A Relative Study on Retinal Vessel Segmentation

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Abstract

Retinal image processing is a standard medical repetition and offers number of profitable products for physicians. In the field of retinal image processing retinal vessel segmentation is the crucial task for detection of cardiovascular diseases in advance. The recognition of erroneous blood vessel may cause in incorrect clinical diagnosis. Various processing steps are required for the extraction of blood vessel from the retinal image such as preprocessing, noise reduction, gray scale conversion and segmentation. Segmentation is the final and important stage of blood vessel extraction process. Many segmentation techniques are proposed by researchers for blood vessel extraction. Methods and comparison of some segmentation techniques are given in this paper.

Keywords: Retinal image, segmentation, blood vessel, cardiovascular.

1. INTRODUCTION

The retina is a light-sensitive layer of nerve tissue lining the internal surface of the eye. The retina creates an image projected on its surface with help of the cornea and crystalline lens, which assists much the similar purpose as the film in a camera. The retina is extremely linked with the fundamental layers of the eyeball beside the edge of the optic nerve head. The optic nerve comprises the ganglion cell axons running to the brain and, furthermore, arriving blood vessels that exposed into the retina to vascular size the retinal layers and neurons. A circular segment of a portion of the retina reveals that the ganglion cells (the output neurons of the retina) lie deepest in the retina nearby to the lens and front of the eye, and the photo sensors (the rods and cones) lie furthest in the retina against the pigment epithelium and choroid. Light must, consequently, transfer over the thickness of the retina formerly prominent and activating the rods and cones [1].

Afterwards the preoccupation of photons by the visual pigment of the photoreceptors is interpreted into first a biochemical message and then an electrical message that can motivate all the subsequent neurons of the retina. The retinal message concerning the photic input and some initial association of the visual image into several forms of sensation are conveyed to the brain from the confounding expulsion shape of the ganglion cells. The structure of retina in human eye was illustrated in figure1.

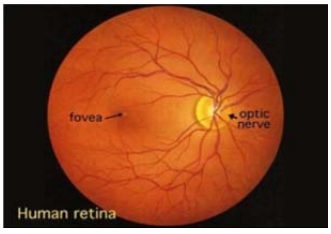

Figure 1. Structure of Human Retina

Optic fundus valuation is generally used in the medicinal department for identifying vascular and non-vascular pathology. Assessment of the retinal vasculature may expose primary symptoms of hypertension, diabetes, arteriosclerosis, cardiovascular disease and stroke. Due to various imaging circumstances retinal images may be corrupted. Subsequently, the improvement of such images and vessels in them is a significant task with direct clinical applications. However, they want the precise extraction of dissimilar vessels from a retinal image. This is a challenging problem due to uncertainties triggered by vessel bifurcations and crossovers [2].

The segmentation of blood vessels from the human retinal image is a significant preprocessing step for the prompt identification of retinal diseases. Because of miscellaneous nature of the vascular network, the manual vessel segmentation is very challenging and time consuming, so the investigators have proposed several automatic approaches for retinal vessel segmentation [3]. The general framework of retinal blood vessel segmentation process is explained in the next section.

2. RETINAL VESSEL SEGMENTATION

This section gives the details about the general processing techniques used for the blood vessel segmentation from the human retinal image. The block diagram of general framework was given in Figure 2. The detailed explanation is given as follows.

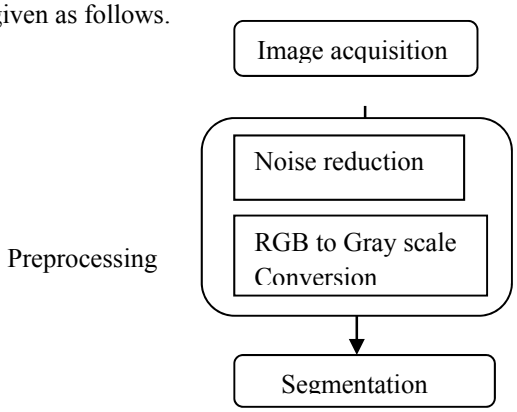

Figure 2. General Retinal Vessel Segmentation process

A. Image Acquisition

Image acquisition is initial stage used in the retinal vessel segmentation process. General devices used for acquisition of retinal images are funduscameras that use visible light and CCD cameras to look into the eye. The retinal images acquired from the above mentioned devices are in RGB form and unwanted noises are present in the image. The sample of original image is shown in figure 3 (a).

