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Survey on Face Recognition Under Variable Illuminations and Poses

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Abstract: A large number of face recognition techniques have been developed in recent years. The face recognition includes recognition of facial features such as eyes, nose, etc. Under controlled conditions and variable illuminations and poses. Face recognition under variable illuminations and poses is more challenging task than under controlled conditions. Thus aim of this paper is mainly to focus on face recognition under variations. Previous research work related to Face recognition yields different Dimensionality reduction subspace methods such as Principle component analysis, Linear discriminant analysis etc. This survey paper discusses various approaches used for face recognition. In addition, relevant topics such as, system evaluation, issues of illumination and pose variation are covered.

Keywords- Biometrics, dictionary learning

I. INTRODUCTION

Face recognition is one of the challenging tasks and from two decades research work is going on over face recognition. In face recognition system there are some training images and a test image. Training images are those images which have specific controlled conditions, while test image is that image which is used to match with given training image for recognition. Current systems work very well when the test image is captured under controlled conditions. The performance degrades significantly when the test image contains variations that are not present in the training images. Some of these variations include illumination, pose, expression, cosmetics and aging. Figure 1 gives a structural behavior of face recognition.

In Face recognition system there are two basic problems: First Identification and Second is Verification problem. In identification, the input to the system is an unknown face and the system reports back the determined identity from a database of known individuals, whereas in verification, the system needs to confirm or reject the claimed identity of the input face.

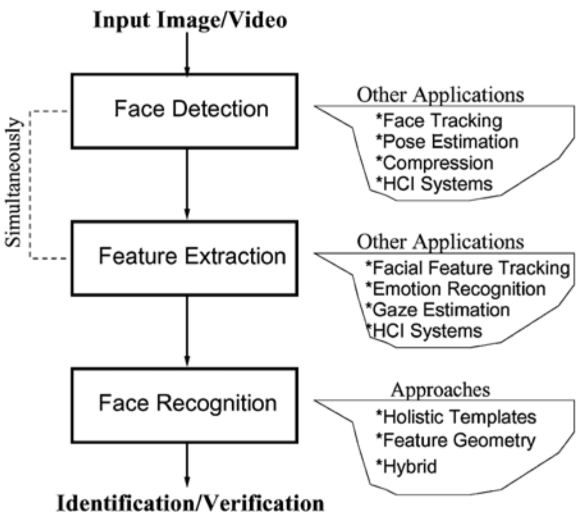

Figure. 1.Configuration of generic face recognition system.

Most of the work in Face Recognition system is focused on detecting individual features such as the eyes, nose, mouth, head outline and defining a face model by the position, size and relationships among these features. Such approaches have proven difficult to extend to multiple views and have often quite fragile, requiring a good initial guess to guide them. Many different techniques have been used for face recognition and some of better techniques are considered here in this survey paper.

II. RELATED RESEARCH ON FACE RECOGNITION

A. *Principle Component Analysis (PCA):*

M.Turk and A.Pentland proposed this method. This approach is based on the Principal Component Analysis of faces. The scheme is based on an information theory approach that decomposes face images into a small set of characteristic feature images called "eigenfaces", which may be thought of as the principal components of the initial training set of face images. Recognition is performed by projecting a new image into the subspace spanned by the eigenfaces (face space) and then classifying the face by comparing its position in face space with the positions of known individuals. Learning by automatic ways and later recognizing new faces is practical within this framework. Recognition under widely varying conditions is achieved by training on a limited number of characteristic views. This approach has advantages over other face recognition schemes in its speed and simplicity, learning capacity and insensitivity to small or gradual changes in the face image. Although it is not an elegant solution to the general recognition problem, the eigenface approach does provide a practical solution that is well fitted to the problem of face recognition. It is fast, relatively simple and has been shown to work well in a constrained environment. It is also implemented using modules of neural networks. [1]

B. *Class Specific Linear Projection:*

In this method the derivative of FLD (Fisher`s Linear Discriminant) is used i.e. Fisherfaces. This projection method produces well separated classes in a low-dimensional subspace, even under severe variation in lighting and facial expressions. By using class specific linear methods for dimensionality reduction and simple classifiers in the reduced feature space, better recognition rates is achieved than with either the linear Subspace method or the Eigenface method. FLD is an example of a class specific

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method, in the sense that it tries to "shape" the scatter in order to make it more reliable for classification. P. Belhumeur, J. Hespanha and D. Kriegman stated that a linear projection of the faces is being made from the high-dimensional image space to a significantly lower dimensional feature space which is insensitive both to variation in lighting direction and facial expression. Projections directions are chosen such that are nearly orthogonal to the within-class scatter, projecting away variations in lighting and facial expression while maintaining discriminability. This method works such that the ratio between class scatter and the within class scatter is maximized. [2]

C. Linear Discriminant Analysis of Facial images:

The approach proposed by K.Etemad and R.Chellappa [3] is a holistic linear discriminant analysis (LDA)-based feature extraction for human faces followed by evidential soft-decision integration for multisource data analysis. This method is a projection-based scheme of low complexity that avoids any iterative search or computation. In this method both off-line feature extraction and on-line feature computation is possible at high speeds and recognition is possible in real time. As highly structured two-dimensional patterns, human face images are analyzed in the spatial and the frequency domains. These patterns are composed of components that are easily recognized at high levels but are loosely defined at low levels of visual system. Each of the facial components has a different discrimination power for identifying a person or the person`s gender, race and age. This is a computational scheme for evaluating the significance of different facial attributes in terms of their discrimination potential.

