A Survey: Face Recognition by Sparse Representation

Jyoti Reddy, Rajesh Kumar Gupta, Dr. Mohan Awasthy

Abstract—**Face recognition is very helpful in many applications such as video surveillance, forensic applications criminal investigations, and in many other fields. The most common methods includes PCA approach based Eigenface, Linear Discriminant Analysis(LDA), Hidden Markov Model(HMM),DWT, geometry based and template matching approaches.In this paper we are using sparse representation approach to attain more robustness to variation in lighting, directions and expressions. This survey paper performs analysis on different approaches and factors affecting the face recognition.**

Index Terms— **Face recognition, sparse representation, LDA, PCA, HMM.**

I. Introduction

People are always trying to make safe their properties for secure access. In the 1960s, scientists began work on using the computer to recognize human faces. Biometrics is a fundamental form of identification and access control in today's 21 century computer science. The term biometric is an abbreviation of (Bio=Pertaining to biology & Metric's=Science and art of measurement). Today's modern computer society requires a system that provides the secure environment & secures services to the users. Biometrics includes finger scan, retina scan, facial recognition, hand scan, voice scan, signature scan etc. Among all biometrics we choose face recognition because it does not requires physical interaction with system and able to recognize a person over a crowd. Typical applications of Face Recognition System are Human-Robot-interaction, Human Computer-interaction, Driver's license, Smart cards, National ID, Passports, Voter registration, Security system, Criminal identification, Personal device logon, Desktop logon, Information security, Database security, Intranet security, Internet access, Medical records Video surveillance, CCTV control and Suspect tracking and investigation[13].

FACE recognition applications to date have fallen into generally two categories. Face recognition has recently seen a lot of success in a family of less-demanding applications such as online image search and family photo album organization, terrorist watch list and mass surveillance applications [1].face recognition includes face verification and face identification.

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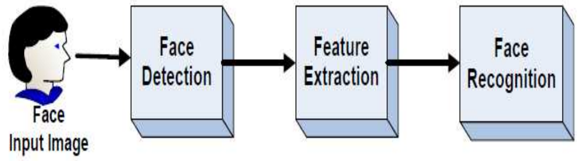


Fig. (a) Face Recognition Procedure

There are number of approaches used for face recognition. The correct recognition rate of frontal face recognition, which has been applied in practice, can reach up to more than 90% [2]. Although some recognition methods have been proposed, and obtained great success during the past few years, robust face recognition methods with higher recognition performances are still desired [6]. Some other researchers address the problem by feature extraction. Besides the classical features such as Eigen faces [9] and Gabor [10], some robust features are also proposes [6].

There is the number of factors that affects face recognition system performance. Recognition rates decreases as any variation in test image is present with respect to training sample images such as occlusion, pose, expression, variable lighting, aging etc. As human face cannot be expression less there may be large number of expression such as smile ,sad, excited etc .This factors reduces the accuracy of system performance. Small sample size (SSS) [2] is important factor in recognition. This affects the performance of PCS and LDA.

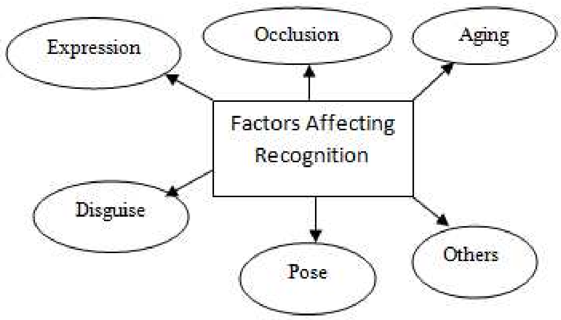


Fig: b Factors Affecting Recognition

II. Face Recognition Techniques

Principal Component Analysis (PCA): PCA is used to find out sub space. PCA is dimensionality reduction technique .PCA maps the high dimensional data into low dimension data. Dimension is reduced by finding new set of variables that are smaller than original set. It is used for classification and compression of data. It provides variables which are uncorrelated.PCA helps to answer which feature on face is more important.

The image space is highly redundant when it describes faces. This happens because each pixel in a face is highly correlated to the others pixels. The objective of PCA is to reduce the dimension of the work space. The maximum number of principal components is the number of variables in the original space. Even so to reduce the dimension, some principal components should be omitted. This means that some principal components can be discarded because they only have a small quantity of data, considering that the larger quantity of information is contained in the other principal components. The eigenfaces are the principal components of the original face images, obtained by the decomposition of PCA, forming the face space from these images [14].

Linear Discriminant Analysis (LDA): It is the dimensionality reduction technique used for normalization. LDA is used to find a linear combination of features which characterizes or separates two or more classes. The resultant is used for dimensionality reduction. LDA is similar to PCA except that the LDA attempts to model difference between object classes.LDA preserves the inter class variation and reduces the intra-class variation. LDA is the linear combination of variables which results the largest mean difference between the desired classes.

The development of the Discrete Wavelet Transforms (DWT) and their multi-resolution properties have naturally led to increased interest in their use for image analysis as an efficient alternative to the use of Fourier transforms. DWT's have been successfully used in a variety of face recognition schemes. However, in many cases, only the approximation components (i.e. the low frequency subbands) at different scales are used either as a feature vector representation of the faces perhaps after some normalisation procedures or to be fed into traditional face recognition schemes such as the PCA as replacement of the original images in the spatial domain[13].

