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Classification of Artery and Vein in Retinal Images using Graph Based Method

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***Abstract*— Medical imaging is the technique to create visual representation of interior of the body. The retinal images are used to view artery and vein to determine the vascular changes and to calculate several systematic diseases such as diabetes, hypertension and cardiovascular. Some techniques use kirsch's template, thinning algorithm, vessel segmentation and graph extraction for the above said diagnosis. In graph extraction the retinal vasculature classifies the entire vascular tree which decides on each intersection point (graph nodes) and assigning the graph links for each vessel segment. Finally, A/V classification is performed through the graph based labelling results with a set of intensity features. The results of proposed method are compared with manual public database.**

***Index Terms*— Blood Vessels, Graph Extraction, Kirsch's Template, Thinning Algorithm.**

I. Introduction

There are two retinal blood vessels one is artery and other is vein. Arteries carry blood away from the heart while most arteries carry oxygenated blood. Arteries have a high blood pressure. Veins carry blood toward the heart. Arteries are bright red but veins are dark blue. Arteries are smaller than vein. Retinal blood vessels affected by several Systemic diseases like diabetes, hypertension and cardio vascular. In diabetic retinopathy, the blood vessels show abnormality[1]. Arteries are thinner but veins are thicker. For diagnosis the diseases it is very essential to distinguish the blood vessels into veins and arteries. To detect these disease stages the retina has to be examined. Blood vessels has segmented before classify the blood vessels into veins and artery.

In retinopathy of eye images using digital image processing includes vessel segmentation, blood vessel dimension and finding Arteriolar to Venular Ratio (AVR)[12]. Automatic AVR has to be identifying blood vessels are veins and arteries. In this paper we propose a graph based extraction the retinal

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vasculature classifies the entire vascular tree decides on each intersection point and assigning the graph links in each vessel segment[6]. Finally, artery and vein classification is performed through the graph labelling results .The proposed method result is compared with public database.

II. LITERATURE SURVEY

Ana Maria mendonca et al [7] described an automated detection for segmenting the retinal vascular network which combines the centreline and morphological method used for vessel segments. Here the vascular network is complex to overcome the problem using several techniques like pre-processing the image, vessel enhancement, seeded the region growing and at last filling the blood vessels and the vascular structure are based on morphological operator. These methods are evaluated using the public databases such as DRIVE and STAR images.

Martinez-perez et al [5] described a semi-automatic quantification method for analyzing the retinal vascular trees. Here they couldn't detect the retinal vessels. To overcome the problem in this method, geometry and network properties are used for subtrees and single vessel segment. For labelling, the skeleton trees are used after automatic measurement and graph generation. In the tracking process, each tree is tracked individually. The user points has root segment and search the unique terminal points and decide the segment in artery and vein. This method uses manually labelled vessel segment for measurement.

Medhane Dipak Vinayak et al [6] described the method for separating the artery and vein using graph extraction for vascular tree. In graph extraction it is having three errors like splitting error, missing and false error to overcome the problem using graph modification. In graph modification has various numbers of intersection points like crossing, meeting and connecting points. The important methods are image registration and matching used for authentication and finally analysis the stages of disease using this techniques.

J.Sivakumar et al [8] described the method for earlier stages segmentation and detection of blood vessels due to overlapping vessels, bifurcation and crossover vessels. First, find true and false blood vessels using tracing method and overcome the problems due to bifurcation and crossing points. The separation of true and false blood vessels is done in simultaneously.

D.Sivasundhara raja et al [9] described the segmentation of retinal images used to detect the diabetic retinopathy and diagnosis, here overlapping tissue to overcome the problem using these techniques like morphological and SVM classifier, it is used to segment and identify the retinal blood vessels. In retinal fundus image has several channel but used the green channel. The green channel is sensitive to the blood vessels. This channel is used to segment and detect the retinal blood vessels. Finally these results are compared with public databases. Morphological and SVM classifier based blood vessel segmentation achieves performances of 78% sensitivity, 97.99 % specificity, and 95 % accuracy

III. PROPOSED SYSTEM

In this paper, the method described a graph structure for classification of artery and vein in which we target the retinal vascular network nearer to optic disc in retinal blood vessels.

