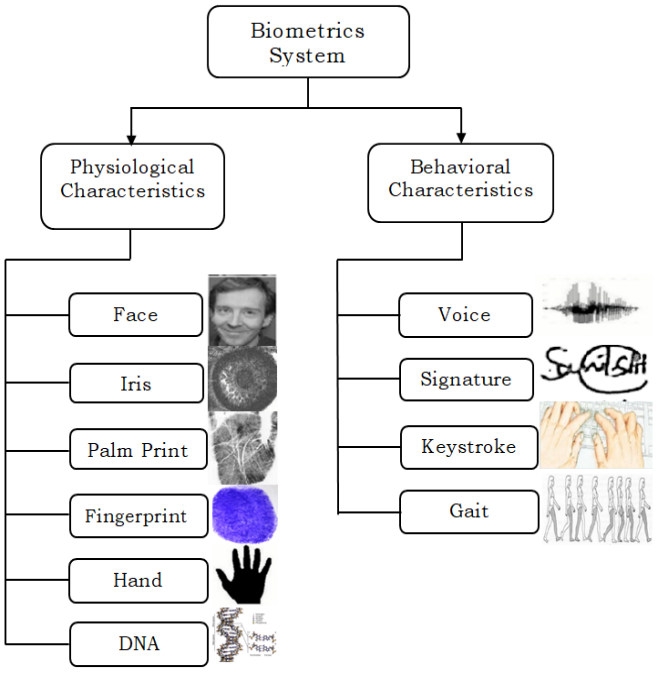

Figure 2: Classification of Biometric traits

The various types of biometric traits for identification of an individual are shown in Fig 2. This paper deals with face recognition technique as a biometric trait which is commonly and effectively used method with wide range of applications such as Security, Law Enforcement, Voter verification and Banking, Internet, E-commerce etc. Since the results obtained are having better accuraccy and safety, it is more efficient method when compared to other biometric trait because face recognition method does not require any physical interaction. The images are captured using any type of the camera but the device should produce good quality of pictures otherwise the image results in low recognition rate in term of its accracy. There are many better procedures that help to motivate towards the topic of Face Recognition from the authentication point of view such as an automatic system is designed which automatically identifies and recognizes the human face that increases the demand for such a system.

A. Brief History of Biometrics [46]

In early 1970's, the first commercial available biometric device was brought to market. One of the first commercial applications was used in 1972 when a Wall Street company, Shearson Hamil, installed a finger-measurement device which served as a time keeping and monitoring application. Hence from 1972, biometrics has improved tremendously in ease of use and diversity of applications. The advancement of biometrics has been driven by the increase in computing power at lower costs, better algorithms and cheaper storage mechanisms available today [5].

B. Identification vs. Verification

Biometric methods are used for either identification or verification purpose. In identification the goal is to identify an individual based on comparison of features collected against a database of previously collected samples. Fig 3 and Fig 4 shows the differences of identification and verification.

Figure 3: Face Authentication/Verification (1:1 matching)

Figure 4: Face Identification/Recognition (1: N matching)

In the verification applications, it is desired to verify whether the subject is the person that they claim to be. This is performed by validating the collected features against a previously collected feature sample for the individual in our library.

The rest of the paper is organized as section II deals with the technical challenges of face recognition. The block diagram of face recognition system is explained in section III. The comparision of recent existing face models are described in section IV. The performance measures for recognition of face is discussed in section V. The advantages, limitations and applications of face recognition system are

explained in section VI. Section VII concludes the work on face recognition.

II. TECHNICAL CHALLENGES IN FACE RECOGNITION SYSTEM

Face Recognition System has gained tremendous importance among the researchers and the industrialists mainly because of the awareness among the public for security, confidentiality and the need to automate the things. Though enormous work has been done in this field of research it still remains a hot area of study. This is due to the limitations of the algorithms under uncontrolled environmental conditions such as illumination changes, occlusions, age factor, etc. Human face is a non-rigid object. The image of the face will vary depending upon the changes in the illumination, poses, aging, and occlusions and so on. Surveillance of videos in real time is challenging due to poor quality of the video being captured. Also the algorithms are developed under the assumptions that multiple image samples of every individual are available. But in real time applications such as identity card database there is a single sample per person. Face detection and verification becomes difficult if these issues are left unaddressed. In the sections to follow some of these issues are described in brief.

