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Application of Edge Enhancement and Edge Detection method for Blood Vessel Extraction from Retinal Images

A.P. Sherine, S. Wilfred Franklin

***Abstract*—The retinal blood vessel has been recognized as a crucial component in both ophthalmological and cardiovascular disease identification, the precise segmentation of the retinal vessel tree has developed the essential stage for computer-aided identification systems. To enhance the accuracy, vigorous, and debauched vessel segmentation technique, this paper has examined an image segmentation process. It has established and executed a scheme of the precise retinal vessel segmentation. Edge Enhancement and Edge Detection (EEED) has been offered for blood vessel extraction (BVE). It has been intended particularly for atypical retinal images covering low vessel contrasts, drusen, exudates, and other artifacts.**

***Index Terms*—BVE, retinal blood vessel, EEED, Retinal image processing**

I. Introduction

Retinal vasculature assembly associates vital data aids the ophthalmologist in perceiving and identifying a diversity of retinal pathology for instance Retinopathy of Prematurity (RoP), diabetic retinopathy, glaucoma, hypertension, and age-related macular degeneration or in identification of diseases associated to brain and heart stocks, that are related to the irregular disparities in retinal vascular structure. Consequently, variations in retina's arterioles and venules morphology have a major indicative value. Generally, vessels segmentation inhabit a extraordinary place in medical image segmentation arena [1–4]; retinal vessels segmentation fits to this group where a wide-ranging of approaches have been established and executed to identify, site and extract retinal vasculature assemblies [5–10]. Standard images are those comprising high contrast vessels and even background radiance and which do not comprise eye anomalies for instance drusen, exudates, lesions, and microaneurysms. Removal of vessel tree for standard images is not much beneficial in contrast with the irregular retinal images which carry valuable data regarding evolution of various eye anomalies. A retinal image has blood vessels with erratic widths (36 micron to 180 micron) and erratic focal point illumination. The contrast of the blood vessels also differs: maximum for dense vessels and minimum for tinny vessels. In the occurrence of abnormalities in the retinal images, removal of tree structure befits complex.

A.P.Sherine, Department of ECE, C.S.I Institute of Technology, Thovalai, Tamil Nadu, India
S.Wilfred Franklin, Department of ECE, C.S.I Institute of Technology, Thovalai, Tamil Nadu, India

Previously, kernel based approaches for instance edge detection filters [11] and matched filters [12, 13] were proposed. In matched filter approaches if a larger kernel is chosen, dense vessels are attained exactly where reedy vessels with enlarged thickness are attained. Minor kernels can aid to exactly choose the reedy vessels with greater correspondence, but the dense vessels are attained with minimum thicknesses. An orthodox matched filtering method thus necessitates more dissimilar sized kernels with various alignments. Several images conforming to various kernels are merged to get the resultant tree structure. Indigenous and province based assets to segment blood vessels have been described in [14] using a probing method. Pixels are categorized as vessels or non-vessels by lessening threshold. A computerized tortuosity extent method for tree extraction is described in [15]. The technique in [15] utilizes matched filtering, thresholding, diminishing and linear classifier algorithm to attain vessel tree. A cataloguing rate of 91% of blood vessel segmentation and 95% of the vessel network was described. Recently, localization and segmentation of optic disc in retinal images [16, 17] has been presented. In EEED method a least of the two images: unique retinal image and its blurry form, is produced which is more blurred by using a Laplacian of Gaussian (LOG) filter which provides an improved form of blood vessels. The image is threshold using OTSU and the noise is detached from the binary image. The resultant image offers a noise free blood vessel tree.

II. BVE using EEED

EEED technique disperses the surplus edges which are not blood vessels. It is very healthy and quick. Most of the methods operate well on standard retinal images having no anomalies. As the retinal image suits anomalous because of the presence of drusen or lesser image contrast, the recital of the methods drops and the vessel tree structures attained with those methods do not signify the real blood vessels tree. To validate the ability of EEED, an image exposed in Figure 1 which is low in contrast and simultaneously comprises a huge number of drusen range over the whole retinal image has been selected. The methods do not offer adequate results mainly for images as shown in Figure 1. The aims of the EEED method are to improve the contrast of blood vessels and simultaneously diffuse the other anomalous topographies available in the retinal image. Implementation of LOG filter improves the vessel contrast and subdues the other anomalous image topographies. It can be threshold by any normal method, such as OTSU thresholding method can be implemented to get binary vessel tree.

