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Review on Retinal Vessel Segmentation Using Neighbourhood Estimator Before Filling on Fundus Images

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ABSTRACT

In retinal images exact detection of vessel is important and hard task. In pathological images detection is difficult with the presence of exudates and abnormalities. The motive of segmentation is to really make the illustration of the image easier so that it can be more smoothly analysed. Many ways of retinal vessel segmentation are planned which could identify the exudates in fundus images in more encouraging manner. The overall objective of this paper is to utilize Neighbourhood Estimator before Filling (NEBF) called inpainting filter which is used to inpaint exudates so that false positive are reduced during vessel enhancement.

Keywords: Vessel segmentation, Exudates, Inpainting NEBF

I. INTRODUCTION

Segmentation indicates subdivides an image into their constituent location and objects. The amount to that subdivision is carried depends upon the issue being solved i.e. Segmentation must end when object of fascination in an images has been isolated.

1.1. Types of eye disease

a) Diabetic Retinopathy: Most typical vision illness and the primary cause of blindness in lots of people. Once the blood vessels are damaged they flow blood and grow sensitive vessels. The various form of diabetic retinopathy involves existence of microaneurysms or haemorrhages, exudates, cotton wool places and macular oedema.

b) Macular degeneration: Macula is the retina's central portion which is responsible for vision in the eye. It is caused by deterioration or breakdown of macula.

c) Glaucoma: Glaucoma is due to injury to the optic nerve that leads to perspective loss. It occurs when fluid builds up in the front part of eye; the extra fluid that builds increases the pressure in eye which damaging the optic nerve.

1.2. Retinal Vessel Segmentation in Fundus Images

Now a days there are number of people increases that are suffering from eye related disorders. Most commom eye related diseases are glaucoma, age-related macular degeneration and diabetic retinopathy. Due to these diseases the chances of loss of vision and blindness are very high [3]. But early diagnosis of these disorders can reduced the chances of blindness and vision loss. With the invention of new systems and advancement of technology various methods are available to take color medical images. Images are taken of different parts of body such as bones, brain, heart, kidney, retina etc. [6]

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Then different processing techniques are used for the analysis of these images. These medical images are very helpful in diagnosis and treatment of many diseases. Fundus picture represents an essential position in testing of eye as fundus has high sensitivity to vascular diseases. From the image of fundus diagnosis of these diseases is quite easy. Retina is an important part of a human eye and is an indicator of eye disorders. Retinal vessels have very important information regarding the condition of patient. From the fundus images retinal blood vessels are segmented by using image segmentation techniques[5]. So our concern is to segment image of retina in such a way so that vessel part and non vessel portions are separated from each other. Then from these segmented vessels automatic diagnosis of various diseases become easy. So our concern is to design an accurate method of retinal vessel segmentation [2].

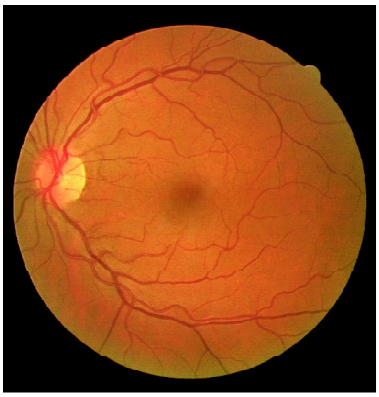

Figure 1.1: Fundus Images

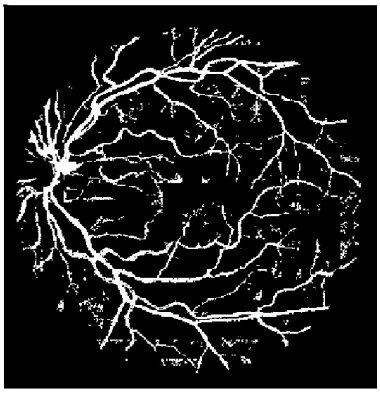

Figure 1.2: Segmented Image

With the advancement of technology various methods are available to take color medical images. Image segmentation techniques help the doctor in automatic analysis of these diseases. Retinal vessel segmentation is an important step in the diagnosis of eye related diseases. Retinal vessels have very important information regarding the condition of patient. Fundus photography play an important part in detection of diseases. Automatic segmentation of fundus image is done by using different techniques[1].

