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**Segmentation of Blood Vessels & Optic Disc in Retinal Image and
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ABSTRACT

Retinal image analysis and identification of retinal diseases are highly important for the early treatment of eye diseases. Retinal image segmentation is trending in the field of ophthalmology. The goal of the proposed system is to segment the blood Vessels and Optic Disc to diagnose retinal diseases without human supervision. In this method, first the vessel tree is extracted using the improved graph cut technique. The max-flow algorithm is used to cut the graph and to perform the optimized segmentation. The Markov random field image reconstruction method is used to segment the optic disc region without any tissue overlaps. The knowledge of blood vessel and the optic disc is an important indicator for disease like diabetic retinopathy.

Keywords: Retinal Image, Graph cut method, Blood vessel segmentation, optic disc segmentation

I. INTRODUCTION

Retinal is a delicate, light sensory membrane at the posterior of eye that acquires the image furnished by the lens. Normally digital Fundus Cameras are used to capture images of Retina. Fundus image is used for further processing to analyze morphology of blood vessels and optic disc. The retinal image segmentation structures helps in unsupervised diagnosis of diseases in medical field of ophthalmology. The morphology of the retinal blood vessel and the optic disc helps in identifying the retinal diseases such as diabetic retinopathy and glaucoma. So we should have a appropriate technique for obtaining retinal vessel tree and optic disc, which doesn't disrupt the original information present in the input image.

First of all, let us understand the most common retinal disorders like Diabetic retinopathy. Chronically high blood sugar from diabetes damages the blood vessels present in retina which might be major cause for diabetic retinopathy. Main purpose of retina layer is detects light from outside and converts the light to signals to be sent to brain by optic nerve. Diabetic retinopathy weakens the blood vessels in the retina and it leads to fluid leakage or bleeding in retina.

Proliferation of new abnormal blood vessels on the surface of the retina happens on advance stage of disease leading to cell loss in the retina.

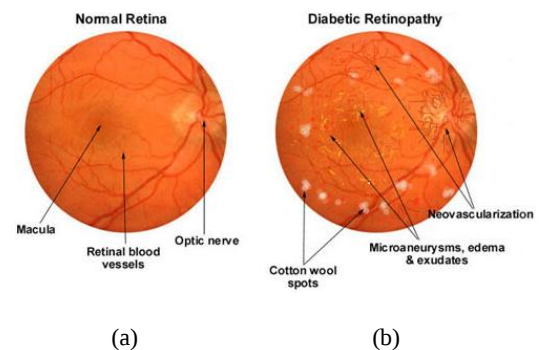


Fig. 1 (a) Normal retinal image (b) Diabetic retinopathy affected retinal image

II. RELATED WORKS

Graph-based approach was implemented by Xiayu[1] for finding blood vessel boundary delineation. This approach measures the widths of the retinal blood vessels and segments its edges. Based on blood vessels weight, graph is constructed. The REVIEW database was used as reference in this work. The deficiencies in this graph based approach are crossing and branching points are not treated individually currently and blood vessel detection points are

not clearly indicated. Xu[2] proposed Tracking-based approach. The tracking method first detects initial seed points on the vessel. It then tracks the remaining neighborhood pixels in the vessel throughout the image by using the continuous spreading of the blood vessels. If the input image has some discontinuity in vessel tree, then this method lacks in extracting a complete vascular tree and needs manual input intervention.

Pixel-processing-based approach was used by Zhang[3]. This approach searches all the possible vessel pixels and provides comprehensive information of the vascular tree in the retinal image since they scan across the whole image. But this method is relatively expensive and requires a set of hardware to be suitable for huge image dataset. There will be significant degradation in performance of this method if the retinal image has presence of noise and lesions.

Morphological processing method is proposed by Aquino[4]. Morphology refers to the study of object forms or shapes. To enhance vessel edges the morphological opening and closing operation are applied to an image based on multi structure elements. Disadvantage of this method is significant features like intersection and bifurcation points may be missed out. Anushikha[5] proposed Region growing method. Region growing is a procedure that groups pixels or regions into larger regions. This method has few drawbacks. It requires user supplied seed points and the selection of seeds that properly represent regions of interest. This may yield over segmentation because of the changes in image intensities.

III. PROPOSED SYSTEM

In the proposed system blood vessels were segmented first and then optic disc is segmented. The main goal of the proposed system is to diagnose diabetic retinopathy based on the segmented vessel and optic disc information. Proposed system uses graph cut method and Max flow algorithm to segment the blood vessels. For optic disc segmentation MRF reconstruction method is used to remove the overlapping vessels from the retinal image.

a. BLOOD VESSEL SEGMENTATION

The first step in diagnosis of retinal diseases is pre-processing of retinal image. Usually the quality of the acquired images will not be good enough for processing. So, it is necessary to improve the quality of retinal image. Pre-processing suppresses the noisy area or undesired

distortions from retinal image, so now the retinal image will be suitable for further processing.

