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Face Recognition using Canny Edge Detector and KL Transform

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Abstract: This paper mainly focuses on the face recognition using edge information and principle component analysis. The edge information is extracted using canny edge detector and further this edge information is used to obtain principle components. This method is innovative as combination of edge information and Eigen images are used for face recognition. The results of this experimentation are evaluated using distance classifiers and are encouraging and will provide guidance for future research work in the field of image processing.

Keywords: Principal Component Analysis, Canny Edge Detector, Distance Classifiers

I. INTRODUCTION

The automatic recognition of human faces presents a significant challenge to the pattern recognition research community. Typically, human faces are very similar in structure with minor differences from person to person. They are actually within one class of human face. Furthermore, lighting condition changes, facial expression, and pose variations further complicate the face recognition task as one of the difficult problems in pattern analysis. YongshengGao et al. [1] proposed a novel concept where faces can be recognized using line edge map.

Line Edge Map (LEM), is generated for face coding and recognition. The detail study on the proposed concept is conducted which covers all aspects on human face recognition, i.e. challenges involved in face recognition as follows, a) Controlled/ideal condition and size variation, b) Varying lighting condition, c) Varying facial expression, and d) Varying pose. This research demonstrates that LEM together with the proposed generic line segment [2] distance measure provide a new way for face coding and recognition. A shape and Texture based Enhanced Fisher Classifier for face Recognition method introduced by Chengjun we have used PCA as baseline preprocessing techniques after edge detection for dimension reduction and whitening of data matrix.

An edge in an image is a contour across which the brightness of the image changes abruptly. In image processing, an edge is often interpreted as one class of singularities. In a function, singularities can be characterized easily as discontinuities where the gradient approaches infinity. However, image data is discrete, so edges in an image often are defined as the local maxima of the gradient. These definitions become the way to lead the work in this section. Edge detection is an important task in image processing.

It is a main tool in pattern recognition, image segmentation, and scene analysis. An edge detector is basically a high pass filter that can be applied to extract the edge points in an image. This topic has attracted many researchers and many achievements have been made [5] [6]. Edges are also considered as boundaries between different textures. Liu et al. [3]. It is a new face coding and recognition method, the enhanced Fisher classifier (EFC), which employs the enhanced fisher linear discriminant model (EFM) on integrated shape and texture features by triangular shape edge detection. These two methods LEM and EFM works by line edge map to extract the information from face which is similar of any edge detection methods which leads to our motivation for research work presented in this paper.

In feature extraction from face images aset of landmark points are first identified from the human face, which are then used for feature measurement based on area, angle and distances between them. Extraction of features from the front view may be performed from the edge images [4].The template matching may be used for extraction of the eyes from the face image, while features such as nose, lips, chin, etc., may be extracted from the horizontal and vertical edge maps of a human face. In feature based methods, local features such as eyes, nose, distance between them and lips are segmented which is then used as an input data for structural classifier [8]. The extracted edge information from face using edge detection methods provide minute details regarding these local features and it leads as feature based approach for face recognition [9].

Edge detection as feature extraction methods

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Edge information plays vital role in many applications of image processing area. The edge information is effectively used in iris recognition, finger print, texture analysis and palmistry analysis. Here we have decided to use edge detection as a feature extraction method to extract edges from facial images. This edge information is further used for extracting the principle components. These principle components from edge information are used with different classifiers to match the facial images for recognition purpose. Here different edge detection methods may be used to evaluate the results. In this paper we have explored Canny edge detectors.Here Canny edge detector is based on first derivative coupled with noise cleaning. As detection of step edges are influenced by the presence of noise. Therefore noise smoothing improves the accuracy of edge detection while adding uncertainty in localizing the edge. Canny edge detector tries to achieve an optimal trade-off between the two by approximating the first derivative of Gaussian. Canny has considered the following criteria for localizing edges:

a. There should be low probability of failing to detect a real edge point and, equivalently, low probability of falsely marking non-edge points. That is to maximize the signal to noise ratio.

b. The point marked by the operator as edge points should be as close as possible to the real edge point. That is minimizing the variance σ^2 of the zero crossing position.

c. The detector should not generate multiple outputs in response to a single edge. That is, there should be low probability of number of peaks to a given edge response.

