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# Review on Different Face Recognition Techniques

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***Abstract— FACE recognition is an important research problem in the field of Pattern Recognition. As one of the most successful applications of image analysis and understanding, face recognition has recently received significant attention, especially during the past several years. Even though current machine recognition systems have reached a certain level of maturity, their success is limited by the conditions imposed by many real applications. For example, recognition of face images acquired in an outdoor environment with changes in illumination and/or pose remains a largely unsolved problem. In other words, current systems are still far away from the capability of the human perception system. Human Face Recognition has become a potential method of biometric authentication because of its most non-intrusive and user-friendly nature. Automatic face recognition poses various challenges due to: (a) inherent variability of face due to age, gender and race; (b) different facial expressions and orientations of same person's face; and (c) images containing faces have high degree of variability in size, texture, background and illumination.***

***Keywords— face Recognition, authentication, Pca ,ica, eignface***

## I. INTRODUCTION

Computer vision is a new area of research is currently hanging in the computer science. It mainly want to solve the problem is to build an intelligent system , extracted from the images useful information or we can say that the purpose of computer vision is to create such as like human can be made for the image the wisdom of response and identification systems. Face recognition is one of more representative and classic application in computer vision basically, any face recognition system consists in comparing previously known face images to other provided [3] face images.

Face recognition is an important research problem spanning numerous fields and disciplines. This is because face recognition, in additional to having numerous practical applications such as bankcard identification, access control, Mug shots searching, security monitoring, and surveillance system, is a fundamental human behavior that is essential for effective communications and interactions among people [1]. This classification is multi-modal, i.e. resulting in a vector of independent measures that could be compared with other vectors in a database. The rapid development of face recognition is due to a combination of factors active development of algorithms, the availability of large databases of facial images, and a method for evaluating the performance of face recognition algorithms. Face recognition problem can be formulated as: given static (still) or video images of a scene, identify or verify one or more persons in the scene by comparing with faces stored in a database. When comparing person verification to face recognition, there are several aspects which differ. First, a client an authorized user of a personal identification system is assumed to be [2] co-operative and makes an identity claim. Computationally this means that it is not necessary to consult the complete set of database images in order to verify a claim.

An incoming image (referred to as a probe image) is thus compared to a small number of model images of the person whose identity is claimed and not, as in the recognition scenario, with every image (or some descriptor of an image) in a potentially large database. Second, an automatic authentication system must operate in near-real time to be acceptable to users. Finally, in recognition experiments, only images of people from the training database are presented to the system, whereas the case of an imposter (most likely a previously unseen person) is of utmost importance for authentication. Face recognition is a biometric approach that employs automated methods to verify or recognize the identity of a living person based on his/her physiological characteristics. In general, a biometric identification system makes use of either physiological characteristics (such as a fingerprint, iris pattern, or face) or behavior patterns (such as hand-writing, voice, or key-stroke pattern) to identify a person. Because of human inherent protectiveness of his/her eyes, some people are reluctant to use eye identification systems. Face recognition has the benefit of being a passive, non intrusive system to verify personal identity in a "natural" and friendly way.

All face recognition algorithms consistent of two major parts: (1) face detection and normalization and (2) face identification. Algorithms that consist of both parts are referred to as fully automatic algorithms and those that consist of only the second part are called partially automatic algorithms. Partially automatic algorithms are given a facial image and the coordinates of the center of the eyes. Fully automatic algorithms are only given facial images. On the other hand, the development of face recognition over the past years allows an organization into three types of recognition algorithms,

 

namely frontal, profile, and view tolerant recognition, depending on the kind of images and the recognition algorithms. Focusing on the aspect of pose invariance, face recognition approaches may be divided into two categories: (i) global approach (ii) component-based approach. In global approach, a single feature vector that represents the whole face image is used as input to a classifier.

