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PCA-Based Face Recognition Using EIGENFACE Method

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Abstract
Face is a difficult multidimensional structure which requires a good computing technique for recognition. The face space is defined by Eigen face and the set of faces which are eigenvectors, which may not correspond to general facial features such as eyes, nose, lips. The Eigen face approach uses the PCA for recognition of the images. This recognition can be performed on a variety of input data sources. The aim of face detection is localization of the face in a image. In the case of sample input it can be an advantage to track the face in between multiple frames, to reduce computational time and preserve the identity of a face (person) between frames. In this paper face recognition is succeeded by Principal Component Analysis (PCA)with Eigenface method for *test data set.*

Keyword:-Eigen face method, Principal Component Analysis (PCA), eigenvectors, face recognition

Introduction

In the recent years, face recognition has received significant attention. In addition, the technology to carry out the complex tasks in face recognition has only just started becoming more readily available. This combined with the wider range of commercial and law enforcement applications have also contributed to the increased interest in face recognition. In computer science, it also covers many different sub-areas such as face detection, face tracking, feature extraction, etc. Eigen face recognition techniques relied on manual definition of geometry-dependent features to be used for recognition. These feature values are depended on the detection of geometric facial features, including the distance and angles between points such as eye corners, mouth extremities, nostrils and chin top as in Weng&Swets (1999). The features defined for the face profiles typically consist of a set of characteristic points on the profile such as the notch between the brow and the nose and the tip of the nose. For example, Kaya and Kobayashi (1972) used Euclidean distances between manually identified points in the images to characterize the faces. In this paper we tested face recognition is succeeded by Principal Component Analysis (PCA)with Eigen face method for trained and test database.

Literature review

Although this manual definition of features is intuitively understandable, the number of features measurable in this way is small and the reliability of each feature measurement is difficult to estimate in Weng & Swets (1999). In addition, there has been an increasing demand to develop systems that are completely automatic and require no human input. These systems have many applications in fields ranging from graphics and human-computer interaction (HCI) to law enforcement and access control.

A face recognition system is required to perform identification, verification or a combination of both these tasks depending on the application. Identification is a multi-class task, where the input image of an unknown individual is matched against a database of known individuals and an identity label is assigned to it. Verification is an easier, two-class task in which the claimed identity of an individual is confirmed or rejected by the classifier. Alternatively, an appropriate error message is provided if the individual does not exist in the database. The main issue with the verification problem is setting the appropriate threshold values, based on which the system decides whether or not the input image and the claimed identity match. These values are typically determined empirically, and are dictated by the dataset.

Automatic face recognition techniques can be grouped in many ways, depending on the criteria chosen to solve the problem Weng&Swets (1999), for example:

- ***Sensing Modality:*** This refers to the inputs the system accepts. For example, 2D intensity images, colour images, infra-red images, 3D range images or some combination of these.
- ***Temporal Content:*** This refers to whether the inputs are of a static or a dynamic nature. Static images are those taken at a particular point in time using a digital camera for instance. Dynamic images are time-varying and are produced using a CCTV camera for example. A dynamic system may be an "all inclusive" system and may facilitate face detection, face tracking and face identification.
- ***Geometry & Viewing Angle:*** Geometry refers to the space in which the system operates: 2D or 3D. 3D systems are inherently view and pose independent, but a 2D system is usually designed for frontal views, profile views, general views or a combination of all of these.
- ***Computational Tools:*** This refers to the actual technique used to perform recognition. Examples include programmed knowledge rules, statistical decision rules, neural networks, genetic algorithms, etc. Although these techniques and their variants

were initially used by themselves, they are now often used in conjunction with each other. These methods are known as hybrid methods and they take advantage of the useful primitives from the constituent methods. Techniques can also be divided into feature-based methods and template-based methods. Feature-based methods first compute a set of geometrical features and use these individual features to match faces. Template-based methods use a single template to represent the entire face and use holistic matching techniques. A comparison of the feature and template matching techniques can be found in Brunelli&Poggio(1993).

