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A Novel Method to Segment Blood Vessels and Optic Disc in the Fundus Retinal Images.

Bathala Sivakumar*, and Srilatha K.

Department of Electronics and Communication Engineering, Sathyabama University Chennai, Tamil Nadu, India

ABSTRACT

Retinal automated analysis images disputing research area. It intends to give automated approach to assist in early diagnosis and detection of eye diseases like as macular degeneration and diabetic retinopathy. In the modern ophthalmology, analysis of retinal image is well known nonintrusive diagnosis technique. This paper proposes hessian filtering algorithm to extract the vessel in retinal image. In order to remove noisy lines and restore separated vessel lines in early vessel network apply hessian filter technique in first step. In second step, multi scale hessian filter technique allows to detect all vessels which contain similar dimensions on chosen scale. In this paper we also propose bilateral filter smoothing for optic disk segmentation. The proposed algorithm will test on DRIVE database to verify that and it works better than counterparts. These filters are used to achieve accuracy image.

Keywords: Bilateral filter, hessian filter, blood vessel, optic disc.

Corresponding author

INTRODUCTION

Computer aided analysis of fundus image gives an immediate retinal features properties and detection preceding to consultant inspection. Image segmentation algorithm plays vital role in application of numerous biomedical images like treatment planning, diagnosis, localization opathology and anatomical structure. In this paper the survey of optic disk and blood vessel segmentation algorithm presents, place different technique and method in perspective through existing research classification. Blood vessels are the part of retina that provide oxygen to retina blood vessel and supply blood. If oxygen and blood aren't smooth then it detect whether any health problems present (cardiovascular, hypertension, diabetes and stroke). The retinal blood vessels segmentation helps to detect problematic veins. Many methods have been made to grip blood vessels segmentation (un-supervised and supervised), but still don't meet issues state of art [1]: (1). The light reflection from center, (2) Blood vessels branching, (3) blood vessel, (4) Blood vessels loss are small/ thin (5) Blood vessel error detection (6) Adjacent merging blood vessels. Retina is extremely organized structure by means of ability to begin visual information process before transmitted through visual cortex optic nerve. Layered structure function searches optical disk restrictions or functional impairments on cells group or layer. However, color perception, depth, shape and contrast takes place in cortex [2]. Abdel-Razik Youssif Aliaa Abdel-Haleim et al [3] OD (Optic Disc) is the major features of retina funds images and original image obtain from VDIS dataset. Optic Disc is most significant from pathology indicator. Based on optic disc segmentation some research was done before that detect OD centroid boundary through segmentation previous researches can done with the active contour model. Initially retina binary images constructed then illumination equalization locate OD. Welfer et al [4] explains to separate optic disk with blood vessel through segmentation. This paper suggested combining two methods, to determine optic disk area in retinal image segmentation K-means clustering technique is used [5]. The wavelet transforms and mathematical morphology application was investigated to identify blood vessels of retina [6]. Mathematical morphology detected the blood vessels of retinal fundus image [7]. Matched filters techniques applied in combination with piecewise thresholding and genetic algorithms [8]. Using multilayer perception of neural networks blood vessels were identified [9]. By two dimensional matched filters the blood vessels of retina were identified [10].

