

## Review Paper on Face Recognition Techniques

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**Abstract**— With information and data collection in richness, there is a much need for high safety. The Face recognition (FR) is a firm growing and interesting vicinity in real time constituting of various aspects. For this a number of set of rules has been developed. The consideration made here is for studying a variety of methodologies or techniques used in for the face recognition (FR) aspect. This consist of the “Principle Component Analysis” concept, the “Linear Discriminant Analysis”, the “Independent Component Analysis”, the “Support Vector Machines”, the Gabor wavelet, also the soft computing tools like the ANN for recognition & some hybrid combination. The evaluation investigates some of these strategies with parameters and challenging situations of FR scenario like the illumination, pose variations and the facial expressions.

**Keywords**— FR, Principal Component Analysis (PCA), the Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA), Artificial Neural Network (ANN).

### I. INTRODUCTION

Face recognition (FR) is the basic task for humans, and one of the important capability of the human perception system when building a computational model for face recognition. The computational model adds hypothetical bits of knowledge to numerous handy applications like computerized group reconnaissance, access control, structure of human PC interface (HCI), the content based type of picture database management, criminal distinguishing proof, etc. The most punctual work on the FR can be followed back to the 1950s and 1960s in psychology [1] and in engineering literature [2]. The earliest studies shows work on facial expression emotions by Darwin [3]. The research on automatic FR by machines started in the 1970 [4] and after the fundamental work of Kanade [5]. In 1995, a review paper [6] gave a systematic survey of FR technology at that time [7]. At that time, video-based FR was still in a growing stage. During the last decades, FR has received amplified attention and has sophisticated technically. Many industrial systems for still FR are now available. Recently, major researches efforts have been putted on video-based face modelling/tracking mechanism, recognition & system integration. New databases have been shaped accordingly and the evaluations of recognition techniques using these databases is carried out. The FR mechanism is said to be as the most vibrant form of applications used nowadays for recognizing patterns and analyzing images.

The paper is organized as follows: Section II presents the face recognition techniques, Section III concludes the paper.

### II. FACE RECOGNITION TECHNIQUES

#### (i) Principal Component Analysis

PCA, the Karhuen-Loeve technique is said to be as the admired technique for feature selection & for dimensionality reduction. FR using the PCA method was first given by Pentland & Turk & the restoration of human faces was done by Kirby [9]. The recognition technique, called as eigen-face outlines a feature space which decreases dimensionality of the novel data space. This reduced space data is used in for the recognition. But the deprived discriminating power within the class and large calculation are the well known familiar problems in PCA technique. The drawback is to overwhelmed it by Linear Discriminant Analysis approach. LDA is said as the prevailing algorithms for selecting the feature. But many LDA based FR system first used PCA to decrease dimensions and then LDA is used to maximize the selective power of feature selection. The cause is that LDA has the diminutive tester size problem in which dataset selected should have larger samples per class for excellent features extraction. Thus implementing LDA results in poor extraction of selective feature. In the proposed terminology [10], the Gabor filters is castoff to filter front face images & PCA is used to decrease the dimension of filtered feature vectors & then LDA is castoff for feature extraction method. LDA is more susceptible than the PCA method & ICA method on partial blocking, but the methodology in PCA is less susceptible to partial blockings compared to the respective LDA & ICA. It is used as a dimension reduction method & for modeling the expression deformation.

A recursive algorithm to calculate the characteristics of PCA method-LDA method is given in [14]. The scheme focuses on hard issues of computing discriminating vector from gradually arriving high dimensionality of data streams not including totaling of the covariance matrix without actually knowing the data in progress. The incremental PCA-LDA scheme proposed is proficient in memory and proficient in the calculation of first basis vectors. The algorithm provides a satisfactory FR success criteria rate as with other famous face recognition methods. Two appearance-based methods such as Modified PCA and (LPP) are pooled in [15] to provide a high FR rate. These feature vectors are equated using Mahal-anobis distance for the assessment making. The Tensor based Multi-linear PCA route is given in [17] which generally extracts the feature straight from tensor depiction fairly than the vector depiction. This technique shows enhanced routine in comparison with well-known techniques in varying environments.

The PCA can outflank other methods when database size is quiet small. The proposed methodology shows [18] that the taken database was sub-grouped by means of features of attention in faces. Merely the obtained groups were delivered by the PCA for recognition purposes. Regardless of obtaining better results of PCA methodology, this method carries drawback of computationally very costly & complex with a slight increase in database sizes, since the image pixels are required to attain the depiction castoff to match the input images with others in the database.

