

## Challenges and Advances in Human Face Recognition from Real Time Video



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### ABSTRACT:

In the recent year human face recognition systems are having significant attention as it has number of applications in various areas such as access control, Internet communication, multimedia based applications, law enforcement, security, surveillance and computer entertainment. Although significant advances has been made, performance of face recognition systems provide satisfactory only under controlled and clean environment and they get degraded with real-world scenarios. The real time video have different conditions such as aging effect, pose variations, occlusion on face, marks on face, variation in light, low resolution and facial expressions. Thus there are number of challenges for accurate and fast face recognition. Though previous worked is for examining face recognition under unconstrained conditions further many opportunities can be identified in this field. Thus, here our goal is to discuss the various challenges involved in existing face recognition systems, providing overviews of face recognition basic framework, advantages & limitation of various face recognition approaches and providing future direction in this area.

**Keywords— face recognition, unconstrained conditions, real-world scenarios, clean environment**

### 1. INTRODUCTION

Face recognition is one of essential biometrics which could be least intrusive as compared with the other techniques such as fingerprint and iris recognition. Face recognition systems take pictures of people's faces when they enter a particular area[25]. In most cases, the people are not entirely aware of the process. In the security domain the work for face-based digital signatures for Video Retrieval [1] and biometric hash[2] are important.

The face recognition system generally operates under verification or identification, where in the verification scenario, the similarity between faces is measured and it is determined that either match or non-match. In the identification, the similarity between provided face image and other face images in a repository is found and top match is returned as the identification result. Face recognition process can be divided into three important steps which are face detection from a scene, feature extraction and face matching/classification different name label could be assigned to the identified faces which could

be useful in various application such as Security, Authentication, Access Control, Multimedia etc. As well as Video based Indexing techniques and Retrieval of human faces in Multimedia system is important field of research[3].

There are different ways by which human face can be taken for recognition from still image, stored video and real time video. For using face recognition from real time video, certain challenges need to focused such as changing illumination, changing facial expression, different poses and angles etc. It has been observed that when there are number of samples to verify for matching then the system response time increases. Such responses timing are dependent of time complexities of the algorithms under deployment. This leads to the parallel processing of information which may reduce the time required for proper video processing[16],[19].

### 2. FACE RECOGNITION TECHNIQUES

There are many techniques for recognizing faces from images\Video some of important approaches [26] are discussed here

#### a. Template Based Approaches

The template based methods consider an input image to compare with different set of templates. Statistical tools can be used for construction of set of templates. Statistical tools such as Principal Component Analysis, Support Vector Machines, Linear Discriminant Analysis, Independent Component Analysis can be helpful.

A template matching process uses pixels, samples, models or textures as pattern. The recognition function computes the differences between these features and the stored templates. It uses correlation or distance measures algorithms.

#### b. Holistic Approaches

In this method face is identified from minimal information. In some algorithms this idea is used processing facial features independently. Hence we can say that relation between the features with the whole face is not taken in to consideration. Some approaches available which use individual feature like eyes.

A combination of features is not supported by this approach.

### c. Model-based Approaches

In this approach, an image is treated as a high-dimensional vector. Here statistical techniques are very useful for deriving a feature space by using the image distribution. Face image expected to compare with the training set. It tries to model a human face. The given sample is need fit in the model, and different parameters of the model are very useful for recognizing different face images.

### d. Statistical Approach

In this approach, every image is represented in terms of n feature which is visualized as a point in n dimensional space. Here the number of coordinates need to denote a data point which is too high. So, choosing and applying correct statistical tool which is useful for extraction and analysis is an important process. Ultimately it is able to define a line, curve, plane or hyper plane that separates faces belonging to various classes.

### e. Neural Network Approach

Number of methods based on Neural Network have been utilized up till now. Classification can be done by using neural networks. One of the approach is to use decision-based NN in which pre-processed is applied and sub sampled faces are classified. Combination of unsupervised and supervised methods are used, supervised method for extracting features and supervised methods for finding features which reduce classification error. This approach can use feed-forward neural networks for classification which could obtain better results. Demonstration of this approach shows that though it is more time-consuming but it is simple comparing with other methods for providing expected results.