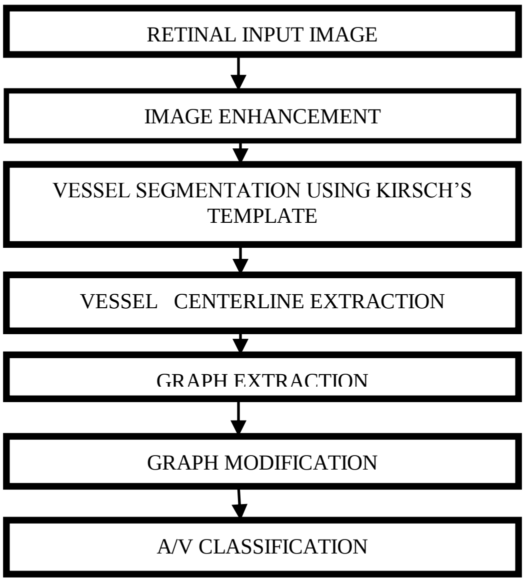

Figure 1:Block diagram of the proposed method for A/V classification.

A. Image Enhancement

Image enhancement is used to enhance the arteries and veins in retinal images. Histogram matching algorithm is applied for normalizing the color images. Image enhancement has two images

i)image smoothing

ii)image sharpening

Image smoothing is to diminish the effect of noise, spurious pixel values and missing pixel values etc. Two methods used in image smoothing are neighbourhood averaging and edge preserving smoothing. Image smoothing is used in two ways,

a) By being able to extract more information from the data as long as the assumption of smoothing is reasonable.

b) By being able to provide analysis that is both flexible and robust.

Image sharpening is to enhance the blurred image.

B. Vessel Segmentation (Kirsch's Template)

Blood vessels of different thicknesses can be extracted using kirsch's template.

$$h_{n,m} = \max_{z=1,\ldots,8} \sum_{i=-1}^{1} \sum_{j=-1}^{1} g_{ij}^{(z)} \cdot f_{n+i,m+j}$$

$$g^{(1)} = \begin{bmatrix} 5 & 5 & 5 \\ -3 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix} g^{(2)} = \begin{bmatrix} 5 & 5 & -3 \\ 5 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix} g^{(3)} = \begin{bmatrix} 5 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & -3 & -3 \end{bmatrix} g^{(4)} = \begin{bmatrix} -3 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & 5 & -3 \end{bmatrix}$$

a) Extraction of blood vessels from enhanced image using kirsch's template

b) Kirsch's template is used for 8 different orientations. This method involves spatial filtering using the templates of different orientation followed by thresholding techniques

c) Variations of output image by changing the value of threshold value.

d) Masking of redundant area of the result is carried out using boundary technique.

e)Extracting the retinal blood vessels using edge detectors for color retinal images, the image segmentation based on the detection of edge is done on in3phases.

i) In first phase, a test image is loaded as RGB images which convert into a grayscale tone image.

ii)In second phase, proceeds the related edge detection mechanism for kirsch methods.

iii) In third phase, if necessary for given method checks the filtered result of gray value at given point is greater than a given threshold value to the edge image shows the resultant edge image to the end user.

C. Vessel Centerline Extraction

The centerline image obtained by applying thinning algorithm in the result of vessel segmentation. Thinning algorithm removes border pixels until object minimizes the connected strokes. The centerline image from the segmented vessel Fig 3(b) is shown in Fig 3(c).Thinning process is shown below

i) Thinning process uses a 3x3 four template to scan the image.

ii)Find the location of pixel (i,j) where pixel image match in template T_1.In this template T_1,all pixel from the top of the image are removed, moving from left to right and from top to bottom.

iii) The central pixel is not an endpoint and connectivity=1 marks this pixel for deletion.

iv) Repeat steps 1 and step 2 for all pixel locations matching template T_1.

v) Repeat steps 1 and 3 remaining pixel location matching template T_2, T_3 and T_4.

vi) The white pixels marked for deletion.