A. Variations in illuminations

The appearance of human face being captured by the camera gets affected by some of the environmental conditions such as lighting. The nature and quality of the camera lenses and sensors will cause changes in the illumination. All these factors will degrade the image quality and in turn the recognition rate. The current face recognition approaches do well under constraint illumination conditions. The performance reduces drastically under real- life scenario. Fig. 5 shows the images of same individual taken under different illuminations condition. Poor illumination will darken the face image while very high illumination will merge portion of the face image with the background. Therefore there is a need to come up with robust face recognition system which can perform well even under unconstraint environmental conditions. Also having appropriate illumination environment for image acquisition is necessary.

Figure 5: The same person seen under varying light conditions can appear dramatically different [48]

B. Variations in the resolution of the camera

This factor will cause the images to be of different resolutions and sizes. Therefore, the algorithm must preprocess the data so that all the images under study and those of the database have same resolution and size. Only after this the actual recognition steps can be carried out.

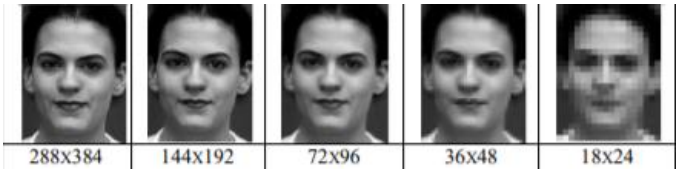

Figure 6: Effect of resolution changes on face recognition [48]

C. Variations in pose

The databases that are currently available do not cover all the angles of the face. Therefore the existing recognition technologies are not precise in giving accurate results. This will necessitate the need for a huge database or else the preprocessing steps must first convert the captured image in appropriate alignment before proceeding with the recognition. Larger databases will increase the memory requirements and also the cost of the implementation. This is a largely debated topic in face recognition and needs improvement. Sample is shown in Fig 7.

Figure 7: Samples of same person in different poses (ORL database)

D. Variations in age

There has been very less work done in this area in the literature mainly because drastic changes occur in the human face with age. Database may have the image of a particular person when he is young and recognition requirement may arise after few decades as shown in Fig 8. Under such situations the recognition will not be accurate. It is practically impossible to collect the database of single person at different ages. Also the quality of images collected a few decades ago and those collected now are different. So here again the recognition rate will be degraded.

Figure 8: Face images with aging and wrinkle variations [48]

E. Variations in the modalities

The image of an individual may be captured by a camera in infrared illumination or there could be a sketch of the individual. These differences in the modality will make the recognition inaccurate because the sketch may be made under the supervision of an eye witness and his explanation may be false as illustrated in Fig 9. Also the infrared images and the database images may be of different camera settings. This poses problems while recognition is carried out.

Figure 9: The false match of face image due to variations in sketch image and the true image.

F. Variations in facial style and/ or facial expressions

The face image to be recognized and those present of the same person in the database may not match perfectly due to the changes in the facial styles such as hairstyles, makeup, etc., and also due to the variations in the expressions such as smiling image, anger expression and so on as shown in Fig 10. That is to say the database may not have the images of the individual under different emotional states. Under such circumstances, the algorithm must first perform preprocessing to convert the image captured to one of the forms present in the database used in testing and training of the system. The other approach is to include all possible images of the individual in the database. Both the techniques are costlier in implementation and time consuming at the same time.

Figure 10: JAFFE image of the same person in different expression

G. Effects of occlusions

It may so happen that the test image to be recognized by the recognition system may be occluded by objects, for example, the face may be captured when it is partially covered by a cloth or spectacles may be present as shown in Fig 11. The individual may have beards and mustaches which may be absent when the database of the same individual was collected. Here the recognition may fail miserably.

Figure 11: Effects of Occlusions [48]

H. Locating the image of the face

First step in any face recognition system is to locate the face of the individual either in a still image or in a video sequence. Elimination of background data and accurately locating the individual under study is difficult. The still image of the person may be of poor quality or is under prominent background. The individual under study may be moving at a fast rate in the video sequence. Locating human face is the first step in face recognition. Therefore the algorithms must be robust to take care of the above mentioned situations.

