

“A Survey on Retinal Blood Vessel Extraction and Segmentation Techniques”

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Abstract: Blood Vessels of Retina changes if a person is diagnosed with the Diabetic retinopathy. Thus, it is essential to work on the detection of pixels of Retina to identify the class of Diabetic retinopathy. Efficient extraction of retinal blood vessels is needed to get the high accurate results. we discussed some of Retinal blood vessel extraction and segmentation techniques in this paper along with their performance with important notes.

Keywords: Blood Vessels, Segmentation, Extraction, Diabetic retinopathy, Databases.

I. INTRODUCTION

The major problem of the working people is diabetic retinopathy. This diabetic retinopathy occurs due to change in blood glucose level and cause changes in retinal blood vessels. This disease presents no symptoms in initial stages, if no proper actions are taken then this result into vision loss. Detection and identification of abnormal changes in retinal vessels can minimize the patients from major vision loss. Thus, the retinal blood vessel extraction is done from fundus images to identify and classify the type/level of diabetic retinopathy.

II. LITERATURE SURVEY

Dr. Pradeep et.al. [2] In this method first, the fundus image is filtered to remove noise. Then in controlled manner the image is segmented. Gray Level Co occurrence Matrix (GLCM) is used to extract the features of retinal images. The databases used in the work are MESSIDOR and DIARETDB0. For MESSIDOR database the sensitivity is 100%, specificity is 83% and accuracy is 95%. And for DIARETDB0 database the sensitivity is 90%, specificity is 100% and accuracy is 93%.

M. Ponni Bala et.al. [3] Proposed a new method for classification of blood vessel by using Extreme Learning Machine (ELM) over Support Vector Machine (SVM). After preprocessing the 2D matched filter is used for blood vessel segmentation. Gray Level Co-occurrence Matrix (GLCM) used for extracting the features of images. The learning of ELM is fast and used as classifier of DR. The databases used in the work are DIARETDB0 and DRIVE. For DIARETDB0 database the sensitivity is 96.66%, specificity is 100% and accuracy is 97.5%. And for DRIVE database the sensitivity is 100%, specificity is 94.11% and accuracy is 95%.

Toufique Soomro et.al. [4] Proposes a method of segmentation concentrating on the improvement of performance of segmentation of small vessels. This algorithm includes morphological and different filtering algorithm to handle the background noise and non-equal lights/illumination and by using anisotropic diffusion filtering to coherent the blood vessels and give initial detection of vessels. The databases used in this algorithm are DRIVE and STARE. For DRIVE database the sensitivity is 74.65% specificity is 96.46% and accuracy is 95.15%. And for STARE database the sensitivity is 74.98%, specificity is 95.96% and accuracy is 95.05%.

Diego Marín et.al. [5] Proposed an improved method for vessel segmentation in Retinal images. In this method, segmentation is performed by using gray-level and moment invariants-based feature. The Neural Network (NN) technique for pixel classification and calculates 7-D vector having gray-level and moment invariants-based features for pixel identification. Databases like DRIVE and STARE is used to test this algorithm. The performance measurements for DRIVE databases is sensitivity 70.67%, specificity 98.01% and accuracy 94.52%. For STARE database the performance measurements are sensitivity 69.44%, specificity 98.19% and accuracy 95.26%.

Farnaz Farokhian et.al. [6] Proposed a fast and high accurate method for blood vessel segmentation. In this method, segmentation includes 3 stages. 1st 180 Gabor filters is used to capture the high frequency information including the edges. 2nd the threshold value is determined, based on this threshold value the image is converted into black and white depending on pixels intensity. 3rd is the error analysis which is the simple performance calculation. The performance measurement for database is sensitivity 68.65%, specificity 97.65 and accuracy is 93.66%.

Razieh Akhavan et.al. [7] Proposed an algorithm that extracts the blood vessel centerline pixels. The final segmentation of retina image is obtained by using region growing method that combines the binary images from centerline detection part with the image from fuzzy vessel segmentation part. In this paper, the enhancement of blood vessel from images is done by using modified morphological operations and the noises are removed from fundus images using Adaptive Fuzzy Switching Median filter. The STARE and DRIVE databases are used to test this algorithm. The performance parameters for DRIVE database is sensitivity 72.52%, specificity 97.33% and accuracy 95.13%. And for STARE database the sensitivity is 77.66%, specificity is 96.80% and accuracy is 95.37%.