## 3. LITERATURE REVIEW

Face recognition is important domain, various researcher have worked on various aspect of it here we have discussed some of the work in face detection and recognition process. Thereafter different approach for overcoming challenges in this field have been studied.

Skin segmentation technique is suggested which uses color pixel for classification analysis and comparison. This approach is useful in various skin texture based face detection[11]. After words Douglas Chai *et al* have presented face segmentation by using skin-color map for the videophone applications which is important for the advancement in technology[12]. Similarly Md. Maruf Monwar *et al* have introduced a system for recognition of faces which is based on skin color for face detection and Eigen face algorithm is used for face recognition[18]. But here not all detected regions contain faces some of them corresponds to parts of human body while other corresponds to some other objects which are having

similar skin color. As we know skin color could be visualized in variation under different illumination further Leyuan Liu *et al* have analyzed and detected variations in skin color under different rapidly changing lighting conditions[10].

Hence a versatile method for face detection as well as recognition is required meanwhile Jun Nishimura have worked on an approach for recognition by using Haar-Like feature and also with cascaded classifier[8]. This technique could serve better performance. Afterword in Pramod Kumar Pandey *et al* have analyzed an approach in which Principal Component Analysis reduces the number of effective variables which can be used for classification and compared with some statistical method[20]. But here in this approach two dimensional PCA based image representation is not as efficient as Principal Component Analysis for the storage requirements. As some other combined approach could be useful and next to this B. Jyostna Devi *et al* have proposed a system for improving capability of Linear Discriminate Analysis when features are extracted using both Principal Component Analysis and Linear Discriminate Analysis few samples of face images are available. Wavelet fusion and NN are used for improving accuracy in classification[21]. But it is limited to real time video and large computational overhead. Binu Muraleedharan Naira *et al* have worked on face detection approach in which they used both frontal face and profile faces. 'Haar' features are utilized for detection[22]. This approach developed for three poses which are right and left and frontal. In this approach lighting variations may affects the performance. Some other combined techniques for improving result such as provided Principal Component Analysis with some of its variation are in used with combination of Linear Discriminate Analysis and Gabor[14]. For better recognition Jongsun Kim *et al* technique for face image recognition using Independent Component Analysis which served robust for handling local distortion and also for partial occlusion[15]. These methods may fail when face images with large variations in facial expression applied in different lighting condition.

Local appearance features have some advantages compare to holistic features. Which remain stable for local changes such as facial expression as well as for occlusion and misalignment of face images[13]. Local Binary Patterns (LBP) are a representative method. It identifies changes in the neighboring pixels of central pixel. It adds computational simplicity due to which it is helpful for analysis of face images in challenging real-time environment [17].

Different researcher have worked for overcoming on various challenges such as low resolution problem, varying lighting conditions, different poses, occlusion etc in this regard various work have been proposed as discussed here. Kamal Nasrollahi *et al* have proposed an approach for applying a reconstruction based super-

resolution[4]. Next to this for pose varying input Richa Singh et al have worked on a face mosaicing scheme which is used for pose varying face images for recognition[23]. This method provide a composite face image while enrollment based on various evidence supported by frontal and semi profile face images of the given subject but it required to keep record of different face templates which represent different poses of a user's face image.

For illumination varying input, Ping-Han Lee et al have suggested a method of the orientated local histogram equalization which is used to compensates variation in lighting while encoding rich information on the edge orientations. The edge orientation can be useful for face recognition and focused on illumination compensation[24] Frontal faces were considered rather than faces with different head position or various facial expression.

