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Extraction of Blood Vessels and Recognition of Bifurcation Points in Retinal Fundus Image

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Abstract: *Retinal vessel extraction is important for the diagnosis of numerous eye diseases and it contains valuable information for the diagnosis of retinal diseases. Diabetic Retinopathy (DR) is a major cause of adult blindness due to changes in blood vessel structure and distribution such as new vessel growth and requires laborious analysis from a specialist. Early recognition of changes in the blood vessel patterns can prevent major vision loss as early intervention is possible. Therefore, proposed algorithm for extraction of blood vessels of the retina and detecting the bifurcation points of blood vessels is efficient and it can be applied to high resolution fundus photographs. Preprocessing operation is performed on high resolution fundus images and the blood vessel network is then extracted from the detected features by manual thresholding followed by a simple morphological operation. The bifurcation points are detected on the binary vessel map obtained using Minutiae techniques. This proposed algorithm is simple and easy to implement and hence it is best suited for fast processing applications.*

Keywords: *Fundus Images ,Blood Vessels , Retinal Images, 2D Median Filter, Morphological Operations, Thresholding, Bifurcation.*

1. Introduction

Eye, an organ associated with vision in man is housed in socket of bone called orbit and is protected from the external air by the eyelids. Light entering the eye through the pupil is focused on the retina.The retina is the only location where blood vessels can be directly captured non-invasively in vivo. Figure 1 shows the cross sectional diagram of human eye. Retinal images of humans play a crucial role in the detection and diagnosis of several eye diseases for the oculists [1-2].The patients might not notice a loss of vision until it becomes too severe, hence early diagnosis and timely treatment is vital to delay or prevent blindness. Retinal fundus images provide a unique possibility to take a non – invasive look at the eye and the systematic status of the human body. The retina can be considered as important for the health status of a person. Fundus images which is taken from different diseased patients are not of good quality and are low contrast, poor light conditioning , noisy, and thus affecting both the retinal background texture and the blood vessels structure.. Their structure will be complex and it includes bifurcations and overlaps that may mix up to detect the system. Therefore, to detect the retinal images is necessary, and among them the detection of blood vessels is most important. As blood vessels detection becomes more essential to diagnosis the diseases in clinical, many researchers have been done in this medical field. In order to utilize these useful characteristics of retinal blood vessels, it is very important to obtain their locations and shape accurately, so the manual detection is difficult. Hence, a manual measurement becomes tedious and time consuming process. Hence, a manual measurement becomes tedious and time consuming process. Therefore, the proposed algorithm efficiently locates and extracts blood vessels in ocular fundus images. It is a huge challenge, since large variability is observed and a natural variation is reported in the appearance of the retina.

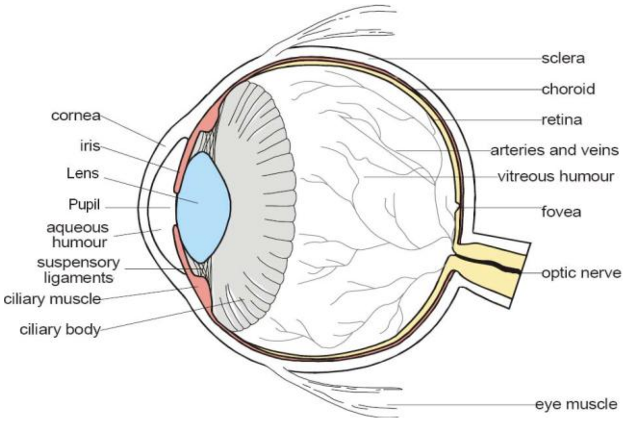

Figure1. *Cross sectional diagram of human eye*

2. METHODOLOGY

There are some image processing techniques which are used in this algorithm to enhance the blood vessels. The main modules are pre-processing, Morphological Operations, 2D Median Filter, Thresholding and Minutiae Techniques which are organized to remove the area that binds more than blood vessels (bifurcation points) found in retinal blood vessels. Figure 2 shows the block diagram for proposed method.