Different methods of image segmentation are available but as compared to other images segmentation of retinal blood vessel is a complex process as there are branches and complex topologies in fundus image. Correct segmentation of these branches is quite necessary. Artefacts are also there in images due to variation in illumination. Also there are vessels of varying diameters that need to be properly segmented. Noisy background of the image also harm the accuracy of the image. So segmentation of fundus image to get the vessel portion is not an easy task. To attain good results different segmentation techniques are used. Some image segmentation techniques that are being used in retinal vessel segmentation are explained in the following section [4].

1.3. Vessel classification

Supervised Method

This method is based on the pre-classified data which classifying each image pixels as vessel and non-vessel pixels using ground truth data. It requires a training phase which needs a training set for manually segmenting the images. Their performance is greater than unsupervised method but it is time consuming.

Unsupervised Method

This method doesn’t require any trained data as in the case of supervised methods. These methods include the clustering techniques which groups the data into clusters.

1.4. Classification Methodologies

Matched Filtering

Used for automated vessel segmentation. It contains kernel that's rotated through small angles in different directions by comparing with input image and observe the worthiness that matches the maximum. Following are the properties to create the filter kernel: 1) in 2-D kernel as they shift outward from the optic disk the vessel diameters reduce. 2) The cross-sectional gray level pixel intensity of body vessels features a Gaussian profile. Their profile could be approximated by a Gaussian curve. 3) Blood vessels normally have confined curvature. Thus, the anti-parallel sets might be approximated by piecewise linear segments.

Vessel tracking

Vessel tracking could be the vessel segmentation method which performs on the one vessel rather than the entire vasculature and then segment a vessel between two points based on local information. The different properties of vessels along with the width, length, contrast, tortuosity and unevenness are considered to find the centreline in retina. The procedure starts with the seed point. Localization of the first vessel point could be manual or automatic. In the manual tracing, the user chooses the first vessel point, which is mainly used in coronary angiography examination and they give precise vessel segmentation. In the automatic tracing, the first vessel point is automatically selected by algorithm.

Model based approach

In this type of approach, to extract the vessel structure the explicit vessel models are used. In this method there are four categories: deformable model, parametric model, generalized cylinders and template matching. Deformable models are used to find object contours by means of parametric curves that deform under the impact of internal and external factors. Parameter model establish objects of interest parametrically. Template matching follows a top down approach to identify a structure model in an image. It follows a top down approach. The generalized cylinder used to represent cylindrical objects.

Mathematical morphology

Mathematical morphology deals with extracting the components from the image like various shapes like boundaries, skeletons. Morphological operators take two arguments: structuring elements and binary images. The structuring element is a small binary image. The different morphological operations include erosion, dilation, opening closing, hit and miss transformation which can be used to find, alter and manipulate characteristics within in the image. Dilation and erosion are dual operations applying to an image that contract or expand the edges of regions. The opening and closing operations used to pick for characteristics and remove noise. The hit and miss transform enables to derive data how objects in a binary picture are related with their surroundings. Both transforms can be used for detecting specific shapes.

Multi- scale Approach

A multi-scale approach performs segmentation at varying image resolutions from low to high. Major vessels are extracted in images which has low resolution while fine vessels are extracted which has high resolution. The main advantage of this method is improved processing speed and robustness. It is based on wavelet transform.

Neighbourhood Estimator Before Filling (NEBF)

NEBF is an inpainting filter which is used to inpaint the exudates i.e. filling the holes in images so that false positives are reduced for vessel enhancement. The main purpose would be to fill exudate in a very clean way. We proceed towards the exudate core. Using threshold to detect exudates they leave the undetected pixels border for this reason we dilate the exudate mask. Iteration by iteration the background pixel diminishes while estimated pixel increase. The NEBF reduces the edges within filled region.

