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Recent Trends in Face Recognition

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Abstract: ***With the advances in information technology coupled with the need for high security, the application of biometric as identification and recognition process has received special attention. The biometric authentication systems are gaining importance and in particular, face biometric is more preferred for person authentication because of its easy and non-intrusive method during acquisition procedure. Face recognition is considered to be one of the most reliable biometric, when security issues are taken into concern. Various methods are used for face recognition. To recognize the face, feature extraction becomes a critical problem. Different methods are used for extraction of facial feature which are broadly classified into linear and nonlinear method. After feature extraction classification has been done using different classifiers.***
Keywords: ***Pre-processing, Feature extraction, Classification, Database***

I. INTRODUCTION

Face recognition is one of the very important biometric authentication technique used now days. There are three major areas in review of face recognition, which are pre-processing steps, methods of feature extraction and classification and related databases. There are several challenges occurs in face recognitions. Face recognitions having several errors like false acceptance and face rejections. These papers discuss first pre-processing, feature extraction, classification, database and challanges and error in face recognitions.

II. PRE-PROCESSING

There are several pre-processing step has been taken to improve the efficiency of the recognition system. The improvement may be in terms of increasing the recognition rate, reducing the processing time and system memory. Following are the few pre-processing steps taken in the face recognition system.

A. Colour image to Gray scale

Colour image has been converted in to gray scale so that it requires less memory, less processing time. The colour image has three planes and it required higher memory to store it. As the number of plane increases the time required to process the image is also increasing. So, colour image require higher time to process, and required more memory to store it while gray scale image having only one plane so to process it needs less time and required less memory compared to the colour image. So to use the system in real time or process the image in less time colour image has been converted into Gray scale image.

B. Rescaling of the image

To have a same size of image in the system and to reduce the required time for face recognition the image has been scale down to less size. There are various methods through which one can resize the image like Nearest-Neighbour interpolation, bilinear interpolation and cubic interpolation.

C. Histogram Equalization

Histogram equalization is the process in which histogram has been redefined and which increase the contrasts of the image. The global contrast of the image has been increased. Through this intensity can be better distributed on the histogram.

D. Zero mean and unit variance

Image has been made zero mean and unit variance so all the image can be proceed simultaneously. Image can be made zero mean by subtracting the mean intensity value from the image.

III. FEATURE EXTRACTION

Face image representation can be broadly classified into two categories, one based on face geometry and another based on face feature. Image feature based methods or template based methods, estimate the correlation between a face and one or more templates, which is later used during recognition. They capture and analyse the global features of a face. Successful and efficient templates can

be constructed using the various techniques. The main reasons to select feature for image representation and analysis is to reduce the dimension.

A. Dimension Reduction

The most important problem in face recognition is the curse of dimensionality problem. The face image having very high dimension and it contain so much irrelevant or non-informative data and that makes much difficult for making decision. Feature extraction can act as a powerful dimension reduction agent. So, it is desirable to select smaller number of relevant and important feature with the help of dimension reduction techniques. High dimension also pose problem in computation, so it's also desirable to reduce the dimension. In statistics, dimension reduction is the process of reducing the number of random variables under consideration $R_N<R_M$ (M<N). The dimension reduction process is divided into two parts: feature extraction and feature selection.
There are several methods available for face image dimension reduction. Some methods are linear method and some are non linear methods. Linear methods are used to transform high dimensional input data into low dimensional data through linear mapping. Non-linear methods are used when data carries so much non linearity within it. Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) and Locality Preserving Projections (LPP) are some popular linear methods and nonlinear methods include Isometric Mapping (ISOMAP) & Locally Linear Embedding (LLE).

B. Linear Feature Extraction of Dimensionality Reduction Techniques

Generally face image representation process is divided into three categories. One approach is known as holistic approach in which the whole image is used for feature extraction. The example of holistic method is PCA, ICA and LDA. Another approach is based on face feature selection like eye, nose, lips, and mouth. Once the feature has been selected the dimension reduction is applied. The other method is the combination of both holistic and feature based method known as hybrid method. This hybrid method used both the local feature as well as whole face.