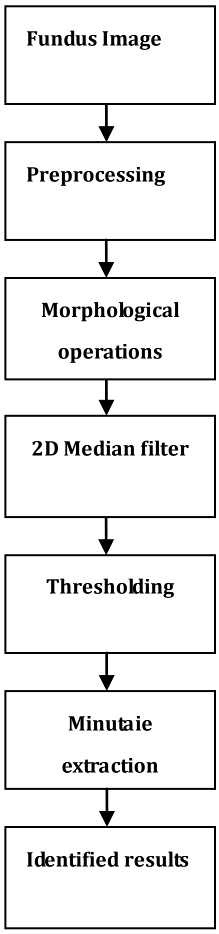

Figure 2. *Block Diagram for proposed method*

2.1 Preprocessing

Retinal images usually have pathological noise and various texture backgrounds, which may cause difficulties in extraction. Therefore, the retinal blood vessel extraction is required pre-processing step to diagnose the diseases. The input is original fundus image of human retina which is captured from fundus camera and the skeletionzed binary image of blood vessels is an output. The figure 3 shows the retinal image.

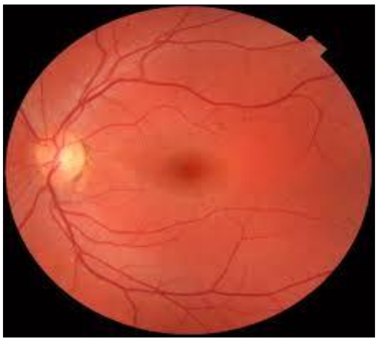

Figure 3. *Retinal image*

In the fundus image the contrast tends to be bright in centre, light in variations, noise influence, hence to minimize this effect pre-processing is essential and have more uniform image.

In the first stage Color retinal fundus image is first converted into a gray-scale image in order to facilitate the greatest contrast of the blood vessels segmentation and to decrease the computational time. Then use the complement function for enhancing the blood vessels of the retina. In the binary image the (black) background pixel become foreground pixel (white).For grey scale the procedure is to replace each pixel value Iinput (i,j) as follows –

$$Ioutput\ (i,j) = MAX - Iinput(i,j)$$

Where MAX = 255 is max possible value in given image representation.

The contrast between blood vessels (foreground) and the retinal tissue (background) is generally poor or non – uniform lighting condition. Therefore, it is necessary to deepen the contrast of these images to provide better transform representation for subsequent image analysis steps. Adaptive Histogram Equalization function is used for contrast enhancing complimentary image.

2.2 Morphological Operations

To analyze shapes within the image and to estimate the background, morphological operations are used which are the set of image processing. Structuring element is applied to the image and same size of the image will be the output. The number of pixels being added or removed from the object in the image is affected by the size and shape of the structuring element. The morphological open function is used for thickening the retinal blood vessels. Morphological operation [3] is erosion followed by dilation using same structuring element for both operation. Opening operation has effect to remove the object that cannot contain complete structuring element. To get more uniform background subtract background image from the image.

2.3 2D-Median Filter

The median filter uses 2D linear structuring element for vessel identification. Median filtering also used to remove illumination [2] variations in the image, a shade correction operation. This is carried out by smoothing the gray channel image with a median filter of a large scale neighborhood window size 3 x 3, on the main image to approximate the background. 2D Median Filter is used for highlighting and removes the noise from morphological open function. As the 2D median filter is non – linear, each pixel value is replaced by median of gray level in neighborhood of pixel. A median filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges.

2.4 Thresholding

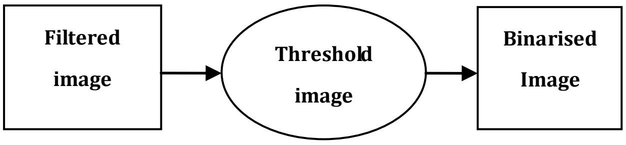

Figure 4. *The process of thresholding along with its inputs and outputs.*

The figure 4 shows the process of thresholding along with its input and output.The main purpose in this step is to eliminate background variations in illumination from an image so that foreground objects may be more easily analyzed. Binary image is produced in which the value of each pixel is either 1(blood vessel) or 0 (background).Then the binary image is skeletionized to reduce all the objects in an image to thin line strokes that retain important information about the shape of original object.