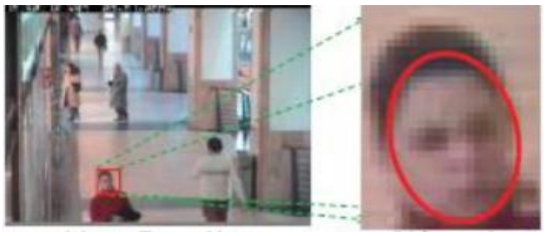

Figure 12: Image captured from CCTV camera

The left side of Fig 12 shows the image captured from a CCTV camera and right image locates the face image of interest. Due to poor quality of the camera, face recognition becomes difficult.

I. Identification of similar faces

If the individual whose recognition is to be carried out has an identical sibling or there is another person looking similar as shown in Fig 13 to the one under study then the recognition results will be faulty. Addressing such issues need additional steps apart from the face recognition.

Figure 13: Example of identical twins' images [48]

III. FUNDAMENTAL STEPS IN FACE RECOGNITION SYSTEM

In this section the fundamental steps of face recognition system is explained in detail. The facial recognition system consists of mainly four important steps. Fig 14 shows the steps in face recognition process.

A. *Detection of Face*

Detecting a face is very simple to the human but it is very difficult for the computer to detect the face. The machine should decide, which pixel must belong to which part of face image and which is not the part of facial image.

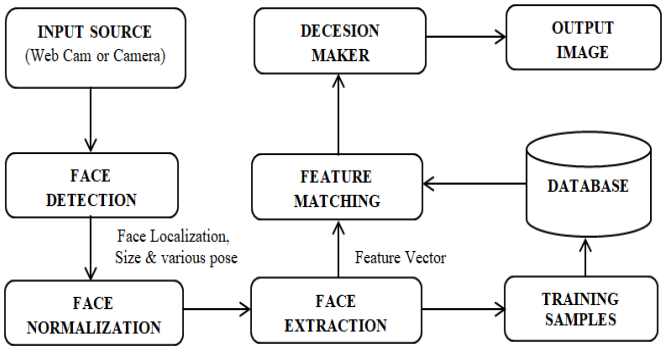

Figure 14: Various Steps of Facial Recognition System

B. *Normalization*

After detecting the face which is separated from its background, the face needs to be normalized. Normalization is a process in which the detected image must be standardized with respect to pose, Size and illumination effect etc that are relevant to the images in the gallery or face database. In order to normalize an image the facial landmarks must be located carefully and accurately. Using these key facial land marks normalization algorithms was developed. Some of the pre-processing approaches are discussed as follows

- ***Histogram Equalization*** is one of the simple and effective approaches used for image enhancement. Here the Image Histogram remains constant with equal distribution of brightness levels where all the values are equal in its probability. The probability of occurrence of gray level 'i' is given in equation 1.

$$P(i)=n_i/N \quad (1)$$

  Where N is total number of pixels in image I and i=0,1,2……m-1.

- ***Adaptive Histogram Equalization*** method computes the histogram of local image centered with the given pixel towards the mapped value of that pixel. So this can achieve a better enhancement.
- ***Gradient*** method involves that the probability distribution of Image Gradient depends on the intrinsic properties of face such as surface geometry and reflectance.
- ***Gamma Correction*** method is used for normalization process. The gamma transform of an image is given in equation 2.

$$G(x, y) = I(x, y)^{1/\gamma} \quad (2)$$

Where I(x, y) denotes input image, γ is gamma co-efficient if it varies the output image becomes darker or brighter. G(x, y) denotes output image. If γ>1 then it gives darker image and if γ <1 then it gives brighter image. So maintain γ to be equal to unity which provides equal distribution of brightness and darkness to the image.

- ***LOG*** is another method of gray scale transformation which is given in equation 3.

$$S = C^* \log (1 + r) \quad (3)$$

Where C is constant and assumes $r \geq 0$. It enhances low gray levels and reduces or compresses the higher gray levels. LOG technique is applied for shadowed and non-uniform illumination distributed images. Fig 15 shows the examples of simple illumination normalization techniques.

