International Journal of Soft Computing 9 (4): 213-218, 2014
ISSN: 1816-9503

Comparative Studies on Canny and Sobel Edge Detection Techniques for Diabetic Retinopathy Eye Image

[1]R. Vijayalakshmi and [2]S. Selvarajan
[1]Department of Computer Science and Engineering, Muthayammal Engineering College, 637 408 Rasipuram, Tamilnadu, India
[2]Muthayammal College of Engineering, 637 408 Rasipuram, Tamilnadu, India

Abstract: Diabetic is one the important cost related injuries. And also it gives the numerous eye problems for humans like diabetic retinopathy. In this research, a new method has been proposed to recognize the eye and also it has been analysed with other technique. Edge detection is one of the important modules of any image processing technique. In this research, researchers have been proposed the Canny Edge Detection technique based on Region of Interest (ROI) and Edge Length (EL) to recognize the human eye. And also Sobel Edge Detection technique is proposed to detect the edge of the diabetic retinopathy eye image. Both the technique have been compared and analysed. The performance of the both technique has been compared and verified with each other. After that it has been validated with existing standard values which was collected from the standard and famous eye hospital in coimbatore. In this research, Canny Edge Detection technique is a novel technique to identify the diabetic retinopathy and also the proposed technique shows significant results compared with Sobel Edge Detection technique.

Key words: Edge detection, ROI, edge length, contrast, Canny edge, Sobel operator

INTRODUCTION

Popularity and also important of the diabetic retinopathy grew considerably over the past 3 years. The problems of diabetic retinopathy eye image processing have attracted the attention of a large number of research teams (Jain *et al*., 2004). Detailed study on eye movement analysis during retinopathy condition sated in the previous research (Bulling *et al*., 2011). Rapid eye detection method for non-glasses type 3D display on portable devices has been studied. But, the retinopathy eye image detection and analysis have now focussed by Kim *et al*. (2010). In this research, a new method to recognition of the diabetic retinopathy eye have been proposed. Edge detection is one of the important modules of any image processing technique (Chibelushi *et al*., 1993). In this research, researchers have proposed the Canny Edge Detection technique based on Region of Interest (ROI) and also Edge Length (EL) to recognize the human eye. For prediction of iris many researchers provided many algorithms. They have studied detail concept of iris (Rankin *et al*., 2009; Schmid *et al*., 2006). All the researchers and authors have focussed on only iris for their study (Bae *et al*., 2003; Sanchez-Reillo and Sanchez-Avila, 2001; Ramlee and Ranjit, 2009; Farouk *et al*., 2001). But, diabetic is one of the most cost related injury (Ross and Jain, 2004; Ross *et al*., 2001). So, now researchers they have focussed on diabetic retinopathy along with iris (Abhyankar *et al*., 2005; Destrempes *et al*., 2009). Now, all the industries are focussed to take more care on their employees. Like during their working environment diabetic will also affected more on health related issues (Suresh *et al*., 2008). The performance of the proposed system has been verified and validated with existing problems. This technique is a novel technique to identify the diabetic retinopathy and also the proposed technique shows significant results and compared with the other conventional technique of sobel operator edge detection technique.

MATERIALS AND METHODS

Proposed research sequence: The flow diagram of the proposed system of diabetic retinopathy eye image edge detection and ROI prediction is shown in Fig. 1. The different process sequence is involved in this process is also given in study. The original image is obtained from the image centre and then it will be incorporated by using Canny Edge Detection algorithm. Both the results have been compared and analysed and also proved this technique also helpful for the diabetic patients. Eye description is shown in Fig. 2.