C. Principal Component Analysis (PCA)

PCA is one of the popular techniques for both dimensionality reduction and face recognition since 1990's. Eigenface introduced by the M.A.Turk and A.P.Pentlend [2]. Since it is a holistic approach as input image is directly used for process. PCA algorithm is used to find the subspace where its vector represents the maximum variance direction in the n dimension space. PCA is a method of transforming a number of correlated variables into a smaller number of uncorrelated variables.PCA space can be used for presentation of data with the minimum error for reconstruction of original data. MPCA and KPCA are fully based on the PCA technique. The PCA transform the input image vector into feature space vector by linear transformation.

$$Y = AX$$

Where A in input image and X is a column vector and Y is the transformed vector.

D. Linear Discriminant Analysis (LDA)

LDA is one of the most famous linear techniques for dimensionality reduction and data classification. In 2000, Li-Fen Chen, Hong-Yuan Mark Liao, Ming-Tat Ko, Ja-Chen Lin, Gwo-Jong Yu have used LDA for feature extraction in face recognition [3]. The main goal of the LDA consists in finding a base of vectors providing the best discrimination among the classes, trying to maximize the between-class differences, minimizing the within-class ones by using scatter matrices. But it suffers from small sample size problem which exists in high dimensional pattern recognition task where number of available sample is smaller than dimensionality of the samples. D-LDA,R-LDA and KDDA are variations of LDA. The LDA use linear transform to transfer image vector to feature space by

$$Y = W^T X$$

Where W is transformation matrix and Y is the projection matrix.. W_{LDA} has been finding from W and S_B and S_W. Where S_B is the between class scattering matrix and S_W is the within class scattering matrix.

E. Singular Value Decomposition (SVD)

SVD is an important factor in the field of signal processing and statistics. Chou-Hao Hsu and Chaur-Chin Chen has used SVD for Face Recognition [4]. It is one of the linear dimensionality reduction technique based on the covariance matrix. The main aim is to reduce the dimension of the data by finding a few orthogonal linear combinations of the original variables with the largest variance. The SVD is applied on the mean subtracted image of the training image.

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$$\psi = \sum_{i=1}^{k} \sigma_i u_i v_i^t$$

Where k is the minimum of right or left singular vector. And $\sigma_1 \geq \sigma_2 \geq \sigma_3 \ldots \geq \sigma_n \geq 0$.
Each training face image $F_i^{(j)}$ is transformed into face feature matrix $X_i^{(j)}$ by

$$X_i^{(j)} = U_t^r F_i^{(j)} V_c$$

Where r and c are user defined.

F. Independent Component Analysis

In 2001, O. Deni, M. Castrillon, and M. Hern andez, "Face Recognition Using Independent Component Analysis and Support Vector Machines", has used ICA for feature extraction in face recognition [5]. ICA is a statistical and computational technique for finding the hidden factors that underlie sets or random variables, measurements, or signals. ICA is superficially related to principal component analysis and factors analysis. The ICA algorithm aims at finding S component as independent as possible so that the set of observed signals can be expressed as a linear combination of statistically independent components. The ICA used higher order statistic relationship among pixels. It use cosine measures to perform the covariance matrix and also it is better than the PCA and LDA performance. Each training face image is transformed into a face feature matrix by $Y = U_r^t F_i V_c$

Where F_i is the input training image and U and V are two vectors.

G. Non-linear technique of dimension reduction

There is several non-linear dimension reduction techniques available and are explained briefly below.

