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Specific face detection from large number of stored faces

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Abstract—Face recognition is grabbing more attention in the area of network information access. Areas such as network security and content retrieval benefit from face recognition technology. As one of the most successful applications of image analysis and understanding, face recognition has recently received significant attention, especially during the past several years. We have implemented a computational model to identify the face of an unknown person by applying eigenfaces. A static and dynamic input of face is taken from the file and process it with the help of MATLAB tools and show the recognize result. The goal is to implement the system (model) for a particular face and distinguish it from a large number of stored faces with some real-time variations as well. The Eigenface approach uses Principal Component Analysis (PCA) algorithm for the recognition of the images. It gives us efficient way to find the lower dimensional space.

Index Terms— Eigen faces, Eigen Vectors, Principal Component Analysis (PCA).

1 Introduction

Developing a computational model of face recognition is quite difficult, because faces are complex, multidimensional and meaningful visual stimuli. They are a natural class of objects and stand in stark contrast to sine wave gratings, the "blocks world", and artificial stimuli used in human and computer vision research [1]. 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. It is typically used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems [2]. To identify duplication with several application such as Criminal identification, Security systems, Image and film processing, Human-computer interaction, Voter list, Airport surveillance, Private surveillance using face recognition method. Face recognition (FR) has emerged as one of the most extensively studied research topics that spans multiple disciplines such as pattern recognition, signal processing and computer vision [3]. Eigenfaces are a set of eigenvectors used in the computer vision problem of human face recognition. A set of eigenfaces can be generated by performing a mathematical process called principal component analysis (PCA) on a large set of images depicting different human faces. Informally, eigenfaces can be considered a set of "standardized face ingredients", derived from statistical analysis of many pictures of faces.

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Any human face can be considered to be a combination of these standard faces. Facial recognition was the source of motivation behind the creation of eigenfaces. For this use, eigenfaces have advantages over other techniques available, such as the system's speed and efficiency. Using eigenfaces is very fast, and able to functionally operate on lots of faces in very little time. Unfortunately, this type of facial recognition does have a drawback to consider: trouble recognizing faces when they are viewed with different levels of light or angles. For the system to work well, the faces need to be seen from a frontal view under similar lighting. Face recognition using eigenfaces has been shown to be quite accurate.

In this paper, we show the recognition 75% successfully when same man but different face image, 100% successfully when known face same image, 100% successfully when unknown man face image. By experimenting with the system to test it under variations of certain conditions, the following correct recognitions were found: an average of 96% with light variation, 85% with orientation variation, and 64% with size variation.

2 Background and Related Works

An easy way to comply with the conference paper much of the work in computer recognition of faces has focused on detecting individual features such as the eyes, nose, mouth, and defining a face model by the position, size, and relationship among the features. Beginning with Bledsoe's [4] and Kanade's [4] early systems, a number of automated or semi-automated face recognition strategies have modeled and classified face based on normalized distances and ratios among feature points. Recently this general approach has been continued and improved by the recent work of Yuille et al. [5]. Connectionist approaches to face identification seek to capture the configurationally, or gestalt-like nature of the task. Fleming and Cottrell [6], building on earlier work by Kohonen and Lahtio [7], use nonlinear units to train a network via back

propagation to classify face image. Stonham's WISARD system [8] has been applied with some success to binary face recognizing both identity and expression.
Recent work by Burt et al. uses a "smart sensing" approach based on multiresolution template matching [9]. This coarse-to-line strategy uses a special purpose computer built to calculate multiresolution pyramid images quickly, and has been demonstrated identifying people in real time. The face models are built by hand from face images.
will be processed as images. You need to embed the images in the paper itself. Please don't send the images as separate files.
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 training set of face images. Recognition is performed by the eigengaces ("face space") and then classifying the face by comparing its position in face space with the position of known individuals. The approach has advantages over other face recognition schemes in its speed and simplicity, insensitivity to small or gradual changes in the face image and performed under different distance measures. Figure 1 shows the working procedure of face recognition method.
There are basically two parts in face recognition technique. First the training part and second the testing part.

