Recognition of Face Images in Frontal View using Eigenface

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Abstract

Face recognition is an active research area that has many real-life applications such as bank/ store security, database face recognition, access control and so on. Each application has each own criteria. In terms of background, faces and application, the numerous presented systems show different capabilities and strengths in aspects of recognition performance. In this paper, we proposed Recognition of real time face images in frontal view using eigenface. Face recognition is performed by projecting a new face image into face space and then comparing its position in the face space with those of known face. After that we find the best match in a face database. The eigenface approach does provide a practical solution that is well fitted to the task of face recognition.

Keyword: *FR (Face Recognition), PCA (Principal Component Analysis), SVD (Single Value Decomposition)*

1. Introduction

Face Recognition is an interesting computer vision problem with many commercial and law enforcement applications. There are two branches of face recognition: Face Recognition (Identification) : The face recognition can be divided into two basic applications. First, given a probe face_image and a gallery of class_ labeled faces. Second, find the correct class-label for the probe image. In other words, "Who am I?"

Face Verification (Authentication) : Given a class-labeled probe face image, decide if the probe image has correct class-label. In other words, "Confirm that I'm a person X".

While research into this area dates back to the 1960's, it is only recently that acceptable results have been obtained. Thus, face recognition is still an area of active research since a completely successful approach or model has not been proposed to solve the face recognition problem. So, face recognition is not one of the most challenging computer vision problems but also has many commercial and law enforcement applications. Thus, face detection and recognition are very difficult tasks due to different lightening, variability in scale, location, orientation (upright, rotated) and pose (frontal and profile).

Approaches on face recognition are generally classified as static (processing still images) and dynamic (processing video image sequences). In this paper, we propose face recognition focus on still image in frontal view because face recognition systems can get high recognition rate for good quality in frontal view.

2. Related Works

This paper described face identification using infrared images and eigenfaces after passing test face through cold effect enhancement and/or sunglasses filtering algorithms and handling facial hair through threshold. Eigenface technique after modification is used to define their eigenspace. Test image before going through the recognition process has to pass through a check to see whether it is a face image or not. The test face is passed through an algorithm to check and enhance if the person come from cold and then is projected to eigenspace to find the match. If a match is not found then it is passed through another algorithm to check whether person has worn sunglasses and if so the image is enhanced in order to make recognition more efficient.

Eigen-based approaches (different and standard) have shown to be efficient in order to deal with the problem of face recognition. Although different approaches have a better performance, their computational complexity represents a serious drawbacks. To overcome that [1] proposed a post different approach, which uses differences between reduced face vectors. The mentioned approaches are compared using the YALE and FERET Database.

At present there are many methods for frontal view face recognition. Few of them can work well when only one example image per class is available. E.Hjelm and B. K. Low [6] presented a method on SVD perturbation to deal with the ‘one example image’ problem and two generalized eigenface algorithms. Their experimental results show that the generalized eigenface algorithms are more accurate and use far fewer eigenfaces than both the standard eigenface and the PCA algorithms.

Y. Jiangsheng [7] proposed face reconstruction techniques that produced models that not only look good when texture mapped, but are also metrically accurate. Their method is designed to work with short uncelebrated video or movie sequences, even when the lighting is poor resulting in secularities and shadows that complicate the algorithm’s task.

K. Curran et al. [8] developed a computer program for human face recognition. A user sits in front of the computer equipped with web camera. The program captures the photo of the user, and through various modules, processes modules that perform separate functions. They used face classification modules with SSD (sum of squared differences) values of face various face regions as features. The result of their research provided a basic for future development of many face recognition applications.

3. Fundamental Steps in Eigenface-based Face Recognition

Fundamental steps for our proposed system is shown in figure 1. The aim of preprocessing in a face recognition system is to try and remove variant factors from a face image in order to allow the later stages of the process to work more effectively. The key function of preprocessing is to improve the image in ways that increase the chances for success of the other process.

