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Retinal Disease Diagnosis by AVR calculation on Retinal Images

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Abstract—Image processing and analysis techniques are increasing importance in all fields of medical science, and are particularly applicable to modern retinopathy, as it is heavily dependent on visually leaning signs. Retinal vessels are affected by various diseases like Diabetes, hypertension, and vascular disease. The vessels are consistent for the calculation of characteristic signs with vascular changes is measured & accessing the stage and severity of some retinal condition. Any changes in retinal blood vessels, such as dilation and prolongation of arteries, veins and their branches can frequently associate with diabetes and other cardiovascular diseases. Blood vessels of retina are divided into two types. They are Arteries and Veins. For diagnosis of various diseases it is more essential to distinguish the vessels into arteries and veins. An abnormal ratio of the size of arteries to vein is one important symptom of various diseases. In the recent years graph have emerged as a unified representation and graph based methods are used for vessel segmentation and vessel registration etc. In this paper our focus is on the approach that is calculation of Arteriolar-to-Venular diameter Ratio (AVR) for the diagnosis of various diseases**.** In this approach retinal image is taken as the input image that image is first enhancing by the Histogram Equalization. Further enhanced image will be segmented and extract the blood vessels. After words extracted vessels are classified into arteries and veins and finally the average diameter ratio of the arteries and veins are calculated. If the AVR will be abnormal then there is diagnosis of a particular disease is takes place.
Keywords- *AVR, Histogram Equalization, Graph, Arteries, Veins.*

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I. INTRODUCTION

Retinal images of humans play an important role in the detection and diagnosis of many eye diseases for ophthalmologists. Some diseases such as diabetic retinopathy, macular degeneration and glaucoma are very dangerous for they can lead to blindness if they are not detected in time and correctly. Therefore, the detection for retinal images is necessary, and among them the detection of blood vessels is most important. The alterations about blood vessels, such as length, width and branching pattern, can not only provide information on pathological changes but can also help to grade diseases severity or automatically diagnose the diseases. Detection of various diseases in eye fundus [1] images have using digital image analysis methods has large potential benefits, which allowing examination of large number of fundus images is very less time and at lower cost. Blood vessels show abnormalities at early stages also blood vessel alterations. Generalized arteriolar and venular narrowing which is related to the higher blood pressure levels, which is generally expressed by the Arteriolar-to-Venular diameter ratio [11]. The AVR value can be an indicator of other diseases like Diabetic retinopathy and retinopathy of prematurity. For the estimation of AVR it is essential to classify the blood vessels that are arteries and veins, since slight classification errors in the vessels can have large influence on the final value. AVR can be comprised of two elements they are Central Retinal Arteriolar Equivalent (CRAE) and Central Retinal Venular Equivalent (CRVE). The Central Retinal Arteriolar Equivalent (CRAE), Central Retinal Venular Equivalent (CRVE) are useful in finding the abnormality in blood vessels. It also beneficial in taking the follow-up of some systemic diseases, namely diabetes, hypertension and other vascular disorders. These diseases even change the vessel branching pattern, so there is the need to make the measurement of bifurcation and other geometrical features such as crossing points, meeting points etc. However, manual detection of blood vessels is much more difficult since the blood vessels in a retinal image are complex and with low contrast. Also, there are usually numbers of retinal images to detect a disease. Hence, it manually measurement becomes tiresome. As a result, reliable and automatic methods for extracting and measuring the vessels in retinal images are needed. Here graph representation [11] can be shown with the bifurcations, crossing points and meeting points of the vessels that are classified into arteries and veins. The main goal of this paper is estimation of the average diameter ratio of the arteries with respect to veins, which is the strong parameter in the diagnosis of the various vascular diseases.