Maria De Marsico et al have proposed robust a technique for variation in pose and lighting changes, here they described the module used to derive distortion indices. The sample pose index accounts for pose quality and the sample illumination index accounts for illumination quality. Performance of this approach might vary for facial expression input sample[5]. Further to this Hasan Demirel et al have suggested a technique for pose invariant system which is based on the probability distribution functions(PDF) of pixels in different color channels. The different PDFs of the equalized and segmented face images are considered as statistical feature vectors for faces recognition[6]. But here different PDF needs to consider for various poses. Abhijith Punnappurath et al have suggested a methodology for performing face recognition under the combined effects of non-uniform blur, illumination, and pose. Most of challenges are tried to cover here still occlusions and large changes in facial expressions are difficult to handle[7].

Sivaram Prasad Mudunuri et al have worked on technique which recognizes faces from low resolution face images captured in uncontrolled environment[9]. It uses multidimensional scaling for learning a common transformation matrix which is used for the whole face and simultaneously transforms the facial features of the low Resolution( LR) and the High Resolution(HR) various training images such that the distance between them approximates the distance had both the images been captured in similar controlled condition. The stereo matching cost estimation for getting the similarity of the provided two images, still the computational time of this is higher as compared to the other approaches. As we can say for achieving better performance from several algorithms and methodology an execution environment and certain other combined or different approach need to be used.

#### 4. OVERVIEW OF FACE RECOGNITION SYSTEM

In this section the overview of face recognition process is provided, various essential phases of a general face recognition process is shown in Figure 1. There are various main phases in this process which are face detection, face tracking, extracting feature and face classification[26][27].

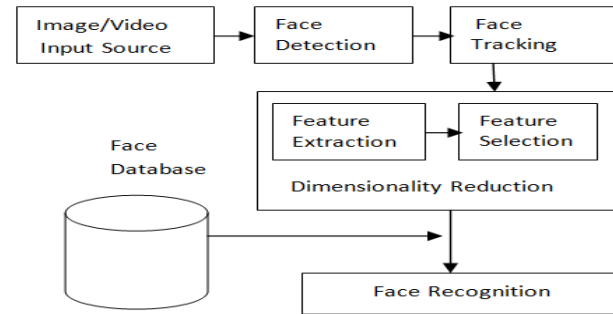


Figure 1: A general view of face recognition system.

**Face Detection:** face detection can include many sub-problems. There are some systems in which detection and location of faces take place at the same time, where as in others first it performs a detection routine and then, if it finds human face positive, they try to locate the face. In color images skin color is used to find faces. Moreover, human skin color varies in different region of the world. In video provides us a chance that we can use motion detection for localizing faces more accurately. As we know there are number of mobile applications in which human head position is estimated while using camera.

**Tracking faces:** When we need to deal with video from which face recognition is to done then video sequence as the input to detect face. Now here systems require to be capable of detecting but tracking faces. Face tracking is a motion estimation problem. In 2D and in 3D faces are tracked differently.

**Feature Extraction & Feature Selection:** There are many feature extraction algorithms. For example, PCA As all the extracted features are not specific and useful for distinguishing so feature selection algorithms are important and used to select a subset of these extracted features this may cause the smallest classification error. When face image not frontal, rotated or with certain facial expression then extracted feature and stored feature are differed with some proportion.

**Face Classification:** After this with help of face dataset and faces from video/image can be classified. There are various classification algorithms. If the variation of faces of the same person could be more the clustering algorithm

are also utilized. NN Classifier, SVM, KNN etc are general used classification techniques. Some naming details are used for managing different users in face recognition system.

## 5. APPLICATIONS OF FACE RECOGNITION SYSTEM

There are many applications of face recognition system. Some of them like access control, Identification Systems,

Surveillance, Pervasive Computing[27] are discussed here.

**a. Access Control.** Face verification is important and very useful in number of system. Now a days use of face-recognition based PC login has become feasible it also increased flexibility compared to password protection. This type of mechanism can also be extended to control authorization in Automated Teller Machines.

### b. Identification Systems.

It is expected that the registered subject must be identified among the millions of people from database but still it is impracticable so various other information such as zip code, age used to narrow the search.