Khan Bahadar Khan et.al. [8] suggested a technique for retinal blood vessels extraction based on Vessel Location Map (VLM) and Frangi filter. In this method an Adaptive Histogram Equalization is used to enhance non-similarity between blood vessels and background of retina image. To eliminate macula and optic disc morphological top-hat filters are used. To eliminate local noise, the top-hat filtered image is subtracted from the high-boost filtered image. Frangi filters is employed at multi scale for the enhancement of blood vessels possessing very different widths. Segmentation is done by using Otsu threshold method on the high-boost filtered image and frangi's enhanced image. In post processing, extraction of a Vessels Location Map (VLM) is done by applying raster to vector transformation technique. The end segmented retina image is obtained by doing pixel to pixel logical AND operation between VLM and Frangi filtered output image. The databases used in the work are STARE, DRIVE and HRF. For STARE database the sensitivity is 79.02%, specificity is 96.45% and accuracy is 95.13%. And for DRIVE database the sensitivity is 73.00%, specificity is 97.93% and accuracy 95.80%. And for HRF database the sensitive is 74.52%, specificity 95.84% and accuracy is 95.23%.

Lili Xu et.al. [9] proposed a technique for segmentation of retinal blood vessels to avoid the variations in difference of large and thin vessels. This method uses adaptive local thresholding to create a binary image then identify the large connected components as large vessels. The remaining fragments in the binary image including some thin vessel segments, are classified by Support Vector Machine (SVM). The tracking growth is employed to thin vessel segments to form the whole vascular network. This method is tested on DRIVE database, and the sensitivity is 77% and the accuracy is 93.2%.

Avijit Dasgupta et.al. [10] proposed method for the retinal image segmentation task as a multi label inference task and using the advantages of the both convolution Neural Networks (NN) and structured prediction. This method is tested on DRIVE database and has the sensitivity 76.91%, specificity 98.01% and accuracy 95.33%.

Saumitra Kumar Kuri et.al [11]. this algorithm consists of optimized Gabor filter with local entropy thresholding. The frequency and position of Gabor filter is set to match the part of blood vessels that need to be enhanced in a green channel image. Segmentation output pixels are classified by using Local Entropy Thresholding method. The performance is tested on DRIVE database and has the sensitivity 98.5% and accuracy 97.94%.

III. METHODOLOGY

The process of retinal blood vessels extraction and segmentation involves some main operations like preprocessing, image acquisition, segmentation, morphological operation and post processing in series fashion as shown in Fig. 1. Preprocessing consists of several enhancement techniques to remove unwanted backgrounds. Image acquisition used to convert the color channel image into green image to reduce the calculation complexity. Blood vessel segmentation blood vessels were segmented by using 2D discrete wavelet transform and it traces the boundaries on the input image. Morphological operation refers to the nonlinear operation performed in shaping of the filter. And at the end post processing step corresponds to the leading hole filling among the pixels and removing falsely noticed isolated pixels.

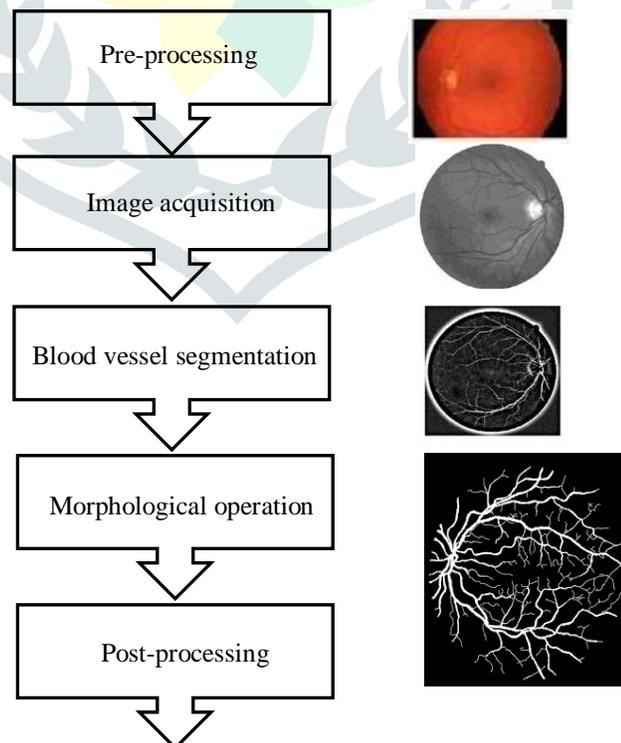


Fig. 1. Flow chart of general image feature extraction.

