Edge Detection Techniques for Iris Recognition System

U T Tania, S M A Motakabber and M I Ibrahimy
Department of Electrical and Computer Engineering
International Islamic University Malaysia
53100 Kuala Lumpur, Malaysia

Email: tandria_17@yahoo.com

Abstract. Nowadays security and authentication are the major parts of our daily life. Iris is one of the most reliable organ or part of human body which can be used for identification and authentication purpose. To develop an iris authentication algorithm for personal identification, this paper examines two edge detection techniques for iris recognition system. Between the Sobel and the Canny edge detection techniques, the experimental result shows that the Canny's technique has better ability to detect points in a digital image where image gray level changes even at slow rate.

1. Introduction

Iris recognition system mainly includes eye image capturing, image pre-processing and edge detection through iris region segmentation, feature extraction and pattern matching. Among them edge detection is one of the major part in iris recognition system. Edge detection technique makes pupil boundary detection accurately and easier. A circular edge detection method is used to look for a circle in the image which has maximum gray level difference with its neighbour [1]. Hough transform uses different approaches which are computationally complex [2]. A texture based method first determines high contrast parts of boundary then detects outer boundary and eyelids [3]. However, its each step is more challenging than previous ones [4]. The segmentation method first uses wavelet transform and then different integral operator is used for localizing the iris [5]. A new noise removing approach is introduced based on the fusion of edge and region information. In this case, whole procedure includes three steps namely, rough localization and normalization, edge information extraction based on phase congruency, and the infusion of edge and region information [6]. Another segmentation method is introduced based on integro-differential operators and Hough transforms [7]. Some researchers mainly focused on the iris image representation and feature matching without introducing a new method for segmentation [8, 9].

2. Methodology

Edge detection is divided into three main steps: image pre-processing, feature extraction of iris image and template matching**.** Image pre-processing consists image conversion from RGB image to gray image, edge detection, localization of iris in a given eye image, filtering etc. Generally edge detection aims at identifying points in a digital image where image brightness changes sharply. The points at which image brightness changes sharply are typically organized into a set of curved line segments termed edges. In this study the Canny edge detection and the Sobel edge detection techniques are considered. In Sobel technique, an operator is selected for each point of the image and it generates the corresponding gradient vector. The main principle of this operator is to convolve the image with a small, separable, and integer filtered values of horizontal and vertical directions of image points. The operator calculates the gradient of the image intensity at each point. For high frequency variations in

the image supposed to be easier to find out the gradient of the image. The Sobel edge detection, the operator uses two 3×3 matrix kernels which are convolved with the original image to calculate the approximations of the derivatives. If the matrix A is defined as a source image, and the W_x and the W_y are the two images which contain the horizontal and vertical derivative of the approximations respectively then the relation can be represented as follows:

$$W_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} *\text{A and } W_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} *\text{A} \quad (1)$$

Where * here denotes the 2-dimensional convolution operation. Since the Sobel kernels can be decomposed as the products of an averaging and a differentiation kernel, they compute the gradient with smoothing. The *x*-coordinate is defined as increasing in the "right"-direction, and the *y*-coordinate is defined as increasing in the "down"-direction. Each point of the image, the resulting gradient approximations can be combined to give the gradient magnitude and gradient's direction by using Equation (2) and Equation (3).

$$W = \sqrt{W_x^2 + W_y^2} \quad (2)$$

$$\theta = \tan^{-1}\left(W_y / W_x\right) \quad (3)$$

Canny edge detection algorithm runs in several steps. First in smoothing step, the operators blur the image to remove noise. Then in finding gradients step when operator detects the large magnitude of gradient of image it marks the edges. In non-maximum suppression step the operator only look for local maxima and marked it as edges. Then the operator applies threshold to determine potential edge. In final step edges are determined by suppressing all edges that are not connected to strong edge. All the edge detection method applied by using MATLAB image processing tool [10]. Original image collected from CASIA database [11].

3. Result and Discussion

Figure 1 shows the results obtained by applying the Sobel edge detection and the Canny edge detection techniques.