II. OVERVIEW OF EXISTING METHODS

This section describes the comprehensive review of the existing techniques, algorithms and methods related to classification of vessels, which provides the diagnosis of the various retinal diseases. To diagnose the retinal diseases variety of methods has been proposed in the literature they are summarized as follows. Many methods based on Pattern Recognition, Region Growing methods, Fuzzy and C-Means Technology, Mathematical Morphology [5], Gabor filter are available. The first and important phase is blood vessels extraction [3]. There are various methods are there for vessel extraction. Blood vessels were extracted using two-dimensional matched filter. Here they introduced an operator feature extraction which was based on optical and spatial properties of objects. The concept of matched filter [1]detection of signals was used for segmentation. Here they construct twelve different templates and that used to search the vessel segments along all possible directions. In Pattern Recognition Techniques it deals with the automatic detection or classification of objects or features. In the vessel extraction domain, Pattern Recognition techniques is concerned with the detection of vessel structures and the vessel features automatically. Pattern Recognization techniques are divides into seven parts. They are multi-scale approaches, skeleton-based that is centerline extraction, Region growing, Ridge-based, Differential Geometry-based approaches, Matching filters, mathematical morphology schemes.There are several methods have explored visual and geometrical properties for A/V classification. Arteries are bright red in color while veins are darker to see, and also artery calibers are smaller than vein calibers. Even vessel calibers can be affected by diseases. Arteries also have thicker walls, which reflect the light as a shiny central reflex strip. Another characteristic of the retinal vessel tree is that, at least in the region near the optic disc, veins rarely cross veins and arteries rarely cross arteries, but both types can bifurcate to narrower vessels, and veins and arteries can cross each other [11]. For this reason, tracking of arteries and veins in the vascular tree is possible, and has been used in some methods to analyze the vessel tree and classify the vessels.

A semi-automatic method [12] for analyzing retinal vascular trees was proposed by Martinez-Perez *et al.* In this method geometrical and topological properties of single vessel segments and subtrees are calculated. First, the skeleton is extracted from the segmentation result, and significant points are detected. For the labeling, the user should point to the root segment of the tree to be tracked, and the algorithm will search for its unique terminal points and in the end, decide if the segment is artery or vein. Another method similar to this was proposed by Rothaus *et al.*, which describes a rule-based algorithm to propagate the vessel labels as either artery or vein throughout the vascular tree. This method uses existing vessel segmentation results, and some manually labeled starting vessel segments. Grisan *et al.* developed a tracking A/V classification technique that classifies the vessels only in a well-defined concentric zone around the optic disc. Then, by using the vessel structure reconstructed by tracking, the classification is propagated outside this zone, where little or no information is available to discriminate arteries from veins. This algorithm is not designed to consider the vessels in the zone all together, but rather partitions the zone into four quadrants, and works separately and locally on each of them.
Vazquez *et al.* described a method which combines a color-based clustering algorithm with a vessel tracking method. First the clustering approach divides the retinal image into four quadrants, then it classifies separately the vessels detected in each quadrant, and finally it combines the results. Then, a tracking strategy based on a minimal path approach is applied to join the vessel segments located at different radii in order to support the classification by voting. A piecewise Gaussian model to describe the intensity distribution of vessel profiles has been proposed by Li *et al*. In this model, the central reflex has been considered. A minimum distance classifier based on the Mahalanobis distance was used to differentiate between the vessel types using features derived
from the estimated parameters. Kondermann *et al.* described two feature extraction methods and two classification methods, based on support vector machines and neural networks, to classify retinal vessels. One of the feature extraction methods is profile-based, while the other is based on the definition of a region of interest (ROI) around each centerline point. To reduce the dimensionality of the feature vectors, they used a multiclass principal component analysis (PCA). Niemeijer *et al*. proposed an automatic method for
classifying retinal vessels into arteries and veins using image features and a classifier. A set of centerline features is extracted and a soft label is assigned to each centerline, indicating the likelihood of its being a vein pixel. Then the average of the soft labels of connected centerline pixels is assigned to each centerline pixel. They tested different classifiers and found that the *k*-nearest neighbor (kNN) classifier provides the best overall performance. In [18], the classification method was enhanced as a step in calculating the AVR value.

For the estimation of AVR there various methods are present in the literature they are as follows.
In the Computer-aided Diagnosis System for the Assessment of Retinal Vascular Changes Behdad gives an automatic method which gives an idea regarding various functionalities, such as vessel segmentation, vessel registration, vessel width estimation, vessel classification into artery/vein and also the optic disc segmentation etc. Here in this concentrate on two parameters, namely the Central Retinal Arteriolar Equivalent (CRAE), Central Retinal Venular Equivalent (CRVE) which are the components of Arteriolar-to-Venular Ratio, also gives various geometrical features associated with vessel bifurcations, vessel crossing points etc regarding the vessels.

