

# Comparison of Retinal Vessel Segmentation Techniques: A Review

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**Abstract - Retinal vessel segmentation is segmentation of an image to extract the vessels to diagnose various diseases such as diabetic retinopathy, pathology related diseases. In this paper, various retinal vessel segmentation diseases has been discussed and compared for the early detection of the diseases. In this paper various techniques has been evaluated and it has been observed that retinal vessel segmentation using infinite perimeter in active contour model is best in case of accuracy.**

**Index Terms-Rotating filter, Structure based, hybrid information, Infinite contour.**

## I. INTRODUCTION

Retinal vessel segmentation is required for the proper detection of diseases. Manual retinal vessel segmentation is time consuming while automatic retinal vessel segmentation is less time consuming and provides more accurate results [1]. Manual segmentation requires some expert person to carry out the segmentation while in automatic vessel segmentation expertise is not required. Retinal vessel segmentation is used to find many eye-related diseases such as diabetic retinopathy and pathology related diseases.

Early detection of eye related diseases is required otherwise vision loss can occur. For the early detection, an accurate and fast vessel segmentation technique is required. So that treatment can be provided at the early stage.

Segmentation of retinal vessels is a challenging task due to similarity of vessels, variation of vessel width and many other problems. For accurate vessel segmentation, many algorithms have been proposed.

Algorithms are of two types-supervised methods and unsupervised methods. Supervised methods usually give better performance than unsupervised methods as supervised methods provide trained classifier for discrimination of vessels and non-vessels.

## II. LITERATURE SURVEY

In this paper, analysis of various retinal vessel segmentation techniques has been done.

*A. Retinal vessel segmentation using structure-based level set method [1]*

Structure-based level set method is proposed by Esra Ataer-Cansizoglu, et al. [1]. Structure-based level set method is an automatic retinal vessel segmentation method. Level set-based methods has been widely used for image segmentation [4]. Level set methods are further of two types: i) edge-based methods [4-6] and ii) region-based methods [7-9]. Level set methods are not extensively used for vessel segmentation. There is not much methods are proposed for vessel segmentation on the base of level set method [1]. This is due to the challenges that are to be faced due to different shape of the vessels [4]. Structure based level set method is applicable on both pathological and non-pathological images.

Structure based level set method consists of three main steps:

- i) Preprocessing
- ii) Modified phase map estimation
- iii) Structure-based level set segmentation

Preprocessing step is used for denoising the image and for sharpening image. Trace based method is used for denoising and shock filter is used to sharpen the image. Secondly, after filtering of an image, green channel of the image is extracted. After that two different images are generated by applying adaptive histogram equalization on the green channel image and then by applying a classical median filter on the equalized histogram image [9]. Lastly, If the input image does not have intensity inhomogeneity, then the equalized histogram image will be considered as the corrected image otherwise corrected image is generated by dividing those images that were generated in the third step.

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The following flowchart represents the complete process.

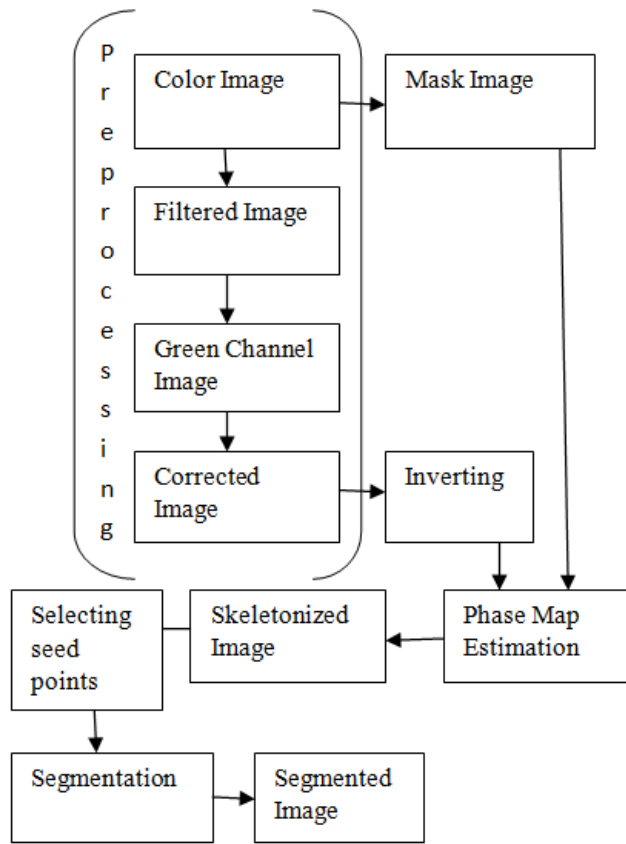


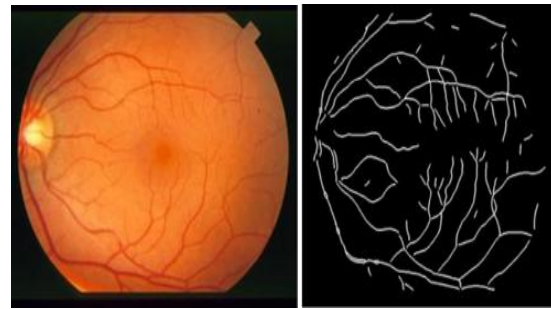
Fig. 1. Structure based level set method

Structure based level set method is little complex method and it works only on green channel of the image.

Modified phase map estimation is a method which is used for estimation of image like whether retinal vessel network contains slim and lengthy vessels with weak edge detection intensities. The log gabor filter is used to extract each and every feature of an image.

