RETINAL ARTERY & VEIN SEGMENTATION TO DETECT GLAUCOMA

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ABSTRACT

Analysis of the retinal image is one of the biggest processes in the field of medical image processing. In recent scenario, there are several diseases affecting the optic nerve. So far, the effective treatment is the early detection of disease. In our paper, we make use of the vessel segmentation algorithm to classify the arteries and the veins. To get more accuracy, we have used the tree topology. This technique can be widely used to detect the disease called glaucoma and several other diseases with retinal vascular manifestations.

Keyword: - *Artery-vein classification, graph theory, image analysis, medical imaging, tree topology.*

1. INTRODUCTION

Various diseases affect blood circulation, thereby leading to either a thickening or a narrowing of arteries and veins. In particular, asymmetric changes in retinal arteriolar vs. venular diameter, as measured by the arteriolar-venular ratio (AVR), have been correlated with a number of diseases including coronary heart disease and stroke , as well as atherosclerosis . Additionally, a high AVR has been associated with higher cholesterol levels and inflammatory markers, including high-sensitivity C-reactive protein, interleukin 6, and amyloid A levels.Other conditions that can cause an abnormal AVR include high blood pressure and diseases of the pancreas . Furthermore, a low AVR is a direct biomarker for diabetic retinopathy(DR), the leading cause of vision loss in working age individuals in developed countries. This low AVR is caused by abnormal widening of the veins due to retinal hypoxia, which arises secondary to microvascular injury in the setting of chronic high blood sugar levels. These vascular changes often precede the onset of symptoms, and if detected, may allow preventive treatments that can reduce the risk of any vision loss. These changes in the retinal vasculature can be captured using a variety of imaging methods, including fundus photography, fluorescein angiography. In particular, fundus photography is the preferred retinal imaging modality for both telemedicine and remote diagnostics due to its lower cost and ease of use. However, it is highly challenging to compute the AVR or any other measure of interest given a fundus image of a patient's arteries and veins, even after accurately segmenting the vasculature from the image. Manually classifying arteries and veins requires expertise in retinal image interpretation and is a very labor-intensive process; in a high resolution image we can often detect over one hundred vessels or vessel segments, many of which are ambiguous and require careful viewing to classify. It is perhaps due to these time constraints that the classic AVR is only calculated using the six largest arteries and veins near the optic nerve . We propose, however, that calculating a global AVR using the widths of smaller vessels might yield an even earlier biomarker of an underlying diseases in smaller vessels are

more vulnerable to changes in blood pressure. However, it is time-prohibitive to manually calculate this global AVR due to the large number of vessels that need to be measured. Therefore, automatic or semi-automatic methods are needed to overcome the time constraints of manual classification. Traditionally, most computer-aided vessel analysis has focused on segmenting the vessels in the image.

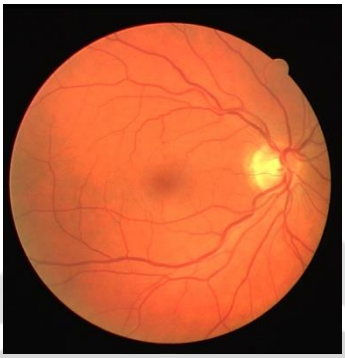

Fig -1:Normal retinal image.

Our proposed framework represents an important step towards developing a clinically viable, automatic AV classification method. The main contributions of this work are as follows:1)A global likelihood model that accurately captures the structural plausibility of a given set of vessel labels. 2)A novel best-first search algorithm that efficiently explores the space of possible vascular networks. 3) A non-metric, random optimization scheme that is able to avoid getting stuck in local minima.4) The formalization of the artery-vein classification problem in terms of the underlying network topology. 5) A novel online dataset of wide-field retinal color images annotated for artery-vein classification.

