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Study on Segmentation of Retinal Blood Vessels Using Wavelet Filter Methodology

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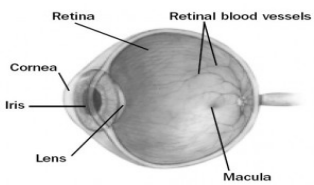
ABSTRACT:For developing retinal screening systems the segmentation of blood vessel is the basis since vessels serve as one of the major landmark features of retina. The eye care specialist can screen abnormalities of vessel using an effective and efficient computer based approach to automated blood vessels segmentation in retinal images. Automated segmentation reduces the time needed by a skilled technician or physician for manual labelling. Thus a reliable vessel segmentation method would be valuable for early detection of alterations due to such diseases. Tools that could be adopted for assisting in Diabetes Retinopathy and many abnormalities in image of retina would be quite helpful. Computer assisted diagnosis (CAD) for different diseases is most common and imaging the medical diagnosis plays a vital role in CAD (Wu and Agam, 2007, 2007a). Therefore, techniques of image processing could assist in identifying abnormalities from image of fundus. Majority of the methods for vessel segmentation are on the basis of probabilistic filters, watershed algorithm, wavelet filter algorithm, Gabor filter and so on (Li et al, 2006).

KEYWORDS:Retinal Blood Vessels, Segmentation, Diabetes Retinopathy, Image Processing, Computer Aided Designing, Morlet wavelet transforms, Wavelet Filter algorithm, Fast Fourier Transform, RGB input

I. INTRODUCTION

The automated retinal structures segmentation enables ophthalmologist to do huge population view monitoring exams for the treatment evaluation and detection or prevention of retinal diseases. This type of non-intrusive diagnosis present in the modern ophthalmology might reduce and prevent the blindness and also prevent several cardiovascular diseases throughout the world. A retinal blood vessel is the most significant and is playing a vital role in treating and detecting the diseases of retina. Segmentation of retinal vessel and its morphological attributes delineation includes width, length, branching pattern or tortuosity and angles are used for screening, treatment, diagnosis and estimation of different cardiovascular diseases.

The retinal blood vessels segmentation by using manual method is one of the tedious and long tasks that also need skill or knowledge and training. It is generally accepted by medical community, which automatic retinal vessels quantification is the initial stage in improvement of computer aided diagnostic system for the ophthalmic disorders. The poor contrast and intensity in-homogeneity of retinal images affects the notable degradation to automated segmentation of blood vessels methods performance. The fundus retinal images intensity in-homogeneity is commonly attributed to image acquisition under various illumination conditions (Joshi and Karule, 2012).



ABOVE FIGURE 1.1 SHOWS THE VEIN OCCLUSIONS, SOURCE: GREVE ET AL., (2013)

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The figure 1.1 shows the vein occlusions with retinal blood vessels. The fluorescein or orange colored dye is injected to the vein in arm and is suddenly followed by the sequence of retinal images, which track dye and its time flows as the image travel via the blood vessels of eyes. The angiogram assists to find the accurate vein blockage sites, the damage level to capillaries or minimum retinal blood vessels, the leakage site, whether -vascularization was developed or not. The scan of Optical Coherence Tomography (OCT) are performed to screen the level and position of swelling inside retina. The modification in structure of retinal blood vessels causes the diseases like hypertension, diabetes and ROP (Retinopathy of Prematurity).

In retinal diagnosis field, there is the rising demand for the early detection of the pathological changes. The promising way is dynamic behaviour observation of vessels inside the retina. The feature vector contains five features and employed for the retinal blood vessels segmentation. The segmentation of vessel in the retinal images may be broadly separated into two sets. The first set contains rule based techniques. The second set contains supervised techniques that need manually tagged images for the training. The feature vector contains seven elements including grey extent of the green channel, wavelet filter response or four scales and two line operative responses.

FIGURE 1.2 RETINAL VESSEL SEGMENTATION BLOCK DIAGRAM, SOURCE: AUTHOR

The figure 1.2 illustrates the block diagram for the retinal vessel segmentation. The initial step in the segmentation process is mainly to acquire retinal fundus picture. Then the next step is to employ the pre-processing to reduce fake prediction of camera apertures border and remove the pathological noise. The tool of feature extraction or segmentation is employed to analyze and detect the singularity or blood vessels and localized properties. The classifier is required at last in order to classify the every pixel in the image as non-vessel or vessel.