Corresponding Author: R. Vijayalakshmi, Department of Computer Science and Engineering, Muthayammal Engineering College, 637 408 Rasipuram, Tamilnadu, India

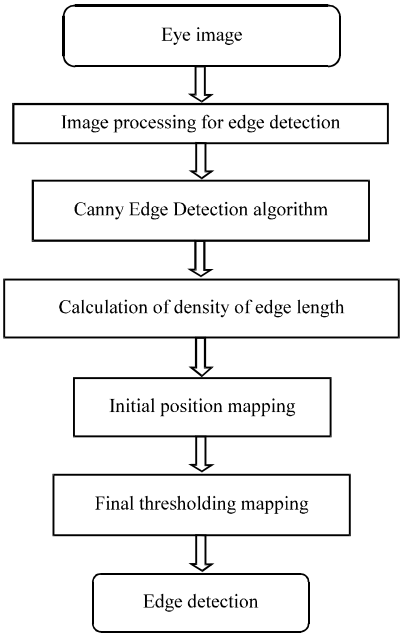

Fig. 1: Work sequence flow chart

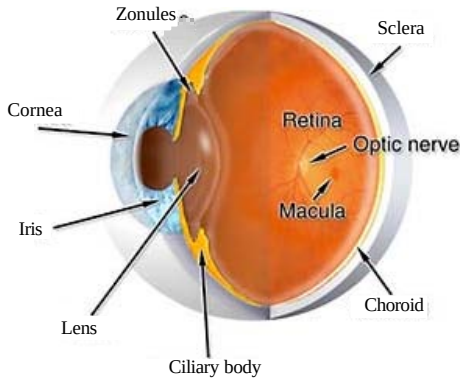

Fig. 2: Description of normal eye anatomy

Pre-processing of initial position of edge parameters detection

Step 1: Calculate the average magnitude:

$$M(1, 2) = \frac{1}{M}\sum_{(1, 2)}^{n}\sqrt{Mx(1, 2)^2 + My(1, 2)^2} \quad (1)$$

Step 2: Calculate the density of the edge length. The density of the edge length is calculated from:

$$L(1, 2) = \frac{C(1, 2)}{\max C(1, 2)} \quad (2)$$

where, C(i, j) is the number of connected pixels at each position of pixel.

Step 3: Calculate the initial position of map from summation of density of edge length and average magnitude:

$$P(1, 2) = \frac{1}{2(M(1, 2) + L(1, 2))} \quad (3)$$

Step 4: Calculate the thresholding of the initial position map. If:

$$P(1, 2) > T_{max} \quad (4)$$

Then, P(1, 2) is the initial position of the edge following. And then, researchers obtained the initial position by setting T_{max} to 92% of the maximum value. Figure 3 shows the significant results of pre-processing.

Canny Edge Detection algorithm: The Canny algorithm can be used an optimal edge detector based on a set of criteria which include finding the most edges by minimizing the error rate, marking edges as closely as possible to the actual edges to maximize localization and marking edges only once when a single edge exists for minimal response (Guerrero *et al*., 2007). According to Canny, the optimal filter that meets all three criteria above can be efficiently approximated using the first derivative of a Gaussian function. Figure 4 shows the image results after image processing using the Canny algorithm:

$$GF(i, j) = \frac{1}{2\pi\sigma^2}e^{\frac{i^2+j^2}{2\pi\sigma^2}} \quad (5)$$

Step 1: Calculate the average magnitude:

$$M(1, 2) = \frac{1}{M}\sum_{(1, 2)}^{n}\sqrt{Mx(1, 2)^2 + My(1, 2)^2} \quad (6)$$

Step 2: Calculate the density of the edge length. The density of the edge length is calculated from:

$$L(1, 2) = \frac{C(1, 2)}{\max C(1, 2)} \quad (7)$$

where, C(i, j) is the number of connected pixels at each position of pixel.

Step 3: Calculate the initial position of map from summation of density of edge length and average magnitude:

$$P(1, 2) = \frac{1}{2}(M(1, 2) + L(1, 2)) \quad (8)$$

Step 4: Calculate the thresholding of the initial position map. If:

