SVM Based Retinal Image Segmentation

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***Abstract*-Eye is one of the most sensitive parts of human body through which we visualize the world. Blindness is one of the most commonly occuring diseases in human . The reason being abnormality in the various layers of retina due to abnormal amount of fluid either excess accumulation or deficit.The blood vessels are the primary anatomical structure that can be visible in retinal images. Retinal blood vessels are one of the most significant features in the fundus image of the eye, which plays a crucial role in the early screening of different ocular diseases. The segmentation of retinal blood vessels has been accepted worldwide for the diagnosis of retinal diseases. This project aims at effectively extracts the retinal blood vessels. We proposed the Support Vector Machine based segmentation technique to accurately extract the blood vessels. This method efficiently segments the vessels and improves the performance parameters. The accuracy achieved is 96%.Implementation part was done in MATLAB 2014a using a DRIVE database openly available online.**

Index Terms – Blood vessels, AHE, CLAHE, Support Vector Machine , fundus image, ocular diseases.

I. INTRODUCTION

The human visual system(HVS) is the most important sensory system for gathering information, navigating, and learning. The eye is the primary sensor of the HVS,with the lens mapping the incoming light patterns onto the retina for transduction to neural signals, which are subsequently transmitted to and interpreted by the visual cortex.Becausetheeyeisavisualsensor,itproducesandprocesses thelargestamountofinformationamongallofthehumansensory system. Several diseases have primary or secondary effects on the eye and the HVS [1].Some Common retinal diseases and conditions include Retinal tear, Retinal detachment, Diabetic retinopathy, Epiretinal membrane, Macular hole, Macular degeneration., Retinitis pigmentosa. A retinal tear occurs when the clear, gel-like substance in the center of your eye (vitreous) shrinks and tugs on the thin layer of tissue lining the back of your eye (retina) with enough traction to cause a break in the tissue. It's often accompanied by the sudden onset of symptoms such as floaters and flashing lights. A retinal detachment is defined by the presence of fluid under the retina. This usually occurs when fluid passes through a retinal tear, causing the retina to lift away from the underlying tissue layers. If you have diabetes, the tiny blood vessels (capillaries) in the back of your eye can deteriorate and leak fluid into and under the retina. This causes the retina to swell, which may blur or distort your vision. Or you may develop new, abnormal capillaries that break and bleed. This also worsens your vision. Epiretinal membrane is pulls up on the retina, which distorts your vision. Objects may appear blurred or crooked. A macular hole is a small defect in the center of the retina at the back of your eye (macula). The hole may develop from abnormal traction between the retina and the vitreous, or it may follow an injury to the eye. In macular degeneration, the center of your retina begins to deteriorate. This causes symptoms such as blurred central vision or a blind spot in the center of the visual field. Retinitis pigmentosa is an inherited degenerative disease. It slowly affects the retina and causes loss of night and side vision [2]. therefore, examination of the eye is an important part of health care not only to assess the HVS ,but also to evaluate the general well-being of the patient. The retina is a multi-layered tissue of light-sensitive cells which has surrounded the posterior cavity of the eye, where light rays are converted into neural signals for interpretation by the brain. Retinal blood vessel network is the only blood vessel network of the body that is visible in a non-invasive imaging method[2] .There are many parameters that can be measured from the retinal vessels structure such as changes in the thickness of the vessels, curvature of the vessel structure, and arteriolar–venular ratio (AVR).AVR has been found useful for early diagnosis of diseases such as hypertension, diabetes, stroke, and the other cardiovascular diseases in adults, and retinopathy of prematurity in infants.[3,4,5].To examine the veins and small arteries in the retina ,we have to analyse the Retinal Blood vessels .This allows us to conclude the information about the function of small vessels. Therefore, for providing an effective and efficient method for extracting the Retinal Blood vessels vessel is necessary. So, basically in this project we deal with effective extraction technique of retinal blood vessels. In this project different segmentation methods based on digital image

processing techniques like contrast enhancement, binarisation, Segmentation based on SVM technique used by Machine learning Algorithm ,which is easier and accurate .The structure of this paper is as follows:

In section I , we have already given the introduction about the paper. section II contains the related work done previously is mentioned on this section .In section III , it gives full detailed descriptions about the method which we used is employed that is our proposed method. Section IV contains the results obtained from our proposed method. Finally, section V is the conclusion of our proposed method.

II. RELATEDWORK

Many researchers are working on different features of vessels segmentation in the retina so that the method will become more effective and accurate.

A vessel segmentation technique based on multi- thresholding in digital fundus images proposed by Preity Et al. [6], performance evaluation on DRIVE database and the method have accuracy of 95.3% and specificity of 98.915 is achieved. Adaptive Histogram Equalization is used for contrast improvement.

One of the efficient method for the extraction of retinal blood vessels using morphological operations and ISODATA clustering technique is proposed by Pilai Et al. [7]. PCA was used for RGB to gray conversion and then K-means clustering used for segmentation.