Many dimensionality decreasing approaches such as the PCA methodology, the Kernel PCA method, the LDA method, and Neighborhood Preserving Embedded method were chosen & are used in demand to decrease loss of categorization routine due to changes in facial look. The recognition performance while expending the PCA and the LDA for dimensionality decreasing looks to be equal in terms of accuracy. It was perceived that LDA method require extremely more time for processing the large number of numerous face images also even number for small databases. In case of (LPP) method and the NPE method, recognition rates were very low if the increased number of faces images were taken as in comparison to that of PCA and the KPCA methods. Projected methodology [19] provides significant improvement in case of light variations, and kernel PCA comes out as the best performers.

The Modified version PCA method intended for FR was projected in [20], here the technique was centralized on the idea of dropping power of eigen-vectors allied with the prevalent Eigen values generally by normalizing feature-vector elements by equivalent standard deviation. The results demonstrate that the technique being given marks in an improved performance rather than the conventional PCA

approaches and LDA approaches & also the computational cost for the same remains exact for PCA and slight less than that for the LDA.

A fresh FR technique is centered on PCA technique, the LDA and the neural network projected in [21]. The technique contains the following steps: Step 1: Preprocessing, Step 2: Dimension reduction by means of PCA, Step 3: Feature extraction with LDA and Step 4: Classification by neural network. Combining of PCA technique and the LDA technique was generally used for achieving better capability of the LDA while sample images were available & the neural classifier was used to lessen the number of mis-classification affected by separate classes. The projected technique was tested on the Face Database-Yale. The Experimental results are verified based on the effectiveness of proposed technique for FR with fewer mis-classification in contrast to previous methodology.

An FR methodology was proposed in part [22], which reduces the computational time though achieving a higher detection precision. PCA is used mainly to decrease dimension extracting feature vector. The GRNN is used as a function approx set-up module to identify whether the image taken as input contains a face or not and if exist then inform about its positioning. This method had shown GRNN attains better than the back-propagation method and answers for some better regularization.

#### (ii) Support Vector Machines

Support Vector Machines (SVM) is a useful technique in classification problems. One obvious example is FR. However, SVM cannot be used when the feature vectors defining samples have lost entries. The classification method that is effectively used in this framework is the all-known Support Vector Machine (SVM) [23], which can be used to the original look space or the subspace of it is obtained after using feature extraction technique [24] [25] [26]. The benefit of SVM classifier over traditional neural network is that SVMs can attain better generalization performance.

#### (iii) Independent Component Analysis

ICA technique for searching essential factors from the multivariate (multidimensional) statistical form data. There is need to implement FR system which make use of ICA in favor of facial image which control face orientations through dissimilar lighting conditions, which provide enhanced results as compared to existing systems [27] [28] [29]. What differentiate ICA from other techniques is that, it search for the component that are statistically independent as well as non gaussian [27]. The ICA is comparable to problem blind source separation [30] that boils behind for finding a linear depiction where in the components need to be statistically independent. The contrast of FR using PCA technique as fit ICA method on FERET database by different classifiers [31]

[32] be discuss & found out that the ICA improved identification rate evaluated by PCA have base imagery statistically independent & together by statistically independent coefficient. FR using ICA by vast rotation angle next to by means of poses in addition to variation in lighting conditions was proposed in [33]. A novel subspace technique known as sequential row & column ICA for FR proposed in [34]. In Independent component analysis every one face image be transformed addicted to vector before calculating independent components. RC\_ICA reduces FR error and dimensionality of recognition subspace becomes smaller. A novel method for FR combines ICA method with the optical correlation technique proposed in [35]. This approach depends on performance of optical correlation technique which strongly discriminate along with robustness of ICA model. ICA model sparked importance in searching for linear transformation to articulate random variables as set combination of linear & statistically independent source variables [36]. ICA provide more dominant data demonstration than PCA as its purpose was to provide an independent rather uncorrelated image disintegration and depiction. A fast incremental primary non Guassian direction analysis method called IPCA\_ICA proposed [37]. This method computes the primary components of a series of image vectors increasingly without estimating covariance matrix and at same time convert these principal components to independent directions which maximize non-Gaussianity of source. IPCA\_ICA was very competent in calculation for first basis vectors. PCA\_ICA attain average success pace than Eigenface method, the Fisherface method and FastICA method.