2. EXISTING WORK

The problem of classifying arteries and veins is relatively new.Compared to other vessel analysist asks such as vessel segmentation or vessel centerline extraction there have been only a few automatic or semi-automatic AV classification methods proposed. We now review some of the most important existing approaches for this problem. AV classification methods generally rely on some combination of vessel features, primarily pixel color, and connectivity constraints to assign one of the two labels to each vessel segment. Mirsharif et al. used a three-step method: they first enhanced the input image, then they estimated different pixel color features and then corrected misclassifications at bifurcations. Kondermanetal explored using both support vector machines and neural networks combined with principal component analysis(PCA) features obtained from small vessel image patches. Relan et al. used a Gaussian mixture model on small vessel patches to classify the main vessels in each optic nerve-centered quadrant, while Vasquez et al. employed a minimal path approach with which they connected a set of extracted concentric vessel segments. Zamperini et al. focused on determining effective features for AV classification. They compared color, spatial, and size features and concluded that a mix of color and position features provided the best results. Other work has focused specifically on estimating the AVR using either the U.S.or the Japanese definition. There has been some work on using graph theory to better classify arteries and veins. All these methods first establish a graph that represents the projected vascular network and then classify different parts of the graph as being either arteries or veins. Rothaus et al., used a semi-automatic method in which they propagate some initial manual edge labels throughout the graph by solving a constraint-satisfaction problem. Lau et al. constructed their graph over a restricted ROI around the optic nerve and then assigned the vessel labels by approximating an optimal forest of subgraphs. Joshi et al. first separated their vascular graph using Dijkstra's shortest-path algorithm to find different subgraphs. They then labeled each subgraph as either artery or vein using a fuzzy classifier. Finally, Dashtbozorg et al. also proposed a two-step graph estimation method for distinguishing arteries from veins. They

first split the vascular graph into subgraphs based on the local angles between edges and then assigned a label to each sub graph using linear discriminant analysis.

3. PROPOSED WORK

The fundus image corresponds to the back image of the retina. The fundus of the eye is the interior surface of the eye opposite the lens and includes the retina, optic disc, macula, fovea, and posterior pole. In the fundus image we can see that the blood vessels look like a network structure. The fundus image consists of a central optic disk. The blood vessels originate from this central optic disk to different regions. Our main goal is to detect Glaucoma in this retinal image.

Glaucoma occurs as a result of increase or decrease in the blood pressure within the eye. It mainly occurs when the fluid in the eye do not circulate normally in the front portion of the retina. This leads to blockage in the blood vessels. The presence of Glaucoma can either lead to thickening or thinning of the blood vessels. In our proposed model, we are using the vessel segmentation algorithm to classify the arteries and veins in the retinal image. In normal conditions, either the arteries will be thicker or the veins will be thinner and vice versa. In case, if there is any abnormality, either both the arteries and veins will be thick or thin. We are implementing this concept to detect Glaucoma.

Calculation of Anterior - venular ratio is very much important to detect the abnormality in the blood vessels. However, it is time-prohibitive to manually calculate this global AVR due to the large number of vessels that need to be measured. Therefore, automatic or semi-automatic methods are needed to overcome the time constraints of manual classification. Traditionally, most computer-aided vessel analysis has focused on segmenting the vessels in the image. Artery-vein (AV) classification, on the other hand, goes one step further and seeks to classify the segmented vessels into either arteries or veins. However, even assuming a perfect segmentation, the before mentioned ambiguity of small and midsized vessels makes automatically classifying arteries and veins a very difficult computational task. To address this problem, we have used the tree topology to classify the arteries and the vessels in the fundus image of the retina.

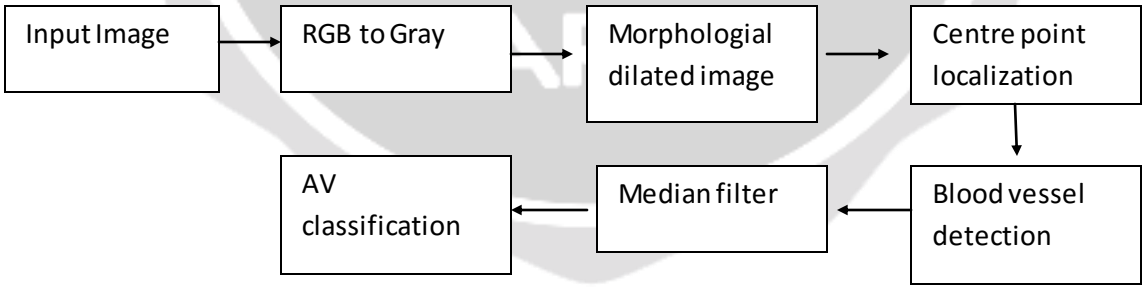

Fig -2:Block diagram.

The algorithm as follows:
Input: Colour fundus image
Output:
Step 1: Convert RGB image to gray-scale in order to reduce the correlated color information.
Step 2:Apply morphological opening operation with a disk shaped structuring element on gray-scale image to reduce the small noise.
Step 3:Use morphological closing operation to remove the vessels structure .
Step 4:Detect the blood vessels by using canny edge detection.
.**Step 5**:Detect the centre point of localization.
Step 6:Classify the arteries and veins.