**Why Use Face For Recognition**

Biometric-based techniques have emerged as the most promising option for recognizing individuals in recent years since, instead of authenticating people and granting them access to physical and virtual domains based on passwords, PINs, smart cards, plastic cards, tokens, keys and so forth, these methods examine an individual's physiological and/or behavioral characteristics in order to determine and/or ascertain his identity. Passwords and PINs are hard to remember and can be stolen or guessed; cards, tokens, keys and the like can be misplaced, forgotten, purloined or duplicated; magnetic cards can become corrupted and unreadable. However, an individual's biological traits cannot be misplaced, forgotten, stolen or forged. Biometric-based technologies include identification based on physiological characteristics (such as face, fingerprints, finger geometry, hand geometry, hand veins, palm, iris, retina, ear and voice) and behavioral traits (such as gait, signature and keystroke dynamics) [1]. Face recognition appears to offer several advantages over other biometric methods, a few of which are outlined here: Almost all these technologies require some voluntary action by the user, i.e., the user needs to place his hand on a hand-rest for fingerprinting or hand geometry detection and has to stand in a fixed position in front of a camera for iris or retina identification. However, face recognition can be done passively without any explicit action or participation on the part of the user since face images can be acquired from a distance by a camera. This is particularly beneficial for security and surveillance purposes. Furthermore, data acquisition in general is fraught with problems for other biometrics: techniques that rely on hands and fingers can be rendered useless if the epidermis tissue is damaged in some way (i.e., bruised or cracked). Iris and retina identification require expensive equipment and are much too sensitive to any body motion. Voice recognition is susceptible to background noises in public places and auditory fluctuations on a phone line or tape recording. Signatures can be modified or forged. However, facial images can be easily obtained with a couple of inexpensive fixed cameras. Good face recognition algorithms and appropriate pre processing of the images can compensate for noise and slight variations in orientation, scale and illumination. Finally, technologies that require multiple individuals to use the same equipment to capture their biological characteristics potentially expose the user to the transmission of germs and impurities from other users. However, face recognition is totally non-intrusive and does not carry any such health risks.

## II. DIFFERENT TECHNIQUES OF FACE RECOGNITION

The major human face recognition techniques that apply mostly to frontal faces, advantages and disadvantages of each method are also given. The methods considered are eigenfaces (eigenfeatures), neural networks, dynamic link architecture, hidden Markov model, geometrical feature matching, and template matching. The approaches are analyzed in terms of the facial representations they used three approach are used for feature extraction holistic approach, feature based approach and holistic approach.

(1) *Holistic matching methods.* These methods use the whole face region as the raw input to a recognition system. One of the most widely used representations of the face region is eigenpictures [Kirby and Sirovich 1990] Sirovich and Kirby 1987], which are based on principal component analysis.

(2) *Feature-based (structural) matching methods.* Typically, in these methods, local features such as the eyes, nose, and mouth are first extracted and their locations and local statistics (geometric and/or appearance) are fed into a structural classifier.

(3) *Hybrid methods.* Just as the human perception system uses both local features and the whole face region to recognize a face, a machine recognition system should use both. One can argue that these methods could potentially offer the best of the two types of methods.

### *A. Feature Extraction*

The importance of facial features for face recognition cannot be overstated. Many face recognition systems need facial features in addition to the holistic face, as suggested by studies in psychology. It is well known that even holistic matching methods, eigenfaces and Fisherfaces need accurate locations of key facial features such as eyes, nose, and mouth to normalize the detected face.

Three types of feature extraction methods can be distinguished:

(1) Generic methods based on edges, lines, and curves.

(2) feature-template-based methods that are used to detect facial features such as eyes

(3) Structural matching methods that take into consideration geometrical constraints on the features.

### *B. Fuzzy hough-klt for face recognition*

Commonly the membership functions of a fuzzy system are designed according to the experience of an expert who knows the behavior of a process. Fuzzy clustering in the input-output space is a technique widely used to create the membership functions of a fuzzy system [5]. Applying the clustering techniques we can also obtain fuzzy sets that are utilized to model the antecedents of the rules in fuzzy systems.