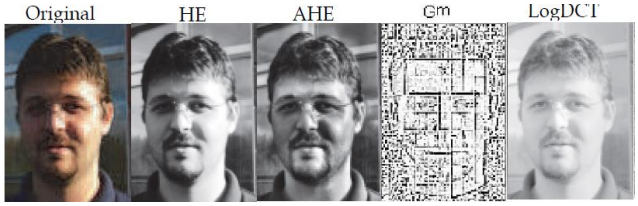

Figure 15: Simple Illumination Normalization examples

C. Feature Extraction

It helps to generate a mathematical representation called "Biometric template" or "Biometric reference" and stores this in the database. Many algorithms are developed for extraction of features such as Local features (LBP, Gabor) and Global features (PCA, LDA). The main requirements for feature extraction algorithms are good discriminative property, consistency, small size and fast computation of data.

- **Eigen faces** decomposes the facial images into a small set of characteristic feature images. It is based on PCA method which helps to find the lower dimensional space and also reduces the dimensionality of image. It is simple, fast and learning capability.
- **Gabor Filter:** Its Representations (frequency and orientation) of Gabor wavelet are based on the human visual system. It is used for representation of texture information that extract features of facial images which are aligned at particular orientations.
- **Local Binary Pattern (LBP):** Local gray level structure that is characterized using LBP operator. It is very effective for texture analysis and classification as it is resistive to lighting effects. Facial image is divided into large number of blocks and features are extracted over the blocks by LBP.

- ***Speeded Up Robust Features (SURF*)**: It is a local feature detector and descriptors where SURF detectors discover the interest points in a facial image. To detect these interest points, SURF utilizes Hessian blob detector, which can be computed with three integer operations. Its feature descriptor is based on the sum of the Haar wavelet method around the point of interest.

- ***Scale Invariant Feature Transform (SIFT)*:** Uses the concept of image pyramid and difference of Gaussians (DOG). Here, Image is convoluted by Gaussian filter at different scales. It is invariant to scaling, rotation and provides improved performance under illumination changes, viewpoint changes etc.
- ***Convolution Neural Network (CNN):*** It is the deep learning method which is useful in face recognition during variations in 2D shapes. Convolution network contains bunch of layers which composed of many neuron Planes where each unit in the plane is associated with past layer using local neighborhood.
- ***Fisher faces*:** Linear Discriminant Analysis (LDA) or Fisher faces is a popular method which measures the between-class scatter normalized by within-class scatter.

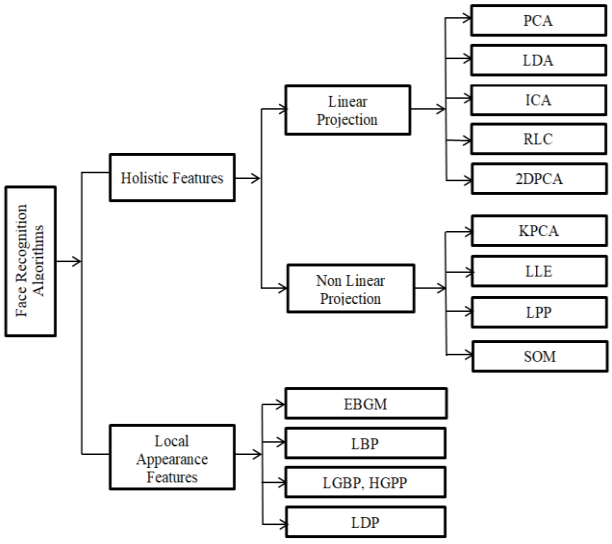

Figure 16: Categories of Traditional Face Recognition Algorithms

D. Recognition of face

Once the features are extracted and stored in the database, then the matching of face image is done with various classifiers such as SVM, NN etc., for classifying the image which helps to distinguish between the genuine face and imposter candidate.

E. Database for face recognition

In this section the various face databases namely AT & T, FERET, JAFFE, CMU multi Pie, LWF, Yale, Indian male, Indian female, Combined and AR face database are discussed to evaluate and recognize the face. AT & T database contains a set of face images taken between April 1992 and April 1994 at AT&T Laboratories, Cambridge. The images were captured at different times, varying the lighting, facial expressions and facial details (glasses / no glasses). All the images were taken against a dark plain background. The CMU Multi-PIE face database contains more than 750,000 images of 337 people. The images were photographed under 15 view points and 19 illumination conditions. Japanese Female Facial Expression (JAFFE) database contains 213 images of 7 facial expressions with 6 basic facial expressions and 1 neutral face, depicting 10 Japanese female models. Labeled Faces in the Wild (LFW) contains 13,000 images of faces collected from the web, labeled with the person's name. Labeled Wikipedia Faces (LWF) dataset contains of 8,500 faces for about 1,500 identities, taken from Wikipedia. Yale face database contains 165 grayscale images in GIF format. They display the different facial expressions such as center-light, with glasses on face, happy moment, left-light, with no glasses on face, normal, right-light, sad and sleepy. Youtube face database contains 3,425 videos of 1,595 different people. All the facial videos were downloaded from YouTube. The AR face database consists of about 4,000 color images corresponding to 126 people's faces which include 70 men and 56 women. Faces with different facial expressions and illumination conditions of the images are considered. Table 2 shows the different face datasets to evaluate the performance of face recognition system.