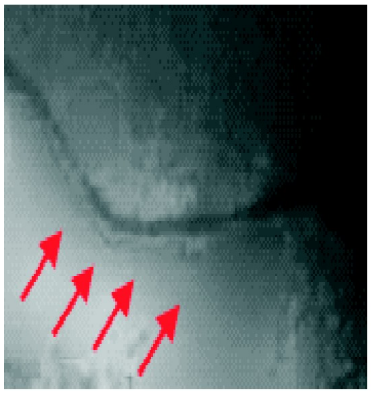

Figure 1.3: without Neighbourhood Estimation

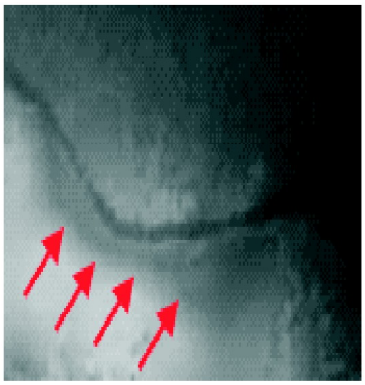

Figure 1.4: smoother edges within exudate region with Neighbourhood Estimation

II. LITERATURE SURVEY

Odstrcilik et al. (2013) [7] the usage of hysteresis binary-classification paradigm for retinal vessel segmentation. Multidimensional feature vector is determined for every pixel to ensure that vessels and background are separated in feature space. Then classification is implemented using several classifiers that base from the hysteresis-classifier design paradigm.

Roychowdhury et al. (2015) [8] Has Proposed a new method that use multiple scales to enhance the contrast of image using Contour let transform. After contrast enhancement, the combination of spatial image processing, (LBP) - Local Binary Pattern, morphological method and is used for blood vessel segmentation from the fundus images. Then classification step is implemented using (MLP)-Multilayer Perceptron and Adaptive Neuro-Fuzzy Inference System (ANFIS).

Priyanka et al. (2013) [9] planned the technique of retinal body vessel segmentation using clustering algorithm DBSCAN. The algorithm is based on the density-based notion of clusters that are created to obtain the clusters that have arbitrary shapes. Just simple feedback parameter is required for DBSCAN and aids the average person in deciding an appropriate price with regard to it.

Muthu et al. (2012) [10] proposed a way to segment the fundus image by using AdaBoost. In this paper 41-D feature vector is created for every pixel. These feature vectors have information regarding the pixel's intensity, spatial properties, and structural properties of image at different scales. Then AdaBoost classifier is used that determines whether pixel belongs to vessel or non-vessel class.

Pereira et al. (2015) [11] feature the usage of Possibilistic fuzzy c-means clustering for segmentation of retinal vessels from fundus image. Possibilistic fuzzy c-means (PFCM) clustering optimised by way of a cuckoo search technique can be used to eliminate the constraints of the prior fuzzy c-means method. This method is very appropriate and robust against the noise.

Akram et al. (2013) [12] proposed a method of retinal blood vessel segmentation that use the pixel intensity data of equally red and green stations of image. That data is applied on modify for non-uniform illumination. To improve the distinction of vessels when compared with background matched filter is used. Then vessel segmentation is bought using spatially fuzzy-c means clustering based thresholding.

Annunziata et al. (2016) [13] has learned that in retinal images the correct vessel detection is a difficult and essential task. In pathological images recognition is more difficult in with the clear presence of exudates and different abnormalities. An unsupervised vessel segmentation method is used to address that problem. An inpainting filtration, called Neighbourhood estimator before filling, is proposed to inpaint exudates in vessel images in a way that regional false positives are significantly reduced all through vessel enhancement.

Retinal image enhancement is reached with a multiple-scale Hessian approach. Experimental effects reveal that the proposed vessel segmentation process outperforms state-of-the-art formulas noted in the new literature, both visually and when it comes to quantitative measurements.

Esakkirajan et al. (2011) [14] proposed an approach applying Local adaptive Histogram Equalization method to part the retinal ships from fundus image. Pre-processing of fundus image is done to enhance the histogram of grey range image. Then consequence of linear and non-linear depth change on body vessel segmentation is observed. The constraints of MF - FDOG centred vessel segmentation methods are eliminated applying adaptive histogram equalization method.

