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VEIN CLASSIFICATION IN RETINAL IMAGES BASED VESSEL SEAM DETECTION AND TRACKING

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***Abstract*— Hypertensive Retinopathy is the second most common retinal disease. HR is damage to the retina caused by high blood pressure. A few measures for finding HR using digital image are Segmentation of blood vessels, measurement of tortuosity, diameter measurement, finding the artery vein ratio. The proposed method using Rough Entropy tested on both RGB and Green Extracted fundus image. Error measures such as PRI, GCE, LCE are calculated using manual segmentation, image and rough entropy segmented image.**

***Index Terms*—Fundus image, Gabor Wavelet, Rough Entropy, Blood vessel segmentation, PRI, GCE, LCE.**

I. INTRODUCTION

The Diagnostic tools which are used for visualizing the blood vessels are Digital fundus photography, Angiography. Prolonged and untreated hypertension may lead to Hypertensive retinopathy. The Signs are vascular tortuosity, copper wiring and silver wiring of arterioles, cotton wool spots, hard exudates. Measuring the vessel diameter to calculate the arteriovenous ratio (AVR) [7], [8], [9], finding the tortuosity and the small blood vessels that involve the eye are damaged, thickening, bulging and leaking are found by using the segmentation of blood vessels.Blood vessel segmentation is the part of the process for diagnosis of hypertensive retinopathy future the vessel width is measured to calculate the arteriovenous ratio (AVR).

Segmentation of blood vessel is not an easy task. Early recognition of changes in the blood vessel patterns can prevent major vision loss as early intervention becomes possible [1], [2]. The relationship between vessel tortuosity and hypertensive retinopathy [3]. Blood vessels were detected by means of mathematical morphology [4]. The Gabor Wavelet is directional and capable of tuning to specific frequencies, therefore permitting it to be adjusted for vessel enhancement and noise filtering in a single stride, having been proven to outperform other oriented feature detection[5].

Computerized system for both extraction and quantitative description of the main vascular diagnostic signs from finding images in hypertensive retinopathy was presented [6].

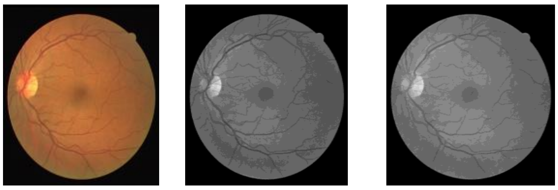
In this paper ,the segmentation of blood vessel is done by using the original image . The original retinal image is in the RGB color model, having an almost empty blue band, whereas red band is normally saturated, but green channel gives a better representation of retinal image features. Green channel is converted into gray image and Gabor wavelet is used for the blood vessel enhancement, due to directional selectiveness capability the Gabor wavelet is used. Sharpening and imfilter is used for sharpening the Gabor wavelet image. The image is converted into a binary image. From that converted image the circle will be removed for further processing. Rough Entropy and Morphological operation are performed to get a resultant segmented image.

II. PROPOSED TECHNIQUE

Due to low contrast the automated blood vessel segmentation is very complicated; in the unhealthy fundus image the width of the vessel can vary from small vessel to large vessel. We use DRIVE retinal imaging dataset fundus images. The proposed technique is implemented in grayscale image and green channel extracted image . The images were captured in digital form using a Canon CR5 non-mydriatic 3CCD. Their size is 768X584 pixels stored in JPEG format. These 40 images have been divided into training and test sets, containing 20 images each. The main purpose of the process is to detect blood vessels and the representation of an image is in rgb color space allow to process separately different channels (IE.), three channels red, blue, green of the spectral response.

A. PREPROCESSING

The preprocessing is required in order to distinguish the blood vessels from the other parts in the retinal image. The retinal image is the input of this phase. It is an RGB image. The grayscale image and green extracted image are obtained from the preprocessing phase. The grayscale image is obtained by converting the RGB retinal image into grayscale. The green extracted image is obtained by extracting of green intensity values from the given RGB retinal image. The blood vessels are highly visible in green intensity when compared with the red and blue intensities of the retinal image. The preprocessing of a sample image is shown in the Fig.1.



(a) (b) (c)