Table 2: Face databases in performance evaluation of recognition systems

Database	Image Size	Images	Subject	Colour /Grey	Imaging Conditions
FERET	256x384	14,126	1,564	colour	controlled
ORL	92x112	400	10	grey	controlled
AR	768x576	4	126	colour	uncontrolled
Yale B	640x480	576	10	colour	uncontrolled
Extended Yale B	640x480	16,128	28	grey	uncontrolled
FRGC	1200x1600	12,776	688	colour	controlled 3D models
FEI	640x480	2800	200	colour	controlled
BioID	382x288	1,521	23	grey	uncontrolled
MIW	---	154	125	colour	uncontrolled
CVL	640x480	114	7	colour	uncontrolled
LFW	250x250	13,233	5,749	colour	uncontrolled
NUAAPI	640x480	---	15	colour	anti-spoofing
CASIA	640x480	---	50	colour	anti-spoofing

IV. COMPARATIVE ANALYSIS OF EXISTING FACE MODELS

In this section various face recognition algorithms along with their recognition rate are discussed. Wenming et al., [14] proposed DPSRC approach to recognize the face. Earlier, many systems used all the patches for classification purpose in case of patch based algorithms which caused reduction in

accuracy and increased time for data computation. So instead of using all the patches, only selected patches were considered. The author proposed Bagging Greedy Algorithm that uses a selected image patches instead of using all patches and a series of local optimums. Results obtained by Greedy Algorithm, Worst-removal based BGA and Random-removal based BGA were compared. Xavier et al., [19] explained about the difficulties faced during the recognition of human face that are captured in uncontrolled environments such as varying orientations, facial expressions and so on. Face alignment process consists of three steps mainly detection of face, facial landmark and face wrapping followed by the sparse classifier. Here for recognition of face images the modified version of the Robust Sparse Coding algorithm were used, which is an improved version of SRC method that uses a diagonal weight matrix 'W' for better robustness to occlusions and other variations in environmental light to solve the Sparse Coding problem of weighted LASSO. The experiments are conducted on LFWA database.

Yong Zhu et al., [22] explained illumination problem which is one of the main drawbacks in the face recognition system. Previously, many authors extensively worked on various methods for existing systems with neglecting the spectral wavelengths which leads to less accuracy. When the different spectral wavelengths were considered along with the variations caused by magnitude and direction is denoted as Heterogeneous lighting, for this reason the author proposed a novel algorithm Logarithm Gradient Histogram which considers all the three aspects of magnitude, direction and spectral wavelengths taken into account that solves the illumination problem of both homogeneous and heterogeneous lighting conditions. The proposed LGH method works on considering multi-scale bank pass filter technique in order to remove the illumination effect which in turn enhances the image and generates two illumination invariant algorithms namely LGO and LGM where in case of post processing it generates Histogram representation that integrate LGO and enhances the LGM. Experiments are conducted on two popular databases CMP-PIE and Extended Yale B database.