RELATED WORK

Sopharak *et al*. [11] using entropy filtering detects the optic disc. After pre processing, probability filter detect the optic disc. By using Otsu's algorithm Binarization done [12] and largest circular shape connected region is blotted as candidate for optic disk. Hoover *et al*. [13] presented fuzzy based voting mechanism to detect optic disc location. Through thinning the vasculatures were segmented and obtained vessel centerlines. After deletion of vessel branches, through fuzzy element every vessel segment extended on both ends. By combining convergence of only thicker retina blood vessels initiate on it and cost function high disk density properties Ravishankar *et al.* [14] attempted to track optic disc. Cost function described to find optic disc optimal location which exploit cost function. Foracchia *et al*. [15] reported improved dataset results. They explained an approach based on vasculature global orientation. Average vessel orientation geometrical model on retina regarding to optic disc location fitted to image. Li *et al*. [16] proposed active shape model utilized to extract vasculature based on optic disc location. Then active shape model information used to detect macular centre. To Huajun Ying *et al.* [17] used fractal analysis to distinguish optic disc area from bright and large regions in retinal fundus image. The optic disk and retinal fundus blood vessel morphology is significant structural indicator to assessing severity retinal diseases like hemorrhages, glaucoma, vein occlusion, neo vascularization, diabetic retinopathy and hypertension. To assess retinal fundus blood vessel tortuosity and diameter or optic disk shape, ophthalmologists used manual planimetry, which generally human error prone and time consuming. Reliable computerized technique for optic disk and blood vessel segmentation preserves different optic disk and vessel characteristics in automatic diagnosis [18]. Using robust distance transform and adaptive histogram equalization preprocessing implemented in retinal fundus image. This process improves robustness and accuracy of graph cut algorithm [19]. H. Yu et al [20] explained segmentation of optic disc. Due to stun bright pathologies and variability detection of optic disc is difficult. To detect optic disc many techniques has been extended. To locate optic disc position the shape and intensity has important properties to use. To select optic disc lightness in CIELAB image, template matching through adaptive template design size is used. After location of Optic disc identification, active counters are used to segment the optic disc. The GVF (gradient vector flow) active contour proposed to segment optic disc which is close to OD contour.

OVERALL PROPOSEDWORK

GREEN CHANNEL EXTRACTION

The retinal image dataset has RGB images of retinal fundus. From RGB retinal image green channel is extracted, because in OD region green color channel has more intensity in RGB retinal image. When compare to blue channel or red channel image green channel has better contrast. When compare to blue and red channel in green channel optic disc appears more contrast. For effective retinal image thresholding green channel is used.

GRAY IMAGE CONVERSION

In retinal fundus image color displayed usually in tri colors like red, green, blue is known as color space RGB. After extracting green channel from RGB retinal fundus image convert in to gray image.

