Optic Disc Detection in Retinal Images Using Morphological Operations

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***Abstract*—Retinal images give unique diagnostic information not only about eye disease but about other organs as well [I]. To give the physicians a tool for objective quantitative assessment of the retina, automated methods have been developed. In this report an automated method for the optic disc segmentation is presented. The proposed method consists of 3 major stages which are blood vessel segmentation, Image block creation and Optic Disc segmentation. These stages consist of several minor steps such as preprocessing, application of morphological operations and other image processing steps. The results have shown that the algorithm is very robust and The DRIVE dataset [2] was used for the experimentation of proposed method. This algorithm was able to detect optic disc in 13 out of 20 retinal images which is 65% sensitivity of the algorithm.**

***Index Terms*—Optic Disc, Blood Vessel Segmentation, CLAHE Algorithm, Morphological Operations, Image Overlapping Blocks**

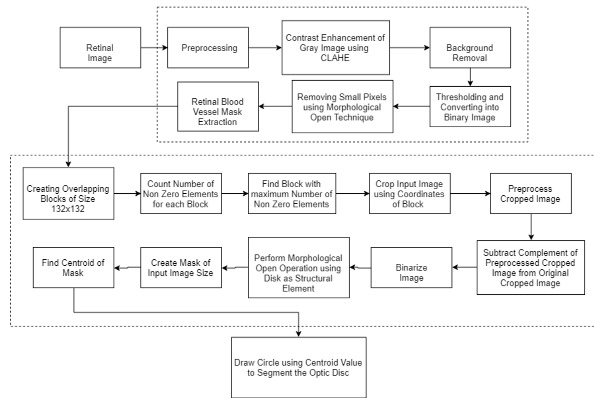


Fig. 1: Block Diagram of the proposed algorithm

I. Introduction

Human being suffer from various optical diseases such as Diabetic Retinopathy & Glaucoma. Digital Images of the retina are used to diagnose these kind of diseases in the patients eye. Diagnosing it on time and starting medication can prevent 98% of severe visual loss[3]. Ophthalmologist might consume lot of time to detect such kind of disease manually. Also it is open to human error to spot minute details which needs to be captured for the diagnosis.Thus there is a requirement for automatic detection of blood vessels and optic disc kind of parameter for the diagnosis with minimum error. The detection of optic disc may be a first step in the early detection of the Glaucoma. Optic disc detection is also required for other diseases in the human eye such as diabetic retinopathy identification.

There are various method exist in the literature for the optic disc detection and segmentation. Methodology presented for the OD segmentation containing different stages by Fraga et al. [4]. Algorithm in [5] the retinal image was normalized by means of the retinex which decrease the contrast variability and increase the process reliability. And there are many such algorithm which detects the optic disc but the algorithm proposed in this approach have simple implementation and faster execution.

In the proposed work the boundary of optic disc is located in three steps approach. First, is segmentation of blood vessels is carried out from the color retina image. Next step is to find the point where the blood vessels are originating which can be obtained by partitioning segmented blood vessel into blocks of images and calculating number of non zero pixels in the blocks. The block with the maximum non zero pixel denotes the place of origin of blood vessels. After finding the block use it to find the optic disc center. Segment the optic disc based on the center of the optic disc and plot a circle using the center. Further the report is divided into three sections. Section II discuss about the methodology used for detecting optic disc which is further partitioned into three subsection. Experimental results and the sensitivity of the proposed approach is discussed in Section III. Last section Section IV provides the summary of the work done in this project.

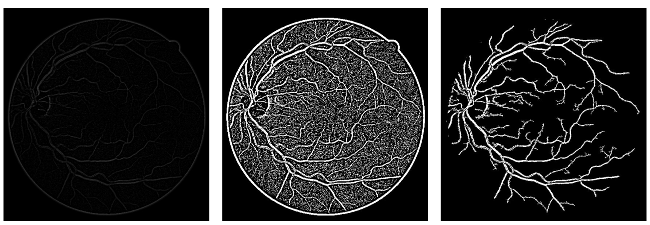
II. Methodology

Digital retinal images are available in various resolutions. This algorithm was designed based on the Digital retinal images provided by the DRIVE database which are of size 584x565 pixels. Fig. 1 show the block diagram of the algorithm developed. The method used for detection of optic disc is divided into three parts which are discussed in detailed in the subsections below.

A. *Blood Vessel Segmentation*

In the following, color retinal image is first converted into gray scale image. In order to extract blood vessel we perform background removal from the gray image. For the process of background removal we first enhance contrast of the image using Contrast Limited Adaptive Histogram Equalization (CLAHE) algorithm. This algorithm enhance contrast of image by getting small section of the image rather applying on whole image at once. After enhancement of contrast of the image apply average filter of size 11x11 and subtract the filter image from the contrast enhanced image which will be left with the blood vessels and some noise when converted into binary image. The next step in blood vessel segmentation from the nosiy binary image is to perform morphological open operation with size 100 to remove small pixels which behaves as noise in the blood segmentation process. At the end of this process we will be having blood vessel segmented image with zero depicting as background pixel and one as foreground or blood vessel. Fig. 2 shows the output from every steps explained above.

