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The Simplest Way of Presenting PCA Algorithm To Recognize Face

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Abstract: Here, in this paper, we have done the study of all the work and research done on the face recognition till date with PCA algorithm The face recognition is the key process for the security reasons. The face recognition process implementation cam solve the cheating done during the attendance, during login, during transaction and many other fields. Face Recognition is a field of multidimensional applications. A lot of work has been done, extensively on the most of details related to face recognition. The process involved consists of face segmentation, feature extraction and finally recognition or identification. The task of face recognition is complicated by factors such as variations in facial expressions, changes in illumination and the orientation of the face of the subject. Also, affecting the accuracy of identification is the background and the inherent noise present during image acquisition.

Keywords: Face recognition, PCA, Symbols.

I. INTRODUCTION

In Face Recognition a lot of work has been done till day. Due to this high amount of work done, a lot of improvement has been carried [1][2] out up to now. So here, we are just discussing that what the technology has got till day after this much advance improvement in the face recognition due to a lot of research by lot of peoples. Face recognition is Method of recognition the human faces. It takes place in two steps i.e first identify the face and second is compare or recognize the face. A general statement of the face recognition problem (in computer vision) can be formulated as follows: Given still or video images of a scene, identify or verify one or more persons in the scene using a stored database of faces. It can also be defined as, a face recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database.

II. FACE RECOGNITION

"Yaar, the old days were better when the instructor use to call out the names and take the attendance. Now the proxy attendance has become a dream by the advent of this new automated system".

Well, the day is not far when the students will be talking likewise while coming out of the lecture halls. Human face recognition is a difficult problem in[3][4][5][7]computer vision. Face recognition is challenging because it is a real world problem. The human face is a complex, natural object that tends not to have easily (automatically) identified edges and features. Applications of face recognition are widespread. There are many robust biometric techniques like fingerprinting which can be used for human authentication then why go for face recognition? In many applications like the surveillance and monitoring ,say, of a public place, the traditional biometric techniques will fail as for obvious reasons we can not ask everyone to come and put his/her thumb on a slide or something similar. So we need a system which is similar to the human eye in some sense to identify a person. To cater this need and using the observations of human psychophysics, face recognition as a field emerged. Different approaches have been tried by several groups, working world wide, to solve this problem. Many commercial products have also found their way into the market using one or the other technique. But so far no system technique [6] exists which has shown satisfactory results in all circumstances. A comparison of these techniques needs to be done. In this project, we will try to do a comparative study of the performances of three algorithms - Artificial Neural Network, Eigenfaces and Active Appearance Model based methods for face recognition.

Often the problem of face recognition is confused with the problem of face detection. The two are related problems but definitely not the same. The latter is often done as a preprocessing step to obtain the position of the face, in the image, to be recognized. The difference is demonstrated as:

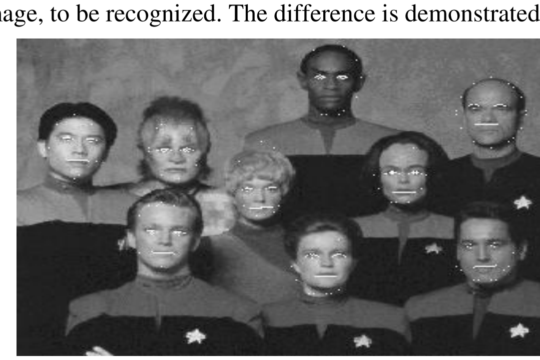


Figure 1. (a) Face Detection

(b) Face Recognition

OUTPUT : (a) There are nine faces detected in the image.
(b) The image contains the face of Sunil Kumar.

III. METHODOLOGY

Here we will show you the PCA algorithm for the recognition of the faces.[8][9] The PCA algorithm is the Statistical approach for recognition algorithms. In statistical approach, each image is represented in terms of d features. So, it's viewed as a point (vector) in a d-dimensional space. The dimensionality -number of coordinates needed to specify a data point- of this [10]data is too high. Therefore, the goal is to choose and apply the right statistical tool for extraction and analysis of the underlaying manifold. These tools must define the embedded face space in the image space and extract the basis functions from the face space. This would permit patterns belonging to different classes to occupy disjoint and compacted regions in the feature space. Consequently, we would be able to define a line, curve, plane or hyperplane that separates faces belonging to different classes.

