FACE RECOGNITION: A SURVEY

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Abstract— Face recognition has been one of the most interesting and important research fields in the past years. Face recognition presents a challenging problem in the field of image analysis and computer vision. The face of a human being conveys a lot of information about identity and emotional state of the person. Many public places usually have surveillance cameras for video capture and these cameras have their significant value for security purpose, identification for law enforcement, authentication for banking and security system access, and personal identification among others. Though tracking and recognizing face objects is a routine task for humans but it is difficult form a system to recognise different faces of human beings. In this paper we review existing methods of face recognition. Face recognition mainly consists of three parts, namely face representation, feature extraction and classification. Face representation represents how to model a face and determines the successive algorithms of detection and recognition. The most useful and unique features of the face image are extracted in the feature extraction phase. In the classification the face image is compared with the images from the database.

Keywords: Face recognition, feature extraction, PCA, LDA, ICA.

I. INTRODUCTION

Over the last few decade lots of work is been done in face recognition [1][2] as it's a best way for person identification [3] because it doesn't require human cooperation [4] so that it became a hot topic in biometrics. Since lots of methods are introduced for recognition which considered as a milestone. 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 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. However, an individual's biological traits cannot be misplaced, forgotten, stolen or forged [1].
Face recognition works in following steps:

A. Face Detection

Face detection is a process to detect the face using any electronic device like camera etc **.** The main function of this step is to determine [5] whether human faces appear in a given image, and [6] where these faces are located at. The expected outputs of this step are patches containing each face in the input image.

B. Face representation

it represents how to model a face. The way to represent a face determines the successive algorithms of detection and identification.[6] For the entry-level recognition, the image is transformed till it has the same 'position' as the images from the database.

C. Feature Extraction

After the face detection step, human-face patches are extracted from images. Feature extraction converts pixel data into a higher-level representation of shape, motion, color, texture, and spatial configuration of the face or its components. Directly using these patches for face recognition have some disadvantages, first, each patch usually contains over 1000 pixels, which are too large to build a robust recognition system1. Second, face patches may be taken from different camera alignments, with different face expressions, illuminations, and may suffer from occlusion and clutter.

D. Classification

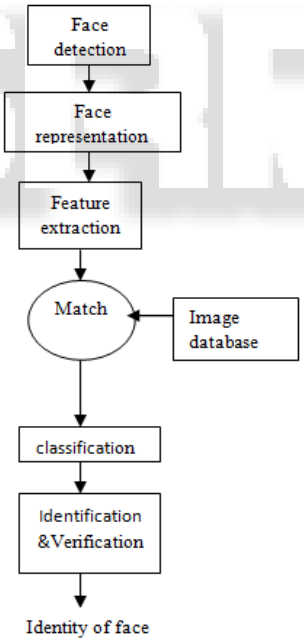

Fig. 1: steps of face recognition

Expression categorization is performed by a classifier, which often consists of models of pattern distribution, coupled to a decision procedure. A wide range of classifiers, covering parametric as well as non-parametric techniques, has been applied to the automatic expression recognition problem [7].

There are two general applications of face recognition, one is called identification and another one is called verification [8]. Face identification means given a face image, we want the system to tell who he / she is or the most probable identification; while in face verification,

given a face image and a guess of the identification, we want the system to tell true or false about the guess. In fig. 2, we show an example of how these three steps work on an input image.

II. FACE RECOGNITION TECHNIQUES

In this section, we separate the ace recognition techniques into four categories: holistic-based method, feature-based method, tem-plate-based method, and part-based method.

A. Holistic-based methods

Holistic approaches attempt to identify faces using global representations, i.e., descriptions based on the entire image rather than on local features of the face.[1] Holistic-based methods are also called appearance-based methods, which mean we use whole information of a face patch and perform some transformation on this patch to get a compact representation for recognition. During the past twenty years, holistic-based methods attract the most attention against other methods, so we will focus more on this category. In the following sub-sections, we will talk about the famous eigenface [9] (performed by the PCA), fisherface (performed by the LDA), and some other transformation basis such as the independent component analysis (ICA), nonlinear dimension reduction technique, and the over-complete database (based on compressive sensing). More interesting techniques could be found in [10][11].

1) Principal Component Analysis

The Principal Component Analysis (PCA) is one of the most successful techniques that have been used in image recognition and compression. PCA is a statistical method under the broad title of *factor analysis*. The purpose of PCA is to reduce the large dimensionality of the data space (observed variables) to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the data economically. This is the case when there is a strong correlation between observed variables.[12][1]

The Pca basis PCA projection basis are purely data-driven, which are computed from the dataset we have. This projection process is also called Karhunen-Loeve transform in the data compression community. Given *N D*-dimensional vectors (In face recognition task, usually), we can get at least min(*N*-1, *D*-1) projection basis with one mean vector: [12]

- Compute the mean vector Ψ (*D*-by-1 vector)
- Subtract each by Ψ and get
- Calculate the covariance matrix Σ of all the s (*D*-by-*D* matrix)
- Calculate the set of Σ (*D*-by-(N-1) matrix, where each eigenvector is aligned as a column vector)
- Preserve the *M* largest eigenvectors based on their eigenvalues (*D*-by-*M* matrix *U*)
- is the eigenface representation (*M*-dimensional vector) of the *i*th face

2) Fisherface and linear Discriminative Analysis

LDA unlike PCA, [14] [15] uses the class information and finds a set of vectors that maximize the between-class scatter while minimizing the within-class scatter.[13] this approach includes two phases: training and classification. In the training phase, a fisher space is established from the training samples and the training faces are projected onto the same subspace. The optimal projection (transformation) can be readily computed by applying the Eigen decomposition on the scatter matrices. In the classification phase, an input face is projected into the fisher space and classified using the euclidean distance as a similarity measure[16]