For the extraction of blood vessels with EEED, a retinal image is first convolved with a large Gaussian blurring kernel. The blurred image will lose all the details contained in the retinal image and will contain only the illumination pattern. Once a Gaussian blurred image is obtained from a retinal image, another image is formed out of the two images. The resulting image is actually a minimum of the two images. The blood vessels in a retinal image normally have intensities lying in the lower range. The minimum image enhances this fact; that is, the blood vessels have the lowest values with enhanced edges in comparison with background. The background in the minimum image is completely diffused suppressing information about the drusen and the optic disc. The minimum image is then blurred a little bit, normally with a Gaussian blurring technique with a small kernel. This process helps to develop continuity in the broken pieces of vessel tree structure. The blurred-minimum image is then convolved with a LOG filter with a kernel size of (9, 9). The resultant image is contrast enhanced and contrast reversed with more prominent vessel trees and more uniform background. If the retinal image contains noise comparable with the contrast of vessel trees, then the noise will also be enhanced. Due to contrast reversal, the vessels now look bright with boundaries having dark edges. This is a typical feature which appears with the use of LOG filters. The application of the LOG filter gives an image with uniform background intensity. This feature is similar to the use of a homomorphic filter on a retinal image. Due to uniform background intensity and the vessel tree having higher intensities as compared with background, the image is simply thresholded using any optimum thresholding technique. We used the OTSU algorithm to obtain optimum thresholding for the image obtained with the LOG filter. The thresholding process converts the LOG filtered image into a binary image. The binary image consists of the blood vessel tree structure and noise. Some images at this stage have more noise and some have relatively less.

Noise in the binary images can be eliminated using a length filtering technique or a noise removal technique. We developed our own noise removal algorithm for binary images. The algorithm works in windows of sizes (x, x) where x may vary from 4 to 16. In this algorithm all the pixel values on the boundary of a window are summed up. If all the boundary pixels have zero values, that is, the sum of boundary pixel values is zero, then all the pixels within the window are deleted. The working of this algorithm gave satisfactory results. After application of this algorithm the image obtained contained only the vessel tree structure. This method is fast and does not involve human intervention at any stage.

III. SIMULATION RESULTS

To implement EEED method for vessel tree extraction, a retinal image as exposed in Figure 1 has been employed. It was convolved with a Gaussian blurring kernel of $\sigma = 24$. The blurred image so attained has been displayed in Figure 2. The minimum of these two images have been calculated and the ensuing image has been exposed in Figure 3. A vessel enriched image on a non-uniform background has been illustrated in Figure 3. It was then convolved with a Gaussian blurring kernel of $\sigma = 1$. This method aids to cultivate steadiness in the vessel tree structure; else wrecked or lost pixels in the binary vessel tree will be perceived as shown in Figure 4. The finest threshold calculated on Figure 4 does not provide a suitable vessel tree since the illumination of the background is still uneven. To neglect this problem, Figure 4 with a LOG kernel of size (9, 9) has been convolved and shown in Figure 5. It is contrast inverted in which the blood vessels have brighter concentrations and dark edges. A finest threshold was evaluated for Figure 5 and the binary image thus attained has been illustrated in Figure 6. Figure 6 has binary noise which is not available in vessel tree structure. The length-filtering method has been employed to eliminate the binary noise which is not availed in vessel tree. A window of size (8, 8) was selected and the noise removal process was implemented for Figure 6 and the subsequent image has been revealed in Figure 7. The noise removal procedure with a window size of (16, 16) has been applied to get a noise free image as shown in Figure 8.

