FACE RECOGNITION USING DIFFERENT TECHNIQUES A REVIEW

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***Abstract*-Face is the index of mind. It is a complex multidimensional structure and needs a good computing technique for recognition. While using automatic system for face recognition, computers are easily confused by changes in illumination, variation in poses and change in angles of faces. A numerous techniques are being used for security and authentication purposes which includes areas in detective agencies and military purpose. This paper reviews the existing methods in automatic face recognition and formulates the way to still increase the performance.**

***Keywords*-**Facial recognition, face detection, authentication, database

I. INTRODUCTION

Nowadays the Human face recognition is currently a wide active research area in computer vision and pattern recognition in which the main focus is on the ways to perform robust biometric identification. Face recognition has a large number of applications including security, person Verification and Internet communication. There are different commercial applications like criminal identification, security system; image and film processing are available for the face recognition. Variability in the appearance of a face image changes due to the expression, illumination, pose and aging so automatic face recognition in 2-D still image is a challenging task. The main reason for the popularity of face recognition is that it can be used in different fields like identity authentication, access control and so on [1].

The block diagram of a typical face recognition system can be shown with the help of Fig 1.The face detection and face extraction are carried out simultaneously. The complete process of face recognition can be shown in the Fig 1.

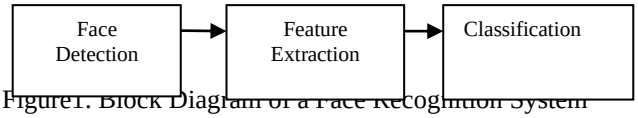

Figure1. Block Diagram of a Face Recognition System

The first step in face recognition system is to detect the face in an image. The main objective of face detection is to find whether there are any faces in the image or not. If the face is present, then it returns the location of the image and extent of the each face. Pre-processing is done to remove the noise and reliance on the precise registration.

There are a lot of factors due to which the face detection is a challenging task.

- Pose.
- Presence or absence of structural components
- Facial expression
- Image orientation
- Imaging conditions

The facial feature detection is the process to detect the presence and location of features, like nose, eyebrow, eyes, lips, mouth, ears, etc. This is done with the assumptions that there is only a single face in an image. In the Face recognition process the input image is compared with the database. Then it provides a report about a match, if any and then the classification is done to identify the sub-population to which new observations belong.

II. METHODS

2.1. Geometric Feature Based Method

The geometric feature based approaches are the earliest approaches to face recognition and detection [1]. In these systems, significant facial features are detected and distances among them as well as other geometric characteristic are combined in a feature vector that is used to represent face. To recognize a face, first feature vector of test image and of the image in database is obtained. Second, a similarity measure between these vectors, most often a minimum distance criterion, is used to determine the identity of the face. As pointed out by Brunelli and Poggio, template based approaches will outperform the early geometric feature based approaches.

2.2. Template Based Method

The template based approaches represent the most popular technique used to recognize and detect faces. Unlike the geometric feature based approaches, template based approaches use a feature vector that represents entire face template rather than the most significant facial features.

2.3. Correlation Based Method

Correlation based methods for face detection are based on the computation of the normalized cross correlation coefficient Cn [4, 5]. The first step in these methods is to determine the location of the significant facial features such as eyes, nose or mouth. The importance of robust facial feature detection for both detection and recognition has resulted in the development of a variety of different facial feature detection algorithms. The facial feature detection method proposed by Brunelli and Poggio uses a set of templates to detect the position of the eyes in an image, by looking for the maximum absolute values of the normalized correlation coefficient of these templates at each point in test image. To cope with scale variations, a set of templates at different scales was used.

The problems associated with the scale variations can be significantly reduced by using hierarchical correlation. For face recognition, the templates corresponding to the significant facial feature of the test images are compared in turn with the corresponding templates of all of the images in the database, returning a vector of matching scores computed through normalized cross correlation. The similarity scores of different features are integrated to obtain a global score that is used for recognition. Beymer extended the correlation based on the approach to a view based approach for recognizing faces under varying orientation, including rotations with respect to the axis perpendicular to the image plane (rotations in image depth). To handle rotations out of image plane, templates from different views were used. After the pose is determined, the task of recognition is reduced to the classical correlation method in which the facial feature templates are matched to the corresponding templates of the appropriate view based models using cross correlation coefficient. However this approach is highly computational expensive and it is sensitive to lighting conditions.

