Face Recognition using Principle Component Analysis

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ABSTRACT
The objective of this paper is to develop the Image processing and Face Recognition using Principle Component Analysis and Log-Gabor filter . Face is a complex multidimensional visual model and developing a computational model for face recognition is difficult. Eigenfaces approach is a principal component analysis method, in which a small set of characteristic pictures are used to describe the variation between face images.

This paper gives the simple implementation of face recognition using principal component analysis, based on information theory concepts, seek a computational model that best describes a face, by extracting the most relevant information contained in that face. The main advantages of the proposed method are its simple implementation, training, and very high recognition accuracy.we implementing the system to find the locations of Log-Gabor features with maximal magnitudes at single scale and multiple orientations using sliding window -based search and then use the same feature locations for all other scales. For further feature compression we used Principal Component Analysis (PCA) because its simple implementation, fast training and because using PCA with Euclidean -based distance measure it is possible to achieve similar recognition accuracy like using EBGM and LDA –based recognition methods.

Keyword
PCA,Log-Gabor filter,Sliding window based search,Euclidean based distance measure.

1. INTRODUCTION
Face recognition has been a very popular research topic in recent years. This paper is a step towards developing a face recognition system which can recognize static images and can be modified to work with dynamic images. In that case the dynamic images received from the camera can first be converted in to the static ones and then the same procedure can be applied on them.Different Approaches for Face Recognition.Elastic face Matching: Elastic graph matching (EGM) is a well-known approach in face recognition area for the robust face recognition to a rotation in depth and facial expression change.

Face Recognition by LDA: Etemad and Chellappa proposed a method on appliance of Linear/Fisher Discriminant Analysis for the face recognition process. LDA is carried out via scatter matrix analysis. The aim is to find the optimal projection which maximizes between class scatter of the face data and minimizes within class scatter of the face data. As in the case of PCA, where the eigenfaces are calculated by the eigenvalue analysis, the projections of LDA are calculated by the generalized eigenvalue equation.

DCT: Discrete Cosine Tranform is a method which finds the feature vectors using Discrete Cosine Transform (DCT). Their system tries to detect the critical areas of the face. The system is based on matching the image to a map of invariant facial attributes associated with specific areas of the face.

PCA: The proposed system is based on an information theory approach that decomposes face images into a small set of characteristic feature images called 'Eigen faces', which are actually the principal components of the initial training set of face images. Recognition is performed by projecting a new image into the subspace spanned by the Eigen faces ('face space') and then classifying the face by comparing its position in the face space with the positions of the known individuals. The Eigen face approach gives us efficient way to find this lower dimensional space. Eigen faces are the Eigenvectors which are representative of each of the dimensions of this face space and they can be considered as various face features. Any face can be expressed as linear combinations of the singular vectors of the set of faces, and these singular vectors are eigenvectors of the covariance matrices.

2. PROPOSED FACE RECOGNITION SYSTEM

2.1Purpose

A facial recognition system is a computer application that for automatically identifying or verifying a person from a digital image. One of the ways to do this is by comparing selected facial features from the image and a facial database.

2.2The acquisition module
This is the entry point of the face recognition process. The user gives the face image as the input to face recognition system in this module. In this case the dynamic images received from the camera can first be converted in to the static image.

2.3 The Image pre-processing module
The face recognition is very important task in face recognition system.The aim of the pre-processing phase was to obtain images which have normalized intensity, uniform size and shape. The original images are first converted into gray scale images. Pointing the centers of two eyes and tip of the chin on each face image, Initially image are denoised (using Gaussian filter with σ=0.5 and window size 5x5 all images are properly rotated, translated, scaled and cropped into 100×100 pixels.In this module the images are normalized and enhanced to improve the recognition of the system. The preprocessing steps implemented are as follows:

- Image size normalization
- Histogram equalization
- Median filtering
- High-pass filtering
- Background removal
- Translation and rotational normalizations