IV. PCA (PRINCIPAL COMPONENT ANALYSIS)

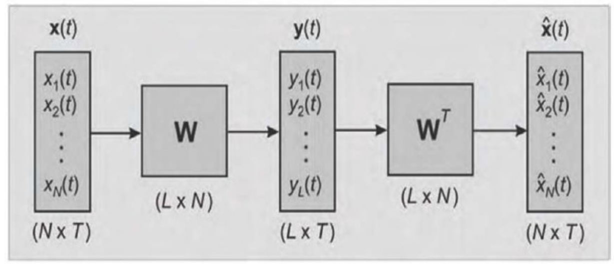
Principal component analysis is appropriate when you have obtained measures on a number of observed variables and wish to develop a smaller [12] number of artificial variables (called principal components) that will account for most of the variance in the observed variables. The principal components may then be used as predictor or criterion variables in subsequent analyses.

PCA Image Processing. The PCA involves a mathematical procedure that transforms a number of correlated variables into a number of uncorrelated variables called principal components. It computes a compact and optimal description of the data set. The first principal component accounts for as much of the variance in the data as possible and each succeeding component accounts for as much of the remaining variance as possible. First principal component is taken to be along the direction with the maximum variance. The second principal component is constrained to lie in the subspace perpendicular of the first. Within this subspace, this component points the direction of maximum variance. The third principal component is taken in the maximum variance direction in the subspace perpendicular to the first two and so on. The PCA is also called as Karhunen-Loève transform or the Hotelling transform. The PCA does not have a fixed set of basis vectors like FFT, DCT and wavelet etc. and its basis vectors depend on the data set.

This article describes the analysis for a specific type of experiment, in which a sequence of images is acquired at regular steps in energy. The resulting data are effectively an image where each pixel within the image contains a spectrum from which spatially resolved quantitative information can be extracted. The advantages for such an experiment are:

a. Given pulse counted images, the resulting images are suitable for proper quantification.
b. Chemical state images are possible.
c. Background subtraction is performed in analogous fashion to normal quantification of spectra. Image artefacts due to background variation are removed.
d. Statistical techniques can be applied to the data set as a whole to offer alternative views of the data and enhance the signal-to-noise in resulting images.
e. The background information can be used to offer layer information in image format.

Schematic of the PCA Model



PCA Algorithm:

Let the source images (images to be fused) be arranged in two-column [13][14][15]vectors. The steps followed to project this data into 2-D subspaces are:

A. Organise the data into column vectors. The resulting matrix Z is of dimension 2 x n.
B. Compute the empirical mean along each column. The empirical mean vector Me has a dimension of 1 x 2.
C. Subtract the empirical mean vector Me from each column of the data matrix Z. The resulting matrix X is of dimension 2 x n.
D. Find the covariance matrix C of X i.e. $=XX^T$ mean of expectation = cov(X)
E. Compute the eigenvectors V and eigenvalue D of C and sort them by decreasing eigenvalue. Both V and D are of dimension 2 x 2.
F. Consider the first column of V which corresponds to larger eigenvalue to compute P1 and P2 as

$$P_1 = \frac{V(1)}{\sum V}$$

And

$$P_2 = \frac{V(2)}{\sum V}$$

Mean subtraction (a.k.a. "mean centering") is necessary for performing PCA to ensure that the first principal component describes the direction of maximum variance. If mean subtraction is not performed, the first principal component might instead correspond more or less to the mean of the data. A mean of zero is needed for finding a basis that minimizes the mean square error of the approximation of the data.[17][18][19].