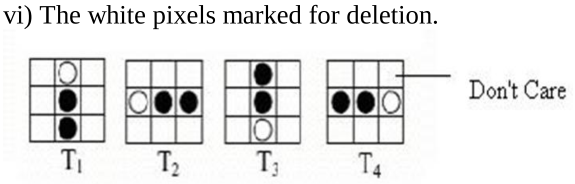

Figure 2:Thinning process

D. Graph Extraction

The graph nodes are extracted from the centerlines image by finding intersection and end points and find the links between nodes. All the intersection points and neighbors are removed. From the centerlines image result we will get the separate vessel segments. Each vessel segment represents the link between two nodes. The graph contains nodes, and each node can be connected. The given link can only connect two nodes.

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E. Graph Modification

If there are any errors in graph extraction, we go for graph modification. Typical errors are splitting nodes, missing link and false link. Necessary modifications should be performed for eliminating the errors. It reduces the complexity of the graph analysis.

F. Graph Analysis

In graph analysis, there are 4 different types of nodes

1. Connecting point: The vessels are never cross or bifurcate and connecting different segment in same vessel.
2. Crossing point: Two types of vessels cross each other.
3. Bifurcation point: Bifurcates vessel into narrower vessel.
4. Meeting point: Two types of vessels meet each other without crossing.

Table 1:
Different cases of nodes and the possible types

Cases	Possible nodes
Nodes of degree 2	Connecting point Meeting point
Nodes of degree 3	Bifurcation point Meeting point
Nodes of degree 4	Bifurcation point Meeting point Crossing point
Nodes of degree 5	Crossing point

G. A/V Classification

The artery and vein classification are measured and normalized the zero mean and standard deviation to each centrelines pixel. The results are tested with classifiers like quadratic discriminant analysis, linear discriminant analysis and k-NN. The database used here is DRIVE image.

Table 2:
List of Centrelines Pixel

Nr.	Features
1-3	Red, Green and Blue intensities.
4-6	Hue, Saturation and Intensity.
7-9	Mean of Red, Green and Blue intensities in the vessel.
10-12	Mean of Hue, Saturation and Intensity in the vessel.
13-15	Standard deviation of Red, Green and Blue intensities in the blood vessel.
16-18	Standard deviation Hue, Saturation and Intensity in the blood vessel.
19-22	Maximum and minimum of Red and Green intensities in the blood vessel.
23-30	Intensity of centerlines pixel in a Gaussian blurred (σ=2, 4, 8, 16) Red and Green plane.

IV. RESULTS AND DISCUSSION

Thus the proposed method detects and extracts the blood vessels from the retinal images. The blood vessels obtained from the proposed method are centerlined. The performance of proposed blood vessel detected image is experimentally validated for original retinal image.

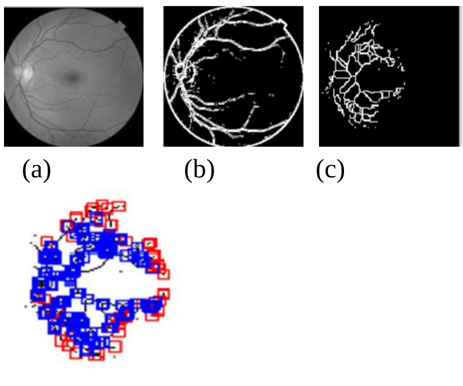

Figure 3:Blood vessel segmentation of retinal image (a) Normal retinal image (b) extraction of blood vessels (c) centerline image (d) Graph extraction.

V. CONCLUSION

The kirsch's template and thinning algorithm are proposed in this paper to detect and extract the blood vessels from retinal image. The graph nodes are extracted from the centreline processed image and used as blood vessels .The proposed method's detected blood vessels contain the average sensitivity of 76%, average specificity of 96.54 % and average accuracy of 98.56% in the retinal image. The work still left is to handle some other techniques to acquire the disease from retinal blood vessels.

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