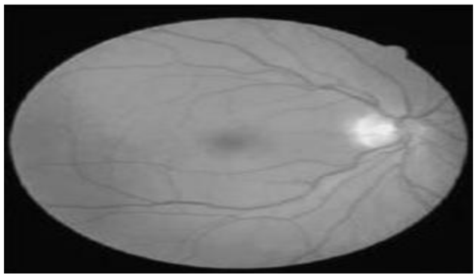

Figure1 Gray converted image

OVERALL ARCHETECTURE

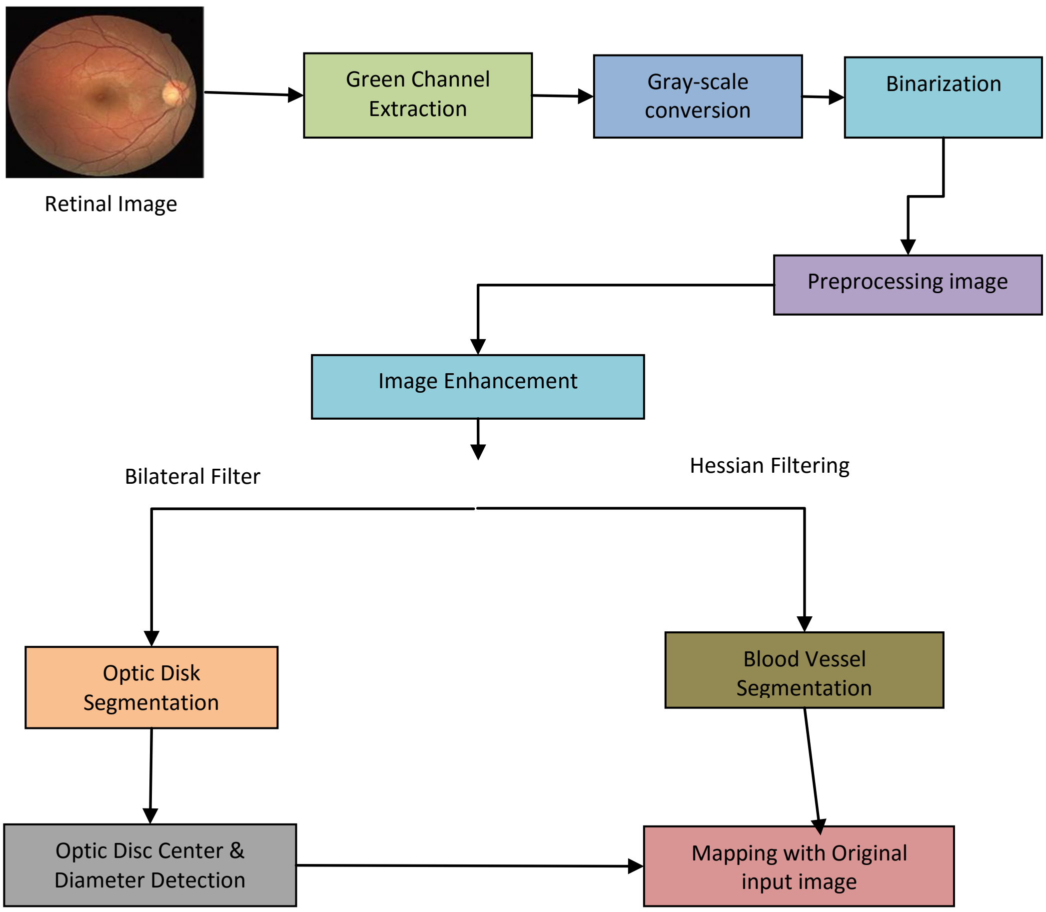

Figure 2 Overall Architecture

PREPROCESSING

In retinal fundus images the blood vessel emerges darker when compare to background related lesions color like hemorrhages and micro aneurysms. During lesions detection it is very necessary except vessel area to keep away from false positives. For blood vessel segmentation one step entailed in retinal images preprocessing. Blood vessels present with high contrast in green channel than the blue and red channel in RGB. Suppress the red and blue color components and only green channels used for processing.

OPTIC DISC SEGMENTATION

Through morphological procedure the OD (optic disc) is segmented. To perform dilation operation structure element utilize as mask. Dilation operation increase boundary size of OD to segment image from the retinal image. For dilation operation of morphological disk shape structure component is used.

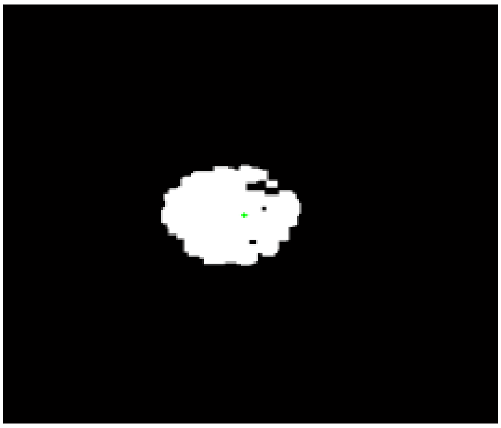

Figure3 Segmented optic disc

OPTIC DISC CENTRE AND DIAMETER DETECTION

The center (m,n) and Optic Disc diameter can be computed as follows.

$$\text{Center (m,n)}=\frac{Sum\ of\ (Pixel(m,n)m\ pixel\ brightness)}{Sum\ of optic\ disk\ pixel\ brightness}$$

Optic Disc Diameter = maxi,j |D(mi, nj)| where D (mi, nj) denotes the distance of any two furthermost pixels in segmented OD.