2.4 Feature extraction using Log-Gabor filters

The feature extraction phase represents a key component of any pattern recognition system.The Log-Gabor filter in frequency domain can be constructed in terms of two components, namely the radial filter component G(f) and the angular filter component G(ɵ). In polar coordinates the filter transfer function could be written in the following form

$$\mathrm{G(F).G(\theta)} = \exp - \left(\left(\log\left({}^{f}/_{f_0} \right) \right)^2 \middle| 2\left(\log(k|f_0)\right)^2 \right) . \exp\left(\frac{(\theta - \theta_0)^2}{2 6_{\theta}^2} \right)$$

f_0 - Centre frequency of filter

k – bandwidth

θ_0 - orientation angle of the filter

$$\boldsymbol{\sigma_\theta} = \Delta\boldsymbol{\theta}/\boldsymbol{s_\theta}$$

We calculate two-dimensional Log-Gabor filter G no, ns in Fourier space of a chosen filter scale and orientation. The size of the filter array Gno,ns is the same as the size of the two dimensional image I that we wish to filter. Then we perform filtering (convolution in Fourier space), magnitude calculation and masking using the following equation Vno,ns=abs(IFFT2(Gno,ns . _ FFT2(I))). _ mask, here ”*” - array (not matrix) multiplication, I - normalized (cropped, masked) face image, Gno,ns - Log-Gabor filter of desired orientation and scale in Fourier space, FFT2 - two-dimensional Fast Fourier Transform, IFFT2 – inverse FFT2, mask - binary mask for masking magnitude image (the same as is used for masking greyscale face image I in order to leave only the internal part of the face), Vno,ns - masked Log-Gabor magnitude image. After image filtering with multiple Log-Gabor filters (Ns scales and No orientations)we get very large number of Log-Gabor features (magnitude values in all Ns · No magnitude images). In order to reduce the number of features and achieve partial face recognition invariance with respect to different facial expressions and minor face detection errors, we use sliding window algorithm. that is illustrated in Fig. 1. Rectangular window of a chosen size (e.g., 8x8 pixels) is slided over the magnitude image Vno,1 using some sliding step (e.g., 6 pixels, overlapping of windows is 8-6=2 pixels).

2.5 Face recognition using Principal Component Analysis of Log-Gabor features

Principal component analysis (PCA) involves a mathematical procedure which extracts facial features for recognition, this approach transforms face images into a small set of characteristic feature images called eigenfaces .The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible. These methods capture the local facial features and their geometric relationships. They often locate anchor points at key facial features (eyes, nose, mouth, etc), connect these points to form a net and then measure the distances and angles of the net to create a unique face ‘print’.

Steps

1. The first step is to obtain a set S with M face

$$S = \{\Gamma_1, \Gamma_2, \Gamma_3, \dots\dots\dots, \Gamma_M\}$$

images. In our example M = 16 . 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**

$$\psi = \frac{1}{M}\sum_{n=1}^{M}\Gamma n$$

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

$$\Phi_i = \Gamma_i - \psi$$

4. Next we seek a set of M orthonormal vectors, u_k, which best describes the distribution of the data. The k^{th} vector, $\mathbf{u_k}$, is chosen such that

$$\lambda_k = \frac{1}{M}\sum_{n=1}^{M}\left(u_k^T \quad \Phi_n\right)^2$$

is a maximum, subject to

$$u_l^T u_k = \delta_{lk} = 1 \quad if\ l = k$$

$$= 0 \quad otherwise$$

Note: u_k and λ_k are the eigenvectors and eigenvalues of the covariance matrix **C**

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

$$C = \frac{1}{M}\sum_{n=1}^{M}\Phi_n \quad \Phi_n^T$$

$$C = AA^T$$

$$A = \{\Phi_1, \Phi_2, \Phi_3 \dots\dots\dots, \Phi_n\}$$

6. A^T

$$L_{mn} = \Phi_m^T \ \Phi_n$$

7. Once we have found the eigenvectors, $\mathbf{v_l}$, $\mathbf{u_l}$

$$u_l = \sum_{k=1}^{M} v_{lk} \quad \Phi_k \qquad l = 1,2, \dots\dots\dots, M$$

3. RECOGNITION PROCEDURE

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

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

$$\Omega^T = [\omega_1, \omega_2, \omega_3 \ \ldots\ldots\ldots \omega_M]$$

3.1 Normalization of face images

For recognition experiments we used two image normalization methods. One method uses manually selected centres of eyes and the tip of chin (3-point normalization method), and another method for normalization uses only the centre's of eyes (2-point normalization method). Image normalization procedure of 3-point method.