2.5 Detection of Bifurcation Points

Retinal vessel land marks are bifurcation point, crossing point and end point. Among these features bifurcation point is reliable and abundant feature in fundus image. One of the unique features is bifurcation points. The junction on vessels from where two child nerves are generated. To detect the bifurcation points, skeleton image for retinal image is taken as input .A region of interest containing the skeleton vessels [4]. The area that binds more than one blood vessel in skeleton image is to be detected and removed. To extract the bifurcation point minutiae extraction is important, It is implemented on skeleton image by using a concept of crossing number (CN).A window of the size 3 x 3 pixels is used in which there are eight neighboring pixels to the central pixel. For 3 x 3 window, if central pixel is 1and has exactly 3 one-value neighborhood, then the central pixel is a bifurcation point. If central pixel is 1and has only 1 one-value neighborhood, then the central pixel is a ridge ending point (ridge point where it ends) that constitute blood vessel pattern. i.e if CN(P)==1,it is a ridge and if CN(P)==3,then it is a bifurcation point. At each step have to compute, In order to see whether a pixel is a bifurcation point of a vessel or binded more than blood vessel, place the 3 x 3 window on the image so that the considered pixel is at the center of the window and find the bifurcation point. If the central pixel does not lie on any vessel, it is not a bifurcation point. If the centre pixel lie on the vessel then it is a bifurcation point .The window is applied to all image pixels (except for the pixels on the edges) and all points are classified into bifurcation points or crossover points (one vessel cross other vessel).

3. Requirement Specification

3.1 Hardware requirement

- Intel Pentium Dual CPU Processor,
- 1 GB RAM

3.2 Software Requirement

- Operating System-Windows 7/windows XP.
- MATLAB software of 7.9.0 version or a higher is selected.
- Image processing toolbox.

4. RESULTS

Digital retinal imaging playing an increasingly prominent role in the diagnosis and treatment of eye diseases and the extraction of clinically useful information has become important task. The proposed algorithm was originally developed for fundus images but it is equally effective for other types of vascular images. The images of retina are collected from DRIVE database [5]. Proposed algorithm may provide a great benefit to ophthalmologists while monitoring, diagnosing and treating the diseases and other ocular-related diseases. Further, the idea developed in this paper can be applied to other images where it is of interest to detect intersections and perform analysis of various vascular objects. Hence, the accuracy was high and all the nodes in image located, detected. For this proposed algorithm GUI is designed in MATLAB for retinal blood vessel extraction and detection of bifurcation points. Figure 4(a), (b), (c) shows the result for extraction of blood vessels. Figure 4(d) shows the final result of the ridges and bifurcation points shown in GUI. The red dots are indicated as ridges and a blue dot is indicated as bifurcation points.