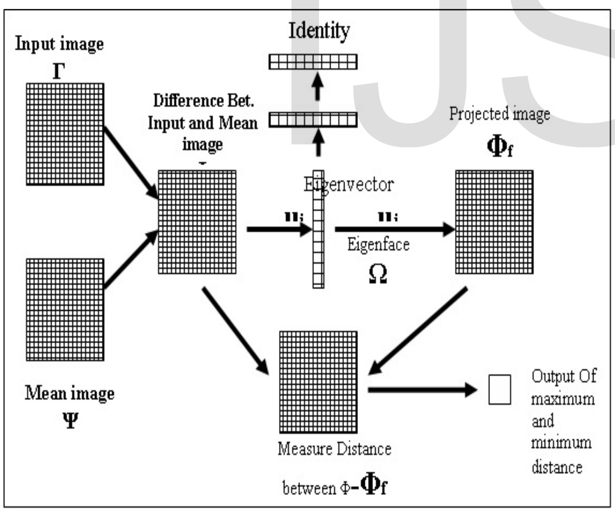

Fig. 1 Graphical representation of working procedure.

There are mainly three steps in any face recognition operation: Data Pre-processing, Feature Extraction and Classification. After taking image from camera, we need to remove various environmental effects such as illumination, rotation or scale from main image. Here, in this stage we also find the eye centers and normalize the face image with various geometric constraints. After that, in any normalized image the location of the eye centers and nose tips are fixed. The position of eye centers and nose tips will not change after this step. And we will continue our next operations with this eye & nose position. The eigenfaces that are created will appear as light and dark areas that are arranged in a specific pattern. This pattern is how different features of a face are singled out to be evaluated and scored. There will be a pattern to evaluate symmetry, if there is any style of facial hair, where the hairline is, or evaluate the size of the nose or mouth. Other eigenfaces have patterns that are less simple to identify, and the image of the eigenface may look very little like a face.
The technique used in creating eigenfaces and using them for recognition is also used outside of facial recognition. This technique is also used for handwriting analysis, lip reading, voice recognition, sign language/hand gestures interpretation and medical imaging analysis. Therefore, some do not use the term eigenface, but prefer to use 'eigenimage'.

3 A System Implementation for Face Recognition

To create a set of eigenfaces, one must prepare a training set of face images. The pictures constituting the training set should have been taken under the same lighting conditions, and must be normalized to have the eyes and mouths aligned across all images. They must also be all resampled to a common pixel resolution (r × c). Each image is treated as one vector, simply by concatenating the rows of pixels in the original image, resulting in a single row with r × c elements. For this implementation, it is assumed that all images of the training set are stored in a single matrix T, where each row of the matrix is an image. Subtract the mean. The average image has to be calculated and then subtracted from each original image in T.
Calculate the eigenvectors and eigenvalues of the covariance matrix S. Each eigenvector has the same dimensionality (number of components) as the original images, and thus can itself be seen as an image. The eigenvectors of this covariance matrix are therefore called eigenfaces. They are the directions in which the images differ from the mean image. Usually this will be a computationally expensive step (if at all possible), but the practical applicability of eigenfaces stems from the possibility to compute the eigenvectors of S efficiently, without ever computing S explicitly, as detailed below. Choose the principal components. The D x D covariance matrix will result in D eigenvectors, each representing a direction in the r × c-dimensional image space. The eigenvectors (eigenfaces) with largest associated eigenvalue are kept.
These eigenfaces can now be used to represent both existing and new faces: we can project a new (mean-subtracted) image on the eigenfaces and thereby record how that new face differs from the mean face. The eigenvalues associated with each eigenface represent how much the images in the training set vary from the mean image in that direction. We lose information by projecting the image on a subset of the eigenvectors, but we minimize this loss by keeping those eigenfaces with the largest eigenvalues. For instance, if we are working with a 100 x 100 image, then we will obtain 10,000 eigenvectors. In practical applications, most faces can typically be identified using a projection on between 100 and 150 eigenfaces, so that most of the 10,000 eigenvectors can be discarded.

Steps of a face recognition system are:

1. The first step is to obtain a set S with M face images. In our example M = 1500 as shown at the beginning of the database. Each image is transformed into a vector of size N and placed into the set.