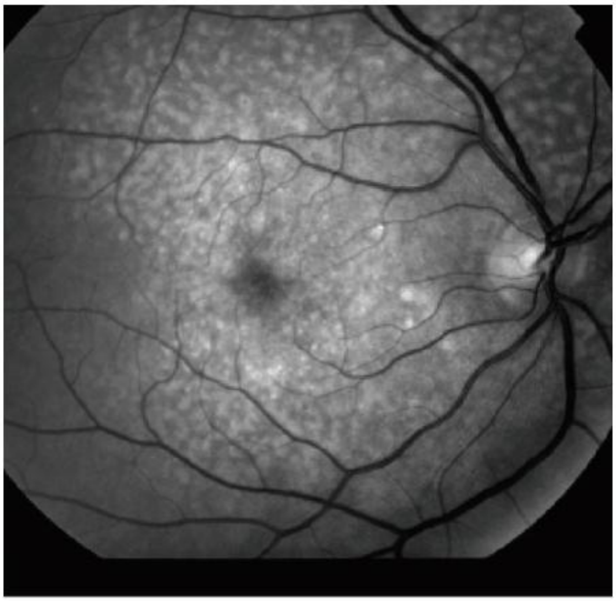

Fig. 1. Original retinal image

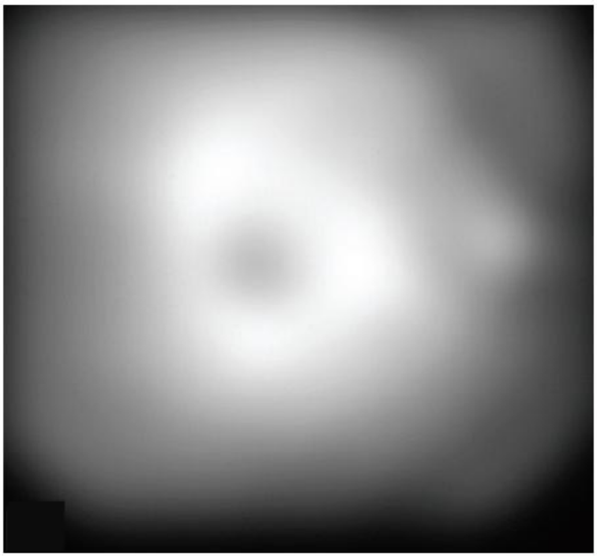

Fig. 2. Gaussian blur of Figure 1 with $\sigma = 24$

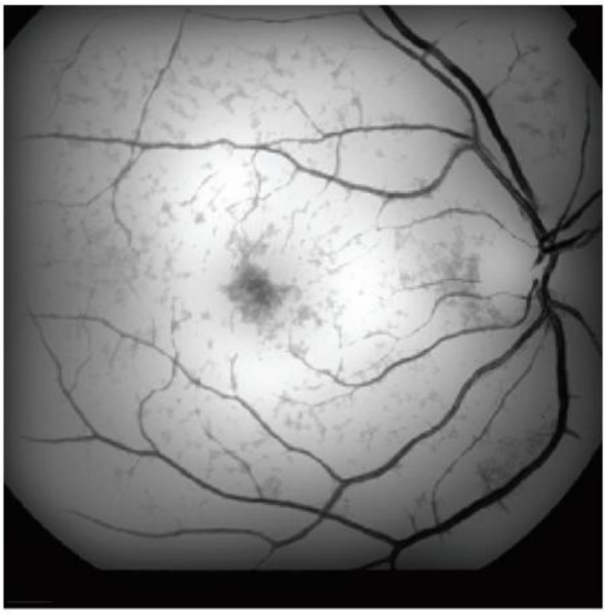

Fig. 3. Minimum of the figures 1 and 2

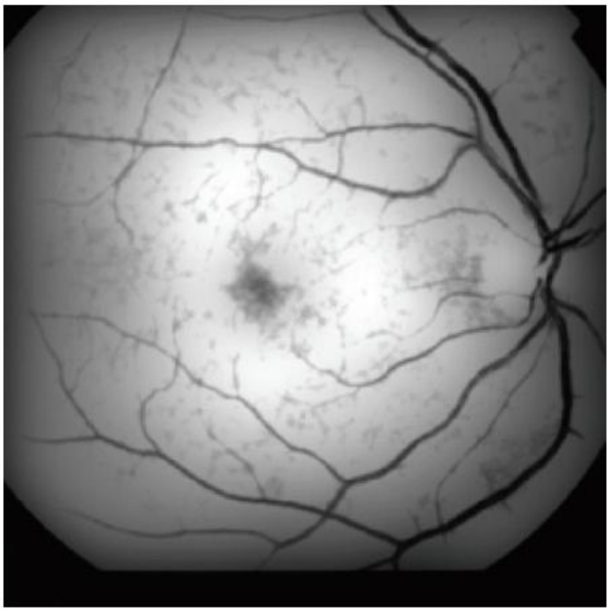

Fig. 4. Gaussian blur of Figure 3 width σ = 1

Fig. 5. Result of LOG filter convolution of size (9, 9) of Figure 4

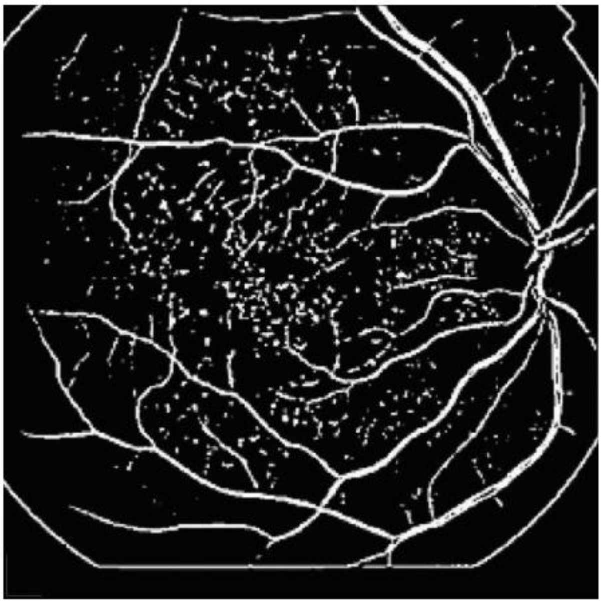

Fig. 6. Optimum threshold of Figure 5

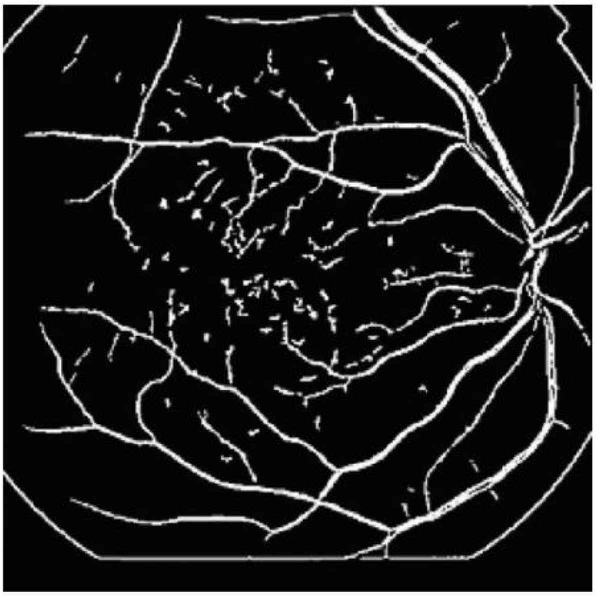

Fig. 7. Application of noise deletion filter of window size (8, 8) to Figure 6

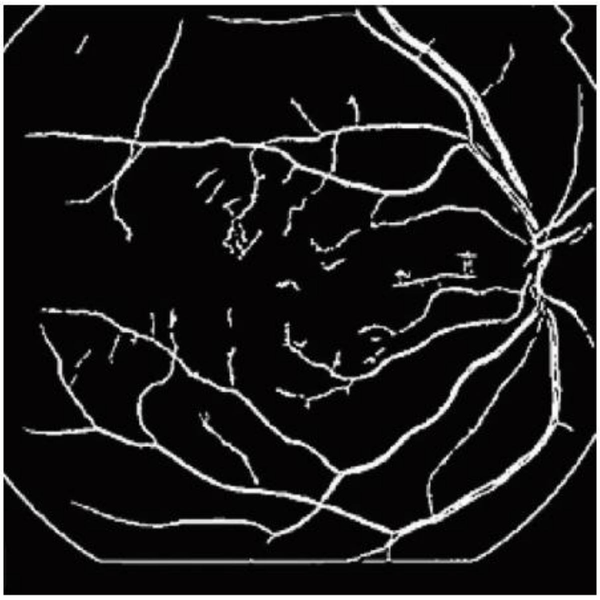

Fig. 8. Application of noise deletion filter of window size (16, 16) to Figure 7

IV. DISCUSSION

Figure 8 attained using EEED comprises a small number of broken pieces of vessels. The execution time was very low for EEED. Other methods excerpt binary vessel trees of retinal images with noise. Some forms of noise filters are deployed to eliminate noise but result with losing parts of the vessels. The proposed method offers a sensible solution to these difficulties. It recovers noise free vessel tree images and simultaneously conserves the thinner vessel segments in the vessel trees.

Other techniques do not offer sensible result with the low quality images. In this study, an image has been chosen with low quality and low contrast where the thinner parts of the vessel tree structure are barely observable with naked eye. In the occurrence of these anomalies, the proposed method provides precise results in the removal of full tree structure retentive the thinner vessel parts and simultaneously eliminating the noise as its characteristic skill.