B. Preprocessing

After the image acquisition of retinal images the preprocessing stage will be done with the input retinal images. Preprocessing stage has two sub actions. They are noise reduction and gray scale conversion.

Noise in retinal color image is normal process due to the various constraints affected during the image acquisition process. It is important to remove the noisy pixels from the input image and improve the quality of the image. Otherwise the noisy pixels degrade the edges of the image and it may cause errors during the blood vessel segmentation process. It has many chances to wrongly identify the noise pixels as the blood vessel. Figure 3 (b) illustrates the noise removed image.

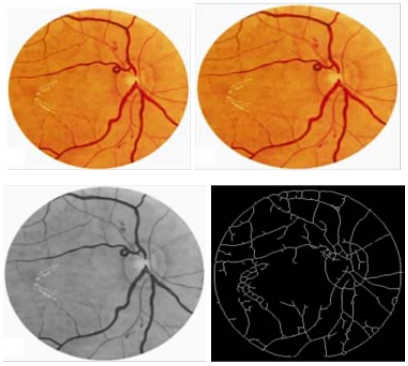

Fig 3 Results of various processes used in blood vessel extraction, a) Original input retinal image, b) Noise removed image, c) Gray scale converted image, d) Extracted blood vessel structure

After removing the noisy pixels from the original input image, it is require converting it into gray scale image. Initially the original image is in the RGB format. The conversion process is takes out by replacing the Red, Green and Blue color pixels into black and white pixels by setting the threshold value. The pixels above the threshold values are changed into black and others are white. The gray scale converted image was shown in Fig.3(c).

C. Segmentation

Segmentation is the final stage of retinal blood vessel segmentation process. The main objective of segmentation is to cluster the same characteristic image pixels into regions. The aim of the segmentation is to shorten and /or modify the demonstration of an image into something that is more meaningful and easier to examine. Image segmentation is usually used to discover objects and boundaries (lines, curves etc.) in the images. The result of image segmentation is a set of patterns that jointly cover the whole image, or a set of contours mined from the image as shown in figure 3 (d). By applying the segmentation process on the preprocessed retinal image the blood vessel structure of the retinal image will be extracted separately.

3. SEGMENTATION METHODS

Retinal vessel extraction comprises segmentation of vascular structure and detection of separate vessels by connecting up segments in the vascular structure to give comprehensive blood vessels. The various segmentation methods used for blood vessel segmentation will be explained as follows:

A. Optimum-path Forest based Segmentation

Qiangfeng peter Lau et al., "simultaneously identifying all true vessels from segmented images" deals with Measurements of retinal blood vessel morphology have been shown to be related to the risk of cardiovascular diseases. The training set is supposed of as a graph, whose nodes are the models and curves are defined by specific adjacency relation. The curves are weighted by the detachments between the feature vectors of their consistent nodes. The nodes can also be weighted by certain probability density function. Any arrangement of different models forms a path joining the terminal nodes and connectivity functional locates a cost to that path. The time consumption of Graph Tracer is exponential to the quantity of edges and is independent of the size of the retinal image as it only deals with the connectivity of complete segments without calculating pixel properties such as intensity [4].

B. Automatic Graph-Based Approach

BehdadDashtbozorg et al., "an automatic graph-based approach for artery/vein classification in retinal images", deals with the classification of arteries and vein in retinal images. The Numerous researches on vessel classification have been proposed, but automatic classification of retinal vessels into arteries and veins has customary narrow of attention, and is still an exposed issue in the retinal image investigation field. In recent years, graphs have developed as a unified demonstration for image analysis, and graph-based approaches have been used for retinal vessel segmentation retinal image registration and retinal vessel classification. A graph is an illustration of the vascular system, where every node denotes a juncture point in the vascular tree, and every link agrees to a vessel segment between two juncture points. For creating the graph, we have used a three-step algorithm. Initially we use the segmented image to acquire the vessel centerlines, then the graph is created from the centerline image, and finally specific further alterations are applied to the graph [5].