2. After you have obtained your set, you will obtain the mean image **ψ**

$$\Psi=\frac{1}{M}\sum_{n=1}^{M}\Gamma_n \quad (1)$$

$$S=\{\Gamma_1,\Gamma_2,\Gamma_3,\dots\dots.\Gamma_M\} \quad (2)$$

3. Then you will find the difference **Φ** between the Storage image and the mean image

$$\phi_i = \Gamma_i - \psi \quad (3)$$

$$A=[\Phi_1, \Phi_2\ \Phi_3 \dots\dots\dots\ \Phi_M]$$

4. We obtain the covariance matrix **C** in the following manner

$$C=\frac{1}{M}\sum_{n=1}^{M}\phi_n\phi_N^T \quad (4)$$

$$=AA^T$$

5. Next we **vv** and **dd** are the eigenvectors and eigenvalues of the covariance matrix **C.**

6. Once we have found the eigenvectors, **v_l**, **u_l**

$$u_l=\sum_{k=1}^{M}v_{lk} \quad (5)$$

$$l=1,\dots\dots\dots, M$$

Fig. 2 These are the eignfaces of our set of original image.

4 Procedure of Recognition System

A new face is transformed into its eigenface components [10]. First we compare our input image with our mean image and multiply their difference with each eigenvector of the A matrix. Each value would represent a weight and would be saved on a vector Ω.

$$\omega_k = u_k^T\ (\Gamma-\psi) \quad (5)$$

$$\Omega^T=[\omega_1, \omega_2, \omega_3, \text{-------}\ \omega_M]$$

We now determine which face class provides the best description for the input image. This is done by minimizing the Euclidean distance

$$\varepsilon_k = ||\Omega - \Omega_k||^2 \quad (6)$$

The input face is considered to belong to a class if min value of ε_k is bellow the given threshold θ_ε. Then the face image is considered to be a known face. If min value of ε_k is above the given threshold, then the image can be determined as an unknown face.

The face recognition system in real world environment is used in different places. These places store numbers of faces. Suppose in voter list of any country stores cores of faces. But completed of our thesis and project we used thousands of human face images. A face image I(x,y) be a two dimensional N by N array of (8 bit) intensity values. An image also be considered as a vector of dimension N x N, so that a typical image of size 128 x 128 becomes a vector of dimension 16384.