H. Kernel Principal Component Analysis (KPCA)

Ming Hsuan Yang, "Face recognition using kernel methods" used KPCA for feature extraction [6]. KPCA is the reformulation of traditional PCA in a high-dimensional space that is constructed using a kernel function. In recent years the reformulation of linear technique with "kernel trick" has led to new successful technique like kernel ridge regression and Support Vector Machines. Ming–Hsuan Yang has used Kernel PCA for face Recognition. Kernel PCA computes the principal eigenvectors of the kernel matrix, rather than those of the covariance matrix. Since the reformulation of PCA in kernel space is straight forward, a kernel matrix is similar to the in product of the data points in the high-dimensional space that is constructed using the kernel function. The application of PCA in kernel space provides Kernel PCA the property of constructing nonlinear mappings. The function used to map the linear data to nonlinear space is given by following equations.

$$K_{ij} = K(r_i, r_j) = \varnothing(r_i)^T \varnothing(r_j)$$

Here K_{ij} is the kernel matrix. There are three types of kernel function available: Polynomial kernel, Gaussian Kernel and sigmoid kernel. The polynomial kernel is given by:

$$K(x, y) = (x, y)^d$$

Where d is the order. The Gaussian Kernel function is given by

$$K(x, y) = \exp\left(-\frac{\|x - y\|^2}{2\sigma^2}\right)$$

Where σ is the variance. The sigmoid kernel is given by

$$K(x, y) = \tanh(k(x, y) + \theta)$$

I. Isometric Mapping (ISOMAP)

Most of the linear methods do not taking consideration of neighboring data points. To preserve such information ISOMAP technique considers the pair wise geodesic distance in the data points. The approximation of geodesic distance is divided into two cases. For, neighboring points, Euclidean distance in the input space provides a good approximation to geodesic distance and faraway points, geodesic distance can be approximated by adding up a sequence of "short hops" between neighboring points. It

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offers some advantage over linear method like computational efficiency with more flexibility [7]. The isometric mapping algorithm can be described in three steps.

1) Neighbors of each point are determined. The neighbors are chosen as points which are within the Є distance or using K-nearest neighbor approach. These neighborhood relations are represented as a weighted graph G over the data points, with edges of weight $d_x(i, j)$ between neighboring points.

2) Isomap estimates the geodesic distances $d_M(i, j)$ between all pairs of points on the manifold M by computing their shortest path distances $d_G(i, j)$ in the graph G. The shortest path can be found by using Floyd-Warshall's algorithm or Dijasktra algorithm.

3) Reduce the dimensionality of the data by using MDS algorithm on the computed shortest path distance matrix.

J. Locally Linear Embedding (LLE)

It is similar to ISOMAP technique. It has several advantages over ISOMAP, including faster optimization when implemented to take advantage of sparse matrix algorithms, and better results with many problems. It describes the local properties of the manifold around a data point by writing the data point as a linear combination of its nearest neighbors and attempts to retain the reconstruction weights in the linear combinations as good as possible [7]. The Locally Linear Embedding algorithm can described in three steps below:

1) Assign neighbors to each data point ***Xi*** using K-NN approach.

2) Compute the weights W_{ij} that best linearly reconstruct ***Xi*** from its neighbors.

3) Compute the low-dimensional embedding vectors ***Yi*** best reconstructed by W_{ij}.

K. Laplacian Eigenmaps Method

It is similar to the LLE approach. Xiaofei He, Shuicheng Yan, Yuxiao Hu, Partha Niyogi and Hong-Jiang Zhang used Laplacian face for Face Recognition [8]. By using Locality Preserving Projections (LPP), the face images are mapped into a face subspace for analysis. The objective function of LPP is

$$\text{Min}\left(\sum_{ij}\left(y_i - y_j\right)^2 S_{ij}\right)$$

Where yi is the one dimensional representation of Xi and Si is the similarity matrix. the optimal map preserving locality can be found by solving the following optimization problem on the manifold:

$$\int_1^M \left(\|\nabla f\|^2\right)$$

L(f)= -div(∇f), L is the Laplacian operator. Given t points in n-dimensional space, the Laplacian Eigenmaps Method (LEM) starts by constructing a weighted graph with t nodes and a set of edges connecting neighboring points. Similar to LLE, the neighborhood graph can be constructed by finding the k nearest neighbors. The final objectives for both LEM and LLE have the same form and differ only in how the matrix is constructed.