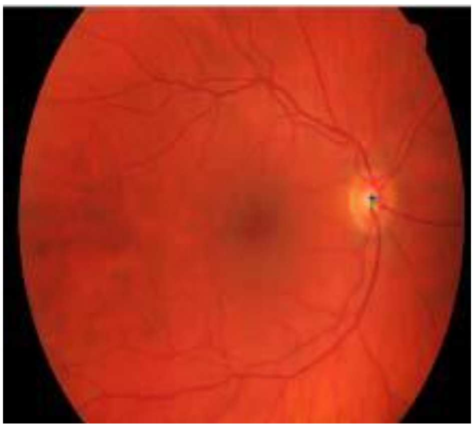

Figure4 Optic disc center

BLOOD VESSEL SEGMENTATION

In retina blood vessels are thin and lengthened structure with difference in length and width. Through preprocessing method the blood vessel fragmented from retinal fundus image.

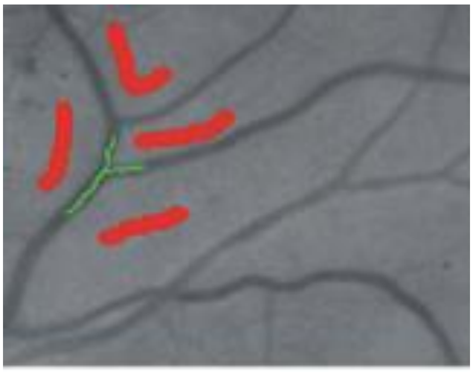

Figure5 Blood vessel

PEAL SIGNAL TO NOISE RATIO (PSNR)

Signal to noise ratio is the maximum power in the peak signal and maximum power in the corrupting noise. The PSNR widely used in image compression technique. The a x b size of image peak signal to noise ratio will be find with the help of Mean Square Error (MSE).

The MSE is defined as

$$MSE=\frac{1}{ab}\sum_{i=0}^{a-1}\sum_{j=0}^{b-1}[X(i,j)-Y(i,j)]^2$$

The PSNR describes as

$$PSNR= 20.log_{10}\ (MAX_X)- 10.\ log_{10}\ (MSE)$$

RESULTS OF OPTIC DISK SEGMENTATION ON THE DRIVE DATASETS

Sensitivity is also called TPR (True Positive Rate). Sensitivity in Drive dataset is defined as

$$TPR =\frac{Tp}{Tp+Fn}$$

Tp is the True Positive and Fn is the False negative and Sensitivity reveals the segmentation process. MAD (mean absolute distance) and O ratio (overlapping ratio) evaluate the performance of optic disc segmentation.

$$O\ ratio=\frac{T\cap S}{T\cup S}$$

T represents the boundary of true optic disc and S represents segmented boundary of optic disc

$$MAD\ (T_c, Sc) = \frac{1}{2}\{\frac{1}{n}\sum_{z=1}^{n} r(t_{cz},S)+\frac{1}{m}\sum_{z=1}^{m} r(s_{ci},T)\}$$

T_C and S_C are contour segmentation.

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Table 1: Performance comparison of DRIVE Dataset

Methods	Average O ratio	Average MAD	Average Sensitivity
Hessian and Bilateral Filter	0.9240	3.29	0.9919
Graph cut	0.5532	9.97	0.7398
Otsu	0.4253	5.27	0.6412

ALGORITHM 1: BILATERAL FILTERING

Bilateral filter is edge-preserving, noise-reducing, non-linear smoothing for an image. The image pixel intensity value replaced by pixel intensity weighted average value. The average value based on Gaussian distribution. The weight depends on pixel Euclidean distance and radiometric differences of range differences like depth distance, color intensity etc. In this paper we using bilateral for optic disc segmentation. It removes the noise from the optic disc image.

Input: Image f (y), dynamic range [-M, M], σ_s^2 and σ_r^2 for the spatial and range filters.