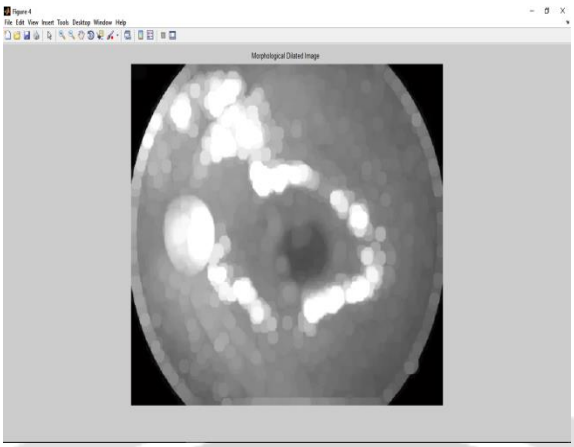

Fig -3:Morphological image.

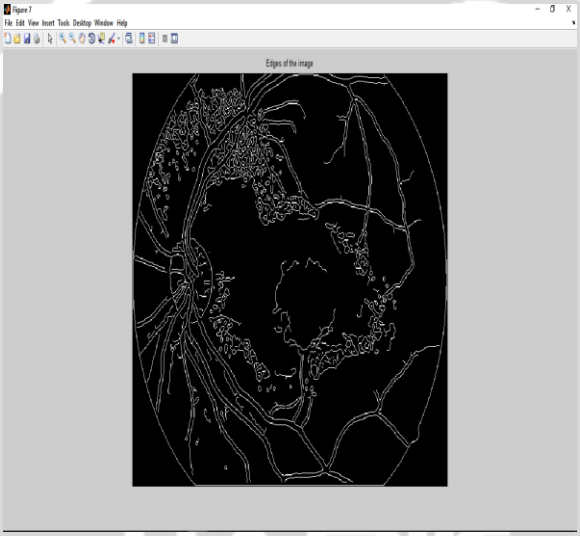

Fig -4:Blood vessel edge detection image.

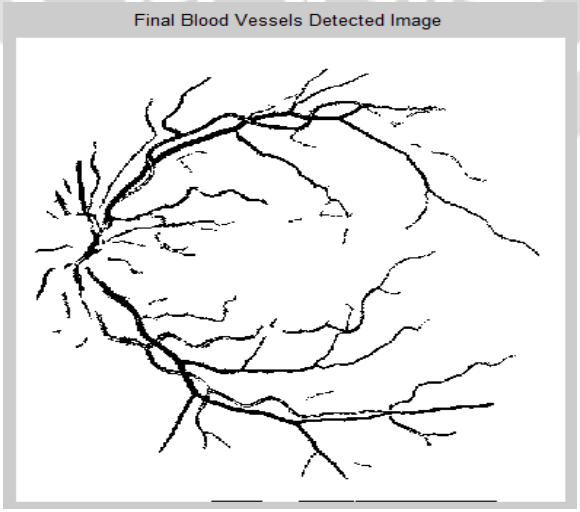

Fig -5:Final blood vessel detection

4. CONCLUSIONS

In this work, we developed a comprehensive, semi-automatic method for distinguishing arteries from veins in aretinal image. Our approach combines tree topology methods to accurately estimate the correct vessel types on four different retinal datasets, outperforming existing methods. Moreover, this method is capable of analyzing vasculature in wide field-of-view fundus photographs, which is a potentially important tool for diagnosing diseases with peripheral retinal vascular manifestations including diabetic retinopathy, retinal vein occlusion, and sickle cell retinopathy. Our future work will focus on using our classification method to better determine diagnostically relevant properties of arteries and veins, such as the arteriolar-venular ratio. We will also refine our automatic planar graph extraction step and extend our algorithm to handle noisy graphs that contain missing or spurious vessels in order to fully automate our framework, which we will then validate in a clinical setting. This robust algorithm will not only distinguish arteries from veins, but also determine if a given edge is a valid vessel, that is, it will also apply unsure and non-vessel categories. If available, we will take advantage of an existing vessel segmentation to constraint our extraction step. We also intend to focus on applying our vessel classification framework to other problems, including identifying the retinal layer in which a capillary lies and distinguishing retinal from choroidal vessels.

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