L. Stochastic Neighbor Embedding (SNE)

It is a probabilistic approach that maps high dimensional data points into low dimension sub space in such a way that preserve the relative distance between the near neighbors. In SNE the similar objects in the high dimensional space are put nearby in low dimension space and dissimilar objects are put away from each other in low dimension space. So, Gaussian kind of distribution is used for selection of data points. SNE is better than LLE because it consider relative distance between every pair of data points [9]. The SNE algorithm is described below with four steps.

1) Neighbors Selection Select neighbors by ϱ neighborhoods or k nearest neighbors.

2) Computing P_{ij} and Q_{ij} Compute the probability, P_{ij} , that xi would pick xj as its neighbor:

$$P_{ij} = \frac{\exp\left(-d_{ij}^2\right)}{\sum_{i \neq k} \exp\left(-d_{ik}^2\right)}$$

Where d_{ij}^2 is the distance between two object x_i and x_j. In the lower-dimensional space, the induced probability Q_{ij} that the image y_i pick y_j as its neighbor, is described by

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$$Q_{ij} = \frac{\exp\left(-\left\|y_i - y_j\right\|^2\right)}{\sum_{i \neq k} \exp\left(-\left\|y_i - y_k\right\|^2\right)}$$

3) A Cost Function The aim of the embedding is to match pij and qij as well as possible. This is achieved by minimizing a cost function which is a sum of Kullback-Leibler divergences between P_{ij} and Q_{ij} for each object.

4) Embedding through Steepest Descent: The set of images, y in the lower-dimensional space, are updated by a gradient-descent method which has the form $y = y^k - \eta^k \nabla f^{(k)}$

Where η^k is a learning rate and ∇f is the gradient.

M. Semi Definite Embedding (SDE)

It can be seen as a variation in KPCA and its algorithm is based on Semi Definite Programming. SDE learn kernel matrix by maximizing the variance in feature space while preserving the distance and angle between nearest neighbors. It has several interesting properties: the main optimization is convex and guaranteed to preserve certain aspects of the local geometry; the method always yields a semi positive definite kernel matrix; the Eigen spectrum of the kernel matrix provides an estimate of the underlying manifold's dimensionality; also, the method does not rely on estimating geodesic distances between far away points on the manifold. It compute the Gram matrix of the maximum variance unfolding that is centered on the origin and preserves the distances of all edges in the neighborhood graph[10]. Let X be the original input and Y be the embedding. If I and j are two neighbors, then the local isometric constraint that needs to be satisfied is:

$$\left|X_i - X_j\right|^2 = \left|Y_i - Y_j\right|^2$$

Let G,K be the Gram matrices of X and Y, G_{ij}= X_i*X_j and K_{ij}= Y_i*Y_j. The distances of neighbor points are preserved, the algorithm aims to maximize the pair wise distance of every pair of points. The objective function to be maximized is:

$$T(Y) = \frac{1}{2N} \sum_{i,j} \left|y_i - y_j\right|^2$$

So, maximizing the function above is equivalent to pulling the points as far away from each other as possible and therefore "unfolds" the manifold. The local isometric constraint prevents the objective function from going to infinity.

1) Two-dimensional Methods

In 2004 Yang et. al presents a new approach based on Two-Dimensional PCA. In this approach they presents that the image need not to convert image into 1d vector like in PCA. They discuss 2DPCA as feature extraction technique and Euclidean distance as their recognition techniques. They applied their algorithm on ORL, Yale and AR database. They compare their algorithm with PCA.

IV. CLASSIFICATION

To classify any object or Face we need to use classifier. The extracted feature is given to the classifier for face classification. There are various classifier used in face recognition. Few have been discuss below.