Table 3: Comparison of various face recognition algorithms

Author	Extraction	Classification	Database	Recognition Rate
MinMoon et al., [8]	CNN	Euclidian Distance	IPES-1280 Face database	88.9%
Hameed et a.,[9]	DWT	Hidden Markov Model	ORL Yale	100% 100%
Jaliya et al., [10]	PCA	Euclidian Distance	Yale B	96%
Regina et al., [11]	PCA	K-Nearest Neighbor	Cropped Yale Own database	76.68% 75.19%
Decheng et al., [12]	SIFT and HOG	Euclidian Distance	e-PRIP	70.1±5.9%
Yang et al., [13]	CNN	SRC	AR	95.83%
Yuli Fu et al., [15]	LBP	Sparse	E Yale B CMU Multi-Pie AR	96.9% 93.9% 94.5%
Lumini et al., [16]	POEM +MBC	SVL Angle	LFW FERET	91.1% 99%
Jun Yu et al., [17]	CNN	Support Vector Machine	CASIA FLW YouTube	88.82%G-Blur 99.87%AGWN 94.67% PN 99.97% SPN 97.66% LR
Hu et al., [18]	PCA	Sparse	ORL FERET	84.5% 42.5%
Maryam et al., [20]	FSDA	Neural Network	ORL Yale B	99.75%(P-I) 100% (P-II) 88.67%(P-I) 88.67%(P-II)
Wang et al., [21]	PCA	Sparse	ORL	99.07±2.84
Nawaf [23]	PCA	Euclidian Distance	ORL	97.5%
Brahim et al., [24]	Gabor Filter	Support Vector Machine	LFW	97.29%
Xin Ai et al., [26]	MMC	Support Vector Machine	Ext Yale B CMUPIE AR	89.40%±1.1 92.94%±0.6 89.03%±0.9

Ding et al., [25] proposed HPN approach which combines both the 2D and 3D methods and also provides three major tasks for FIER. This helped to consider and work on loss of semantic information, next non-linear facial texture wrapping and finally Occlusion. Experiments were conducted and results were compared with other state-of-art methods on

various popular databases such as FERET, CMU-PIE and Multi-PIE datasets. Vigneau et al., [27] focused on problems produced by temporal variation conditions mainly due to environmental condition, response time during capture of face that affects the performance of face recognition. So in order to overcome this problem, the author uses two thermal face databases that involved capture sessions with real and variable conditions. The comparative analysis of existing face recognition models to authenticate an individual is tabulated in table 3.

V. PERFORMANCE METRICS

In order to measure the performance rate of a biometric system, several parameters or metrics are considered. Some of the performance metrics namely FAR, FRR, TSR and EER are discussed [1] [5].

- False Accept Rate (FAR)–It is defined as the probability where the system incorrectly matches the input pattern to a non-matching template in the database. It provides the percentage of invalid inputs that are incorrectly accepted.
- False Reject Rate (FRR)–It is defined as the probability where the system fails to detect a match between the input pattern and a matching template in the database. It provides the percentage of valid inputs that are incorrectly rejected.
- Receiver Operating Characteristic–The ROC plot is a visual characterization of the trade-off between the FAR and the FRR. It is also known as relative operating characteristic.
- Equal Error Rate (EER)–The rate at which both accept and reject errors are equal. It is noted that, the EER value can be easily obtained from the ROC. It is recorded that device with low EER is most accurate.

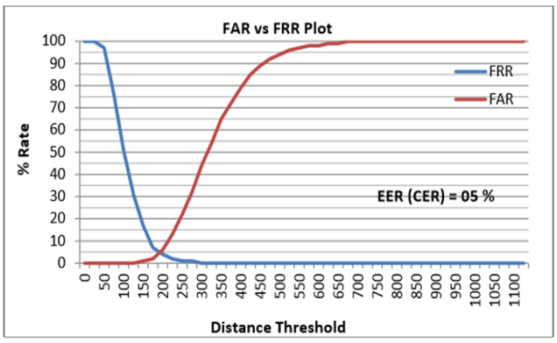

Figure 17: Graph of FAR v/s FRR

Other metrics such as Failure to Enroll Rate (FTE), Failure to Capture Rate (FTC) & Template Capacity are related to the sensor devices. As shown in Fig. 17. Each point on the plot represents a hypothetical system's performance at various sensitivity settings. With such a plot, it is easy to compare these rates to determine the equal error rate. If the device produces lower rate of EER, then the system is treated as more accurate.

VI. MERITS AND APPLICATIONS OF FACE RECOGNITION SYSTEM

In this section, the advantages and applications of face recognition models to authenticate an individual are addressed.

A. Applications of face recognition system

The applications of face recognition system over other biometric traits are as follows

- ***Access to ATM:*** To prevent the illegal accessing of ATM, it is suggested to save the images of the customers in the database of the bank. So, whenever the customer enters the ATM the software has to take a picture of the user through high resolution camera and the same has to be compared with the stored database. Once it is matched the access is being permitted. The arrangement is shown in Fig 18.