 

### *C. Gath-Gheva algorithm*

The Gath-Gheva algorithm GG, is a fuzzy clustering algorithm. One of the advantages of the GG algorithm is that it can utilize the label of the data to create fuzzy clusters in order to construct the antecedents of a fuzzy inference system [6]. The first term is based on the GG algorithm for non-supervised clustering. The second is based on the probability that the rith cluster describes the density of the class of the k-th data. The second term, allows the use of class labels, and is defined as the consequent probability

### *D. Eigenfaces*

Eigenface is one of the most thoroughly investigated approaches to face recognition. It is also known as Karhunen-Loève expansion, eigenpicture, eigenvector, and principal component. They argued that any face images could be approximately reconstructed by a small collection of weights for each face and a standard face picture (eigenpicture). The weights describing each face are obtained by projecting the face image onto the eigenpicture. In mathematical terms, eigenfaces are the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images. The eigenvectors are ordered to represent different amounts of the variation, respectively, among the faces. Each face can be represented exactly by a linear combination of the eigenfaces. It can also be approximated using only the "best" eigenvectors with the largest eigenvalues. The best M eigenfaces construct an M dimensional space, i.e., the "face space. Illumination normalization [4] is usually necessary for the eigenfaces approach. They used a modular eigenspace which was composed of the above eigenfeatures (i.e., eigeneyes, eigennose, and eigenmouth). This method would be less sensitive to appearance changes than the standard eigenface method.

Face recognition using eigenfaces As a general view, this algorithm extracts the relevant information of an image and encodes it as efficiently as possible. For this purpose, a collection of images from the same person is evaluated in order to obtain the variation. Mathematically, the algorithm calculates the eigenvectors of the covariance matrix of the set of face images. [4] Each image from the set contribute to an eigenvector, these vectors characterize the variations between the images. When we represent these eigenvectors, we call it eigenfaces. Every face can be represented as a linear combination of the eigenfaces; however, we can reduce the number of eigenfaces to the ones with greater values, so we can make it more efficient. The basic idea of the algorithm is develop a system that can compare not images themselves, but these feature weights explained before. The algorithm can be reduced to the next simple steps.

1. Acquire a database of face images, calculate the eigenfaces and determine the face space with all them. It will be necessary for further recognitions
2. When a new image is found, calculate its set of weights.
3. Determine if the image is a face; to do so, we have to see of it is close enough to the face space.
4. Finally, it will be determined if the image corresponds to a known face of the database of not.

### *E. Contour Matching Method*

Once the standard matrix for the face contours is obtained, the next step is to determine their match. The first algorithm is a distance matching method while the second algorithm is the proposed angle matching method.

### *F. Hough Transform*

The Hough transform is a useful transformation to detect geometric patterns in images, like lines, circles, and ellipses.

### *G. Face recognition approach based on kernel*

The discriminative common vectors (DCV) algorithm is a recently addressed discriminant method, which shows better face recognition effects than some commonly used linear discriminant algorithms. The radial basis function (RBF) neural network is widely applied to the function approximation and pattern classification. One of the interesting research topics of RBF network is how to set appropriate hidden-layer units. Based on DCV, we design a new nonlinear feature extraction algorithm that is the kernel DCV (KDCV) algorithm and we employ the DCV generated by KDCV as the hidden-layer units of the RBF network. Then we present a novel face recognition approach that is the KDCV-RBF approach. The radial basis function (RBF) neural network is widely applied to function approximation and pattern classification. RBF network has following theoretical advantages [5]: (i) global optimal approximation characteristic and favorable classification capability; (ii) rapid convergence of learning procedure; (iii) an optimal network to accomplish the mapping function in the feed-forward neural networks. One of interesting research topics of RBF network is how to set appropriate hidden-layer units. we use the kernel discriminative common vectors generated by KDCV as the hidden-layer units and adopt the same kernel function for KDCV and RBF. We then present a novel face recognition approach that is the DCV-RBF approach. Testing on a public large face database (AR database), the experiments demonstrate the effectiveness of the presented approach.