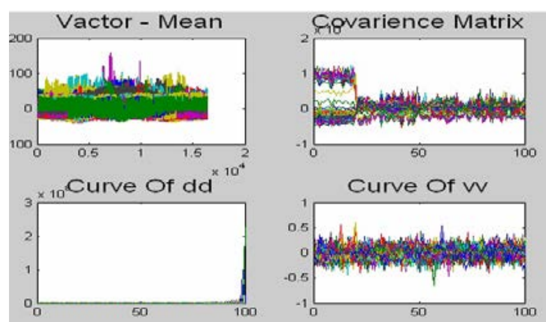

Fig. 3 Curve of Mean, Covarience Matrix, dd and vv

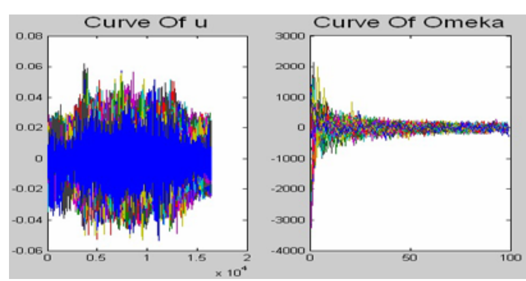

Fig. 4 Curve of U and Curve of Omeka

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Input Image no	Min Euclidan Dsitance	Input Image no	Min Euclidan Dsitance	Input Image no	Min Euclidan Dsitance	Input Image no	Min Euclidan Dsitance
01	4.757e+7	26	0	51	6.5861e+7	76	7.7856e+7
02	6.2236e+7	27	0	52	1.6294e+8	77	8.4029e+7
03	3.9498e+7	28	0	53	7.4895e+7	78	7.3703e+7
04	6.4744e+7	29	0	54	8.074e+7	79	7.415e+7
05	5.4738e+7	30	0	55	6.4495e+7	80	5.8378e+7
06	1.1712e+8	31	0	56	7.4569e+7	81	6.8765e+7
07	9.5857e+7	32	0	57	5.0854e+7	82	8.1976e+7
08	4.0128e+7	33	0	58	6.3981e+7	83	1.0107e+8
09	5.968e+7	34	0	59	1.0633e+8	84	1.0292e+8
10	3.8247e+7	35	0	60	8.0951e+7	85	4.914e+07
11	8.5518e+7	36	0	61	8.0404e+7	86	8.2966e+7
12	2.8508e+7	37	0	62	8.1201e+7	87	7.4886e+7
13	5.2559e+7	38	0	63	1.5723e+8	88	5.5324e+7
14	5.7944e+7	39	0	64	8.9919e+7	89	9.9758e+7
15	6.4528e+7	40	0	65	1.129e+8	90	6.9881e+7
16	5.6651e+7	41	0	66	6.8513e+7	91	1.7324e+8
17	4.8762e+7	42	0	67	5.4034e+7	92	5.0646e+7
18	3.5955e+7	43	0	68	8.5834e+7	93	4.8564e+7
19	6.367e+7	44	0	69	1.0414e+8	94	7.9311e+7
20	5.673e+7	45	0	70	1.2984e+8	95	6.6356e+7
21	0	46	0	71	6.0965e+7	96	8.4514e+7
22	0	47	0	72	6.9484e+7	97	6.4528e+7
23	0	48	0	73	1.9268e+8	98	8.5518e+7
24	0	49	0	74	5.524e+7	99	8.6984e+7
25	0	50	0	75	9.7328e+7	100	6.7258e+7

Table 1 Min Value of Euclidian Distance

Input Image no	Max Euclidan Dsitance	Input Image no	Max Euclidan Dsitance	Input Image no	Max Euclidan Dsitance	Input Image no	Min Euclidan Dsitance
01	1.8332e+9	26	1.3892e+9	51	1.1128e+9	76	1.2529e+9
02	1.6634e+9	27	1.3484e+9	52	1.3855e+9	77	1.2553e+9
03	1.8163e+9	28	1.152e+9	53	1.1475e+9	78	1.1401e+9
04	1.8142e+9	29	1.1078e+9	54	1.1445e+9	79	1.0014e+9
05	1.7111e+9	30	1.2035e+9	55	1.0884e+9	80	1.0876e+9
06	1.5258e+9	31	1.6108e+9	56	1.5136e+9	81	1.2535e+9
07	1.7379e+9	32	1.1122e+9	57	1.0571e+9	82	1.128
08	1.8079e+9	33	1.1672e+9	58	1.1575e+9	83	1.1696e+9
09	1.8155e+9	34	1.5701e+9	59	1.0904e+9	84	1.1529e+9
10	1.8388e+9	35	1.7324e+9	60	1.0817e+9	85	1.4284e+9
11	1.7934e+9	36	1.1398e+9	61	1.0276e+9	86	1.1273e+9
12	1.8611e+9	37	1.2711e+9	62	1.2694e+9	87	1.362e+97
13	1.8411e+9	38	1.1843e+9	63	1.2874e+9	88	1.0081e+9
14	1.7364e+9	39	1.0452e+9	64	1.094e+9	89	9.8906e+8
15	1.8287e+9	40	1.245e+9	65	1.4641e+9	90	1.306
16	1.7914e+9	41	1.2399e+9	66	1.2982e+9	91	1.2377e+9
17	1.8597e+9	42	1.2052e+9	67	1.3292e+9	92	1.0331e+9
18	1.8522e+9	43	1.4612e+9	68	1.0613e+9	93	1.3026e+9
19	1.8776e+9	44	1.2052e+9	69	1.1682e+9	94	1.1716e+9
20	1.0935e+9	45	1.2137e09	70	1.1694e+9	95	1.449e+97
21	1.3565e+9	46	1.2137e+9	71	9.8873e+8	96	1.1102e+9
22	1.33e+9	47	1.622e+9	72	1.4382e+9	97	1.4822e+9
23	1.1486e9	48	1.369e+9	73	1.4336e+9	98	1.5698e+9
24	1.2403e+9	49	1.6163e+9	74	1.2192e+9	99	1.0646e+9
25	1.1671e9	50	1.213	75	1.3194e9	100	1.0082e+9

Table 2 Max Value of Euclidian Distance

First we input a known image and observed the Euclidean distance. This distance tells us how close the input image is from the the images on our training set. As we can see from the values at the end of each picture the maximum Euclidean distance for a face is approximately 9.8906e+8 and the minimum is around 4.8445e+007. Based on these distances we can make a decision of whether the face is a known face, an unknown face, or not a face at all. This result shows in Table 3.