Roychowdhury et al. (2014) [15] has proposed a method for segmentation of the retinal vessel from the fundus images using line operators. A line detector is used on green channel of the fundus image. Then linear features are calculated based on average grey level along lines which have 15 pixels and pass at 12 orientations from target pixel. Two different segmentation methods| are used. Firstly simple line detector is used and threshold is applied to obtain unsupervised pixel classification. Secondly a support vector machine is employed for construct feature vector. For this reason, two orthogonal line detector is used. Therefore retinal vessel segmentation is attained by using two different methods.

Shanmugavadivu et al. (2012) [16] follow an approach using radial projection and semi-supervised approach for fundus picture segmentation. That technique emphasis on the removal of two kinds of ships i.e. broad and thin vessel. Vessel centrelines that consist of the low-contrast and narrow ships are produced using radial projection method. Then revised steerable complex wavelet is employed to improve the improvement below numerous machines and the function vector is built so that vessel pixel is represented by range strength. The significant ships are produced using semi-supervised self-training. Final segmentation of the fundus picture is acquired by the mixture of two kinds of vessels.

Saleh et al. (2014) [17] has proposed a method of retinal blood vessel segmentation from fundus image. Pixel classification is performed using seven dimensional function vectors that are extracted from the fundus image. Neural Network scheme is useful for classification that may determine whether a pixels belonging to vessel or non-vessel class. Then in post processing stage, gaps in pixels which can be found in retinal vessels are filled and false pixel vessels are removed.

Kafieh et al. (2013) [18] proposed a scheme that use combined filters consist of Frangi filter, matched filter and Gabor filter for feature extraction and enhancement of vessel. Then two different methods are used segment the image after vessel enhancement. First is a deformable model used for segmentation and second method is fuzzy-c means. Therefore in this approach firstly vessels are enhanced by applying combination of filters and fundus image vessel enhancement segmentation is performed using two methods.

CONCLUSION

Correct vessel detection in retinal images is a significant and difficult task. Automated segmentation of fundus image represents a significant role in detection of eye diseases. Lately, a few types of retinal vessel segmentation are planned which could detect the exudates in fundus images in more promising manner. The NEBF filter has revealed great usefulness in removing exudates. Detection of vessel and different Retinal structures combined together could solve the issue of precise and reliable retinal vessel segmentation technique. The review has shown that the issue of segmentation technique applying evolutionary optimization is ignored in fundus images. In future we will increase the accuracy of vessel segmentation a hybrid Neighbourhood Estimator before Filling with ant colony based segmentation.

REFERENCES

[1] Fang, Guoliang, Nan Yang, Huchuan Lu, and Kaisong Li. "Automatic segmentation of hard exudates in fundus images based on boosted soft segmentation." In *Intelligent Control and Information Processing (ICICIP), 2010 International Conference on*, pp. 633-638. IEEE, 2010.

[2] Rozlan, Ahmad Zikri, N. S. Mohd Ali, and Hadzli Hashim. "GUI system for enhancing blood vessels segmentation in digital fundus images." In *Control and System Graduate Research Colloquium (ICSGRC), 2012 IEEE*, pp. 55-59. IEEE, 2012

[3] Giachetti, Andrea, Khai Sing Chin, Emanuele Trucco, Caroline Cobb, and Peter J. Wilson. "Multiresolution localization and segmentation of the optical disc in fundus images using inpainted background and vessel information." In *Image Processing (ICIP), 2011 18th IEEE International Conference on*, pp. 2145-2148. IEEE, 2011.

[4] Kong, Lingwang, Qiong Li, and Shanhu Huang. "Color Image Segmentation Scheme for Retinopathic Fundus." In *Computer Science and Software Engineering, 2008 International Conference on*, vol. 6, pp. 237-240. IEEE, 2008.

[5] Lee, Noah, Andrew Laine, and R. Theodore Smith. "A hybrid segmentation approach for geographic atrophy in fundus auto-fluorescence images for diagnosis of age-related macular degeneration." In *Engineering in Medicine and Biology Society, 2007. EMBS 2007. 29th Annual International Conference of the IEEE*, pp. 4965-4968. IEEE, 2007.