#### (iv) Gabor Wavelet

Face recognition feature can be used for enhancing vectors of high intensity extracted with GV Transform of front face image combined together with ICA in [38]. Gabor features are identified since one of greatest exposition for FR. In years recently, Gabor wavelets is broadly designed for face depiction by FR researchers [39] [40] [41] [42] [43], because kernels of Gabor wavelets are analogous to 2D accessible field profile of mammal cortical plain cells, that exhibit enviable characteristics of spatial vicinity because of orientation selectivity, earlier works of Gabor features contain complete impressive results for FR. Classic techniques includes (DLA) [39] method, (EBGM) method [40], classifier (GFC) method [41], and (AGFC) method [42]. Gabor features is also being used for recognition of gait as well as gender recognition recently [44] [45]. In the paper, [46] it is observed that however Gabor phases seems sensitive to local variations, they can easily discriminate among patterns having similar magnitudes, i.e. they provide more complete information about local image features. Therefore, Gabor phases know how to work comparably fine with magnitude, as long as Gabor phases sensitivity to the misalignment and the local variations are able to be

remunerated carefully. In previous work, authors projected to characterize face images through Binary Pattern of local Gabor , to come together Gabor magnitudes among local binary patterns operator [47]. Enhanced results achieved as compared to LBP and GFC. Since face depiction with LGBP based on local histograms, which are insensitive to local variations [48], likewise LGBP local histograms used to hold back the compaction of Gabor phases to the restricted variations. Encoding Gabor phases by LBP and local histograms, a very remarkable recognition rates similar with that of the Gabor magnitudes-based technique were achieved, which shows efficacy of Gabor phases in discrimination of diverse faces. A novel technique for extraction of the facial features proposed in [49] is base on Gabor wavelet depiction of face image and the kernel least square discrimination technique. The experimental result is base lying on XM2VTS [50] and ORL [51] databases which show that kernel least square discrimination approach based on Gabor outperforms feature extraction technique such as PCA method, LDA method, Kernel PCA method or (GDA) method as well as the combination of these method with Gabor depiction of face images. A method accessible [52] make use of GWT to take out high intensity characteristic vector of face images combined with ICA for enhanced FR.

Among the new methods used in literature for extraction feature, it has been proved that Gabor filter take out maximum information from the local image regions [53] [54] and it is unvarying to, translation, rotation, variations owing to lighting with scale [55] [56] [57]. In [58] [59] Gabor wavelets & neural network was offered for face detection, A. Khatun *et al* [60] recommend hybrid neural network answer for FR trained by means of Gabor features. P. Latha *et al* [61] utilize Gabor wavelet to present face, and used neural network to categorize views of faces. The dimensionality was decreased by the PCA. A technique for extracting feature vector of whole face from image database by means of the Gabor filters, well-known to be constant to lighting and facial expression, developed in [62]. This network achieve higher recognition rate and improved categorization efficiency when feature vectors had low dimensions.

#### (v) Linear Discriminant Analysis

The LDA is a dominant method for FR. It yields an efficient depiction that transform novel data space into low-dimensional feature space linearly in which the data are well separated. However with-in scatter matrix (SW) class become singular in FR and traditional LDA cannot be solved ,which is the undersampled problem of LDA (also known as the small size of sample problem). A subspace analysis technique for FR called Kernel Discriminant Locality Preserving Projections (MMDLPP) projected in [63] based on analysis of LDA method, LPP and kernel function. The non linear subspace not only preserves facial manifold

structure locally but also highlight on discriminant information.

United with Maximum Margin Criterion (MMC) new technique called maximizing margin and the discriminant locality preserving projections (MMDLPP) is projected in [64] to find the subspace that best discriminate diverse face change and preserves the intrinsic relation of the local neighbourhood in the similar face class according to preceding class label information. The proposed technique is compared with PCA technique as well as with Locality Preserving Projections technique (LPP) ORL, YALE, YALEB face databases and authors have revealed that it provides a better depiction of class information and achieves improved recognition accuracy. Illumination Adaptive Linear Discriminant Analysis method (IALDA) was projected in [65] which solves light variation problems in FR. The recognition precision of the suggested technique (IALDA), is far higher than PCA technique and LDA technique. The recognition correctness of the suggested technique was lower than Logarithmic Total Variation technique (LTV) [66]. However, The LTV technique have high time complexity. Hence, the LTV technique is not practically suitable. At same time, it also indicate that the projected IALDA technique is robust for lighting variations. David Monzo *et.al.* [67] correlated some techniques to extract facial landmark and deliberated their influence on FR problems. In order to attain fair comparison, they used the equivalent number of facial landmark and the similar type of descriptors (HOG descriptors) for each approach. The relative results were acquired by means of FERET and FRGC [68] datasets and reveal that enhanced recognition rates were acquired when the landmark are situated on real facial fiducial points. Here assessment was done by means of PCA technique [69], LDA technique [70] and Orthogonal Linear Discriminant Analysis technique (OLDA) [71]. OLDA is one of different varieties of LDA which plans to embrace issue of undersampling. The fundamental suggestion of OLDA, the discriminant vectors are orthogonal to one other. In [71] Ye provides an proficient way of computing OLDA.