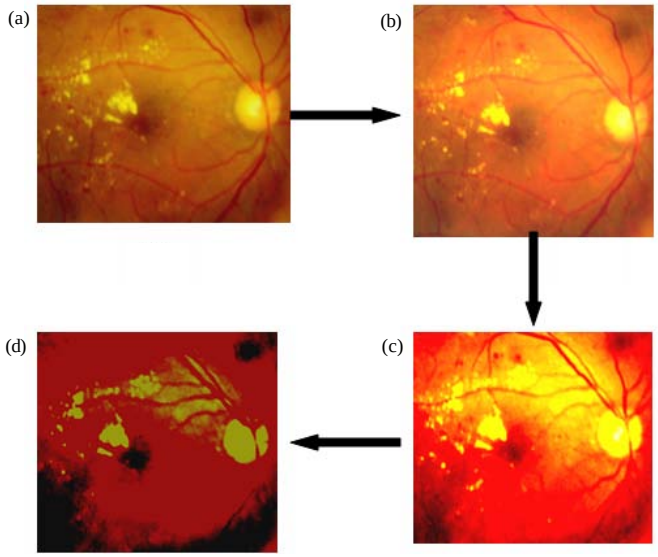

Fig. 3: a) Noisy eye image; b) average magnitude image; c) density of the edge length and d) final noise removed image

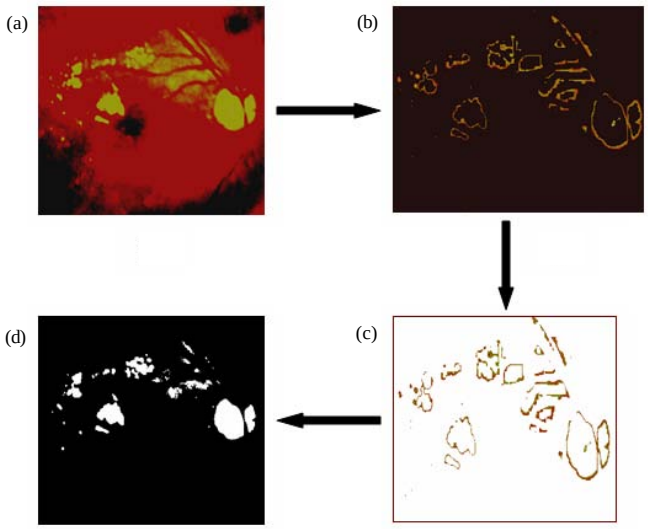

Fig. 4: a) Noisy eye image; b) density of the edge length; c) initial position map and d) final thresholding of edge map

$$P(1, 2) > T_{max} \quad (9)$$

Then, P(1, 2) is the initial position of the edge following. And then, researchers obtained the initial position by setting T_{max} to 92% of the maximum value.

Sobel Edge Detection technique: This technique performs 2D spatial gradient measurement on an image and also it emphasizes regions of high spatial frequency that correspond to edges. Typically, it is used to find the approximate absolute gradient magnitude at each point in an input greyscale image. In theory at least, the operator consists of a pair of 3×3 convolution masks as shown in Fig. 4. One mask is simply the other rotated by 90°. This is very similar to the Roberts cross operator. These masks are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one mask for each of the two perpendicular orientations (Theera-Umpon and Dhompongsa, 2007). The masks can be applied separately to the input image to produce separate measurements of the gradient component in each orientation that is G_x and G_y. These can be combined together to find the absolute magnitude of the gradient at

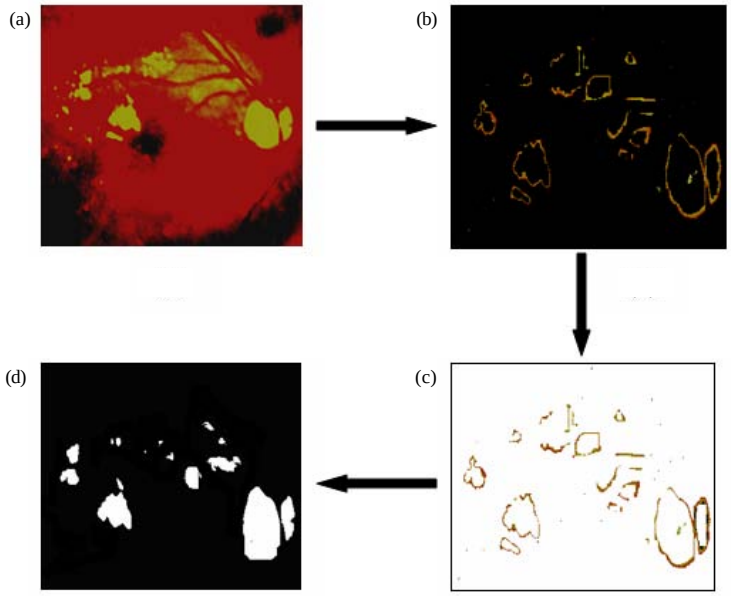

Fig. 5: a) Noisy eye image; b) density of the edge length; c) initial position map and d) final thresholding of edge map