Given the good detection, localization and response to a true edge, the algorithmic steps for Canny edge detection are as follows,

1. Convolve the image *g(r,c)* with a Gaussian function (select appropriate σ) to get smooth image *g'(r,c)*, i.e.

$$\bar{g}(r,c) = g(r,c) * G(r,c;\sigma) \qquad (3)$$

2. Apply first difference gradient operator to compute edge strength.

$$d_1 = \frac{1}{2}\{g'(r,c) - g'(r,c-1) + g'(r-1,c) - g'(r-1,c-1)\} \qquad (4)$$

$$d_2 = \frac{1}{2}\{g'(r,c) - g'(r-1,c) + g'(r,c-1) - g'(r-1,c-1)\} \qquad (5)$$

Then edge magnitude and direction are obtained as before by Eqn. (1) and (2).

3. Apply non-maximal suppression to the gradient magnitude. This is achieved by suppressing the edge magnitudes not in the direction of the gradient. In factinCanny's approach, the edge direction is reduced to any one of the fourdirections. To perform this task for a given point, its gradient is compared with that of points of its 3x3 neighborhood. If the candidate magnitude is greater than that of neighbourhood, the edge strength is maintained, else it is discarded

Table 2: First five Eigenvector component values

EV1	-0.0407	0.08986	-0.0814	0.10025	-0.065
EV2	-0.2224	-0.61629	-0.0732	0.01769	-0.077
EV3	0.0296	0.05287	-0.0774	0.11022	0.1298
EV4	0.6352	-0.1630	0.0106	-0.0798	-0.096
EV5	0.6352	-0.16309	0.0106	-0.07986	-0.096

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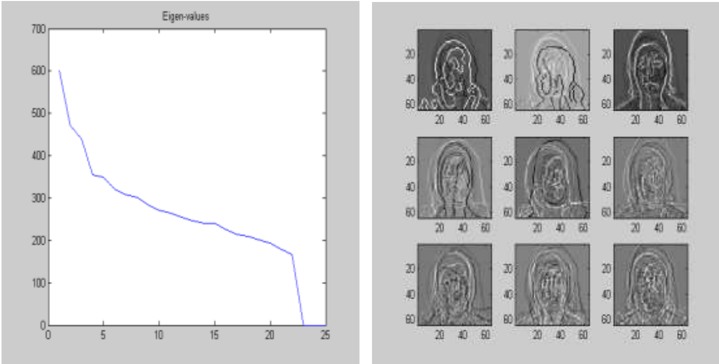

Fig 1. (a) Eigenvalues (b) EigenImages

4. Apply threshold to the non-maxima suppressed image. Similar to any other edge-detection process, the edge magnitudes below a certain value are discarded. However, the Canny's approach employs a clever double thresholding commonly referred to as hysteresis. In these process two thresholds, upper and lower thresholds are set by the user so that for a given edgel chain if the magnitude of one edgel of the chain is greater than the upper threshold, all edgels above the lower thresholds are selected as edge points. Canny has not provided any basis for selecting upper and lower thresholds and similar to many such applications, selections of the thresholds are application dependent.