Structure based level set method is used to trace retinal vasculature. The level set function can be discretized more easily as compared to other methods[5].

This segmentation method provides basis for the development of computer-based image analysis algorithms. Further study is going on to works on all the channels of an image.



(a) (b)

Fig. 1.1. (a) Original Image (b) Segmented Image

### B. Retinal vessel segmentation using rotating filtration[2]

Rotating filtration method is proposed by S.Badawy, et al.[2]. Rotating filtration is used to visualize minute and big vessels. Four filters are used for edge detection. Each filter is applied on retinal image and each filter rotates at different angles in an image.

The four filters that are used in this method are :

- i) High pass filter.
- ii) Laplacian filter.
- iii) Sobel filter.
- iv) Laplacian of gaussian filter

High pass filter is used to enhance the edges and it also eliminates low frequency components from the image. It detects all the edges by rotating in different directions.

Laplacian filter is similar to high pass filter. Summation of all components is equal to zero. The only difference between laplacian and high pass filter is that in laplacian filter no component has value zero.

Sobel filter is an edge detection filter. It uses two masks which are applied simultaneously on an image. One mask is used to detect blood vessels and other mask is obtained from rotation.

Laplacian of gaussian (Log) filter is used to find the areas of high spatial frequencies which is blood vessel edges in or method[2].

The output of first three filters is blood vessels. Laplacian of gaussian represents more superior smooth blood vessels. Hence tiny blood vessels are extracted by using rotating filtration method.

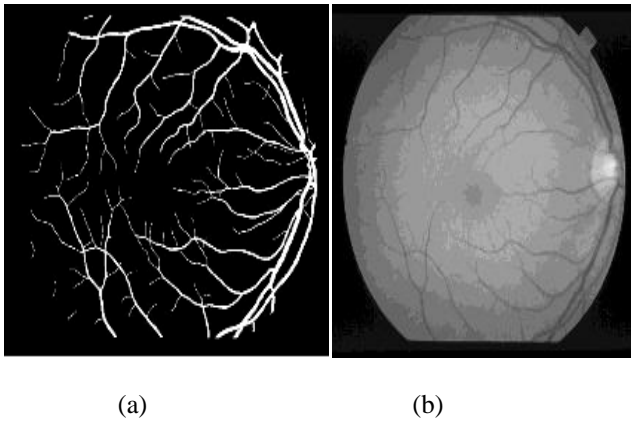


Fig. 2. (a)Original Image (b)Segmented Image

*C.Retinal vessel segmentation using infinite perimeter active contour model with hybrid region information with application to retinal images[3]*

This method is proposed by Yitian Zhao, et al.[3].The detection of vessels is the first most important step for the diagnosis of diseases and after that more advanced functions can be performed such as sharpening of vessel edges,denoising etc.

In an infinite active contour model that uses hybrid region information,an infinite perimeter regularizer provided by using Lebesgue measure of the  $\gamma$ -neighborhood of boundaries is used for better detection of small oscillatory structures than the traditional models[3].This method takes the advantage of using different types of region information, such as combination of intensity information and local phase based enhancement map[3].

The local phase based enhancement map is used for preserving vessel edges and intensity information is used for correct feature's segmentation[3].

The Local phase based enhancement map is reliable and accurate and intensity information excludes unimportant information in the image[3].

Infinite active contour model has been discussed only for retinal images but this method also suitable for segmentation of other images that are used to diagnose diseases related to other organs of the body.

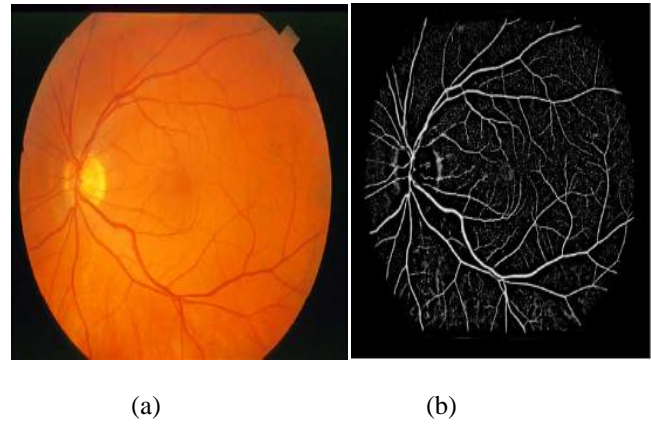


Fig.3. (a) Original Image (b)Segmented Image

### III. CONCLUSION

The performance of all the three techniques is evaluated on the basis of Specificity, Sensitivity and Accuracy.

It has been observed that the accuracy of Infinite perimeter active contour model with hybrid region information method is high because it provides accurate and reliable results.

Accuracy of Structure-based level set method is low as compared to Infinite perimeter active contour model with hybrid region information as it is little complex process.

Accuracy of rotating filtration is the lowest because every filter rotates at each and every angle of an image

Table I. COMPARATIVE ANALYSIS OF VARIOUS RETINAL VESSEL SEGMENTATION TECHNIQUES

Technique	Specificity (SP)	Sensitivity (SE)	Accuracy (ACC)	Advantages
Structure based level set method	0.9613	0.7704	0.9365	It filters the image and then performs segmentation.
Rotating Filtration	0.937	0.733	0.916	Each filter is applied on an image in a rotating manner.
Infinite perimeter active contour model	0.982	0.742	0.954	It provides accurate and reliable results.

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