Test Image Type	Threshold Value	Recognition Rate
Known Image	4.8445e+007	100%
Unknown Image	9.8906e+8	100%
Known but Different Angle	4.8445e+007	75%

Table 3 Recognition Rate of Testing Image

5 Result Analysis

From this result , we show the recognition 75% successfully when same man but different face image, 100% successfully when known face same image, 100% successfully when unknown man face image.

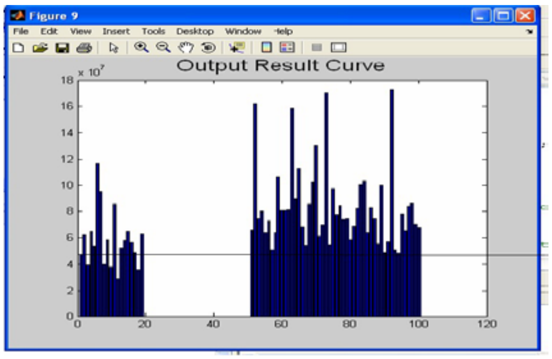

Fig. 5 Output Result of known man different image

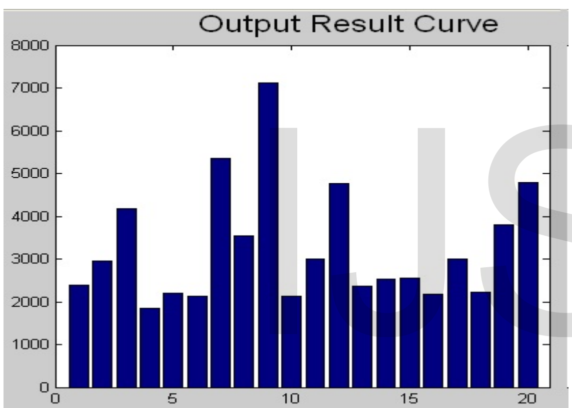

Fig. 6 Output Result of known man same image

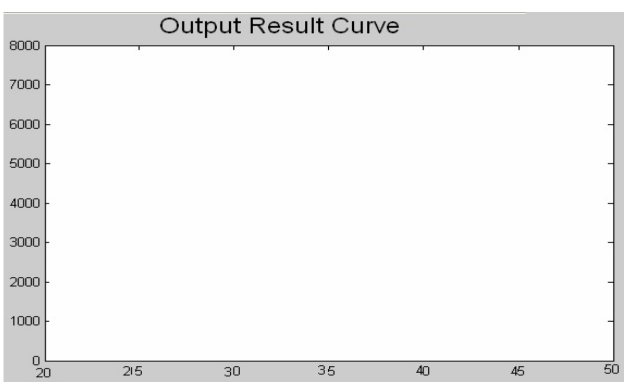

Fig. 7 Output Result of known man same image

6 FURTHER ISSUES AND CONCLUTION

We are currently extending the system to deal with a range of aspects by defining a small number of face classes for each known person corresponding to characteristic views [10]. Because of the speed of the recognition, the system has many chances within a few seconds to attempt to recognize many slightly different views, at least one of which is likely to fall close to one of the characteristic views. An intelligent system should also have an ability to adapt over time. Reasoning about images in face space provides a means to learn and subsequently recognize new faces in an unsupervised manner [12]. When an image is sufficiently close to face space but not classified as one of the familiar faces, it is initially labeled as unknown. The eigenface approach to face recognition was motivated by information theory, leading to the idea of basing face recognition on a small set of image features that best approximate the set of known face images, without requiring that they correspond to our intuitive notion of facial parts and features. Although it is not an elegant solution to general object 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 somewhat constrained environment.

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