Assuming zero empirical mean (the empirical mean of the distribution has been subtracted from the data set), the principal component w1 of a data set X can be defined as:

$$\mathbf{w}_1 = \arg\max_{\|\mathbf{w}\|=1} \operatorname{Var}\{\mathbf{w}^\top \mathbf{X}\} = \arg\max_{\|\mathbf{w}\|=1} E\left\{\left(\mathbf{w}^\top \mathbf{X}\right)^2\right\}$$

With the first k − 1 component, the kth component can be found by subtracting the first k − 1 principal component from X:

$$\hat{\mathbf{X}}_{k-1} = \mathbf{X} - \sum_{i=1}^{k-1} \mathbf{w}_i \mathbf{w}_i^\top \mathbf{X}$$

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and by substituting this as the new data set to find a principal component in

$$\mathbf{w}_k = \arg\max_{\|\mathbf{w}\|=1} E\left\{\left(\mathbf{w}^\top \hat{\mathbf{X}}_{k-1}\right)^2\right\}.$$

PCA is equivalent to empirical orthogonal functions (EOF), a name which is used in meteorology.

An autoencoder neural network with a linear hidden layer is similar to PCA. Upon convergence, the weight vectors of the K neurons in the hidden layer will form a basis for the space spanned by the first K principal components. Unlike PCA, this technique will not necessarily produce orthogonal vectors.

Table 1: - of symbols and abbreviations

Symbol	Meaning	Dimensions	Indices
$\mathrm{X} = \{X[m,n]\}$	data matrix, consisting of the set of all data vectors, one vector per column	$M \times N$	$m = 1 \ldots M$ $n = 1 \ldots N$
N	the number of column vectors in the data set	1×1	scalar
M	the number of elements in each column vector (dimension)	1×1	scalar
L	the number of dimensions in the dimensionally reduced subspace, $1 \le L \le M$	1×1	scalar
$\mathrm{u} = \{u[m]\}$	vector of empirical means, one mean for each row *m* of the data matrix	$M \times 1$	$m = 1 \ldots M$
$\mathrm{s} = \{s[m]\}$	vector of empirical standard deviations, one standard deviation for each row *m* of the data matrix	$M \times 1$	$m = 1 \ldots M$
$\mathrm{h} = \{h[n]\}$	vector of all 1's	$1 \times N$	$n = 1 \ldots N$
$\mathrm{B} = \{B[m,n]\}$	deviations from the mean of each row *m* of the data matrix	$M \times N$	$m = 1 \ldots M$ $n = 1 \ldots N$
$\mathrm{Z} = \{Z[m,n]\}$	z-scores, computed using the mean and standard deviation for each row *m* of the data matrix	$M \times N$	$m = 1 \ldots M$ $n = 1 \ldots N$
$\mathrm{C} = \{C[p,q]\}$	covariance matrix	$M \times M$	$p = 1 \ldots M$ $q = 1 \ldots M$
$\mathrm{R} = \{R[p,q]\}$	correlation matrix	$M \times M$	$p = 1 \ldots M$ $q = 1 \ldots M$
$\mathrm{V} = \{V[p,q]\}$	matrix consisting of the set of all eigenvectors of C, one eigenvector per column	$M \times M$	$p = 1 \ldots M$ $q = 1 \ldots M$
$\mathrm{D} = \{D[p,q]\}$	diagonal matrix consisting of the set of all eigenvalues of C along its principal diagonal, and 0 for all other elements	$M \times M$	$p = 1 \ldots M$ $q = 1 \ldots M$
$\mathrm{W} = \{W[p,q]\}$	matrix of basis vectors, one vector per column, where each basis vector is one of the eigenvectors of C, and where the vectors in W are a sub-set of those in V	$M \times L$	$p = 1 \ldots M$ $q = 1 \ldots L$
$\mathrm{Y} = \{Y[m,n]\}$	matrix consisting of *N* column vectors, where each vector is the projection of the corresponding data vector from matrix X onto the basis vectors contained in the columns of matrix W.	$L \times N$	$m = 1 \ldots L$ $n = 1 \ldots N$

V. CONCLUSION

The PCA algorithm is the best face recognition algorithm. This is the simplest and the easiest way of recognizing the human face. The every term used in the PCA algorithm is having a very clean and clear description that is shown in the table, due to which the layman can also use this algorithm just by reading the table and symbol and can understand the PCA algorithm. So due to this nature of its simplicity and easy feature, I will try to do work on PCA algorithm for face recognition and will do more in the field of face recognition just by using the PCA algorithm.

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