Principal Component Analysis (pca) and Eigen Face

Principal Component Analysis (PCA) is a dimensionality reduction technique based on extracting the desired number of principal components or feature axes from the multidimensional data. These feature axes are ordered according to the proportion of variance they explain in the set of faces analyzed (training set). PCA is closely related to Kaxhunen Transform (KLT). It is found that under the assumption of zero-mean, the formulations of PCA and KLT are identical. Calculating Eigen faces The mathematical details here are taken almost entirely from Turk and Pent land's papers. Let a face image I(x, y) be a 2D (N x N) array of intensity values. Let there be M such images. An image can also be considered as an N2-dimensional vector, or equivalently, as a point in the N2-dimensional space. Since all face images These Eigen faces highlight the nn 11ý1 CD discriminatory power of tile technique as it captures the different features of the dataset. Particularly noticeable is the capture of pose information in tile third Eigen face. Lack of 0 distinct features such as the eyes and the lips is indicative of tile input images not having been normalized to align facial features across the dataset, same class of images, they will not be randomly distributed in this space. And can be described by a relatively low dimensional subspace. PCA aims to find those vectors that best account for tile distribution of face images within this image space. These vectors define tile subspace of face images, or the face space. It transpires that these vectors are the eigenvectors of the covariance matrix corresponding to the original face images. And they have a face-like appearance.

Let the Training set of face image be

$\{T_1, T_2, T_3, \ldots\}$ (N^2 x M)

Mean face of the Set:

$\psi = \frac{1}{M} \sum_{n=1}^{M} T_n \; (N^2 \times 1)$

Which is equivalent to:

$C=AA^T$ (N^2 x N^2)

The covariance matrix C is subject to PCA, and yields a set of M orthonormal vectors u_n and their associated eigenvalues λ_n. These give the best description of the distribution of the images in the face space. C is a matrix of size (N2 x N2), and finding the eigenvalues and eigenvectors of this is computationally very intensive.

Thus, the calculations are greatly reduced from the order of the number of pixels in the images (N2) to the order of the number of images in the training set (M). The associated eigenvalues allow the eigenvectors to be ranked according to their usefulness in characterizing the variation among the images.

Let 'M' satisfy

$$\frac{\sum_{i=M'+1}^{m} \mu i}{\sum_{i=1}^{m} \mu i} < P$$

Distance Metric

The distance used in this paper is Euclidean distance and Mahalanobis distance.

Euclidean distance

$$d_E(x, y) = \sqrt{\sum_{i=1}^{n} (x_i, y_i)2}$$

Mahalanobis distance

$$d_M = \sqrt{(x-y)T \sum -1 \; (x-y)}$$

Database Description

We run our test dataset and training dataset depending on the face94[11] face database as follows: Dr. Libor Spacek is the one who constructed the face94 face database. This database is a collection of facial images. This collection consists of 4 folders of images like face94, face95, face96 and grimace. For our work we use the face94 image database. Based on face94, our own test and training datasets has been constructed. In the test dataset we choose randomly one image of 10 persons and in the training dataset two images of 10 persons has been chosen. Images that we choose for both the dataset is different from each other.