#### (vi) Artificial Neural Network

Multi-Layer Perceptron having the feed-forward learning technique is choosed for the projected method since it is easy and it has potential into the supervised pattern matching. It have been effectively used for numerous pattern categorization problems [72]. The new technique for facial detection by means of the Gabor wavelet and the neural network having the feed-forward presented in [73]. The technique use the Gabor wavel-et transform along with the neural network having feed forward finds the feature characteristics and also extract the vectors having feature. Experimental results, exhibit that projected methodology gives improved results compared to graph matching and the eigenfaces technique, known to the most successful

techniques. The technique for convolutional neural network projected in [74] where processing cells shunt inhibitory neurons. A conventional feed-forward design used these neurons previously for categorization & non-linear regression and they are more powerful compared to MLPs [75] [76] as they can approximate the complex decision surface a lot more willingly than the MLPs themselves. The Hybrid NN solution was offered in [77] which use the combination of the local image sampling, self-organizing maps and convolutional neural network. Self-organizing maps provides the quantization for the sample image into topological space in which input which are close to original space are close to the output space, thus provide dimensionality decrease and invariance for minor change in the sample images, furthermore these Convolutional Neural Network method (CNN) provide in support of subjective invariance to the rotation, scale, translation and deformation of sample image. The PCA+CNN & SOM+CNN technique are both better to eigenfaces method even if there is only one training image for per person. SOM+CNN technique again and again perform superior than PCA+CNN method. FR technique proposed in [78] which employ Polynomial Neural Network method (PNN)[79][80]. PNN evaluates face possibilities for image patterns by multi-scale shifted from the local region & works as a classifier. PCA technique used for decreasing dimensionality of image prototype and extracts feature for PNN. Using single network the author had achieved quite high recognition rate and slight false positive rate for images with complex background. In comparison to multilayer perceptron, the performance of PNN is better. To best reveal geometry of 3D face manifold which improves recognition, the Spectral Regression Kernel Discriminate Analysis method [81] base on the regression along with spectral graph analysis introduced in proposed [82] method. While sample vectors known to be linearly independent, which generally is case for the problems of small size of sample; SRKDA can efficiently provide more correct solutions than the ordinary subspace learning techniques. Not only does it solve the high dimensional and the small size of sample problem, but it also enhance the feature extraction from the non-linear structure of a local face. Detailed comparison between SRKDA method[81], PCA method [8], LPP v [83], OLPP method [84], SR method [81], and KDA method [81] to demonstrate efficiency of proposed method for 3D FR, especially with respect to expression variations. SRKDA method only desires to solve a set of regularize regression problems and eigenvector computation are not involved, which is a huge computational cost saving.

An epic Haarlet Pyramid based FR procedure was proposed in [85]. Here FR is done by extracting image feature set from Haarlets on the gray plane. PCA is usually used except it is very time consuming. In paper [86] authors have given the comparative study of different FR technique

for plastic surgery depend on the experimentation done by authors it has been concluded that FR technique such as PCA technique ,FDA technique ,LLA technique ,LBP technique & GNN technique have shown recognition rate higher than that of 40% for the local plastic surgery. The new approach for plastic surgery based FR using the near set theory is projected in [87] [88]. The approach based on the near set theory of comparing the pre and the post surgical face images is proposed in [89].

### III. CONCLUSION

In this paper we have made an attempt to re-evaluate a significant number of papers to cover the recent improvement in the field of FR . Present study show that for enhanced FR new techniques have to be developed using hybrid techniques of soft computing such as ANN technique, SVM technique, SOM technique may yield better performance. The list here provides more detailed understanding of the approaches enlisted.

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