Fig. 1. a) Original image b) green extracted image c) Gray scale image

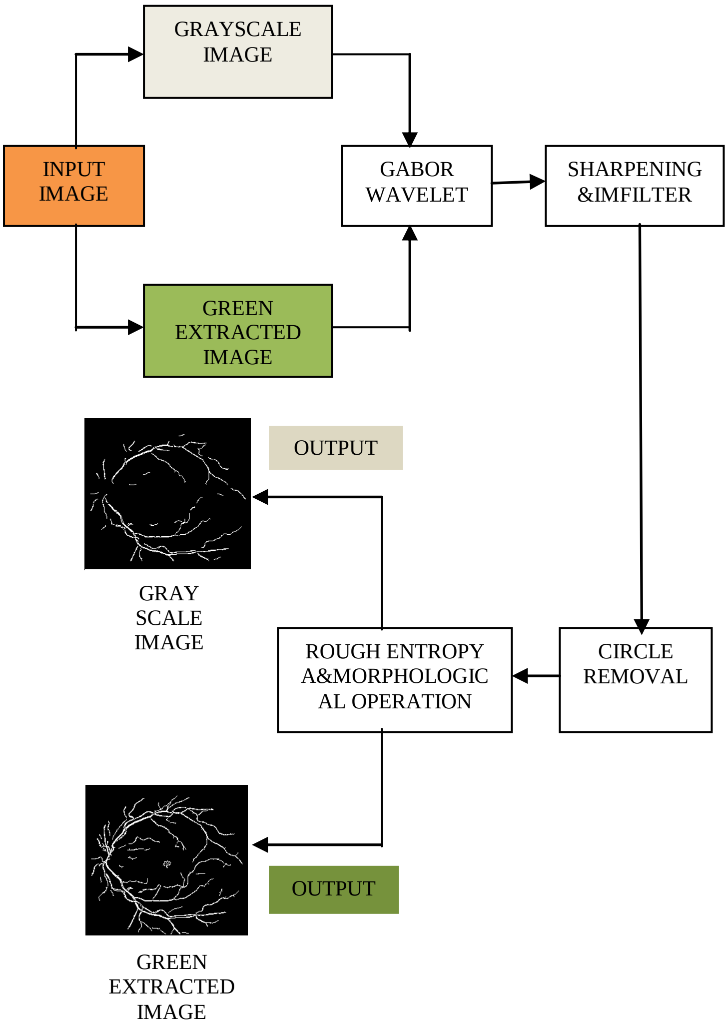
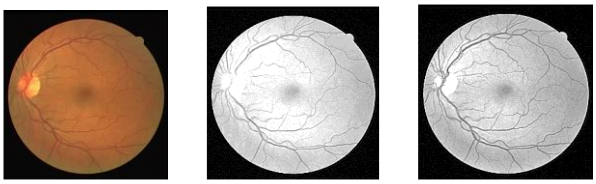


Fig. 2. The complete flow diagram for blood vessel segmentation using rough entropy

B. Enhancement

The further enhancement is performed to increase the intensity of the blood vessels in the retinal image. The grayscale image and green extracted image are taken as the input for this phase. Gabor Wavelet and Sharpening spatial filters are applied to enhance the preprocessed image which is described in the further sections. The Gabor Wavelet is used for enhancing the vascular pattern especially for thinner and less visible vessels. Due to directional selectiveness capability the Gabor wavelet is used for enhancing process. By tuning Gabor wavelet to a suitable frequency, for which each pixel position, scale, the strong wavelet response of a blood vessel.

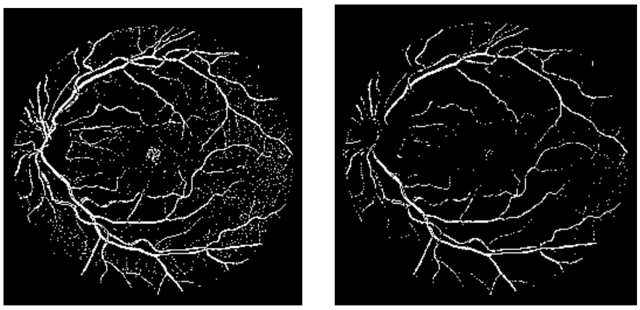


(a) (b) (c)

Fig. 3. a) Original retinal image b) gray scale on Gabor wavelet applied image c) green extracted Gabor applied image.

C. Sharpening Filter and circle removal

The main objective of sharpening spatial filter is to highlight the transformation in intensity. We used a sharpening filter to enhance and increase the intensity so that the vascular pattern will appear a darker. Filtering refers to accepting or rejecting certain frequency components. The sharpening can be done with the result of Gabor wavelet. After applying sharpening the image can be converted into binary then circle can be removed for further segmentation as shown in fig.4



(a) (b)

Fig. 4. a) Circle removal for green extracted image b) circle removal of gray scale image.

III. PROPOSED WORK

1) Rough entropy

Rough entropy measures calculation of the cluster centers, which is based on lower and upper approximation generated by assignment of data objects to the cluster centers. Roughness of the cluster center are calculated from lower and upper approximations of each cluster center. In the next step, rough entropy is calculated as the sum of all entropies of cluster center roughness values. The higher roughness measure value describes the cluster model with more uncertainty at the border.

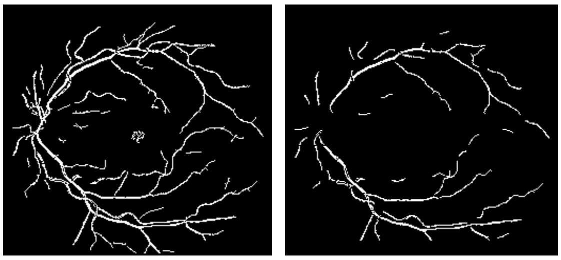
$$H(x) = -\sum_{j=1}^{m} p(a_j) \sum_{i=1}^{n} p(c_i/a_j) \log p(c_i/a_j) \quad (1)$$

Where H(x) is the rough entropy image,p is the probability for an image, a1…. A are the attributes and c1… cn are decision values.