A. Euclidian Distance

In 2004 Jian Yang, David Zhang, Alejandro F. Frangi, and Jing-yu Yang, "Two-Dimensional PCA: A New Approach to Appearance-Based Face Representation and Recognition" has used Euclidian Distance for Face Recognition [10]. The Euclidian Distance is the measure of the distance between the two points in the Euclidian space. It is one of the most widely used classification technique in face recognition. The Euclidian Distance between two vectors is calculated using the following equation. Here Bi=[$Y_1^{(1)}$,$Y_1^{(2)}$,$Y_1^{(3)}$,……,$Y_1^{(n)}$] and Bj=[$Y_1^{(j)}$,$Y_1^{(j)}$,$Y_1^{(j)}$, ……,$Y_1^{(j)}$] are two arbitrary feature matrix

$$D\left(B_i, B_j\right) = \sum_{k=0}^{n} \left\|y_k^i - y_k^j\right\|^2$$

Where || $Y_k^{(i)}$ - $Y_k^{(j)}$ || is the Euclidian distance between two vectors. Suppose B1, B2,…., Bm is the image in the training samples. Each and every sample assigns a class W_k. For a given test sample B, if D (B, Bi) = min (D (B, Bj)) where BiϵW_k and the resulting decision is BϵW_k.

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B. Support Vector Machine

In 2001, O. Deni, M. Castrillon, and M. Hern andez, "Face Recognition Using Independent Component Analysis and Support Vector Machines" has used SVM for Face recognition [5]. Support Vector Machine is one of the tools used for classification of the pattern. SVM is a learning technique that is considered an effective method for general purpose pattern recognition because of its high generalization performance without the need to add other knowledge. Intuitively, given a set of points belonging to two classes, a SVM finds the hyperplane that separates the largest possible fraction of points of the same class on the same side, while maximizing the distance from either class to the hyperplane. The SVM use kernel trick and work in high dimensional space [5]. The Hyperplane is defined as follows

$$Y(x) = \sum_{i=1}^{n} a_i Y^i k(x^i, x^{ii}) + b$$

Here $K(x^i, x^{ii})$ is a Kernel Function.

C. K-NN classifier

In pattern recognition, the k-nearest neighbor algorithm (k-NN) is a method for classifying objects based on closest training examples in the feature space. K-NN is a type of instance-based learning, or lazy learning where the function is only approximated locally and all computation is deferred until classification. The k-nearest neighbor algorithm is amongst the simplest of all machine learning algorithms. The neighbors are taken from a set of objects for which the correct classification is known. This can be thought of as the training set for the algorithm, though no explicit training step is required. The *k*-nearest neighbor algorithm is sensitive to the local structure of the data. For each test image, locate the k closest member of the training data set. A Euclidean distance measure is used to calculate how close each member of the training is close to the test class. The classification accuracy of "k"-NN can be improved significantly if the distance metric is learned with specialized algorithms such as Large Margin Nearest Neighbor or Neighborhood components analysis. Given a point x to be classified, Select the K nearest neighbors of x [11]. Assign to x the majority label of these K neighbors. Usually, K is odd. This algorithm functions as follows:

1) Compute Euclidean from target plot to those that were sampled.
2) Order samples taking for account calculated distances.
3) Choose heuristically optimal *k* nearest neighbor based on RMSE done by cross validation technique.
4) Calculate an inverse distance weighted average with the *k*-nearest multivariate neighbors.

D. Artificial Neural Network

In 2010, Mayank Agarwal, Nikunj Jain, Mr. Manish Kumar and Himanshu Agrawal, " Face Recognition Using Eigen Faces and Artificial Neural Network" has used Artificial Neural Network Artificial for classification in face recognition [12]. Artificial Neural network use the organizational principal of Human Brain. It is used for decision making process like pattern recognition. So, ANN is one of the very famous techniques used for classification of face.

There are various types of Neural Network have been used in face recognition. They are Feed Forward Neural network, Back Propagation Numeral Network. There are neuron resides in the various layers of the networks. These neurons are connected with each other via link and each link having some values called weights. They are having three layers: Input layer, Hidden layer and Output layer. The Input layer is responsible for inserting the information in to the network. The Hidden layer is responsible for processing the information and Output layer used to provide output to the comparator which compares the output with the predefined values generated using training of Neural Network.