IV. PERFORMANCE MEASUREMENT

Sensitivity: Sensitivity is defined as the percentage of the actual vessel pixels that are detected.

$$\text{Sensitivity} = \frac{TP}{FN+TP} * 100$$

Specificity: Specificity is defined as the percentage of non-vessel pixels that are correctly classified as non-vessel pixels.

$$\text{Specificity} = \frac{TN}{TN+FP} * 100$$

Accuracy: Accuracy is defined as the percentage of the ratio of total numbers of correctly classified instances and the test size.

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} * 100$$

Where,

TN = Truly classified pixels that are non-vessel pixels.

TP = Truly classified pixels that are vessel pixels.

FN = No. of pixels that have falsely classified as non-vessel pixels.

FP = No. of pixels that have falsely classified as vessel pixels.

V. ANALYSIS OF DIFFERENT METHODS

SL. NO	TECHNIQUE	DATABASE	TP	TN	FP	FN	SENSITIVITY	SPECIFICITY	ACCURACY	REMARK
1	Dr. Pradeep and Sandeep [2]	MESSIDOR DIARETDB0	14 9	5 5	1 0	0 1	100 90	83 100	95 93	Concept of machine learning helps to classify the type of DR with good accuracy.
2	M. Ponni Bala and S. Vijayachitra [3]	DIARETDB0 (SVM) DRIVE (SVM) DIARETDB0 (ELM) DRIVE (ELM)	26 3 29 3	9 15 10 16	1 2 0 1	4 0 1 0	86.66 100 96.66 100	90 88.23 100 94.11	87.5 90 97.5 95	Using ELM results into high accuracy. ELM outputs are calculated analytically, and it is a fast network.
3	Toufique Soomro [4]	DRIVE STARE	- -	- -	- -	- -	74.65 74.98	96.46 95.96	95.15 95.05	Double threshold binarization helps to get a well segmented image. But compromised with poor sensitivity.
4	Diego Marín et.al. [5]	DRIVE STARE	- -	- -	- -	- -	70.67 69.44	98.01 98.19	94.52 95.26	The NN scheme for pixel classification is used for fast and high accuracy classification. But the sensitivity is low.
5	Farnaz Farokhian et.al. [6]	DRIVE	-	-	-	-	68.65	97.65	93.66	The high frequency information in the vessels are extracted using Gabor filter.
6	Razieh Akhavan et.al [7]	DRIVE STARE	- -	- -	- -	- -	72.52 77.66	97.33 96.80	95.13 95.37	A fuzzy approach which uses fuzzy C-means clustering technique to generate representation of the retinal vascular network with actual width of the vessels.
7	Khan Bahadar Khan et.al [8]	STARE DRIVE HRF	- - -	- - -	- - -	- - -	79.02 73.00 74.52	96.45 97.93 95.84	95.13 95.80 95.23	The aim of this method is to remove noise and other disease's abnormalities by identifying VLM, then logical AND operation performed with the output of the Frangi filter applied for vessel enhancement.
8	Lili Xu et.al [9]	DRIVE	-	-	-	-	77	-	93.2	This method uses threshold to produce a binary image then extract the pixels. And uses SVM for segmentation.
9	Avijit Dasgupta et.al [10]	DRIVE	-	-	-	-	76.91	98.01	95.33	This method uses combination of convolution neural networks and structured prediction for better performance.
10	Saumitra Kumar Kuri et.al [11]	DRIVE	-	-	-	-	98.5	-	97.94	Gabor filtering used for feature extraction and local entropy thresholding for segmentation.

VI. CONCLUSION

In this paper some of retinal vessel segmentation techniques have been discussed along with their type of approach and strong points. From above papers it can be concluded that for satisfactory performance of algorithm the retinal image should be contrast and enhanced by using filters so that better pixels extraction can be done. Green channel image provides efficient contrast than other channels. Performance measurements vary accordingly with the different algorithms used.

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