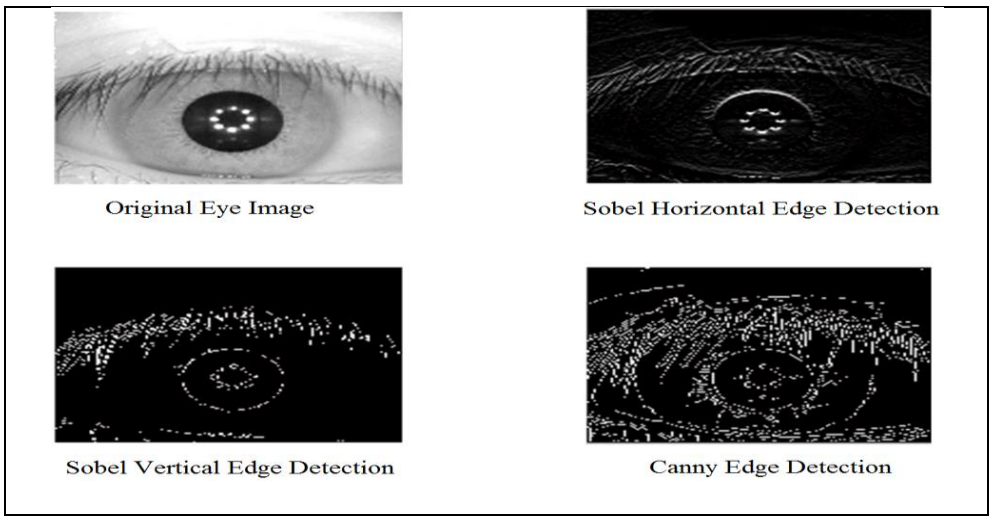

Figure 1: Edge detection by Sobel and Canny techniques.

The result shows how rapidly and smoothly the image changes. The Canny operator is optimum even for noisy images. This operator fills the gap between strong and weak edges of the image. Compared to other edge detection techniques, this operator is less fooled by specious noise. Generally horizontal edge detection is more readable than vertical edge detection. In Sobel edge detection method, it looks for both horizontal and vertical edges independently then represents them together. The Canny edge detection technique is more efficient to detect both the slow variation of gray level as well as strong variation of gray level of the image.

4. Conclusion

It is observed that the Canny edge detection technique has better performance compared to the Sobel edge detection technique. Unless the preconditions are particularly suitable, it is difficult to find an edge detector that performs significantly better than the Canny edge detector. However Sobel edge detection technique has the ability to detect both horizontal and vertical edges individually that presented in combined form, thus computation is relatively cost-effective.

References

[1] Daugman J 2004 How iris recognition works, Circuits and Systems for Video Technology IEEE Transactions on, **14** 21.

[2] Wildes R P 1997 Iris recognition: an emerging biometric technology, Proceedings of the IEEE, **85** 1348

[3] Ma L, Tan T, Wang Y and Zhang D 2003 Personal identification based on iris texture analysis, Pattern Analysis and Machine Intelligence IEEE Transactions on, **25** 1519

[4] Barzegar N, and Moin M S 2008 A new approach for iris localization in iris recognition systems, In Computer Systems and Applications, AICCSA , IEEE/ACS International Conference on 516

[5] Sun Z, Wang Y, Tan T and Cui J 2005 Improving iris recognition accuracy via cascaded classifiers, Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on, **35** 435

[6] Huang J, Ma L, Tan T and Wang Y 2003 Learning based enhancement model of iris, In Proceedings of the 14th British Machine Vision Conference (BMVC'03) 153

[7] Tisse C L, Martin L, Torres L and Robert M 2002 Person identification technique using human iris recognition, In Proc. of Vision Interface

[8] Boles W W and Boashash B 1998 A human identification technique using images of the iris and wavelet transform, Signal Processing, IEEE Transactions on, **46** 1185

[9] Lim S, Lee K, Byeon O and Kim T 2001 Efficient iris recognition through improvement of feature vector and classifier, *ETRI journal*, **23** 61

[10] MATLAB6.5 Image processing toolbox tutorial http://www.cs.otago.ac.nz/cosc451/Resources/matlab_ipt_tutorial.pdf, [Last viewed March 3, 2013]

[11] Center for biometrics and security research, http://www.cbsr.ia.ac.cn/english/index.asp [Last viewed June 17, 2013]