### *H. Principle Component Analysis (PCA)*

The Principal Component Analysis (PCA) is one of the most successful methods that have been used in digital image processing and pattern recognition. The purpose of PCA is to reduce the large dimensionality of the data space for describing the data efficiently. PCA is mathematically defined as an orthogonal linear transformation that transforms the data to a new coordinate system[2] such that the greatest variance by any projection of the data comes to lie on the first coordinate (called the first principal component), the second greatest variance on the second coordinate, and so on. PCA

 

is theoretically the optimum transform for given data in least square terms.[3] PCA can be used for dimensionality reduction in a data set by retaining those characteristics of the data set that contribute most to its variance, by keeping lower-order principal components and ignoring higher-order ones. Such low-order components often contain the "most important" aspects of the data.

### *I. Independent Component Analysis (ICA)*

Independent Component Analysis (ICA) (Bartlett et al., 2002; Draper et al., 2003) minimizes both second-order and higher order dependencies in the input data and attempts to find the basis along which the data (when projected onto them) are statistically independent. ICA representations are designed to maximize information transmission in the presence of noise and, thus, they may be more robust to variations such as lighting conditions, changes in hair, make-up, and facial expression, which can be considered forms of noise with respect to the main source of information in our face database: the person's identity. The robust recognition across different days is particularly encouraging, since most applications of automated face recognition contain the noise inherent to identifying images collected on a different day from the sample images.

### *J. Fisherface based algorithm*

The Fisherface approach is also one of the most widely used methods for feature extraction in face images. This approach tries to find the projection direction in which, images belonging to different classes are separated maximally [5]. According to Shang-Hung Lin, Fisherface algorithm is a refinement of the eigenface algorithm to cater the illumination variation. Bulhumeur reported that Fisherface algorithm performs better than eigenface in a circumstance where the lighting condition is varied.This approach requires several training images for each face. Therefore, it cannot be applied to the face recognition applications where only one example image per person is available for training.

### *K. Skin color based algorithm*

Skin color is the most obvious and important features of human faces. Human skin colors are distinguished from different ethnic through the intensity of the skin color not the chromatic features. One of facial feature methods is involving skin color based processing method. According to Crowley and Coutaz, one of the simplest algorithms for detecting skin pixels is to use skin color algorithm. Each pixel is classified as skin color and non-skin color. This classification is based on its color component, which is modeled by Gaussian probability density [4]. For an input image, this method utilizes color space for the skin region as the classification. Threshold is applied to mask the skin region. Finally, a bounding box is drawn to extract the face from the input image. According to Sanjay Kr. Singh *et al.*, skin color processing method offers a faster processing time than other facial feature methods and orientation invariant. However, Yeong Nam Chae*et al.* has a diverse opinion whereby skin color method is time consuming as it scans the target image linearly which involves a large space of scanning. Hence, they have proposed a novel method using sub-windows scanning instead of the conventional linear scanning. This proposed method works by scanning the image sparsely based the facial color density by determining the horizontal and vertical intervals. From the experiment, the results reveal that this proposed method was successfully detects faces in a shorter period of time compared to the conventional method. The sub-windows scanning method contributes to the less computational time as it skips the sub-windows that do not consist of possible faces. There are three most popular color spaces, namely, the RGB, YCbCr and HIS.

### *L. Gabor Wavelet*

Gabor wavelet transform utilizes spatial frequency structures and orientation relation. This method is a type of Gaussian modulated sinusoidal wave of the Fourier transform. Gabor wavelet approach works by detecting short lines, [4] ending lines and sharp changes in curvature. These curves correspond well with the prominent features of human faces such as mouth, nose, eyebrow, jaw line and cheekbone. Therefore, Gabor wavelet is very well known in feature detecting.