In Automated detection and classification of major retinal vessels for determination of diameter ratio of arteries and veins. [13] Here firstly detect the major retinal vessels and classify them into arteries and veins for the estimation of AVR ratio. Here starting with the retinal vessel segmentation provided on the images in the database, here arteries and veins each in the upper and lower temporal regions were first selected manually for establishing the gold standard. Then applied the black top-hat transformation and double-ring filter to extract the retinal blood vessels from the original color image. From the extracted vessels, then the large vessels extending from the optic disc to temporal regions were first selected as target vessels for calculation of AVR. Then the Image features were extracted from the vessel segments that will get after segmentation from the edge of optic discs. After that the target vessel segments in the training cases were classified into arteries and veins by using the linear discriminate analysis.

In Arteriolar-to-venular diameter ratio estimation-A pixel-parallel approach [14] used a methodology to extract the retinal vessel tree, which will be tested in a fine-grain pixel-parallel processor array, is used for the estimation of the AVR ratio in angiographies. In Vivo Assessment of Retinal Vascular Wall Dimensions. [15] Here used a transgenic mouse model to quantify AVR in vivo based on total vessel dimensions. In Assessment of vascular changes in retinal images [16] gives an automatic approach for the estimation of the AVR in retinal images. It explains the method includes vessel segmentation, , optic disc detection, vessel caliber estimation, region of interest determination, classification of vessels and finally AVR calculation. In Hypertensive Retinopathy Diagnosis from Fundus Images by Estimation of AVR [17] has proposed an algorithm in which first step having initially the blood vessels are segmented out from the pre processed retinal grayscale images. Then the features of

Gray level and moment were extracted to classify the resulted pixels belongs to the blood vessel class or not should be decided. Variations in the intensity of the pixel and alterations in color information is considered to classify the retinal blood vessel into arteries and veins. To measure the arteriolar-to-venular ratio first estimates the vessel width method which is useful for diagnosing the early stages of the hypertension. In An improved system for the automatic estimation of the Arteriolar-to-Venular diameter Ratio (AVR) in retinal images [18] gives an enhanced system to calculate the AVR value that is Arteriolar-to-Venular Diameter Ratio by automatically. First of all enhanced the Retinal image to highlight the vessel network, and then the vessels should be traced by the vessel tracking algorithm. After getting the vessel structure, the position of the optic disc was find out on the basis of that the AVR value to be calculated. After that blood vessels get classified into arteries and veins, even the caliber also computed fro that easily estimate the AVR value. Some improvements were needed in the post-processing algorithms to enhance vessel tracking method and gives a new artery/vein classification technique. In an Automatic Estimation of the Arteriolar-to-Venular Diameter Ratio (AVR) in retinal images [19] here developed a computerized system to estimate AVR value automatically. Here original image were enhanced by ant enhancing method like histogram equalization. Extracted vessels then traced by a vessel tracking algorithm. From the detected vessel structure, the position of the optic disc is derived and find out the region where AVR is calculated. Blood vessels within this region are classified into arteries or veins, and also the caliber were estimated and finally the AVR parameter is computed.

In Automated selection of major arteries and veins for measurement of arteriolar-to-venular diameter ratio on retinal fundus images [20] here present an automatic method for measurement of arteriolar-to-venular diameter ratio (AVR). The method includes the segmentation of the optic disc for the determination of the AVR value. Retinal vessel segmentation, vessel classification into arteries and veins, selection of major vessel pairs, and measurement of AVR value can be calculated. This method gives the objective calculation of AVR value.

III. CONCLUSION

We are going to extend new approach which having retinal color image enhancement by Histogram Equalization. Followed by extraction of vessels using Kirsch's threshold-based Templates method and extracted vessel image will be smoothed by Median Filter. After words Classification of vessels will be done. After classification Graph representation will be there on the basis of bifurcations and crossing points and the AVR will be calculated. Finally the diagnosis of retinal disease will be takes place by finding the abnormality in the AVR value. Extensive experiments on two large and challenging DRIVE and INSPIRE-AVR datasets will show the significant improvement of our new approach over the state-of-the-art.

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