The camera images of non-mydriatic were analyzed in the efforts to enhance the quality and fine tune of detection of retinal blood vessel in the medical imaging or monitoring. The Morlet wavelet filter is employed as the technique for retinal blood vessels segmentation in mixture with supervised classification, probabilities of supervised classifier and adoptive thresholding mixed with the adoptive thresholding. The automated blood vessels evaluation patterns, which may be employed by the rural health experts is being extended now from the camera images of fluorescein labeled to non-mydriatic. The space scale wavelet analysis ability may be utilized to decompose the structure of vessels to the differently scaled Morlet wavelets, in order to segment or extract them from retinal fundus (Fraz et al., 2012).

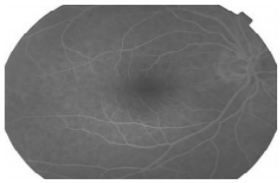

FIGURE 1.3 SEGMENTATION OF BLOOD VESSELS USING MORLET WAVELET TRANSFORM (REAL FLUORESCEIN IMAGE OF RETINA), SOURCE: CORNFORTH ET AL., (2005)

The figure 1.3 demonstrates the segmentation of blood vessels using Morlet wavelet transform showing the real fluorescein image of retina. The wavelet transform application was examined for the retinal blood vessels identification. The diameter ratio from arteriolar to venular of retinal vessels as the disease indicators associated modifications in the tree of retinal blood vessels. The vasculature of retina is collection of veins and arteries looking to as extended features with the tributaries visible inside retinal image. There is the broad variety of vessel widths sorting from one to twenty pixels based on both image resolution and vessel widths.

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II. RELATED WORK

Soares et al (2006) presented a method to segment the retinal vessel using two-dimensional supervised classification and Morlet wavelet. Proposed research produces segmentations by categorizing every pixel of image as non-vessel or vessel on the basis of feature vector (FV) in pixel. FVs are involved with intensity of pixels and continuous 2D Morlet wavelet transforms were considered at multiple scales. Apart from these, it was noted that distributions of probability are estimated on the basis of labelled pixel's training sets acquired from manual segmentations.

According to the research by Akram et al (2009) he developed two-dimensional approach of Gabor wavelet for automated segmentation of blood vessels (BV) which is effective for handling images in the vessels under different conditions with reasonable reliability and accuracy for medical diagnosis. Issues with retinal images (RI) is that vascular pattern's visibility is not good. Therefore, it is significant for enhancing the vascular pattern. Vessels are improved before to their identification. At the same time, it was pointed out that the segmentation mask of vessel is developed by applying thresholding. It was found that proposed method performs well to detect vessels as well as effectively improves and segments the patterns of vascular.

Joshi and Karule (2012) described the techniques on the basis of morphological operation and adopted numerous images. Contrast-limited adaptive histogram equalization moved the image into more suitable look for the segmentation's algorithm application. This research detects the BV on the basis of morphological operation which is robust and successful to represent the directional model of RV.

Akram et al (2009a) presented a method that adopts two-dimensional Gabor wavelet and at the same time adopts sharpening filter for enhancing and sharpening the vascular pattern. Such techniques situate and segment the BV using algorithm of edge detection and morphological operations. Such techniques in this research are tested on publicly present database namely STARE of manually labelled images that were expanded for facilitating comparative researches on segmentation of BV in RI. From the findings of the experimental outcomes it was indicated that proposed method performs well to enhance and segment the vascular pattern. Thus it can be concluded that proposed techniques are tested particularly on STARE database and it was confirmed that proposed method performs well.

Shajahan and Roy (2012) carried out a research to enhance retinal BV segmentation algorithm on the basis of Multistructure element's morphology. Intrinsic characteristics of RI makes the process of vessel detection more complicated. High potential of transforms in the curvelet for representing images containing edges, enhanced the image contrast of RI for part of segmentation. BV distributed in unique directions is identified through the morphology of multi-structure elements. It was stated that false edges are eliminated by reconstruction of morphological, whereas preserve thin vessels. Application of analysis of connected components and filtering of length assisted to eliminate the remaining false edges more specifically and accurately. Thus it can be inferred from the analysis that the false edges are eliminated by reconstruction of morphological, whereas preserve thin vessels.