### *M. Back Propagation*

Back propagation deploys the technique of calculating the error made in the output neuron and propagates them back to the inner neuron or this method is also known as "learn by examples". Therefore, a learning set consists of input examples for each case must be included. The output value is compared to the examples in the training set and an error value is calculated. This error value is then propagated back to the neuron and used to adjust the [2] weights. Small changes are made to the weight value to reduce the error value. This process repeats until it reaches a pre-determined value. The back propagation neural network is used to recognize and classify aspects of the image of a human's face such as the expression of the person in the image, the orientation of the face in the image and also the presence of any accessories such as sunglasses and beard

### *N. Line Edge Map (LEM)*

Edge information is a useful object representation feature that is insensitive to illumination changes to certain extent. Though the edge map is widely used in various pattern recognition fields, it has been neglected in face recognition except in recent work reported in [4]. Edge images of objects could be used for object recognition and to achieve similar accuracy as gray-level pictures

 

This algorithm describes a new technique based on line edge maps (LEM) to accomplish face recognition. In addition, it proposes a line matching technique to make this task possible. In opposition with other algorithms, LEM uses physiologic features from human faces to solve the problem; it mainly uses mouth, nose and eyes as the most characteristic ones. In order to measure the similarity of human faces the face images are firstly converted into gray-level pictures. The images are encoded into binary edge maps using Sobel edge detection algorithm. This system is very similar to the way human beings perceive other people faces as it was stated in many psychological studies. The main advantage of line edge maps is the low sensitiveness to illumination changes, because it is an intermediate-level image representation derived from low-level edge map representation.[3] The algorithm has another important improvement, it is the low memory requirements because the kind of data used. There is an example of a face line edge map; it can be noticed that it keeps face features but in a very simplified level

### *O. Hidden Markov Model (HMM)*

Hidden Markov model (HMM) is a promising method that works well for images with variations in lighting, facial expression, and orientation.[1] To process images using HMM, the temporal or space sequences are to be considered. In simple terms HMM can be defined as set of finite states with associated probability distributions. Only the outcome is visible to the external user not the states and hence the name Hidden Markov Model.

### *P. DCT-HMM Approach*

Conventional HMMs are 1D data modelers. To facilitate them to be useful for 2D image applications, either they are to be redefined in 2D context, or 2D data must be converted to lD, without losing [4] significant information. In the present context, the second approach is used, i.e. 2D face image data is converted to 1D sequence, and then used for HMM training and testing. This crucial step of converting 2D image information to 1D vector is performed.

### *Q. SVM (Support vector machines)*

Support vector machines are a set of related supervised learning methods used for classification and regression. Viewing input data as two sets of vectors in an n-dimensional space, an SVM will construct a separating hyper plane in that space, one which maximizes the margin between the two data sets[7]. To calculate the margin, two parallel hyper planes are constructed, one on each side of the separating hyper plane, which is "pushed up against" the two data sets. Intuitively, a good separation is achieved by the hyper plane that has the largest distance to the neighboring data points of both classes, since in general the larger the margin the better the generalization error of the classifier

### *R. Pure geometry methods*

Geometrical feature matching techniques are based on the computation of a set of geometrical features from the picture of a face. The fact that face recognition is possible even at coarse [1] resolution as low as 8x6 pixels when the single facial features are hardly revealed in detail, implies that the overall geometrical configuration of the face features is sufficient for recognition. The overall configuration can be described by a vector representing the position and size of the main facial features, such as eyes and eyebrows, nose, mouth, and the shape of face outline. There are many methods for geometry like gabor decomposition methods ,haar transformation etc

## III. CONCLUSION

Face Recognition is an active Research area in pattern recognition. Different systems are able to automatically identity information for secure transactions, for surveillance and security tasks, and for access control to buildings. These applications usually work in controlled environments and recognition algorithms that can take advantage of the environmental constraints to obtain high recognition accuracy. There are many methods and approaches like Eigen space/PCA, Neural Network, edges detection, Skin color model, knowledge based Approaches, image based approaches, multi wavelets, DCV, SVM used for Face recognition.

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