V. CONCLUSION

BVE is complex due to the diversity of illumination disorders, patient races, low contrast small vessel recognition, and the adjustment between precision and calculation efficacy. The results of BVE are the basis of several vital medical applications. By investigating the distribution of vessel site, width and tortuosity, some diseases can be identified early, which intensely lessen the risk of grave impact. Likewise, blood vessel network is the only palpable structure that subsists in all retinal images. It can be utilized as the innovatory for retinal image recording and biometric verification. This study has established and executed an accurate system for retinal vessel segmentation. Edge Enhancement and Edge Detection (EEED) has been presented for BVE. It has been modeled for anomalous retinal images having low vessel contrasts, drusen, exudates, and other artifacts. The results imply the efficacy of the proposed method. The study not only be employed to retinal images, but also recognition glitches of any linear shape substances for instance roads on the satellite map. This work is projected to build a foundation for future studies on biomedical image processing.

REFERENCES

[1] Lesage, D.; Angelini, E.D.; Bloch, I.; Funka-Lea, G. A review of 3D vessel lumen segmentation techniques: Models, features and extraction schemes. Med. Image Anal. 2009, 13, 819–845.

[2] Kirbas, C.; Quek, F. A review of vessel extraction techniques and algorithms. ACM Comput. Surv. CSUR 2004, 36, 81–121.

[3] Kirbas, C.; Quek, F.K. Vessel extraction techniques and algorithms: A survey. In Proceedings of the Third IEEE symposium on Bioinformatics and Bioengineering, Bethesda, MD, USA, 12 March 2003; pp. 238–245.

[4] Suri, J.S.; Liu, K.; Reden, L.; Laxminarayan, S. A review on MR vascular image processing: Skeleton versus nonskeleton approaches: Part II. IEEE Trans. Inf. Technol. Biomed. 2002, 6, 338–350.

[5] Fraz, M.M.; Remagnino, P.; Hoppe, A.; Uyyanonvara, B.; Rudnicka, A.R.; Owen, C.G.; Barman, S.A. Blood vessel segmentation methodologies in retinal images—A survey. Comput. Methods Program Biomed. 2012, 108, 407–433.

[6] Srinidhi, C.L.; Aparna, P.; Rajan, J. Recent Advancements in Retinal Vessel Segmentation. J. Med. Syst. 2017, 41, 70.

[7] Dash, J.; Bhoi, N. A Survey on Blood Vessel Detection Methodologies in Retinal Images. In Proceedings of the 2015 International Conference on Computational Intelligence and Networks, Bhubaneshwar, India, 12–13 January 2015; pp. 166–171.

[8] Mansour, R. Evolutionary Computing Enriched Computer Aided Diagnosis System for Diabetic Retinopathy: A Survey. IEEE Rev. Biomed. Eng. 2017, 10, 334–349.

[9] Pohankar, N.P.; Wankhade, N.R. Different methods used for extraction of blood vessels from retinal images. In Proceedings of the 2016 World Conference on Futuristic Trends in Research and Innovation for Social Welfare (Startup Conclave), Coimbatore, India, 29 February–1 March 2016; pp. 1–4.

[10] Singh, N.; Kaur, L. A survey on blood vessel segmentation methods in retinal images. In Proceedings of the 2015 International Conference on Electronic Design, Computer Networks & Automated Verification (EDCAV), Shillong, India, 29–30 January 2015; pp. 23–28.

[11] R. C. Gonzalez and R. E. Woods, Digital Image Processing, 2nd edition, 2001.

[12] S. Chaudhuri, S. Chatterjee, N. Katz, M. Nelson, and M. Goldbaum, "Detection of blood vessels in retinal images using two-dimensional matched flters," IEEE Transactions on Medical Imaging, vol. 8, no. 3, pp. 263–269, 1989.

[13] D. H. Friedman, Detection of Signals by Template Matching, Johns Hopkins University Press, Baltimore, Md, USA, 1969.

[14] A. Hoover, "Locating blood vessels in retinal images by piecewise threshold probing of a matched filter response," IEEE Transactions on Medical Imaging, vol. 19, no. 3, pp. 203–210, 2000.

[15] W. E. Hart, M. Goldbaum, B. Cote, P. Kube, and M. R. Nelson, "Automated measurement of retinal vascular tortuosity," in Proceedings of the AMIA Fall Conference, 1997.

[16] A. A. Mudassar and S. Butt, "Snakes with coordinate regeneration technique: an application to retinal disc boundary detection," Journal of Medical Engineering, vol. 2013, Article ID 852613, 11 pages, 2013.

[17] A. A. Mudassar and S. Butt, "Application of principal component analysis in automatic localization of optic disc and fovea in retinal images," Journal of Medical Engineering, vol. 2013, Article ID 989712, 12 pages, 2013.