[6] Yin, Fengshou, Jiang Liu, Sim Heng Ong, Ying Sun, Damon WK Wong, Ngan Meng Tan, Carol Cheung, Mani Baskaran, Tin Aung, and Tien Yin Wong. "Model-based optic nerve head segmentation on retinal fundus images." In *Engineering in Medicine and Biology Society, EMBC, 2011 Annual International Conference of the IEEE*, pp. 2626-2629. IEEE, 2011.

[7] Odstrcilik, Jan, Radim Kolar, Attila Budai, Joachim Hornegger, Jiri Jan, Jiri Gazarek, Tomas Kubena, Pavel Cernosek, Ondrej Svoboda, and Elli Angelopoulou. "Retinal vessel segmentation by improved matched filtering: evaluation on a new high-resolution fundus image database." *IET Image Processing* 7, no. 4 (2013): 373-383.

[8] Roychowdhury, S., D. D. Koozekanani, and K. K. Parhi. "Iterative Vessel Segmentation of Fundus Images." (2015).

[9] Priyanka Kamboj, Versha Rani,"Image Enhancement Using Hybrid Filtering Techniques", International Journal of Science and Research, Vol 2, No. 6, June 2013.

[10] Muthu Rama Krishnan, M., U. Rajendra Acharya, Chua Kuang Chua, Lim Choo Min, Eddie Yin-Kwee Ng, Milind M. Mushrif, and Augustinus Laude. "Application of intuitionistic fuzzy histon segmentation for the automated detection of optic disc in digital fundus images." In *Biomedical and Health Informatics (BHI), 2012 IEEE-EMBS International Conference on*, pp. 444-447. IEEE, 2012.

[11] Pereira, Carla, Luís Gonçalves, and Manuel Ferreira. "Exudate segmentation in fundus images using an ant colony optimization approach." *Information Sciences* 296 (2015): 14-24.

[12] Akram, M. Usman, Sundus Mujtaba, and Anam Tariq. "Automated drusen segmentation in fundus images for diagnosing age related macular degeneration." In *Electronics, Computer and Computation (ICECCO), 2013 International Conference on*, pp. 17-20. IEEE, 2013.

[13] R. Annunziata, A. Garzelli, L. Ballerini, A. Mecocci and E. Trucco, "Leveraging Multiscale Hessian-Based Enhancement with a Novel Exudate Inpainting Technique for Retinal Vessel Segmentation," in *IEEE Journal of Biomedical and Health Informatics*, vol. 20, no. 4, pp. 1129-1138, July 2016.

[14] S. Esakkirajan, T. Veerakumar, Adabala N. Subramanyam, and C. H. PremChand, "Removal of High Density Salt and Pepper Noise Through Modified Decision Based Unsymmetric Trimmed Median Filter", IEEE SIGNAL PROCESSING LETTERS, VOL. 18, NO. 5, MAY 2011.

[15] Roychowdhury, S., D. D. Koozekanani, and K. K. Parhi. "Blood Vessel Segmentation of Fundus Images by Major Vessel Extraction and Sub-Image Classification." (2014).

[16] Shanmugavadivu, Eliahim Jeevaraj, "Laplace Equation based Adaptive Median Filter for Highly Corrupted Images" International Conference on Computer Communication and Informatics 2012, Jan. 10 – 12, 2012.

[17] Saleh, Marwan D., N. D. Salih, C. Eswaran, and Junaidi Abdullah. "Automated segmentation of optic disc in fundus images." In *Signal Processing & its Applications (CSPA), 2014 IEEE 10th International Colloquium on*, pp. 145-150. IEEE, 2014.

[18] Kafieh, Rahele, Hosseins Rabbani, Fedra Hajizadeh, and Mohammadreza Ommani. "An accurate multimodal 3-D vessel segmentation method based on brightness variations on OCT layers and curvelet domain fundus image analysis." *Biomedical Engineering, IEEE Transactions on* 60, no. 10 (2013): 2815-2823.