C. separations of Arteries from Vein

Mirsharif et al., "developing an automatic method for separation of arteries from veins in retinal images" deal with analyzing the retinal blood vessels that can provide very helpful information to doctor for early detection of diseases such as diabetic retinopathy. Try and test the method for group of images with different sizes. Finally achieve the best result using group of eighteen consecutive centerline points. Thus long vessel segments are divided into smaller vessels of length nearly 18 pixels. Then extract 6 characters for each piece of segment and use each one as an input feature vector to classifier. In fact to classify vessel segments instead of vessel points. Those long vessels are sub divided into smaller vessels and the centerline pixels are counted from it. If the artery pixels are identified by classifier are more than those classified as vein in each vessel segment, all pixels of the related vessel segment are labeled artery. [6].

D. Branches Filtering Approach

I.K.E .Purnama et al., "branches filtering approach to extract retinal blood vessels in fundus image" deals with analyzing the retinal blood vessels can produce information about an abnormality and investigating its pathological changes. The new method for the blood vessel segmentation in retinal images exploits max-tree and the branches filtering approach. Max-tree is used to represents the images, and the filtering procedure uses branches filtering approach to select the branches of the tree based on the elongation attribute of the nodes. In the original Max-Tree, the filtering standards are applied to all nodes of the tree. The idea of branches filtering approach was inspired by the fact that in some applications the predictable objects are hard to distinguish from unwanted neighboring objects, or they are in the noisy image. This filtering approach is appropriate if the expected objects can be identified although by only a little information, and this information is present in the leaf nodes of Max-Tree. The images are grey-level images, and the values are between 0 and 255. The grey-level was used as a standard in the filtering procedure, and in the Max-Tree creation procedure this information was stored in each node [7].

E. Principal Curve Based Segmentation

S .You et al., "principal curve based retinal vessel segmentation towards diagnosis of retinal diseases" deals with the extraction of retinal vessel do an major role in the diagnosis and study of retinal diseases, such as age-related macular degeneration (AMD), diabetic retinopathy, retinopathy of prematurity (ROP).vessel diameters, tortuosity, branch length, angles, and bifurcations are essential to diagnosing these diseases. The implementation of the proposed method is relating to analyzed by measuring the sensitivity, specificity, and accuracy between the thresholded Frangi filtered images and the manual labels. The experimental results demonstrate the feasibility of using the integration of the Frangi filter and our previously developed locally defined principal curve projection and tracing algorithm to extract retinal vessels. Since this is a preprocessing step for the feature extraction, branches and bifurcation points are not considered in this paper. The proposed vessel segmentation method provides sufficient preliminary results towards the future disease diagnosis.tn the future; we will improve our approach for the segmentation of the retinal vessels and extract features from these segmented vessels. These features will be trained as metrics to determine retinal disease [8].

4. COMPARISON OF BLOOD VESSEL SEGMENTATION TECHNIQUES

The comparison table for above mentioned retinal blood vessel segmentation techniques and their accuracy are given in the Table 1.

TABLE 1. ACCURACY COMPARISON OF VARIOUS SEGMENTATION TECHNIQUES

Author Name	**Technique Used**	**Accuracy**
Qiangfeng Peter Lau et al.	Optimum-path forest based Segmentation	98.7 %
BehdadDashtbozorg et al.	Graph based Segmentation	87.4 %
Mirsharif.G et al.	Multi Scale Line Detection Technique	86 %
Purnama I.K.E et al.	Branches Filtering Approach	93.95 %
You.S et al.	Principal Curve based segmentation	94.56 %

5. CONCLUSION

In the field of retinal image processing retinal vessel segmentation is the crucial task for detection of cardiovascular diseases in advance. Segmentation is the final and important stage of blood vessel extraction process. Though, this is a challenging task due to the low contrast of reedy vessels to the background, non-uniform illumination, and the dominant light reflex. Even though many promising techniques and algorithms have been developed, it is still an open area for more research. Accuracy of the segmentation process is essential to achieve more precise and repeatable radiological diagnostic systems. Accuracy can be improved by incorporating a priori information on vessel anatomy and let high level knowledge guide the segmentation algorithm this paper provides a survey of current vessel segmentation methods.

In future, segmentation of retinal blood vessels will be performed by using an innovative clustering algorithm which is based on the nearest neighbor concept that is used in the KNN classifier. The advantage of this algorithm is does not need a training set and it gives improved accuracy on retinal blood vessel segmentation process.

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