each point and the orientation of that gradient. The gradient magnitude is given in Fig. 5:

$$|G| = \sqrt{G_x^2 + G_y^2} \tag{10}$$

Although typically, an approximate magnitude is computed using:

$$|G| = |G_x| + |G_y| \tag{11}$$

Which is much faster to compute. The angle of orientation of the edge (relative to the pixel grid) girise to the spatial gradient is given by:

$$\alpha = \arctan\left(\frac{G_y}{G_x}\right) - \frac{3\pi}{4} \tag{12}$$

In this case, orientation 0 is taken to mean that the direction of maximum contrast from black to white runs from left to right on the image and other angles are measured anti-clockwise from this. Often, this absolute magnitude is the only output the user sees the two components of the gradient are conveniently computed and added in a single pass over the input image using the pseudo convolution operator shown in Fig. 5. Using this mask the approximate magnitude is given by:

$$|G| = \left| \begin{matrix} (N_1 + 2xN_2 + N_3) - (N_7 + 2xN_8 + N_9) + \\ (N_3 + 2xN_8 + N_9) - (N_1 + 2xN_4 + N_7) \end{matrix} \right| \tag{13}$$

The Sobel operator is slower to compute than the Roberts cross operator but its larger convolution mask smooth's the input image to a greater extend and so makes the operator less sensitive to noise (Rankin *et al*., 2009; Bae *et al*., 2003). The problem can be avoided by using an image type that supports pixel values with a larger range.

RESULTS AND DISCUSSION

To further evaluate the efficiency of the proposed method in addition to the visual inspection, the proposed Boundary Detection Method numerically using the Hausdorff distance and the probability of error in image segmentation. Where, P(O) and P(B) are probabilities of objects and background in images. The objects surrounded by the contours obtained using the five snake models and the proposed method are compared with that manually drawn by skilled doctors from the Medical Hospital. Table 1 shows the average results of probability of error in image segmentation of canny edge detection algorithm, Sobel Edge Detection algorithm and medical standard value and also predicts the error difference. Showing the results it shows the error difference value is very minimal and also negligible. So, the proposed techniques produced nearer to the standard value. Figure 6 shows the comparative analysis of Canny edge detection value, Sobel operator value and the Medical standard value which is collected from the standard hospital.

Table 1: Average results of probability of error in image segmentation

Image illustration	Canny edge segmentation (%)	Sobel edge detection (%)	Medical standard value (%)	Error difference (Canny) (%)	Error difference (Sobel) (%)
Edge length	9.52	9.42	9.51	+0.01	-0.09
Contrast	6.76	6.85	6.73	+0.03	+0.12
Lag of accommodation	8.01	8.05	8.00	- 0.01	+0.05
ROI	7.43	7.35	7.44	- 0.01	-0.09

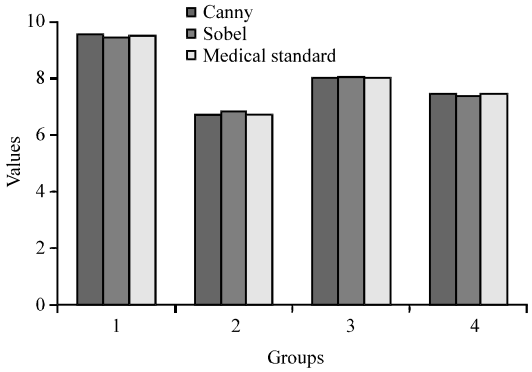

Fig. 6: Comparative analysis graph for Canny edge detection value, Sobel value and medical standard value

CONCLUSION

Edge detection is one of the important modules of any image processing technique. In this research, researchers have proposed the edge detection technique based on Region of Interest (ROI) and also Edge Length (EL) to recognize the human eye. The performance of the proposed systems has been verified and validated with existing problem. Out of two proposed technique, Canny Edge Detection technique is a novel technique to identify the diabetic retinopathy and also the proposed technique shows significant results and compared with the other conventional techniques and also using this technique researchers can able to predict the cholesterol inside the eye as one of the future extraction.