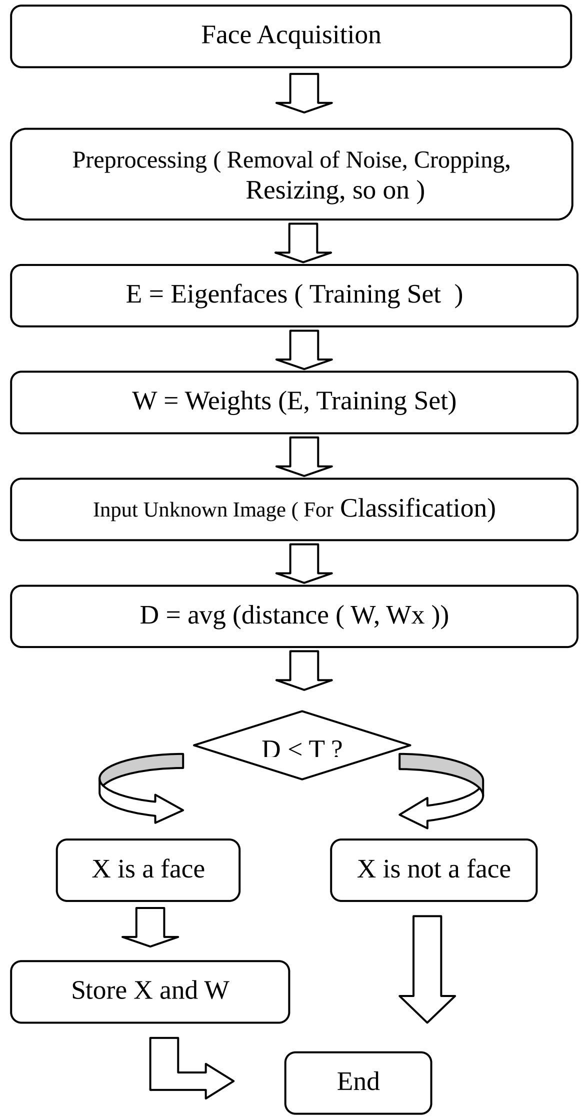


Figure.1 Real Time Eigen-based Face Recognition Algorithm

In general, it contains removing noise, cropping the input face image, resizing and normalization. The preprocessing step reduces the irrelevant information, eliminates noise and analyses the input image. Informal testing on face images with structured and unstructured (random) noise added in show that the system is reasonably robust to degraded input.

To be robust in the face of the types of image degradations, a noisy image face should cause recognition performance to degrade gracefully rather than abruptly. so we should use noise free image in database. In this paper, we use ‘salt and pepper’ method for the noise and ‘median filtering’ method to remove the noise because median filtering is a non linear operation often used in image processing to reduce ‘salt and pepper’ noise, see in figure 2.

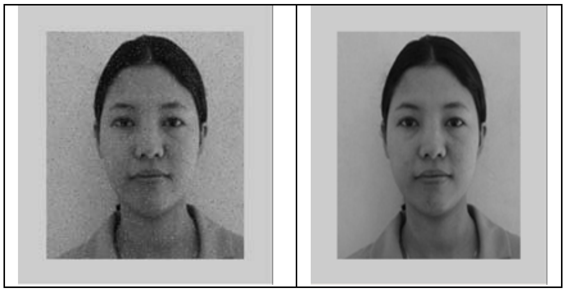
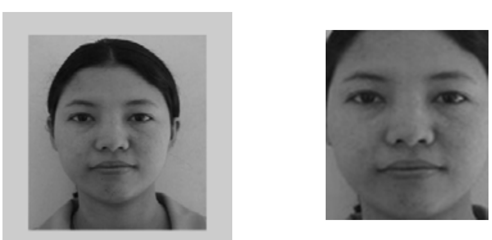


Figure 2 : Noise removal image

Cropping creates a new image from the selected region. The system must be able to crop the face and remove the unwanted background. In our proposed system, the face images are automatically cropped from the original input image by approximately placing the eye levels in the middle of the image. After passing the cropping step, the face images are resized to a uniform size.