Shabbir et al (2013) compared and evaluated the computerized methods for BV enhancement and segmentation in RI. Two techniques are assessed using STARE and DRIVE databases of RI. It was found that global thresholding technique and Gabor wavelet is better for the segmentation and improvement of vessel. Apart from these, it was noted that Gabor wavelet improves the vessel and minimizes noises which was found in the image. Global thresholding segment enhances all foreground vessels size irrespective of their sizes. Other techniques namely Laplacian of Gaussian filter for improvement as well as adaptive thresholding especially for segmentation provides less visibility of vessels and accurate outcomes. Thus it can be clear from the literature that global thresholding technique and Gabor wavelet is better for the segmentation and improvement of vessel.

Chaudhari et al (2014) developed a method for segmenting the RV using multi-directional, multi-scale Gabor wavelet as well as supervised classifier. FV is obtained by integrating the Gabor responses and intensity values of green channel at unique scale. It was confirmed that Gabor wavelet is effective in improved vessel at the same time and filtering out noise. Further LMSE (linear minimum squared error) classifier demonstrates a reasonable performance with fast training phase and classification. Thus it can be concluded that Gabor wavelet is effective in improved vessels.

Nayak et al (2015) surveyed the algorithm of retinal BV segmentation for retinopathy of diabetes using wavelet. Gabor wavelet is effective to enhance the vessel, contrast at the same time eliminates the noise. Such technique is selected since it has potential to detect related features and tune to particular frequencies. Moreover, it could adjust specific to the frequency, noise in the background could be filtered. Issue with segmentation of BV is that vascular

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pattern visibility is not good particularly for vessels which are thin. Therefore, it is significant for enhancing the vascular pattern. Apart from these, it was noted that Gabor wavelets have capability of directional selectiveness.

III. IMPORTANCE OF RETINAL BLOOD VESSEL

The retinal images are affected by all factors and that influence the body vasculature in common. Eyes of human are the distinct human body region in which the vascular condition may be observed directly. The blood vessels contribute the most important retinal image features and its properties are significantly influenced by global. The segmentation of blood vessels in retina is most important in determining and treating various diseases like hypertension, diabetes and arteriosclerosis. Additionally, it assists to identify several eye diseases like retinal artery occlusion, retinal choroidal neovascularization and also create modifications in retinal vasculature. On the last some years, various segmentation methods are used for retinal structure segmentation like optic disc, blood vessels and diseases including lesions in retinal fundus images. For example,

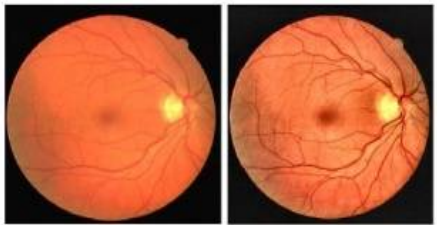

Figure 1.4 both normal and abnormal retinal images, Source: Raja, Vasuk and Kumar (2014)

The above figure 1.4 illustrates the retinal images for both normal and abnormal conditions. As said by above statements, the blood vessels segmentation in retinal images may be considered as valuable purpose for detection and prevention of glaucoma diagnosis and diabetic retinopathy.

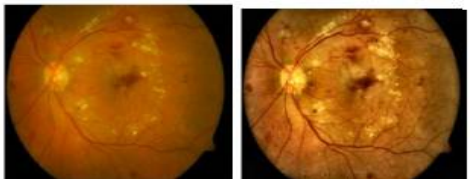

Figure 1.5 retinal images with enhancement, Source: Raja, Vasuk and Kumar (2014)

The figure 1.5 demonstrates the enhancement of retinal image segmentation with the help of SVM classifier. The causes are considered as damages in optic nerves, the diagnosis may be depended on examination of retinal blood vessels.