2.4. Matching Pursuit Based Method

Philips introduced a template based face detection and recognition system that uses a matching pursuit filter to obtain the face vector [2]. The matching pursuit algorithm applied to an image iteratively selects from a dictionary of basic functions the best decomposition of the image by minimizing the residue of the image in all iterations. The algorithm describes by Philips constructs the best decomposition of a set of images by iteratively optimizing a cost function, which is determined from the residues of the individual images. The dictionary of basic functions used by the author consists of two dimensional wavelets, which gives a better image representation than the PCA (Principal Component Analysis) and LDA (Linear Discriminant Analysis) based techniques where the images were stored as vectors. For recognition the cost function is a measure of distances between faces and is maximized at each iteration. For detection the goal is to find a filter that clusters together in similar templates and minimized in each iteration. The feature represents the average value of the projection of the templates on the selected basis

2.5. Singular Value Decomposition Based Method

The face recognition method in this section use the general result stated by the singular value decomposition theorem. Z. Hong revealed the importance of using Singular Value Decomposition Method (SVD) for human face recognition by providing several important properties of the singular values (SV) vector which include: the stability of the SV vector to small perturbations caused by stochastic variation in the intensity image, the proportional variation of the SV vector with the pixel intensities, the variances of the SV feature vector to rotation, translation and mirror transformation [3]. The above properties of the SV vector provide the theoretical basis for using singular values as image features. Among the various dimensionality reducing transformations, the Linear Discriminant Transform is the most popular one.

2.6. The Dynamic Link Matching Method

The above template based matching methods use an Euclidean distance to identify a face in a gallery or to detect a face from a background. A more flexible distance measure that accounts for common facial transformations is the dynamic link introduced by Lades et al. [4]. In this approach, a rectangular grid is centered all faces in the gallery. The feature vector is calculated based on Gabor type wavelets, computed at all points of the grid.

A new face is identified if the cost function, which is a weighted sum of two terms, is minimized. The first term in the cost function is small when the distance between feature vectors is small and the second term is small when the relative distance between the grid points in the test and the gallery image is preserved. It is the second term of this cost function that gives the “elasticity” of this matching measure. While the grid of the image remains rectangular, the grid that is “best fit” over the test image is stretched. Under certain constraints, until the minimum of the cost function is achieved. The minimum value of the cost function is used further to identify the unknown face.

2.7. Illumination Invariant Processing Method

The problem of determining functions of an image of an object that are insensitive to illumination changes are considered [5,6]. An object with Lambertian reflection has no discriminative functions that are invariant to illumination. This result leads the author to adopt a probabilistic approach in which they analytically determine a probability distribution for the image gradient as a function of the surfaces geometry and reflectance. Their distribution reveals that the direction of the image gradient is insensitive to changes in illumination direction. Verify this empirically by constructing a distribution for the image gradient from more than twenty million samples of gradients in a database of thousand two hundred and eighty images of twenty inanimate objects taken under varying lighting conditions. Using this distribution, they develop an illumination insensitive measure of image comparison and test it on the problem of face recognition. In another method, they consider only the set of images of an object under variable illumination, including multiple, extended light sources, shadows, and color. They prove that the set of n-pixel monochrome images of a convex object with a Lambertian reflectance function, illuminated by an arbitrary number of point light sources at infinity, forms a convex polyhedral cone in IR and that the dimension of this illumination cone equals the number of distinct surface normal. Furthermore, the illumination cone can be constructed from as few as three images. In addition, the set of n-pixel images of an object of any shape and with a more general reflectance function, seen under all possible illumination conditions, still forms a convex cone in IRn. These results immediately suggest certain approaches to object recognition. Throughout, they present results demonstrating the illumination cone representation.