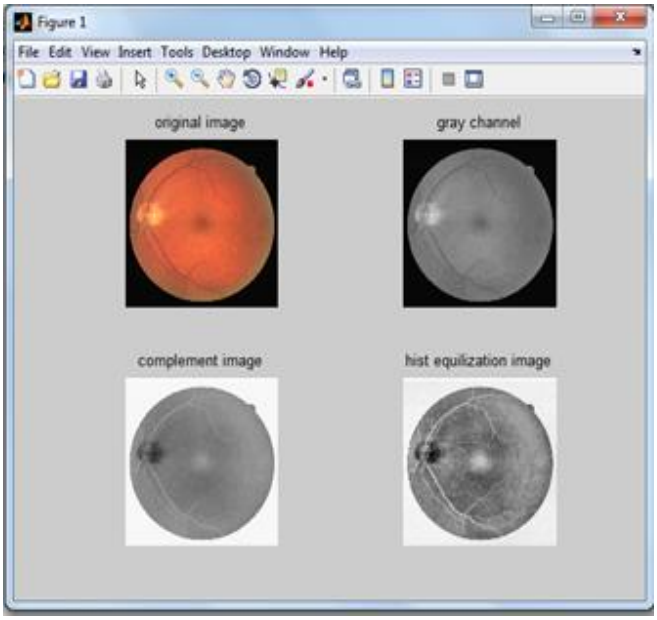

Figure 5 (a). *Fundus I mage and blood vessels enhanced images.*

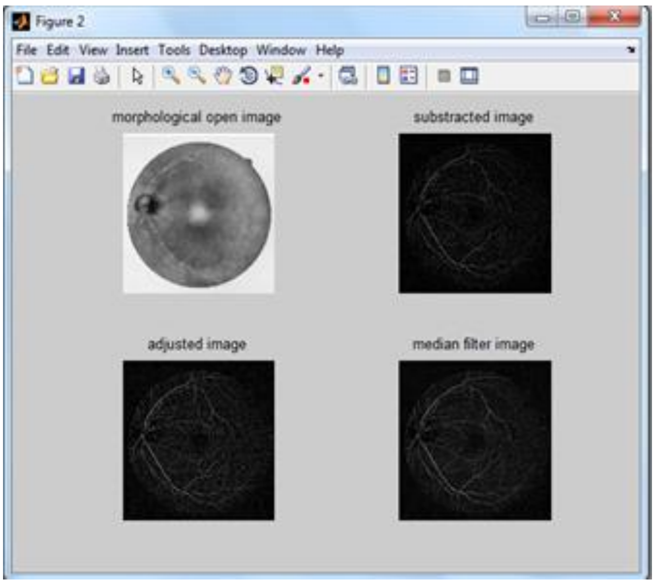

Figure 5 (b). *Image obtained to extract the blood vessels*

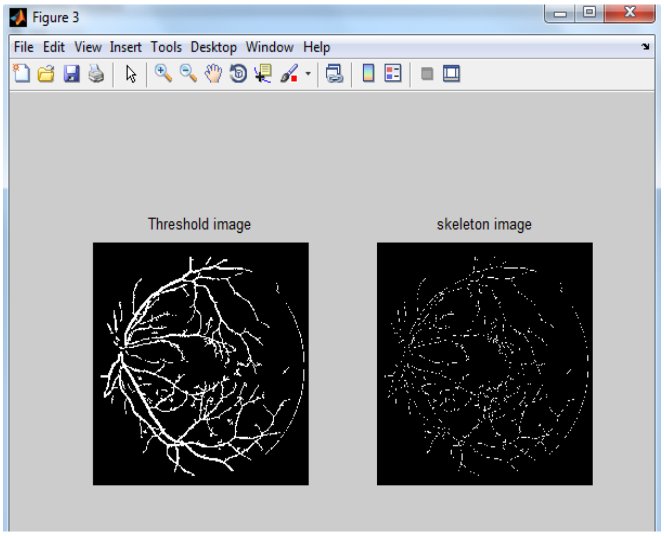

Figure 5 (c). *Binary image and skeletionized image*

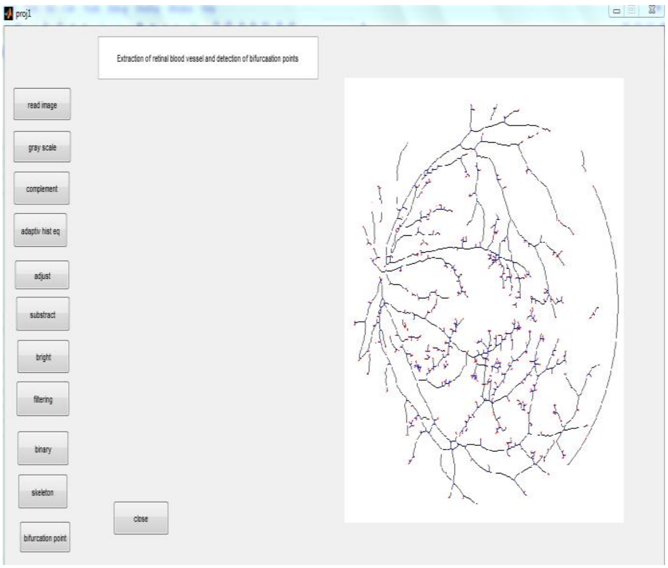

Figure 5 (d). *Ridges and bifurcation points shown in GUI.*

5. Conclusion

This work presents a robust and efficient method for detecting blood vessels in retinal images despite the inherent problems of the images, such as low contrast and intensity variations. Accurate estimation of overall steps of the algorithm is very important for reliable result**.** Image processing techniques are used in this proposed algorithm for extracting the blood vessel of the retina and detecting the bifurcation points of extracted blood vessels. It is easy, simple, reliable, high accurate and efficient algorithm for extracting the blood vessel of the retina and detection of bifurcation points. Proposed vessel extraction technique does not require any user intervention, for both normal and abnormal images has consistent performance.

References

[1] Ana MM, Aurelio C, "Segmentation of Retinal Blood Vessels segmentation by Combining the Centerlines detection And Reconstruction of Morphological", IEEE Trans Medical imaging 2008, 25:1200-1213.

[2] C. Serranob and B. Achab "Detection of blood vessels in color fundus images automatically." Published by Elsevier E., 2010.

[3] A. Bhuiyan ,Nath B., "Classification of Bifurcation and Branch Points detection on Retinal images",(DICTA), 2012 International Conference .

[4] TheDRIVEdatabase,http://www.isi.uu.nl/Research/Databases/DRIVE.in.http://en.wikipedia.org/wiki/BloodVessel Extraction

[5] Chris Solomon, Toby Breckon, "Fundamentals of Digital Image Processing", This edition first published 2011, _ 2011 by John Wiley & Sons. Ltd.

[6] Gonzales R.C., Woods R.E, "Digital Image Processing" (2ed. PH, 2001) (400dpi)(T)(C) (ISBN201180758) (813s) CsIp.