(a) **(b)**

Figure 3 The cropped image

4. Eigenface

In mathematical terms, the eigen vectors of the covariance matrix of the face images, treating an image as a point (or vector) in a very high dimensional space. The eigenvectors are ordered, each one accounting for a different amount of the variation among the face images. These eigenvectors can be thought of as a set of features which together characterize the variation among face images. Each image contributes some amount to each eigenvector, so the eigenvector formed from an ensemble of face images appears as a sort of ghostly face image, referred to as an eigenface. Each eigenface deviates from uniform grey where some facial feature differs among the set of training faces: collectively, they map the variations between faces.

Let the training set of the faces images be $\phi_1, \phi_2, ..., \phi_M$ where M be the number of images in the database.

The average face of the set is defined by $\vec{m} = \frac{1}{M}\sum_{i=1}^{M}\phi_N$.

Each face differs from the average by the vector $r_i = \phi_i - \vec{m}$.

Built the matrix A which is N^2 by M.

Find the covariance matrix which is N^2 by N^2, $Cov = AA^T$

$$L = A^T A$$

Find the eigen vector of L. Eigen vector Cov are linear combination of image space with the eigenvector of L. And then compute each face is projection onto the face space.

A new face image ϕ is transformed into each Eigenface components $\vec{r}_m = \phi - \vec{m}$.

Compute each projection onto the facespace. Compute the face space between the recognize face and all known faces (Training face).Then Reconstruct the face from the eigenface and after that compute the distance between the face and its reconstruction. We can distinguish between a known face or not fixing the threshold value.

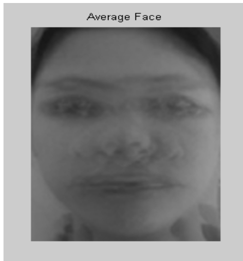


Figure 4 The average face

5. Experiments and Results

The early attempts at making computers recognize faces were limited by the use of impoverished face models and feature descriptions (e.g. Locating features from an edge image and matching simple distances and ratios), assuming that a face is no more than the sum of its parts, the individual features). Eigenface is a practical approach for face recognition. PCA reduces the dimension size of an image greatly in a short period of time. The experiment has been done with several real images. The set of training database is created by 100 frontal face images. The sizes are fixed to 200 x 300 pixel dimensions in JPEG format.

The accuracy of eigenface is also satisfactory (over 90%) with frontal faces. The recognition errors (nearly 10 %) were due to the variation of pose, lighting, and so on.

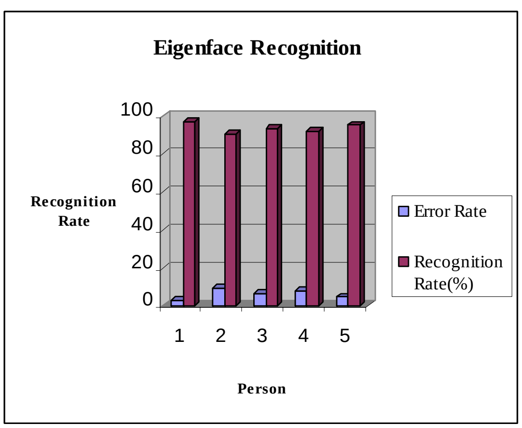


Figure 4 Face Recognition using Eigenface

6. Conclusion

The eigenface approach to face recognition leads to the idea of basing face recognition on a small set of image features that best approximate the set of known faces images, without requiring that they correspond to our intuitive notions of facial parts and features. Although not indeed as a solution to the general object recognition problem, our proposed system provide a practical solution that is well fitted to the task of face recognition. So, by using the eigenface recognition method we get several advantages such as raw intensity data are used directly for learning and recognition without any significant low-level or mid-level processing, no knowledge of geometry and reflectance of faces is required, and it reduces the amount of data.

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