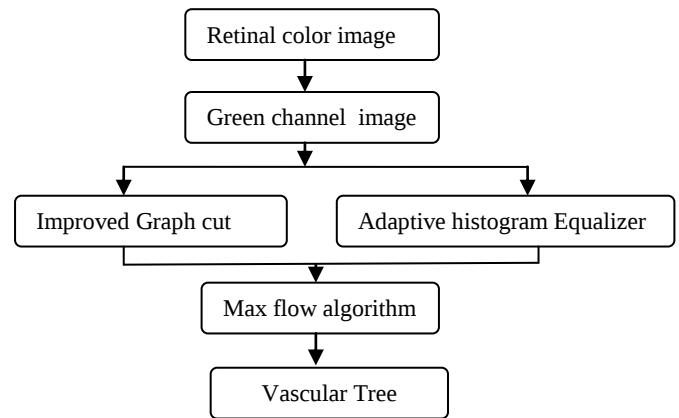


Fig. 3 Steps involved in Blood vessel segmentation

The input color retinal image is converted into green channel image for further processing by contrast enhancement process. The illumination of the input image is equalized and an adaptive histogram equalizer is used to enhance the green channel image. Window length values were carefully chosen to increase the contrast between vessel and background pixel. Morphological binary open process is used to get rid of undesirable pixels. Thus false positives were reduced and quality of the image is increased.

Now improved graph cut method is used to segment the blood vessels from the retinal image. The graph method is defined as g energy-based segmentation method. To minimize energy generated from given image data, image is optimized using energy-based segmentation. A graph can be formed by defining nodes and edges that connects the neighborhood nodes. The relationship between neighborhood pixel elements is used to form the graph of foreground and background terminal pixels. Prior knowledge was needed into the graph formulation to find the optimal segmentation. This graph cut technique used to incorporate this need.

Main disadvantage of graph cut algorithm is the shrinking bias problem which causes a significant degradation of the performance on thin elongated structures like the blood vessels. During graph formation, the thin edges of the blood vessel information can be lost due to the selection lowest cost path. To overcome the shrinking bias issue vectors flux were added into the construction of the graph.

Vectors flux can improve the alignment of edge pixels and allows a balance between shrinking and stretching

during the segmentation of blood vessels. The graph is constructed by incorporating the flux of vector with symmetric and antisymmetric part of the graph. Symmetric part is used to assign weights on the edges between the neighboring pixels and antisymmetric part is to assign weight on edges between a given pixel and the terminals. Thus the blood vessels are decomposed into X-direction and Y-direction. The optimal segmentation is found by using max-flow algorithm by cutting the graph. Thus blood vessels are segmented from the retinal image.

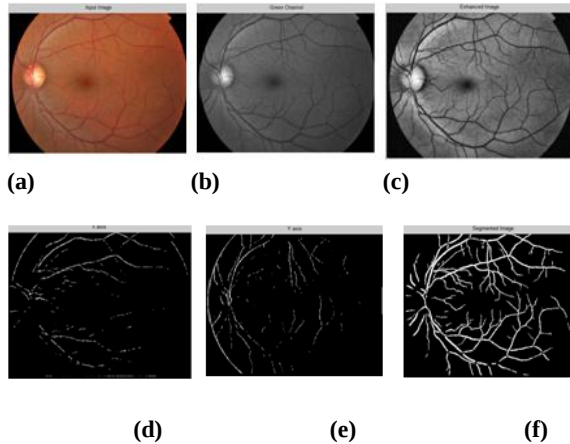


Fig. 4 (a) Input image (b) Green channel Image (c) Enhanced image (d) X-axis segmented blood vessel (e) Y-axis segmented blood vessel (f) Segmented blood vessel

b. OPTIC DISK SEGMENTATION

The first step in optic disc segmentation is defining the location of the optic disc. The MRF method is applied to eliminate the vessel from the optic disc region.

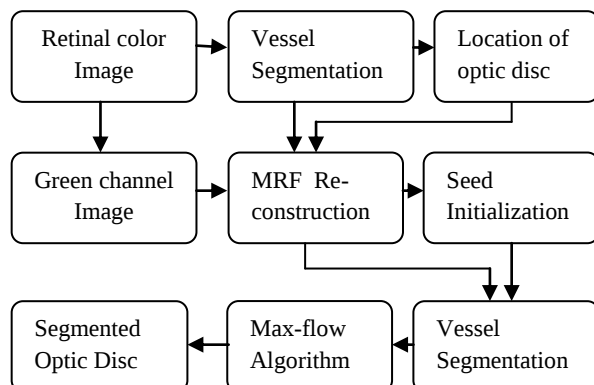


Fig. 5 Steps involved in Optic disc segmentation

The first step in optic disc segmentation is to define the location of the optic disc. To estimate the optic disc

location, the convergences of blood vessels were considered. First the brightest region is detected by the algorithm to find the location of the optic disc. This point is called centroid and this point is adjusted until the center of the optic disc is identified by the algorithm. The whole area covered by the optic disc is considered as Region of Interest(ROI).