II. CANNY EDGE DETECTION

Canny detector finds edge by looking for local maxima of the gradient *f(x,y)*. The gradient is calculated using the derivative of a Gaussian filter. The method uses two thresholds to detect strong and weak edges and includes the weak edges at the output only if they are connected to strong edges. Therefore this method is more likely to detect true weak edges. The Canny edge detector [7] is the most powerful edge detector provided by function edge. In this method the image is smoothed using a Gaussian filter with a specified standard deviation, σ, to reduce noise. The local gradient,

$$g(x,y) = \left[G^2x + G^2y\right]^{1/2} \quad (1)$$

and edge direction,

$$\alpha(x,y) = \tan^{-1}(Gy / Gx) \quad (2)$$

are computed at each point. *Gx* and *Gy* computed using sobel, prewitt or Roberts method of edge detection. An edge point is defined to be a point whose strength is locally maximum in the direction of the gradient. Edge also can be defined as discontinuities in image intensity from one pixel to another. The edges for an image are always the important characteristics that offer an indication for a higher frequency. Detection of edges for an image may help for image segmentation, data compression, and also help for well matching, such as image reconstruction and so on.

Pre-processing by PCA

The preprocessing using PCA used to overcome the practical considerations as dimension reduction. Using the covariance matrix the obtained few eigenvalues are represented by Table 1. These values are in descending order and approaches to zero represented row wise in the table. This principle of eigenvalue is used to reduce the dimension of eigenvector matrix, and it becomes the advantage of PCA for dimension reduction. The eigenvalues from the Table 1 are represented by graphically in Figure 1(a).

Table 1: Few Eigen values obtained (row wise).

Value 1	Value 2	Value 3	Value 4	Value 5
600.13	471.819	439.483	354.715	348.365
Value 6	Value 7	Value 8	Value 9	Value 10
319.530	308.026	301.368	282.982	270.814
Value 11	Value 12	Value 13	Value 14	Value 15
264.083	253.969	246.700	240.844	239.910

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The eigenvector components values are shown by Table 2 and the eigen images are represented by Figure 1(b). Few values of one eigenvector is represented by one row. These eigen images are nothing but eigenvectors obtained from covariance matrix of input data. The eigenvector matrix is further used by classifiers for face recognition purpose.

III. RESULTS WITH CANNY EDGE DETECTOR

In the first part the evaluation of face recognition is performed with Canny edge detector to extract edge information. This edge information is further used by PCA for dimension reduction and whitening data matrix [10] [11]. The face images are used with variation of pose, illumination and facial expressions. Here the facial position looking left, right, up, and down are considered. In this experiment, we considered the images from Indian and Asian face database only as the database has sufficient number of sample images for pose variations. Face images for illuminations and facial expressions variation are used from Asian face database.

Principle component analysis is one interesting methods of face recognition, but we have done experimentation with PCA with edge information and evaluated results.

Table 3: Result with PCA + Canny

No of Principle components	Pose variation		Illumination change		Facial Expression	
	L1	L2	L1	L2	L1	L2
25	76	80	76	80	80	80
50	70	72	68	70	72	68
100	65	67	64	67	66	65
200	61	61.5	59.5	62	62	63

IV. CONCLUSION

In these experimentations we have used two distance metrics L1 and L2. The results of PCA algorithm with L1 and L2 distance metrics with variation in pose, illumination and expressions are shown in Table 3. In this experimentation we have used four sets of principle components like 25, 50, 100 and 200. The results achieved by PCA method are varying from 60% to 80%. Specifically the results achieved by combination of PCA+L2 norms are almost 80% when the numbers of principle components are 25 for all facial conditions. To the best of our knowledge, there is hardly any reported research work on face recognition using edge information as features for face recognition with PCA algorithms. The recognition accuracy achieved is maximum 80%, because we calculate the Principle components from Edge detected face images, where we lost global information of facial images.

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BIOGRAPHY

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Kumari Ramnika Jha has completed M.E. (Electronics) from SKN Sinhgad College of Engineering, Korti, Pandharpur, India. She has completed her B.E. (ECE) from Sri Nandhanam college of Engineering &Technology,Tirupattur,Tamil Nadu(Anna University) India. She has total 6 Publications in International and National Journals and Conferences. Currently working as an Assistant Professor at D. Y. Patil College of Engineering Akurdi, Pune,India.

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