The second most important disease is glaucoma, which is the reason for blindness throughout the world. If the glaucoma isn't detected properly or previously then optic nerve damages are irreversible and also it may cause blindness, finally. The automatic segmentation of blood vessels in the retinal images is very critical process. The vessels may be detected in tomographic images or reflectivity images, for diagnostic functions. The structure of the vessels required to describe discretely for inside and region of optic disk in order to raise the diagnostic expression. There are various pathologies influencing the structure of retinal vascular because of diabetic retinopathy may be identified in the retinal images. The segmentation of blood vessel from the retinal images plays a vital role for diagnosing the difficulties because of cardiovascular disease, stroke, hypertension, diabetes etc. the accurate and automatic segmentation of blood vessels in retinal image might give various helpful features for the diagnosis of different retinal diseases and decrease the workload of doctors. The retinal image contains large variability and low contrast in process of image acquisition that declines the automatic segmentation of blood vessels. To make use of these retinal blood vessels features is very significant to attain the shapes and locations accurately (Raja, Vasuk and Kumar, 2014).

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IV. RETINAL BLOOD VESSELS SEGMENTATION USING WAVELET FILTER TECHNIQUE:

The eye disease of diabetics points out to be collection of eye issues along with threats to the vision. The abnormalities causes complications in retina and worst case of severe vision loss or blindness is said to be Diabetic Retinopathy. The retinopathy of non-proliferative is less critical diabetic retinopathy forms and happens when the abnormality increases in retinal capillaries, permitting fluid to seep out into the eye tissues. The small blood vessels network known as CNV (choroidal neo-vascularization), starts in choroid and attaining a retina's blood supplying portion. When the blood supplying amount of retina is reduced, the vision can be degraded and in critical situations, blindness can take place. The most general signatures of diabetic retinopathy are such as spots of cotton wool, dilated retinal veins, hemorrhages and hard exudates.

Retinal images are also called as ocular or fundus images that are attained by making photographs of backside of eye. Vessel segmentation and enhancement are used for monitoring of the disease of diabetic retinopathy. The specialists of eye care may screen the huge populations for the abnormalities of vessel after the growth of effective and efficient computer oriented technique to the automated blood vessel segmentation in retinal images.

The retinal blood vessels measurement and detection may be employed to classify the disease severity, as the portion of automated diagnosis process of disease or in therapy progression assessment. The retinal blood vessels segmentation contains measurable modifications in branching angles, diameter, and length, effect of disease. Hence, reliable technique of blood vessel segmentation and extraction might be valuable for detection and characterization of modifications because of such diseases. Automated and computerized segmentation gives consistency and decreases the time needed by the skilled technician or physician for the manual labeling. The pattern of retinal vascular is mainly used for the automatic creation of retinal mappings for age oriented macular degeneration treatment, segmentation of characteristic retinal vasculature points for multimodal or temporal image registration of retinal image of mosaic synthesis, localization of fovea and optic disc position identification.

Several challenges faced in the detection of automated blood vessel have broad range of width of vessel, low contrast relating to the appearance and background of different structures in retinal image like optic disc, retinal boundary and then other pathologies. The tracking technique contains lines of vessel center directed by the local information. The features of pixel are created depends on the representation of retinal blood vessel segmentation. There are several features are provided and the selection of feature scheme is utilized to choose those to give the seperability of best class.

Automatically placing the exact vascular pattern is the most significant in blood vessel screening system's implementation. The automated blood vessel screening system is mainly to facilitate the experts is a customer electronics application. The method used for segmenting blood vessels from the retinal images with high accuracy when compared to previous methods. In this method, the retinal image with monochromatic RGB is considered as input image and wavelet filter is employed to enhance vascular pattern particularly less and thin visible vessels are enhanced with the help of wavelet filters. The segmentation of blood vessels binary mask is generated by using thresholding enhanced retinal image. Retinal blood vessels are noted by masking procedure that allocates zero to non blood vessel pixels and single to all pixels and that belongs to blood vessels.

The input images are with 768 × 584 pixels of 8 bits per color channel. The dataset of retinal image is separated into training set and test. The test set is employed for performance measurement of vessel segmentation algorithms. Images with manually segmented by first human observer are employed as segmentation sets and ground truth serving as human observer location for the comparison of truth performance. The fraction of true positive is the fraction of true positive count or pixels which actually belong to the vessels and total vessel pixels count in retinal image. The fraction of false positive is measured by separating the false positives or pixels which are did not belongs to the vessels with the non vessel pixels count in retinal image.