D. Independent Component Analysis:

Unlike Principle Component Analysis (PCA) which found basis image that are dependent on only pair wise relationships between pixels in the image database, Independent Component Analysis (ICA) is a method which makes the use of higher order relationships, to found basis images, such as phase spectrum for distinguishing the faces. Bell and Sejnowski`s ICA algorithm, a generalization of PCA. Two different architectures for developing image representations of faces using ICA. Architecture I treated images as random variables and pixels as random trials. This architecture was related to the one used by Bell and Sejnowski to separate mixtures of auditory signals into independent sound sources. Under this architecture, ICA found a basis set of statistically independent images. The images in this basis set were sparse and localized in space, resembling facial features. Architecture II treated pixels as random variables and images as random trials. Under this architecture, the image coefficients were approximately results in independence, forming a factorial face code. This method was studied by M. Bartlett, J. Movellan and T. Sejnowski [4].

E. Matching Pursuit Filters:

P.J. Phillips [5] proposed the method of matching pursuit filters. A face identification algorithm that automatically locates facial features and identifies the located faces. The algorithm is based on a new class of filters called matching pursuit filters, which are wavelet expansions that are both data and problem-adaptive. This means that matching pursuit filters are explicitly designed to solve the pattern recognition problems encountered in face recognition such as locating faces and distinguishing between faces. Thus, two sets of filters were constructed, one set for the detection of facial features and one set for the identification of faces. In this algorithm, modeling the face as five geometric regions is done, which gives the algorithm the flexibility to adjust to deformations and variations in faces. This shows that face identification algorithms based on matching pursuit algorithms are viable and can serve as a basis for a practical face identification system.

F. Sparse Representation Classification:

Based on a sparse representation computed by 1-minimization, a general classification algorithm for (image-based) object recognition. This new framework provides new insights into two crucial issues in face recognition: feature extraction and robustness to occlusion. For feature extraction, if sparsity in the recognition problem is properly harnessed, the choice of features is no longer critical. This was studied by J.Wright, A.Y.Yang, A.Ganesh, S.S.Sastry and Y.Ma[6]. And even The theory of sparse representation helps predict how much occlusion the recognition algorithm can handle and how to choose the training images to maximize robustness to occlusion.

An algorithm to make sparse representation invariant to image-plane transformations was given by J.Huang, X.Huang and D.Metaxas [7]. The approach simultaneously recovers the image plane transformation and sparse representation when a test image is not aligned with the model images. In this recovery of the sparse representation of the target image based on the model images and the image plane transformation between the target image and the model images is simultaneously possible.

A. Wagner and Z. Zhou [8] stated a simple and practical system for face recognition with a high degree of robustness and stability to all variations. They have demonstrated how to use tools from sparse representation to align a test face image with a set of frontal training images in the presence of significant registration error and occlusion.

G. Compressive sensing approach:

The sparsity has been exploited using distributed compressive sensing theory, was studied by P.Nagesh and B.Li [9]. Which enables to grossly represent the training images of a given subject by only two feature images, one that captures the holistic features of the face and the other that captures the different expressions in all training samples. It is shown that a new test image of a subject can be fairly well approximated using only the two feature images from the same subject. Hence the storage space has been drastically reduced and operational dimensionality by keeping only these two feature images or their random measurements. Furthermore, it was shown that substantially low dimensional versions of the training features, such as ones extracted from critically downsampled training images, or low dimensional random projection of original feature images, still have sufficient information for good classification. Extensive experiments with publically available databases show that, on average, the approach performs better than the state of the art despite using only such super compact feature representation.

H. Dictionary Based Face Recognition:

V.M. Patel, T. wu, S. Biswas, P.J. Phillips, and R.Chellappa[10] proposed this method. A face recognition algorithm based on dictionary learning methods that is robust to changes in lighting and pose. Given training samples from each class, class specific dictionaries are trained with some fixed number of atoms. Then test face image is projected onto the span of the atoms in each learned dictionary. The residual vectors are then used for classification. Then integrating a relighting approach within framework so that adding elements to gallery and robustness to illumination and pose changes is possible. Unlike K-SVD –based face recognition algorithm, the Dictionary –based face recognition (DFR) algorithm uses reconstructive approach to discrimination and does not require multiple images to be available.

III. CONCLUSION

Earlier works concentrate mainly on face recognition under controlled conditions but as variable illuminations and poses is more challenging task, this paper reviewed different algorithms related to face recognition. We focused on different methods for face recognition .Among different methods Dictionary based Face Recognition is more effective among all the methods as it gives the solution over the variable illuminations and poses with maximum recognition rates 95.99% for 30 dimensional feature spaces on Extended Yale B database and make use of reconstructive approach. Dictionary based face recognition showed performance of 94% on PIE Database. Its recognition rate is 93.7% with AR Database. Also the Efficiency of DFR goes on increasing when the data dimension increases.

Issues regarding discriminative approach needs to be addressed properly as discriminative methods are sensitive to noise.

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