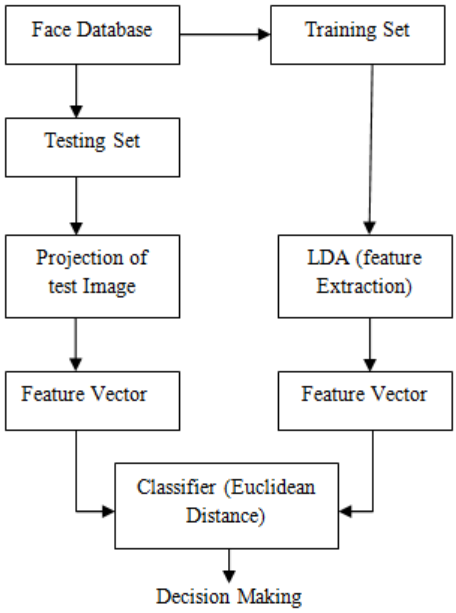

Fig. 3: Linear Discriminative analysis

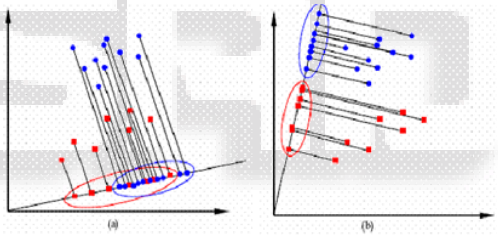

Fig. 2: (a) points mixed when projected onto a line
(b)points separated when projected onto another line

3) Independent Component Analysis

The PCA exploits the second-order statistical property of the training set (the cova-riance matrix) and yields projection bases that make the projected samples uncorre-lated with each other [17]. The second-order property only depends on the pair-wise re-lationships between pixels, while some important information for face recognition may be contained in the higher-order relationships among pixels. The independent component analysis (ICA) [18][19] is a generalization of the PCA, which is sensitive to the higher-order statistics.[13]

4) Local Binary Pattern

LBP is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. Local pattern" in LBP operators is defined in the neighborhood of a pixel and describes the relationships between the pixel and its neighborhood pixels. According to the definition of the LBP operator, local patterns are represented with binary codes, which are

constructed by threshold the gray values of the neighbourhood relative to the corresponding value of the central pixel, as can be seen in Fig. 1[20]. In this figure, ones are represented by white circles and zeros by black circles. Fig. 2 illustrates the LBP codes of some possible local patterns, including spots, flat areas, edges, edge ends, and curves.[21]

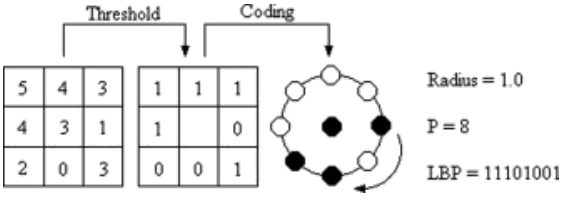

Fig.4: Local Binary pattern

B. Feature-based methods

Feature-based approaches first process the input image to identify and extract (and measure) distinctive facial features such as the eyes, mouth, nose, etc., as well as other fiducial marks, and then compute the geometric relationships among those facial points, thus reducing the input facial image to a vector of geometric features. Standard statistical pattern recognition techniques are then employed to match faces using these measurements.[13]

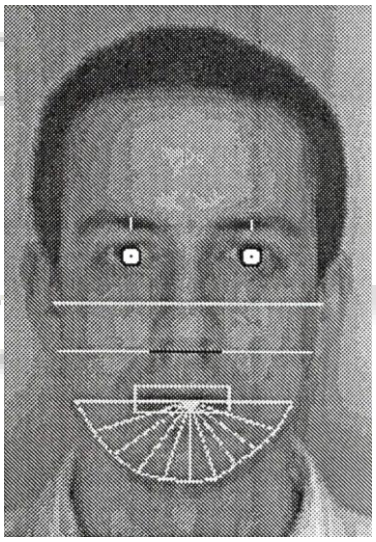

Fig 5. Geometrical features (white) used in the face recognition experiments [13][22]. (©1993 IEEE)

C. Template-based methods

The recognition system based on the two methods introduced above usually perform feature extraction for all face images stored in the database and train classifiers or define some metric to compute the similarity of a test face patch with each class person class.[13] To overcome variations of faces, these methods increase their database to accommodate much more samples and expect the trained transformation basis or defined distance metric could attenuate the intra-class variation while maintaining the inter-class variation.[22] Traditional template-matching is pretty much like using dis-tance metric for face recognition, which means selecting a set of symbolic templates for each class (person), the similarity measurement is computed between a test im-age and each class, and the class with the highest similarity score is the selected as the correct match. Recently, deformable template techniques are proposed [23].

D. Part-based methods

To be distinguished from the feature-based category, the part-based methods detect significant parts from the face image and combine the part appearances with machine learning tools for recognition, while the feature-based methods extract features from facial feature points or the whole face and compare these features to achieve the recognition purpose[13].

III. CONCLUSION

Face recognition is a challenging problem in the field of computer vision and image analysis. It has gained so much popularity because of its use in many application areas like security, Surveillance, verification, criminal justice system etc. Progress in automatic face recognition driven by: searching large face databases in real-time with high accuracy and low cost. Humans are not necessarily the best for this task. In this paper i have explained various techniques of face recognition. It mainly consists of three parts, namely face representation, feature extraction and classification. I have focused on feature extraction and recognition aspects of the face recognition.

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