1. Set $\gamma=\pi|2M$, and $\rho=\gamma\sigma_r$.
2. If $\sigma_r > \gamma^{-2}$, select any large Z. Else, set Z= $(\gamma\sigma_r)^{-2}$, or use a look-up table to fix M.
3. For $0\leq z \leq Z$, set up the images bn(y) = exp(jγ(2z-Z)f(z)/ρ$\sqrt{Z}$) and gZ(y) = f (y)bn(y), and the coefficients dn(x) = 2^{-N} $\binom{Z}{z}$ exp (-jγ(2z-Z)f(y)/ρ$\sqrt{Z}$).
4. Use an algorithm to filter bn(y) and gn(y) with a variance σ_s^2 to get $\bar{b}$n(y) and $\bar{g}$n(y).
5. Set $\tilde{f}(y)$ as the ratio of $\sum_{z=0}^{Z} d_z$(y)$\overline{g_n}$(y) and $\sum_{z=0}^{Z} d_z$(y)$\overline{b_n}$(x). Return: Filtered image $\bar{f}$(y).

ALGORITHM 2: HESSIAN FILTERING ALGORITHM

Hessian filtering optimize the training recurrent network and encoder. Hessian filter uses the method of conjugate gradient to update directions via curvature-vector that calculated on similar time gradient. Multi scale hessian filtering method performs the segmentation at different resolution image. The hessian filters increasing the processing speed. The blood vessel of retinal fundus image extracts by high resolution by hessian filter. It increases the robustness of a segmentation process. After segmentation, low resolution and weak structures and strong structure could be in high resolution segmentation process.

1: Input: n1, inputs matrix (with A columns, one per case)
2: for all x from 1 to m-1 do
3: u_x+1 $\leftarrow$ $W_x n_x$
4: n_x+1   g(u_x+1)
5: end for
6: f $\leftarrow \sum_{a=1}^{A} L_a$($n_{m,a}$)/ A
7: Output: f

1. RESULT AND DISCUSSION

Figure 6 Green Channel Image

In figure6 presents the Green channel image. Then the input image will extract using RGB color. When compare to red channel green channel has better contrast.

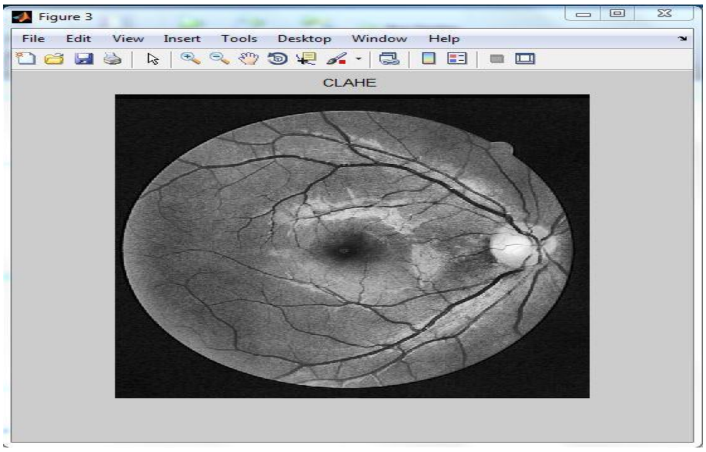

Figure 7 Gray Scale Image

In figure7 presents the gray scale image. After Green channel extraction the extracted image will convert in to gray scale.

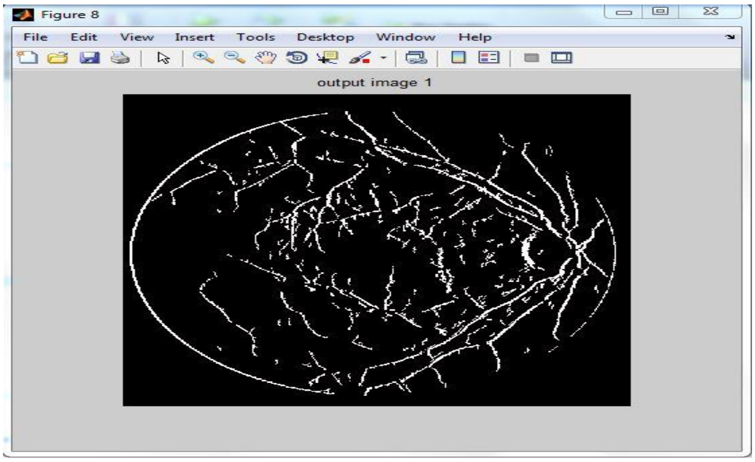

Figure 8 Blood Vessel Segmentation

In figure8 presents blood vessel segmentation. Through preprocess the blood vessel segment from the retinal fundus image.