E. Fuzzy Clustering approach

In 2007 Jianming Lu, Xue Yuan, and Takashi Yahagi, "A Method of Face Recognition Based on Fuzzy c-Means Clustering and Associated Sub-NNs" used Fuzzy c-means Clustering for face recognition [13]. In the method of Fuzzy classification the element is grouped into fuzzy set. Initially class has been defined by certain property and all the element having similar class has been grouped in a similar class. Various membership functions have been used for classification in fuzzy logic. Fuzzy classification is the partition of the feature space into fuzzy class. The conventional approach of pattern recognition is to clustering the training sample and associative cluster to given samples. Fuzzy *c*-means (FCM) is an optimal fuzzy clustering method. The goal of this unsupervised algorithm is to partition a data set into a small number of representative groups. It calculates the cluster centers by minimizing the following generalized loss function

$$J_m(U,V) = \sum_{j=1}^{n}\sum_{i=1}^{c} U_{ij}^{m} d_{ij}^{2}$$

Where c is the number of clusters, m is the weight value, N is the number of data points; dij is the distance between data point j and the cluster centre i, normally dij refers to the Euclidean distance. U_{ij} is the fuzzy membership matrix.

F. Neuro-Fuzzy Approach

In 2012, PRASANTH.R. S & SARITHA. R has been used Neuro-Fuzzy approach in Eigen Domain [14]. Neuro-Fuzzy approach is the combination of Fuzzy Logic and Neural Network. The extracted feature vector is given to the fuzzy network. When fuzzy logic is applied on the data set it is known as Fuzzification and after that the fuzzified vector has been given to the neural network for classification.

Fuzzification is the process of altering the real value into fuzzy value. Fuzzification is one of the powerful problems solving methodology having wide range of applications like image and information processing. It resembles human deciding with its power to work from near data and discovered accurate solutions.

Fuzzification is used to increase the speed of operation and increase the accuracy. Fuzzy logic may be two valued logic true or false. Membership function has been defined. Feed forward neural network and Back propagation neural network can be used for classification. The NN will map the input image into any one of the classes with respect to the exemplars.

2.4.7 Adaptive Neuro-Fuzzy Interface system

In 1993 Prof. J. S. Roger Jang in National Tsing Hua University has proposed the ANFIS. The model represents a neural network approach combined with fuzzy inference system based on Takagi-Sugeno inference model. ANFIS is a hybrid learning algorithm which uses the learning ability of neural networks to adjust the membership function parameters in a fuzzy inference system in order to build the adaptive system. Fuzzy inference can provide rule base generation from human expert's knowledge whereas the neural network approach supports tuning of membership function parameters from input output data pairs.

V. DATABASES

When benchmarking an algorithm it is recommended to use a standard database [15]. There are several databases available publically like ORL, FERET, Yale, PIE, Multi-PIE etc. The FERET database was collected in 15 sessions between August 1993 and July 1996.

The database contains 1564 sets of images for a total of 14,126 images that includes 1199 individuals and 365 duplicate sets of images. A duplicate set is a second set of images of a person already in the database and was usually taken on a different day. For some individuals, over two years had elapsed between their first and last sittings, with some subjects being photographed multiple times. This time lapse was important because it enabled researchers to study, for the first time, changes in a subject's appearance that occur over a year.

The Yale database contains 165 grayscale images in GIF format of 15 individuals. There are 11 images per subject, one per different facial expression or configuration: center-light, w/glasses, happy, left-light, w/no glasses, normal, right-light, sad, sleepy, surprised, and wink. The Yale B contains 5760 single light source images of 10 subjects each seen under 576 viewing conditions. For every subject in a particular pose, an image with ambient (background) illumination was also captured. The PIE database, collected at Carnegie Mellon University in 2000, has been very influential in advancing research in face recognition across pose and illumination. Despite its success the PIE database has several shortcomings: a limited number of subjects, a single recording session and only few expressions captured.

To address these issues researchers at Carnegie Mellon University collected the Multi-PIE database. It contains 337 subjects, captured under 15 view points and 19 illumination conditions in four recording sessions for a total of more than 750,000 images.

The database was generated in Olivetti Research laboratory in April 1992. The ORL or AT&T database contains 400 images of 40 people each person having 10 images.