Discrete Wavelet Transform (DWT):
DWT is based on sub band coding. It is a frequency domain approach and signal analysis tool used for feature extraction, removing of noise and other application [3].It first performs decomposition along the rows of images then along the columns. The resultant decomposed result represents the frequency localization of original image.DWT has a high compression ratio.

Singular Value Decomposition (SVD):
SVD is a key aspect in the area of signal processing and statistics. It is one of the best linear dimensionality reduction methods based on the covariance matrix [8]. The main intention is to minimize the dimension of the data by finding limited orthogonal linear combinations of the original variables with maximum variance. Most of the researches are also used this method for face recognition.

Hidden Markov Models (HMMs):
HMM approach is used to recognize human face while categorizing the perceptive face into number of features like eyes, nose mouth etc. HMMs require a series of experimental 1D and 2D images. Images should be transferred to 1D spatial sequence. One of the key drawbacks of HMM is that it is susceptible to geometrical shape.
Based on the feature space, existing classical classifiers can be used, such as NN (Nearest Neighbor), Support Vector Machines (SVM) [11] and boosting [12].NN is based on distance measure. NN belongs to the Nearest Feature based Classifiers (NFCs)[6] ,the performance of NFCs is degraded when different object classes are similar.

Sparse Representation Based Classification: Sparse representation face recognition (SRC) [4] is modeled based on the image subspace assumption [5], it uses training sample images to span a face subspaces. This approach tries to construct test images from training images. In sparse representation, faces to be tested are approximately expressed as a linear sparse combination of all types of training faces, and testing samples for the minimum reconstruction residue of various types of training samples are determined by calculating the sparse combination coefficient [2]. This approach improves the recognition performance and reduces the effect of occlusion.

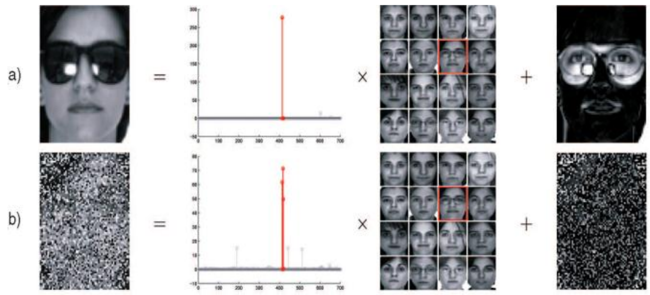


Fig:c. Overview of sparse representation, test samples are represented on left (a) partially occluded and (b) corrupted as a linear combination of training images (middle) plus sparse error due to occlusion or corruption. Red darker block represents training image that identify the input test image.

SRC algorithm is given as following:

1. A matrix is generated which contains all the training samples of each class. A dictionary contains all the samples of each class.
2. A random sparse vector is selected having few non zero in random location.
3. Test sample is given by linear combination of training samples. The linear relationship between test sample y in terms of all training sample is given by-

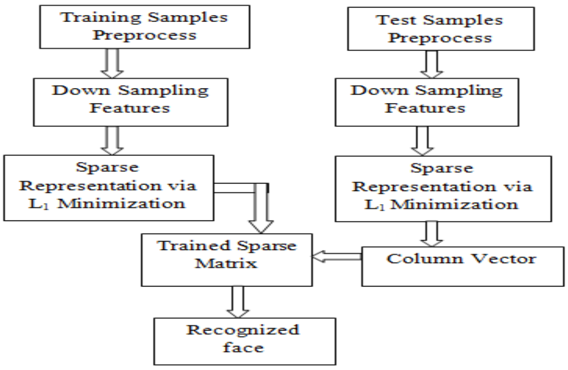
$$y = A\, x_0$$

A: is dictionary having all the training samples.
x_0: random sparse vector calculated by l_1 minimization
y: test sample

III. METHODOLOGY

1) Training samples are preprocessing to remove noise presents in samples. Noise are noting but the undesired information that contaminated on training images. In preprocessing image enhancement, smoothing, gradient, normalization is done.
2) In next step down sampling is performed and feature is extracted from each sample class set.

3) Extracted feature is arranged in none zero representation called sparse representation calculated via L1 minimization.
4) Each samples are arranged in row and extracted down sampled feature is arranges in columns. We get trained sparse matrix.



5) Next step is to preprocessing the test sample and noise is removed. After normalization down sampled features are extracted and arranged in non zero representation called sparse representation via L1 minimization, then construct the column vector.
6) Now column vector is matched to trained sparse matrix. It gave the result whose image on training sample best matches the test sample and we get recognition. If given test sample is not present in training sample then recognition gives the result no match is found.

IV. Conclusion

In this paper we represent a number of approaches for face recognition. The quality of recognition system decreases due to occlusion, pose and variation present in image. SRC is generalization of NN and NFCs, but it is more robust to occlusion and illumination .SRC results 100% recognition result even if 60% occlusion is present.SRC gives the improvement in face recognition system performance.

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