The contrast of blood vessels present in the retinal image might mislead the segmentation of optic disc and it might break the continuity of the optic disc. MRF reconstruction method can be used to overcome this problem. But this method is computationally complex and it requires more computations. If we perform this algorithm on the entire retinal image then it will be time consuming, so we can perform this algorithm only on the ROI image.

Now graph cut algorithm is used to remove the blood vessels from the ROI image. This method separates foreground and background pixels. Max flow algorithm can be deployed to achieve optimum blood vessel segmentation.

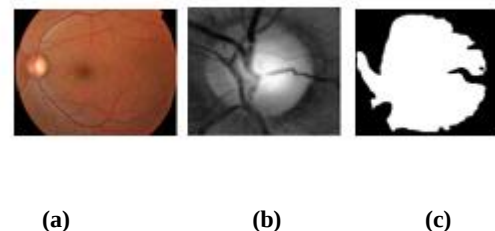


Fig.6 (a) Input image (b) Reconstructed ROI (c) Segmented optic disc.

c. DISEASE IDENTIFICATION

One of the first abnormalities detected were microaneurysms which represent local enlargements of the retinal capillaries. Hemorrhages can be caused by ruptured microaneurysms. Over longer period of time, hard exudates may appear. Lipid formations leaking from weakened blood vessels are hard exudates. The blood vessels may become obstructed which causes microinfarcts in the retina as the retinopathy advances. These microinfarcts are called soft exudates. Extensive lack of oxygen caused by microinfarcts causes the development of new fragile vessels. It's a serious eyesight threatening state and may cause major loss in visual acuity or even permanent blindness and this phenomenon is called neovascularization. Vessel tracking technique can be used to find parent-child relationship between blood vessel segments towards a point of convergence assumed be the

centre of the optic disk. Morphological processing is used to identify the diseases present in the retinal image.

Morphological operations like dilation and erosion were used as a structuring element to analyze the input retinal image. Morphological reconstruction is nothing but the output of multiple dilation of the image to form the marker image and mask image. These operations were performed on the Retinal image after removing the Optic disc using above mentioned process.

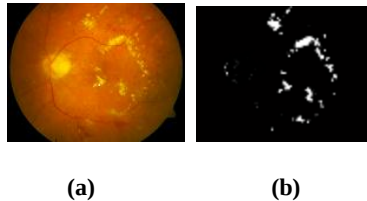


Fig.7 (a) Input image (b) diabetic retinopathy

IV. DATASETS USED FOR RETINAL IMAGE

a. DRIVE :

Digital retinal Images for vessel extraction (DRIVE) provides set of fundus images for analysis. Fundus images were taken using Canon CR5 non-mydratic 3CCD camera with field of view value as 45 degree. This database has 40 images and those were used for training and test sets.

b. STARE:

STructured analysis of the Retina (STARE) database was initiated by the University of California. STARE database has around 20 images taken by a Top-ConTRV-50 fundus camera with field of view value 35 degree .The mask image for this dataset was calculated using a simple threshold technique for each color channel.

c. DIARETDB1:

Diabetic retinopathy database(DIARETDB) is a publically available database for validating diabetic retinopathy detection algorithms. This database has around 89 fundus images. 5 images were normal retinal image without any sign of Diabetic retinopathy but rest of 84 has mild signs of Diabetic retinopathy.

V. DISCUSSIONS AND CONCLUSION

This paper has discussed about the improved graph cut and Max flow methods used for blood vessels

and optic disk segmentation in retinal. We have integrated the concept of flux with graph cut method to improve the quality of the blood vessels segmented from the input image. Also we have deployed Markov random field method and compensation method for reconstructing the image and to extract the proper image of optic disc. The process also use pre-processing techniques such as contrast enhancement, Morphological operation like binary opening, distance transform and adaptive histogram equalization method.

The main improvement proposed in this paper is to overcome tissue shrinking and tissue overlapping issues. The overlapping ratio is calculated for this method and it shows good improvement over the existing segmentation methods. Also the sensitivity value (ratio of true positives and false negatives) is improved which means that this method is almost accurate.

We have evaluated this segmentation method across various publically available image databases and also with the retinal image obtained from Dr.Agarwal eye clinic. Thus we can use this method in various medical fields to analyze the input image. This method is fast and effective since it doesn't require any manual supervision.

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