Figure 18: Secured ATM machine

- ***Duplication of Voter:*** To avoid vote duplication, the database of all the constituencies has to be prepared. At voting booths the image of the voter has to be captured and compared with the stored database. Then the voting site accept the voter if the image matches the database and permits the voter for voting as shown in Fig 19.

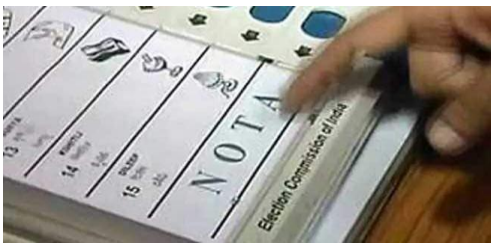

Figure 19: Secured Voting machine

- ***Identification of a Person:*** Other technologies may not help effectively to identify the unauthorized persons in the crowded places. Using face recognition technology it is easy to identify and verify the terrorist in the places like airports, railway stations and malls. The same can be used in police stations to identify the criminals if they are already under any crime cases as shown in Fig 20.

Figure 20: Identification of face

- ***Examination:*** Face recognition can be implemented during conduction of various competitive examinations like IAS, KAS, IPS, and Medical, Engineering etc. The applicant can be identified and verified through face recognition technique.
- ***Attendance:*** In offices and colleges this technology can be used to identify, verify and for attendance purpose.

Figure 21: Security in Examination

- ***Verification:*** To verify the documents during passport and visa at airports, to verify the driving license and other documents helps in saving time.

Figure 22: Verification of an individual person

- ***Banking Sector:*** In banking sector face recognition can be deployed in vaults and lockers for access control verification and identification of authentic users.
- ***Replacement of Barcode:*** The barcode can be stolen by anybody and may leads to illegal activities. So the replacement of barcode by face recognition helps in better access and provides security.

B. Merits of face recognition system

The advantages of face recognition system over other biometric traits are explained as follows

- High Accuracy: 3D facial recognition technologies and infrared cameras made the identification process to be accurate. There are fewer chances of false results as face recognition security software will successfully track every aspect to protect the better level protection. It assures that the person identified is right person.
- Security: It has a great security measures compared to other biometric techniques. All the corporate and the private premises will be safe and secure as the FRS will be continuously monitoring the authorized and unauthorized person.
- Easy process: FR tools work smoothly with the existing software already installed in users system. So there is no need of spending extra money and time to redevelop software.
- No time fraud: Facial recognition technology keeps track of time attendance of the employee. It avoids the time fraud among the workers. It makes the process fast and employees don't need to prove their identity.
- Automated: It replaced the manual recognition done by the security guards. It automates the identification process and no need to monitor the cameras every time. It reduces the expenses.

C. Demerits of face recognition system

The demerits of face recognition system over other biometric traits are discussed as follows

- Low processing speed: Storing a captured video or image requires a specified amount of space. Process of every image and video leads in huge waste of resources. This is the reason most of the time only a fraction is used through an FRT. Technicians use various methods to minimize the processing time but while transferring the data via network, there is a limit for the input-output processing speed.
- Size and quality of an image: If we take image of a person from a video or a screenshot to compare with the existing database, the quality and the size of the image to be under test varies. It affects the process of FR system. The picture taken from the distance also matters the quality and makes the FR process hard. So to overcome this most of the systems specifies the size and quality of the image to be captured but it affects the initial cost of the system.
- Influence of camera: During identification process the angle of the surveillance also matters. For FR process different angles of the face are required, so higher resolution photo provides more accurate matches. Some frauds may happen with the FR were a person may remove his beard or glasses or any marks may lead to wrong results. In order to remove such failures the database need to be updated regularly.

VII. CONCLUSIONS AND FUTURE SCOPE

Among all biometric methods for human authentication, face recognition have been used more frequently and has become more popular for the last twenty years. Automatic face recognition has many commercial and security applications in identity validation. The availability of such feasible technologies as well as the increasing request for reliable security systems has been a motivation for researchers to develop new methods for face recognition. This paper provides the fundamentals of face recognition system including major components namely face detection, tracking, alignment and feature extraction. It also points out the technical challenges of building a face recognition system. In addition the performance metrics to measure the performance rate of the face recognition models and applications of face recognition system are addressed to motivate the researchers for developing the face recognition models having maximum success rate and low error rates.

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