The database having images of 112*92 pixels size and all are monochrome image. The face image having taken at different times, varying the lighting, facial expressions like open or closed eyes, smiling or not smiling and facial details glasses or no glasses. The images were taken with a tolerance for some tilting and rotation of the face of up to 20 degrees. Moreover, there is also some variation in the scale of up to about 10 percent.

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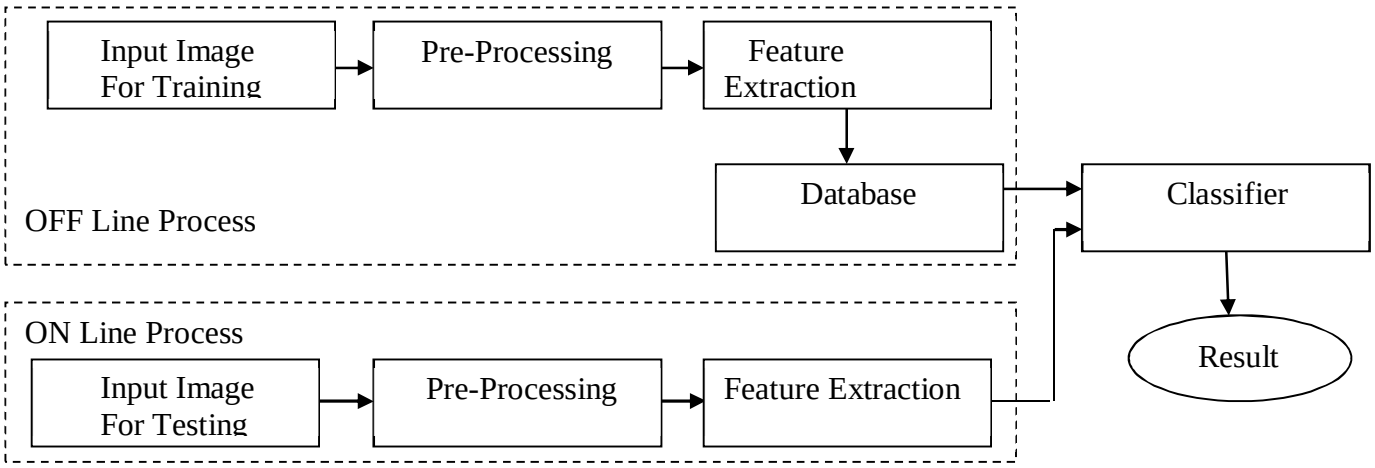
VI. FACE RECOGNITION SYSTEM ARCHITECTURE



Block diagram shows the architecture of face recognition systems. Face recognition systems consists of two face training and testing. The systems need to train by the train images and then test images has been applied. In real time processing train image database has been stored and then person belongs to that data base can be recognised. Training and testing procedure includes pre-processing, feature extraction and Classifications. In real time processing it also include image acquisition before pre processing.

VII. CHALLENGES IN FACE RECOGNITION

The face recognition system is used for identification and classification of the human. The system should be robust and it should work in every situation efficiently. Though the system is designed efficiently it may happen that in certain situation it may fail to identify and recognize the face. The condition may be:

1) Physical Change: facial expression change; aging; personal appearance (make-up, glasses, facial hair, hairstyle, disguise).
2) Acquisition geometry changes: change in scale, location and in-plane rotation of the face facing the camera) as well as rotation in depth (facing the camera obliquely, or presentation of a profile, not full-frontal face).
3) Imaging changes: lighting variation; camera variations; channel characteristics (especially in broadcast, or compressed images).
4) Similar faces: Sibling

VIII. ERRORS IN FACE RECOGNITION

There are two types of error in the face recognition system: False Acceptance Ratio (FAR) and False Rejection Ratio (FRR).
False Acceptance Ratio: The percentage of times a system produces a false accept, which occurs when an individual is incorrectly matched to another individual's existing biometric.
False Rejection Ratio: The percentage of times the system produces a false reject. A false reject occurs when an individual is not matched to his/her own existing biometric template.