3.2 Distance Measure

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

4. System Architecture

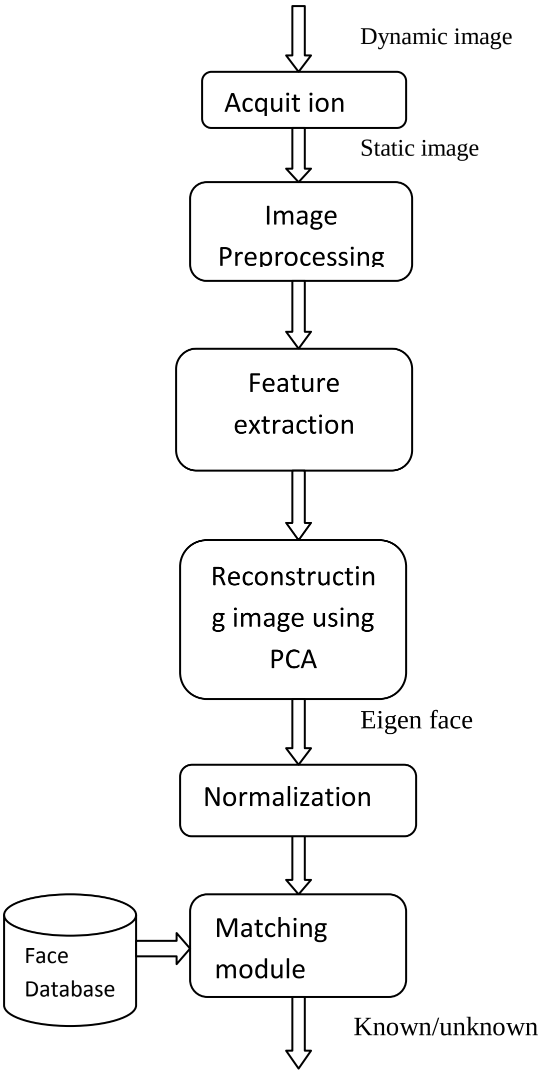

Fig 1 : Overall architecture of Face recognition System

4. STEPWISE ALGORITHM

Input image- Face image
Output image-Known or unknown .
Step1:Camera capture the image and convert the dynamic image into static image and stored into the database.
Step2:Perform Image Preprocessing
It consist of denoising,, cropping, masking of the image ,3-point normalization and histogram equalization, background removal.
Step3:Feature extraction is done by using log Gabor Filter.
Step4: Less feature are selected using Sliding Window algorithm.
Step5:Reconstructuring image by using PCA.

1. All training set images are resized and converted in to a single vector.
2. The test image is resized and converted in to a single vector.
3. The mean image of all training set images plus test image is calculated.
4. Then the mean image is subtracted from each image of the training set as well as from the test image. After subtraction we will get new images called as difference images.
5. All difference images of training set as well as test image are converted in to a column vector i.e. column-wise concatenation of all images.
6. Then using covariance matrix the eigenvector and eigenvalues are calculated. Each eigenvector belongs to one of the eigenface.
7. Using product of each eigenimages with the difference images will get the weight vector of each class as well as the weight vector of the test image.
8. Then the weight of the test image is subtracted from each weight vector of the difference image.
9. Then the Euclidean distance of each class of the images in the database is calculated.
10. The class having the minimum distance, the test image belongs to that class.

5. APPLICATION

Various potential applications are:

1. Person Identification
2. Human-Computer interaction
3. Security and Surveillance Capability Systems

6. CONCLUSION AND FUTURE SCOPE

In this study we used Principle Component Analysis. the Face recognition is a highly satisfactory and successful process in many types of applications such as biometric security, voter databases to reduce duplicate registrations,digital image of a person which can be used as a password and many other important activities. The objective of this work is to implement a reliable Principal Component Analysis (PCA)-based face recognition system and study its performance using standard face databases. Although the recognition rate is quite satisfactory, this rate can be increased by implementing a system based on cumulative characteristic of PCA.

7. REFERENCES

[1] P. Liu, K. Jia, Z. Wang and Z. Lv, "A New and Effective Image Retrieval Method Based on CombinedFeatures", Proc. IEEE Int. Conf. on Image and Graphics, vol. I, pp. 786, August 2007

[2] N. R. Howe and D. P. Huttenlocher, "Integrating Color, Texture and Geometry forImage Retrieval", Proc.IEEE Conf. on Computer Vision and Pattern Recognition, vol. II, pp. 239-246, June 2000

[3] Dr. Fuhui Long, Dr. Hongjiang Zhang and Prof. David Dagan Feng "Fundam entals Of Content-Based ImageRetrieval".

[4] W. Y. Ma and B. S. Manjunath, "A comparison of wavelet transform features for texture image annotation," in Proc. IEEE International Conf. On Image Processing, 1995.

[5] "Facial Recognition using Eigenfaces by PCA" by Prof. Y.Vijaya Lata, Chandra Kiran Bharadwaj Tungathurthi, H. Ram Mohan Rao, Dr.A. Govardhan, Dr.L.P. Reddy, International Journal of Recent Trends in Engineering, Vol. 1, No. 1, May 2009