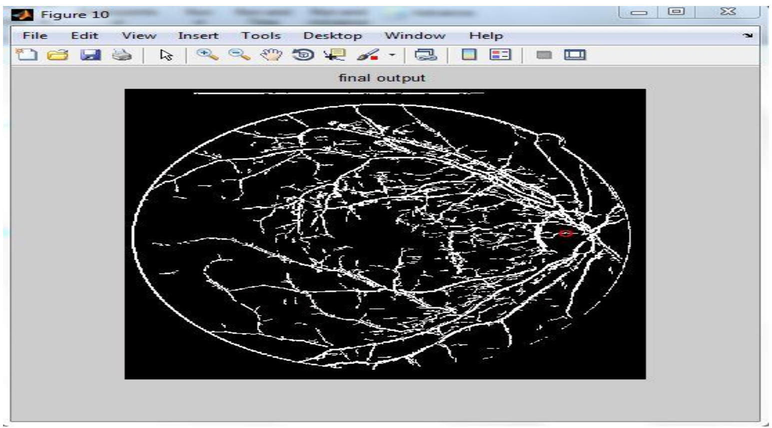

Figure 9 Optic Disk and Blood Vessel Segmentation

In figure9 presents optic disk and blood vessel segmentation. In retinal fundus image the optic disk will segment through morphological procedure and blood vessel will segment through preprocessing method.

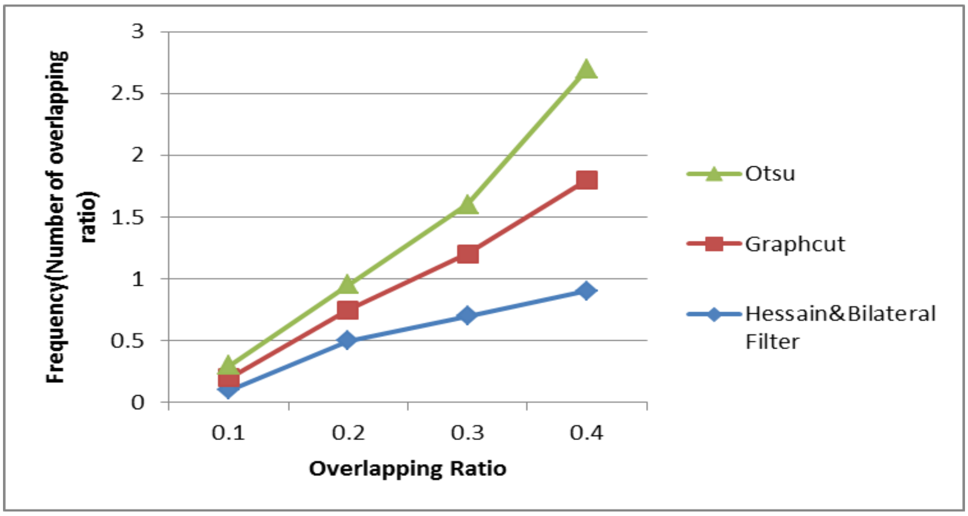

Figure 10 Overlapping Ratio of DRIVE image

In figure10 presents overlapping ratio of DRIVE image. Hessian and bilateral filtering achieve minimum overlapping ratio. The segmentation on DRIVE with hessian and bilateral achieve better results.

CONCLUSION

This paper presents the optic disk and blood vessel segmentation to increase the accuracy of the retinal image. Through RGB the green channel of the image extracted and converted into grayscale. The gray scale image binarized then it enhanced through preprocessing technique. After that optic disk and blood vessel segmented by using bilateral and hessian filtering. Through segmented image the optic disk center and diameter identified. Through this we achieved better retinal fundus accuracy image.

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