Image processing based technique to auto-segment the blood vessels from the retinal image proposed by Bantan Et al [8]. Performance evaluation on HRF database with accuracy of 94%, specificity of 97% and sensitivity of 69%. In this project the error calculation was done between the resulting image and ground truth image, and also mean squared error was calculated.

The thresholding based blood vessels extraction technique from retinal fundus images proposed by Dash Et al. [9]. Performance evaluation on two different databases namely STARE and DRIVE, the method was 95% accurate. Median filtering and mean c- threshold based method was used.

Another paper on retinal image enhancement techniques to segment the blood vessel, an algorithm was proposed by Bandara Et al. [10].Performance Evaluation on DRIVE database, 94% of accuracy achieved by this method. SUACE algorithm used and improved form of Tyler Coye algorithm with hough line transform for blood vessel reconstruction.

A vessel segmentation technique based on unsupervised fuzzy c mean clustering based thresholding in pathological digital fundus images proposed by Kande Et al. [11], performance evaluation on two different databases, STARE and DRIVE and the method is 93.85% accurate. In this method ROC curve also obtained .Matched Filter is used to enhance the contrast of image.

J. Elson Et al.[12] For the automatic extraction of the vessel , A Multi-Scale Matched Filter (MSMF) approach was used. An MSMF originated from Social Group Optimization (SGO) was used to extract retinal blood vessels. Performance evaluation on STARE and DRIVE were used and the optimum filter values for MSMF were achieved to improve the accuracy of vessel extraction.

In this method, the solution of accurately locating the vessels in the retinal image was discussed. Chaudhuri Et al.[13] created an operator based on the spatial and optical properties of the object for the feature selection. The Gaussian-shaped curve was used to approximate blood vessel. A 2-D MF was introduced to detect the vessel in the retinal image based on piecewise linear segmentation. This method has shown decent results to detect vessels even in fluoresce in angiogram image .Accuracy is 87.73 % is achieved.

Mapayi Et al. [14] proposed an automated technique to segment the retinal vessels. Performance evaluation on the DRIVE database, the method was 94.4% accurate and a high sensitivity rate of 73.02% was achieved. A combination of difference image (DI) and fuzzy c means approaches are being used.

For improving the contrast of the images ,we use Adaptive Histogram Equalization (AHE) and Contrast limited Adaptive Histogram Equalization (CLAHE). Segmentation part is done by Machine learning approaches. It will be more easier and accurate.

III. PROPOSED METHOD

In this work, the DRIVE database which is publicly available is employed. Performance evaluation on different images and several parameters are calculated. Different steps are involved and the flow chart given below clearly depicts the approach being used here to segment the blood vessels from fundus image. To capture the image of the eye a special type of camera is used which is known as fundus camera and this particular image is termed as fundus image. Peripheral retina, macula and optic disk are the main structures that can be visualized in fundus images. Numbers of database of fundus image of eye are openly available on different repositories on the internet. Basically the whole system can be divided into 3 parts which includes the pre-processing, segmentation and post processing of the image. At the end of post processing we get the output image.

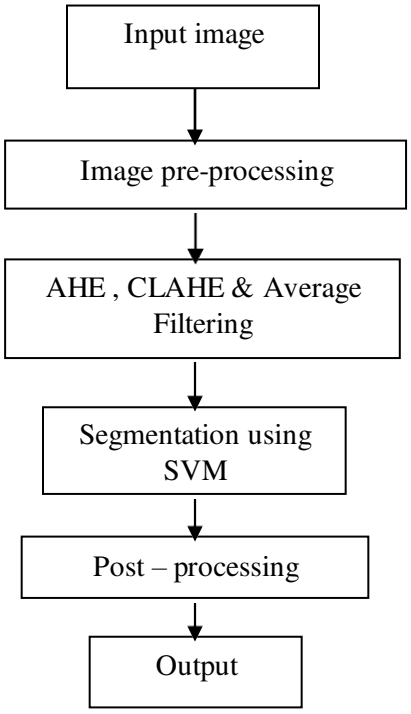

Fig.1 Flow diagram of proposed method

A. *Step 1: Pre-processing of image*

Here first we resize the input image and then convert the input image which is in RGB form to gray and the histogram is performed. In this project we used Adaptive Histogram Equalization for contrast improvement. It slightly differs from histogram equalization as in AHE different histograms are computed on different sections of image. AHE over amplifies the noise hence a better variant of AHE is used to limit amplification so the problem of noise is being reduced by using this approach and that variant is Contrast Limited Adaptive Histogram Equalization which is termed as CLAHE. After this equalization process Average filter is used. This is a special type of filter used for averaging.

B. *Step 2: image segmentation*

It is basically a method to partition the image or we can say representation of the image which is easier to analyse. Image segmentation is widely used for edge detection or curve detection. Here in this project for segmentation of retinal blood vessels we used Support Vector Machine technique. After that image is converted into binary which is called binarization of image.