REFERENCES

Abhyankar, S., L.A. Hornak and S.C. Schuckers, 2005. Biorthogonal wavelet-based iris recognition. Proceedings of the SPIE Symposium Defense and Security Conference Volume 5779, March 28-29, 2005, Orlando, FL., pp: 59-67.

Bae, K., S.I. Noh and J. Kim, 2003. Iris feature extraction using independent component analysis. Proceedings of the 14th Conference on Audio and Video Based Biometric Person Authentication, June 9-11, 2003, Guildford, UK., pp: 838-844.

Bulling, A., J.A. Ward, H. Gellersen and G. Troster, 2011. Eye movement analysis for activity recognition using electrooculography. IEEE Trans. Pattern Anal. Mach. Intell., 33: 741-753.

Chibelushi, C.C., J.S. Mason and F. Deravi, 1993. Integration of acoustic and visual speech for speaker recognition. Proceedings of the 3rd European Conference on Speech Communication and Technology, September 22-25, 1993, Berlin, Germany, pp: 157-160.

Destrempes, F., J. Meunier, M.F. Giroux, G. Soulez and G. Cloutier, 2009. Segmentation in ultrasonic B-mode images of healthy carotid arteries using mixtures of nakagami distributions and stochastic optimization. IEEE Trans. Med. Imag., 28: 215-229.

Farouk, R.M., R. Kumar and K.A. Riad, 2001. Iris matching using multi-dimensional artificial neural network. IET Comput. Vision, 5: 178-184.

Guerrero, J., S.E. Salcudean, J.A. McEwen, B.A. Masri and S. Nicolaou, 2007. Real-time vessel segmentation and tracking for ultrasound imaging applications. IEEE Trans. Med. Imag., 26: 1079-1090.

Jain, A.K., A. Ross and S. Prabhakar, 2004. An introduction to biometric recognition. IEEE Trans. Circuits Syst. Video Technol., 14: 4-20.

Kim, B.S., H. Lee and W.Y. Kim, 2010. Rapid eye detection method for non-glasses type 3D display on portable devices. IEEE Trans. Consumer Electron., 56: 2498-2505.

Ramlee, R.A. and S. Ranjit, 2009. Using iris recognition algorithm, detecting cholesterol presence. Proceedings of the International Conference on Information Management and Engineering, April 3-5, 2009, Kuala Lumpur, pp: 714-717.

Rankin, D., B. Scotney, P. Morrow, R. McDowell and B. Pierscionek, 2009. Comparing and improving algorithms for iris recognition. Proceedings of the 13th International Machine Vision and Image Processing Conference, September 2-4, 2009, Dublin, pp: 99-104.

Ross, A. and A.K. Jain, 2004. Multimodal biometrics: An overview. Proceedings of the 12th European Signal Processing Conference, September 6-10, 2004, Vienna, Austria, pp: 1221-1224.

Ross, A., A.K. Jain and J.Z. Qian, 2001. Information fusion in biometrics. Proceedings of the Third International Conference on Audio- and Video-Based Biometric Person Authentication, June 2001, Springer-Verlag, London, pp: 354-359.

Sanchez-Reillo, R. and C. Sanchez-Avila, 2001. Iris recognition with low template size. Proceedings of the 3rd International Conference on Audio- and Video-Based Biometric Person Authentication, June 6–8, 2001, Halmstad, Sweden, pp: 324-329.

Schmid, N.A., M.V. Ketkar, H. Singh and B. Cukic, 2006. Performance analysis of iris-based identification system at the matching score level. IEEE Trans. Inform. Forensics Secur., 1: 154-168.

Suresh, P., M. Madheswaran and R. Kesavan, 2008. Finite element modelling and analysis of magnetic resonance imaging of lumbar spine using Pro/E software. Int. J. Comput. Intell. Health Care Inform., 1: 50-56.

Theera-Umpon, N. and S. Dhompongsa, 2007. Morphological granulometric features of nucleus in automatic bone marrow white blood cell classification. IEEE Trans. Inform. Technol. Biomed., 11: 353-359.