Experimental Results

Test dataset

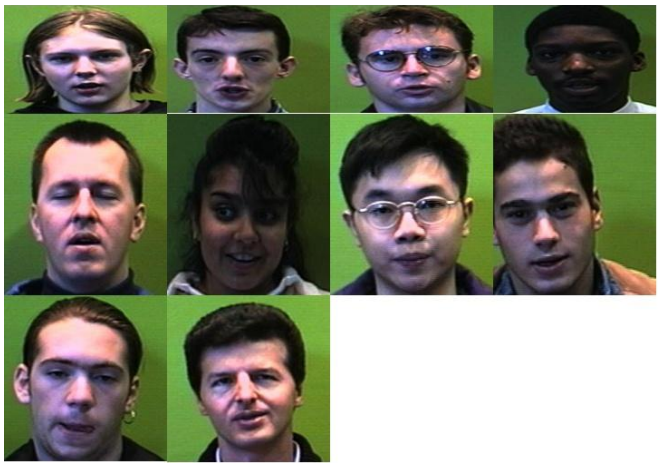
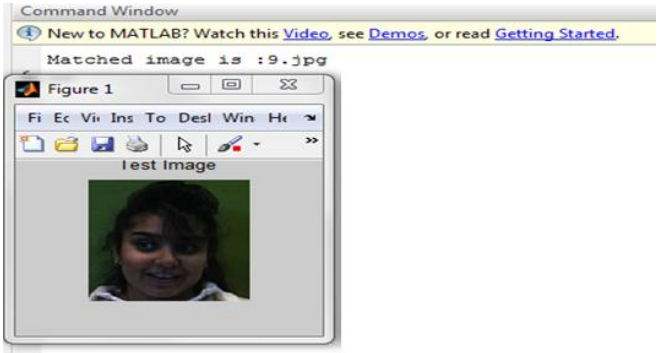


Figure 1: Test dataset with 10 images.

Train Dataset

Figure 2 :Train Dataset with 20 images

The implementation is done in matlab, First test dataset image with the respective number for matching has been selected, next train dataset was selected for matching. Then the corresponding figure is matched and the resulting figure is shown below.



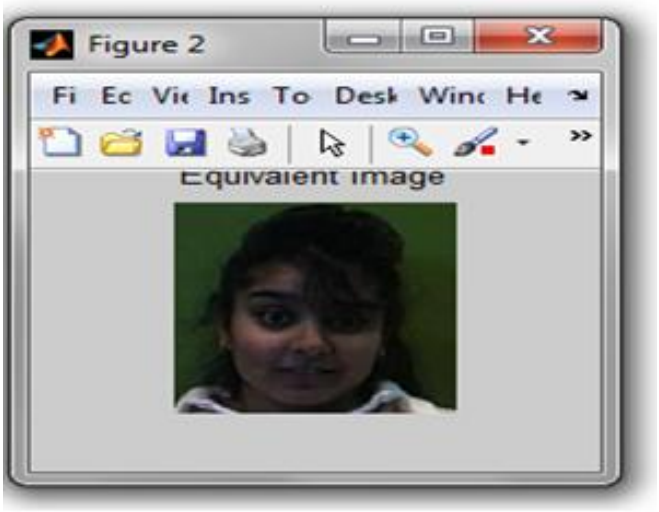


Figure 3 : Test image and equivalent image from the database

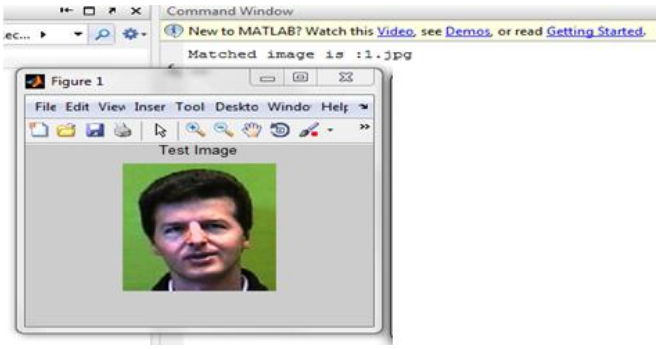


Figure 4 : Test image and equivalent image from the database

Conclusion

In this work for face recognition, the PCA along with Eigenfaces is a well-known algorithm that has been implemented in matlab, The Results of face recognition experiments for PCA based Eigenfaces approach is a well-established technique for 2D images and the approach to perform the recognition task. It is more meaningful to compare it with test and trained database. The distance

measures of Mahalanobis distance has better performance than Euclidean distance for face recognition task.

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