(a) image1 (b) image2 (c) image3



(d) image4 (e) image5 (f) image6

Fig. 2: Blood Segmentation Process: a) Gray Scale Image b) Contrast Enhanced Image using CLAHE c) Filtered Image using Average Filtering d) Background Removed Image e) Binary Image with blood vessel segmented and noise f) Noise Removed Image of Blood vessel extracted image

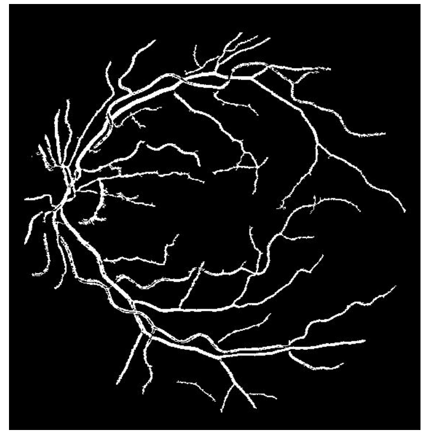
Here for the detection of optic disc we are supposed to extract the thick blood vessel only thin blood vessel will not contribute much towards locating the center of optic disc.

B. Image Overlapping Block Creation

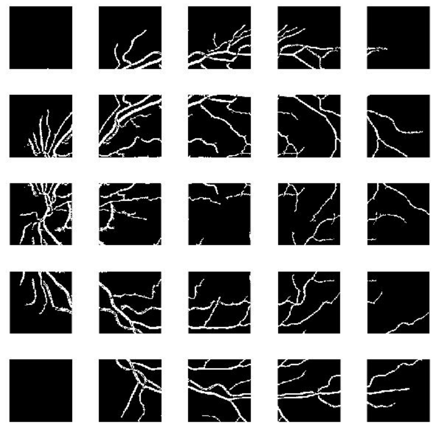
In this section implementation of overlapping block creation is done over non-overlapping blocks. The reason for choosing overlapping block creation is because we require block of image in which the origin of blood vessel spreading out in the retina is available. So block extraction is carried out on the binary image of the segmented blood vessel. First, we require to fix the block size and based on the trial and error method for this algorithm we have used 132x132 block size and shifting of block is carried out by 32 pixels in x and y direction which gives us 25 blocks from 584x565 size image. Fig.3 shows the extracted blocks of images.

C. Optic Disc Segmentation

Final part of the algorithm is to detection of optic disc using the blocks of image obtain in the above process. As shown in the Fig 3.(b) iterating through every block of image finding



(a) image1



(b) image4

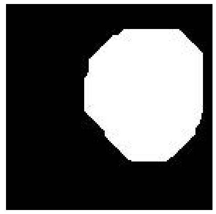
Fig. 3: Overlapping Block Creation Process: a) Blood Vessel Extracted Image b) Blocks of Image

the block with the maximum number of non zero element. The reason for finding the maximum number of non zero element is over the origin of blood vessel spreading the blood vessel will be thick and there will be more number of blood vessel which can be used as finding parameter for the origin of blood vessel. Thus the block with the maximum number of non zero element is used to extract same size block from the original image and then morphological operations are performed on the block of retina image to obtain the mask of optic disc. The size of the mask obtained will be equal to the size of the block so we need to scale the size to the original image. After getting the mask of optic disc centroid is calculated and the a circle is plotted with the diameter of 40 pixel using that centroid value in the original image. Fig. 4 shows the step to obtain the optic disc.

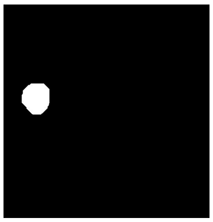
III. Experimental Results

Experiment is carried out on 20 retinal images taken from Digital Retinal Images for Vessel Extraction (DRIVE) database. Parameters were choose based on the trial and

(a) image1



(b) image1



(c) image4

(d) image1

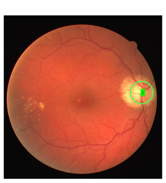
Fig. 4: Overlapping Block Creation Process: a) Blood Vessel Extracted Image b) Blocks of Image

error method. For blood vessel segmentation Number of histogram bins used to build a contrast enhancing transformation, specified as a positive integer scalar. Higher values result in greater dynamic range at the cost of slower processing speed. So choose to keep nbins as 128 and CLAHE contrast enhancement using tiles of 8x8. Average smoothing applied with kernel size of 11x11. For removing noise from binary image of used open operation with maximum number of pixel in object as 100. Next part is to creat blocks of output image from blood vessel segmentation and I have kept the size of block as 132x132 based on trial and error method which gives total 25 blocks of input image of size 584x565. Cropped Image used for the segmentation of Optic Disc. Applied Average filtering using 5x5 kernel. Converted into binary after obtaining bright spot and applied morphological open operation using disc as structural element of radius 25. Obtained binary mask used to draw a circle on input rgb image by finding centroid of the mask.

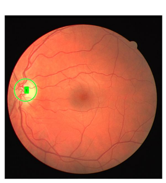
(a) image1

(b) image2

(c) image3



(d) image4



(e) image5

(f) image6

Fig. 5: Optic Disc Segmented Images

Fig. 2 Shows the output images with the green circle on optic disc. This method takes average 5-8 secs to locate the optic disc in the input image. Accuracy can be calculated as given below,

$$Total\ number\ of\ Input\ Image:\ 20\ Images$$

$$Optic\ Disc\ segmented\ correctly:\ 13\ Images$$

$$Optic\ Disc\ segmented\ incorrectly:\ 7\ Images$$

$$Sensitivity\ of\ algorithm:\ 13/(13+7) = 65\%$$

Thus 65% of the time proposed approach was able to detect the optic disc location correctly.

IV. Summary

The proposed algorithm is robust and fast to execute. It was experimented on 20 retina images and we got 65% of the accuracy to detect the optic disc correctly. There are limitation to this algorithms such as this algorithm work for fixed size image which can be improved as future scope.

References

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