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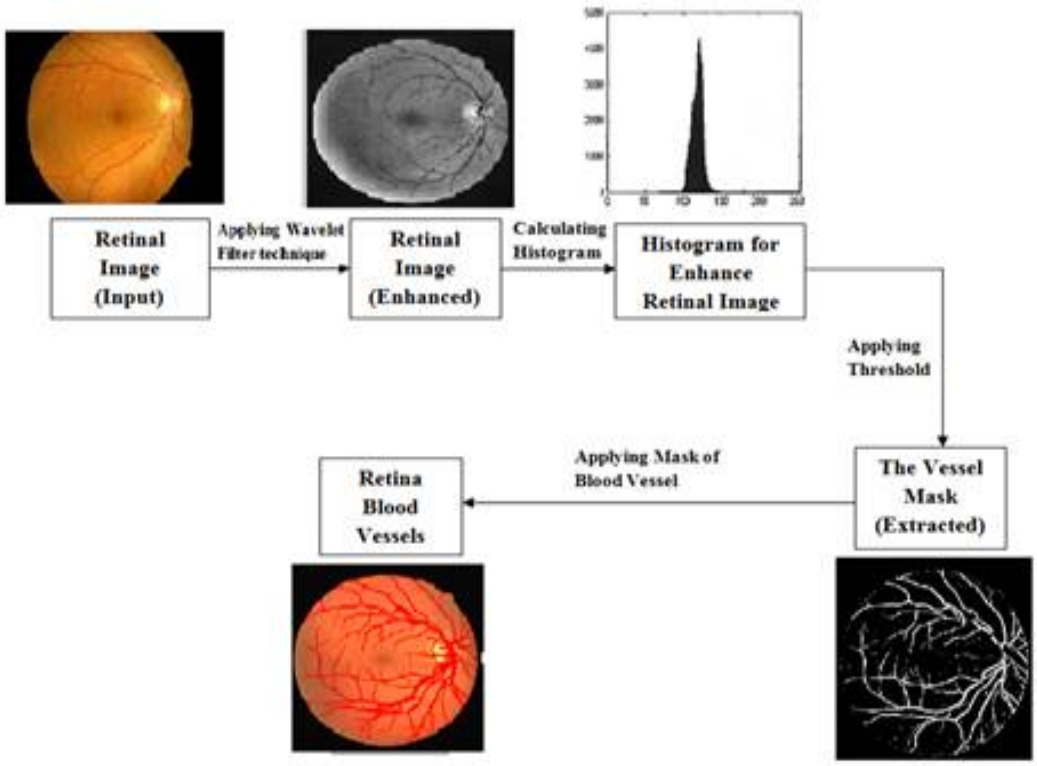

Figure 1.6 Flow diagram for Retinal Blood Vessel Segmentation system, Source: Author

The above figure 1.6 shows the flow diagram for retinal blood vessel segmentation system. The technique is performed regarding the segmentation of vessels accuracy with the help of publicly available database. The RGB retinal image is considered as the input image. After that applying wavelet filter techniques to that image we get enhancedimage, with that we are measuring the histogram. A well designed program code in MATLAB software has enabled author to get the enhanced retinal image from RGB input image. The thresholds are applied to the extracted vessel mask and apply the mask of blood vessel to the retinal blood vessel, at last.

V. RESULTS

The wavelet filters for automated segmentation of retinal blood vessels is efficient to handle the vessel images under different conditions with the reliability and reasonable accuracy for the medical diagnosis. The retinal images problem is that vascular patterns visibility is generally not good. Thus, it required to enhance the pattern of vascular. The vessels are enhanced to the detection. The segmentation of vessel mask is generated by applying the thresholding. The wavelet filters are used to enhance thin vessels and vascular pattern. The wavelet filter is mainly employed to its directional exclusiveness abilities of detecting related features and then fine tuning to particular frequencies. The result shows the techniques performances well in detecting the vessels and effectively enhances and vascular pattern segmentation

VI. CONCLUSION AND FUTURE WORK

The results have showed that the proposed method performs better segmentation of retinal blood vessels specially by using Wavelet Filter Method as compared with the existing methods. Wavelet filter method is adopted because of its directional selectiveness potential to detect related features as well as fine tuned to particular frequencies. Wavelet filter method is adopted in order to enhance the thin vessels as well as vascular patterns. In future more

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methods showing higher percentage accuracy in images and enhanced results of segmentation in Retinal Blood Vessels can be designed which would prove to be a boon to Medical analysis field with help of CAD.

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BIOGRAPHY

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