IX. CONCLUSION

This paper discusses various techniques used for face recognition technology, that includes pre-processing, feature extraction and classifications. It also includes various database to standardises the algorithms. It also discusses challenges in face recognition and various errors in face recognitions. one can use any of the available combinations for face recognitions like PCA with Neural Network, 2D PCA with ANFIS and so on.

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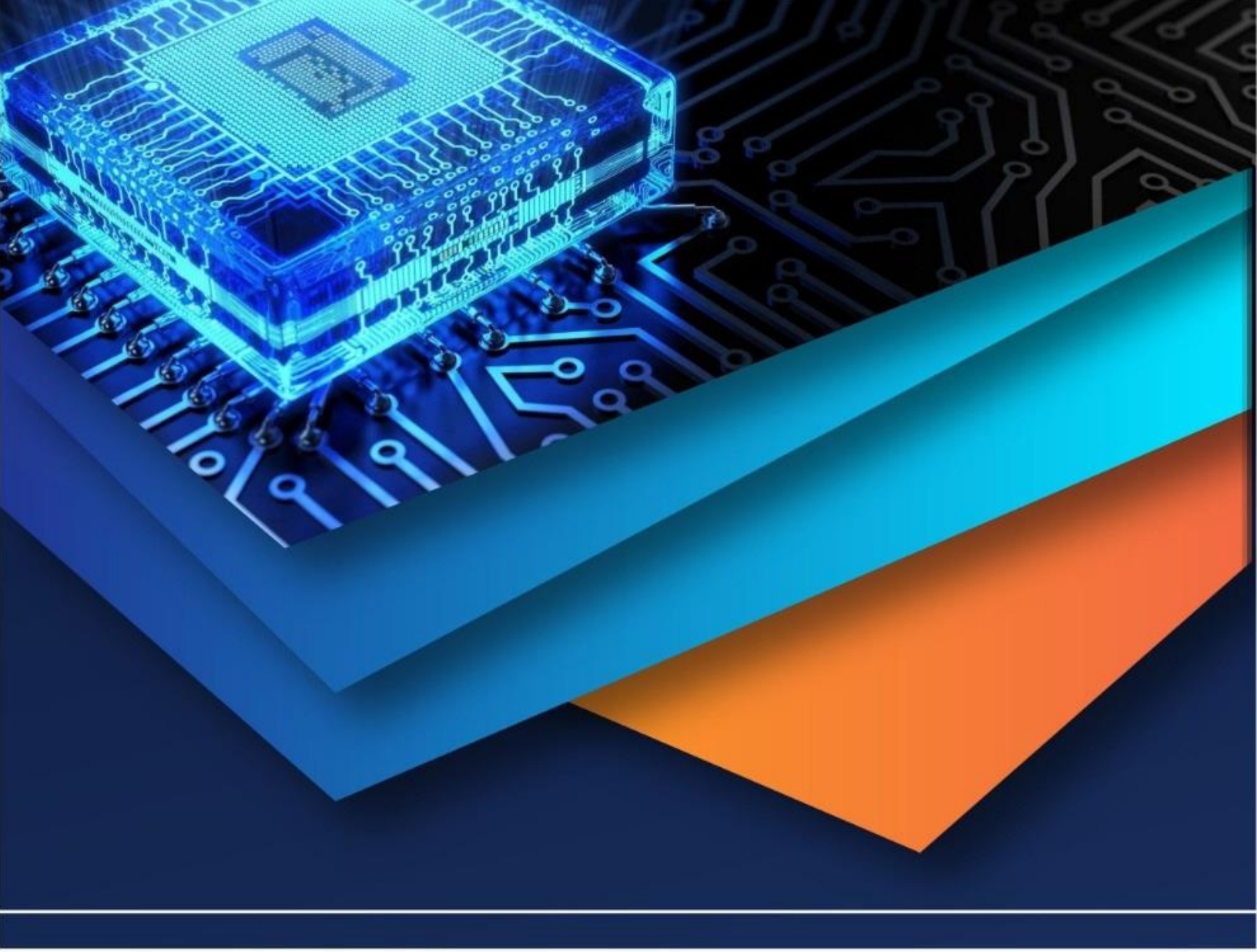

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