C. *Step 3: post processing*

This is the last step which is to be done for the final output. As there are so many imperfections in the image, some morphological operations are performed. The comparison of pixels is done with respect to the input image for removing the imperfections. In general morphological operations are used on binary images so the conversion of image to binary is done in segmentation section only. There are different morphological operators, the most common morphological operators are Dilation, Erosion ,Closing etc. To the boundary of an image, the addition of pixels is done by using Dilation whereas for removing the pixels from the boundary of an image is done by using Erosion. Here to remove the isolated pixels, clean operation is used. Also to amplify the noise in the output image.

IV. RESULTS

We tested our proposed method on the sample of images present in the DRIVE database. The performance parameters calculated by comparing the segmented image which we have obtained with the ground truth image. The parameters evaluation is based on pixel classification. Outcome is either pixel classified as a vessel or the surrounding. Basically there are 4 probabilities: two misclassification and two classification namely True Positive (TP), False Positive (FP), False Negative (FN) and true negative (TN). On the basis of these classified and misclassified vessels, we have calculated the Accuracy, Specificity and Sensitivity. The overall pixels correctly classified in the field of view of an image is abbreviated as FOV.

Measures	**Descriptions**
Accuracy(ACU)	TP+TN/ FOV

Table I depicts the mathematical formulas which have been used in the proposed method for calculating the performance parameters.

Authors	**Accuracy**
Kande	93.85%
Dash	95%
Bantan	94.70%
Bandara	94%
Preity	95.3%
Our method	96%

Table II depicts the comparison between different author's approaches and our method.

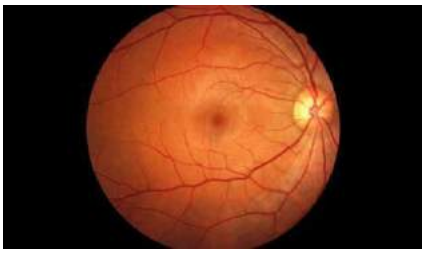

Fig. 2 Input image

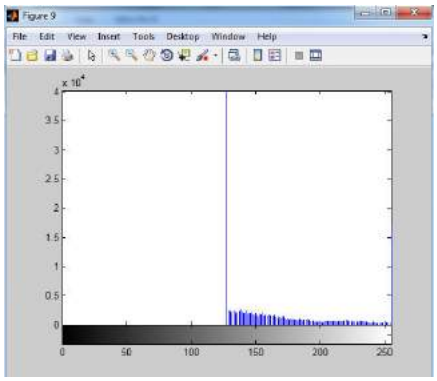

Fig. 3 Histogram image

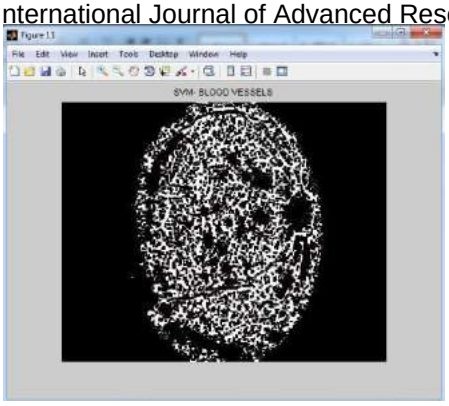

Fig. 4 SVM blood vessels

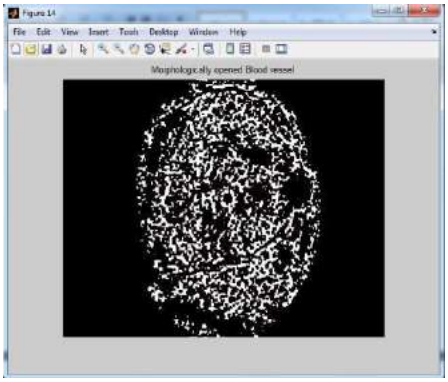

Fig. 5 Morphologically opened blood vessels

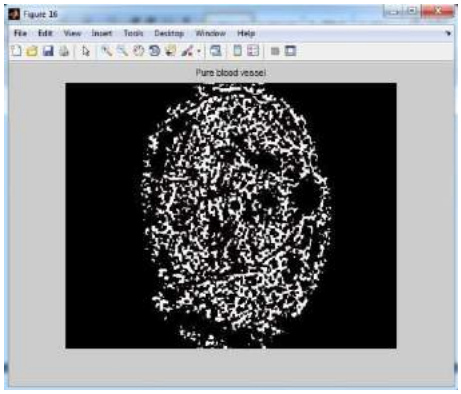

Fig. 6 Pure blood vessels

V. CONCLUSION

This Paper has been presented on comprehensive details of Retinal Images , Support Vector Machine in Image Processing. The proposed method use the Support Vector Machine Based Retinal Image Segmentation which accurately extracts retinal blood vessels. This method is effectively segments the vessels and improves the performance parameters. It works really well with a clear margin of separation and It uses a subset of training points in the decision function (called support vectors), so it is also memory efficient. The accuracy of 96% is achieved. This is better compared to existing method.

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