**c. Surveillance.** In face recognition subject need not to actively participate in the process of capturing. He/ she may not aware of that face image or other activities are captured. Here this process can be applied to search for watch-list for 'interesting' people. This technique is helpful for investigation department to search suspected criminals using surveillance footage of a crime to search through a database of suspects.

**d. Pervasive Computing.** In this domain face recognition is very essential because various computing devices are equipped with sensors in many appliances at our homes and in our vehicles. They are now more widespread. We can say that with use of Internet of a Thing all of these devices are connected together through computer network, by making the pervasive infrastructure 'human aware' Smart Home system are launched in attractive product in the market.

## 6. CHALLENGES OF FACE RECOGNITION SYSTEM

The main limitation of face recognition are computational complexity and low accuracy as there are many attributes which can be variability of images of a single face adding complexity in the recognition process if those are not avoided with use of careful design by considering capture situation. Otherwise such variability could lead to failures in face recognition. Variability include Physical changes, Acquisition changes, Imaging Changes and Illumination Changes[25][27]. Thus challenges in face recognition process can be summarized as given here.

**a. Physical changes:** There are number parameters which causes physical changes, such as changing facial expression, aging effect, variation in personal appearance, Marks on faces make-up, glasses on face, facial hair, different hairstyle. Failure may occur in face detection and recognition due to any of these parameter.

**b. Acquisition Geometry Changes:** In real time face recognition subject may not be aware that his/her face is captured so there might be some face with different angles and poses. Therefore variety of faces of the same subject whit changing scale, image rotated in different angles, not full-frontal face become difficult to identify.

**c. Imaging Changes:** There are various camera available in the market. Images\video taken from these camera might be differ in resolution, lightning and point of focus, and other properties. Therefore in real time face recognition imaging change produces due to illumination change ,image/video from different quality camera.

**d. Facial Occlusion:** Some time face might be covered with scarf or there could be mask on face, goggles so the original face could be partially captured by machine and hence might be generate inaccurate detection and recognition result .

It is hard to say that current system can handle all of these challenges. Some examples of challenges in face recognition system are shown in Figure 2



Figure.2 Examples of some challenges that may be existing in a human face recognition such as Challenges due to variation in illumination , pose/viewpoint variations, ageing variations ,facial expression/facial style, occlusion on face.

## 7. REVIEW ANALYSIS AND DISCUSSION

In today's era analyzing video containing face is very important for finding age, gender and other related information. As compare to still image system video information have many advantages There are sequence frames in video this redundancy helps to improve system performance. In spite of significant amount of research has been done in face recognition from still face images but face recognition from video is need to explore more. Time required for processing could be more as depending on the video resolution, number of samples for comparison and some other factors so graphical processing unit plays important role in the video processing and analysis for face recognition system.

Though some of research effort have been taken for Graphical Processing Unit(GPU) based work still future research could be extended to implement various algorithms like LBP on parallel processing units adding more parallelism different phases. As we can say from the literature that there is not a single face recognition from real time video which all the challenges are overcome. It is proved that any approach which tries to overcome more challenges time overhead increases. It has been observed that number of frames per second increases in processing of high speed video performance of only CPU based system get decreased and hence GPU based system could be designed and developed for frame level processing. So GPU based approach could be useful for parallel processing of number of samples . This could achieve high rate of recognition.

## 8. CONCLUSION

As we know face recognition system having different challenges in the computer vision systems. It has received a high importance over the recent years due to

its various applications in multimedia based systems. Although researcher have put their efforts which could provide good result for providing better result in constrained conditions. It is yet to achieve accurate and fast result in these situations. As our paper aims to provide various daily life applications, overview of current scenario of face recognition technology research guidelines for improving the performance of the face recognition systems. This paper can be served as a reference point in face recognition system which provide challenges and advancements in face recognition. Expecting that in future with the consideration of appropriate approaches in which computational complexity could be reduced, for better utilization in real-time commercial face recognition system.

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