2) Morphological operation

Morphological operation is the important part in image segmentation. By using the imsubtract Tophat and bottom hat has been performed. Subtracting an open image from the original is called a top hat transform. Bottomhat is defined as the closing of the image minus the image.

Finally, clean and bwareaopen is used after the rough entropy image**.** Clean in bwmorph removes pixels individual 1s that are surrounded by 0s. Bwareaopen removes from a rough entropy image all connected components (objects) that have fewer than P pixels, producing another binary image, BW2.
The resultant image is shown in the Fig.5. as



(a) (b)

Fig. 5. a) Resultant green extracted image b) Resultant gray scale image

IV. SEGMENTATION ERROR MEASURE

The segmented image is compared to the manually segmented image based on their performance measures for both the grayscale image and green extracted image. The Probability Rand Index (PRI), Global Consistency Error (GCE), Local Consistency Error (LCE) measures are used for comparison process. The comparison results shows that the the segmented image from green extracted image is more similar to the manually segmented image.

a) Rand Index

Rand Index (RI) was motivated by standard classification problems in which the outcome of a classification scheme has to be compared to a correct classified. The most common performance measure of this problem calculates the fraction of correctly classified (respectively misclassified) elements to all elements. For Rand, comparing two clusters was just a natural extension of this problem which has a corresponding extension of the performance measure: instead of counting single elements he counts correctly classified pairs Of elements. Thus, RI is defined by:

$$R1\,(S, S') = 2\,(N11+N00)\,/(N(N-1)) \quad (2)$$

Denotes the numbers of pairs that are in the same cluster under S and S', N00 denotes the number of pairs that are in different clusters under S and S'. RI depends on both the Number of clusters and the number of elements, and ranges from 0 to 1. S and S' are identical when RI equals to 1 [14].

b) Global Consistency Error and Local consistency Error

D. Martin proposed several error measures to quantify the consistency between image segmentations of differing granularity [12],[13].Let S and S' be two segmentations of an image I= (x1, x2,.. xN) consisting of N pixels. For a given pixel xi, consider the classes (segments) that contain xi in S and S'. We denote these sets of pixels by C(S,xi) and C(S',xi), respectively. Local Refinement Error (LRE) is then defined at point pi as:

$$LRE = E(GT,S,pi) = |R(GT,pi)\backslash R(S,pi)| \,/\, |R(GT,pi)| \quad (3)$$

The value of GCE will fall in the range [0…..1].The value closer to zero denotes better segmentation .

$$GCE = 1/n \min \sum_{\text{All } pi} E(GT,S,pi), \sum_{\text{all } pi} E(S,GT,pi) \quad (4)$$

$$LCE = 1/n \sum_{\text{all } pi} \min E(GT,S,pi),\ E(S,GT,pi) \quad (5)$$

Table1.SEGMENTATION ERROR MEASURE FOR GRAY SCALE AND GREEN EXTRACTED IMAGE

	RGB IMAGES				GREEN EXTRACTED IMAGES			
	T1	T2	T3	T4	T1	T2	T3	T4
RI	0.6521	0.6645	0.7066	0.6671	0.6580	0.6788	0.7160	0.6809
GCE	0.3145	0.1915	0.1570	0.4033	0.0392	0.0404	0.0328	0.0395
LCE	0.2141	0.1715	0.1461	0.4031	0.0375	0.0405	0.0378	0.0467

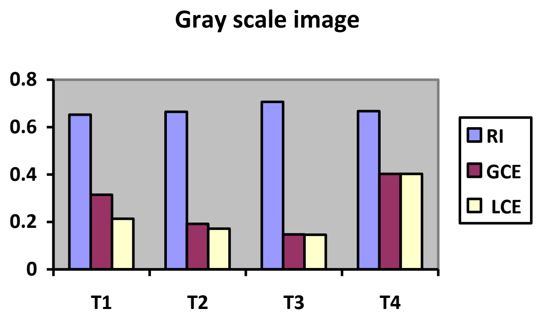


Fig. 6. segmentation error measure for gray scale image

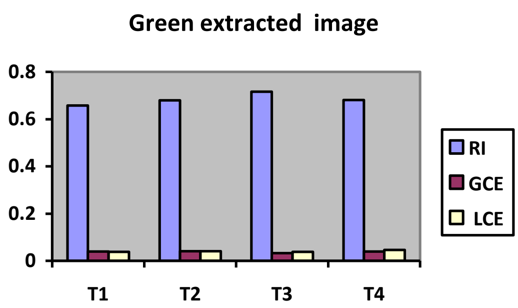


Fig. 7. segmentation error measure for green extracted image

V.CONCLUSION

The Hypertensive eye disease is detected by automated process from the retinal blood vessel images. The blood

vessels are extracted using this proposed method. The proposed method follows various steps from preprocessing to the segmentation of blood vessels. The each step is performed for the betterment of the result. The efficiency of this proposed work is analyzed by comparing it with manual segmentation. The performance measures of both grayscale image and green image is compared. The grayscale image is dissimilar when compared to the manual segmented image. But the green extracted image is more similar when compared to the manual segmented image. The green extracted image provides better result than the gray scale image.

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