2.8. Support Vector Machine Approach

Face recognition is a K class problem, where K is the number of known individuals; and support vector machines (SVMs) are a binary classification method [7]. By reformulating the face recognition problem and reinterpreting the output of the SVM classifier, they

developed a SVM-based face recognition algorithm. The face recognition problem is formulated as a problem in difference space, which models dissimilarities between two facial images. In difference space we formulate face recognition as a two class problem. The classes are: dissimilarities between faces of the same person, and dissimilarities between faces of different people. By modifying the interpretation of the decision surface generated by SVM, we generated a similarity metric between faces that are learned from examples of differences between faces. The SVM-based algorithm is compared with a principal component analysis (PCA) based algorithm on a difficult set of images from the FERET database. Performance was measured for both verification and identification scenarios. The identification performance for SVM is 77-78% versus 54% for PCA. For verification, the equal error rate is 7% for SVM and 13% for PCA.

2.9. Neural Network Based Algorithm

Templates have been also used as input to Neural Network (NN) based systems. Lawrence et.al proposed a hybrid neural network approach that combines local image sampling, a self organizing map (SOM) and a convolution neural network [8]. The SOP provides a set of features that represents a more compact and robust representation of the image samples. These features are then fed into the convolution neural network. This architecture provides partial invariance to translation, rotation, scale and face deformation. Along with this efficient probabilistic decision based neural network (PDBNN) for face detection and recognition is introduced. The feature vector used consists of intensity and edge values obtained from the facial region of the down sampled image in the training set. The facial region contains eyes and nose, but excludes the hair and mouth. Two PDBNN were trained with these feature vectors and used one for the face detection and other for the face recognition.

2.10. Model Based Method

Hidden Markov Model Based Approach

In this approach, the most significant facial features of a frontal face which includes hair, forehead, eyes, nose and mouth which occur in a natural order from top to bottom even if the image undergo small variation in the image plane perpendicular to the image plane. One dimensional HMM (Hidden Markov Model) is used for modeling the image, where the observation vectors are obtained from DCT or KLT coefficients. They gives face images for each subject of the training set, the goal of the training set is to optimize the parameters of the Hidden Markov Model to best describe the observations in the sense of maximizing the probability of the observations given in the model. Recognition is carried out by matching the best test image against each of the trained models. To do this, the image is converted to an observation sequence and then model likelihoods are computed for each face model. The model with the highest likelihood reveals the identity of the unknown face.

III. RESULTS

Methods	**Percentage of correct classification(PCC)**
Geometrical feature matching and Template matching	Template matching achieved 100% to 90% for Geometrical feature matching.
Support Vector Machine	Identification performance is 77.78% versus 54% for PCA. Verification performance is 93%versus 87% for PCA.
Hidden Markov model (HMMs)	87%

IV. APPLICATIONS

There are numerous application areas in which face recognition can be exploited. Some are discussed below:

4.1 Security (access control to buildings, airports, ATM machines and border checkpoints computer/network security, email authentication on multimedia workstations).

4.2 Surveillance (a large number of CCTVs can be monitored to look for known criminals, drug offenders, etc. and authorities can be notified when one is located.

4.3 General identity verification (electoral registration, banking, national IDs, passports, drivers' licenses, employee IDs).

4.4 Criminal justice systems (booking systems, post-event analysis, forensics).

4.5 Image database investigations (searching image databases of licensed drivers, benefit recipients, missing children, immigrants and police bookings).

4.6 Multi-media environments with adaptive human computer interfaces (behavior monitoring at childcare or old people's centers, recognizing a customer and assessing his needs).

4.7 Witness faces reconstruction.

In addition to these applications, the underlying techniques in the current face recognition technology have also been modified and used for related applications such as gender classification , expression recognition and facial feature recognition and tracking, each of these has its utility in various domains: for instance, expression recognition can be utilized in the field of medicine for intensive care monitoring while facial feature recognition and detection can be exploited for tracking a vehicle driver's eyes and thus monitoring his fatigue, as well as for stress detection.

V. CONCLUSION

This paper discusses different approaches which have been employed in automatic face recognition. In the geometrical based method, the geometrical features are selected and the significant facial features are detected. The correlation based approach needs face template rather than the significant facial features. Neural network based approaches are more efficient when it contains no more than a few hundred weights. The Hidden Markov model optimizes the

parameters to best describe the observations in the sense of maximizing the probability of observations given in the model. Face recognition area need for improvements as Subject-based template, inaccurate registration, Illumination dependent and Feature selection.

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