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Fundus Blood Vessels Extraction Using Digital Image Processing Techniques

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***Abstract*— Diabetic retinopathy is major eye complications produced by the diabetes mellitus, which causes other problems such as stroke, cardiovascular disease, diabetic nephropathy and diabetic neuropathy. Diabetic retinopathy consequences in visual conflicts and can lead to permanent blindness. Therefore, a regular diabetic retinopathy screening is essential for early treatment, along with an effective risk factor management to overcome the diabetic complications and reduce morbidity and mortality influence. In this paper we perform the digital image processing techniques to extract the retinal blood vessels. This algorithm is tested on STARE database.**

Keywords*— *Retina, Fundus, Blood Vessel, Diabetic Retinopathy

I. INTRODUCTION

Numerous clinical studies shows the relationship between alterations in the topologies of the human retinal blood vessel, the projection and the disease growth, such as diabetic retinopathy, hypertensive retinopathy, and macular degeneration. Certainly, the detection of these vascular changes always has gaps. The manual steps are slow, which may be subjected to a bias of the perceiver. Author presents this paper to investigate a new method for measuring the blood vessel diameter in the retinal image [1]. Diabetic Retinopathy, which is one of the primary root of visual death and visual impairment in middle aged patient. The present learning focus is developing the extraction of normal and isolated characteristics or marks in color retinal images. The adaptive filters are tuned to match the part of vessel to be extracted in green channel images. To classify the pixels into vessels and non-vessels the Biogeography Based Optimization Algorithm is applied [2]. Diabetic Retinopathy is a major cause of blindness due to diabetes in the human society. Early detection of it helps the patients to stop blindness and to be conscious of the seriousness of the disease. Image processing techniques are extensively used for early detection of diabetic retinopathy to permit medication or laser therapy to be performed to avoid or delay visual loss. In this paper, author present a technique to detect and classify DR that first extracts features such as blood vessels, micro-aneurysm, exudates by image processing and then uses student's t-test to select appropriate discriminative features and finally, apply Support Vector Machine (SVM) to perform multi-stage classifications to detect the presence of DR along with the degree of its severity in the scale of mild, moderate and severe in its presence [3]. Diabetic Retinopathy (DR) is an eye sickness which influences 80 to 85 percent of the patients who have diabetes for more than ten years. The retinal fundus images are commonly used for detection and analysis of diabetic retinopathy disease in clinics. The raw retinal fundus images are very hard to development by machine learning algorithms. In this paper, pre-processing of raw retinal fundus images are performed using extraction of green channel, histogram equalization, image enhancement and resizing techniques. Fourteen features are also extracted from pre-processed images for quantitative analysis. The experiments are performed using Kaggle Diabetic Retinopathy dataset, and the results are evaluated by considering the mean value and standard deviation for extracted features [4]. Digital retinal imaging is a stimulating screening method for which effective, robust and cost effective methods are still to be developed. Regular screening for diabetic retinopathy and diabetic maculopathy diseases is necessary in order to identify the group at risk of visual impairment. This paper presents a novel automatic detection of diabetic retinopathy and maculopathy in eye fundus images by employing fuzzy image processing techniques [5]. Image segmentation walls the image into various regions thus by making image more easy to read and understand. This segmentation process can be applied on different types of images. Though segmentation has proved to be useful in nearly every field but it plays a major role when it is practical to retina images where it helps in the early diagnosis of certain diseases related to eye [6]. Accurate segmentation of retinal blood vessel plays very significant role for the competent diagnosis of retinal vascular complaints. In this paper, Entropy based thresholding along with multiple features is proposed. Multiple features like vesselness measure, magnitude response of gabor filter and gamma correction with inverted green channel are extracted. These extracted features are combined using neural network. Later, Entropy based thresholding is used to get the segmented blood vessel [7].

II. METHODOLOGY

Diabetic retinopathy lesions are extracted by the following expressions.

a. Green Channel: -

$$g = \frac{G}{(R+G+B)} \qquad (1)$$

Here g is a Green channel and R, G and B are Red, Green and Blue respectively. Because green channel shows the high intensity as compare to red and blue respectively.

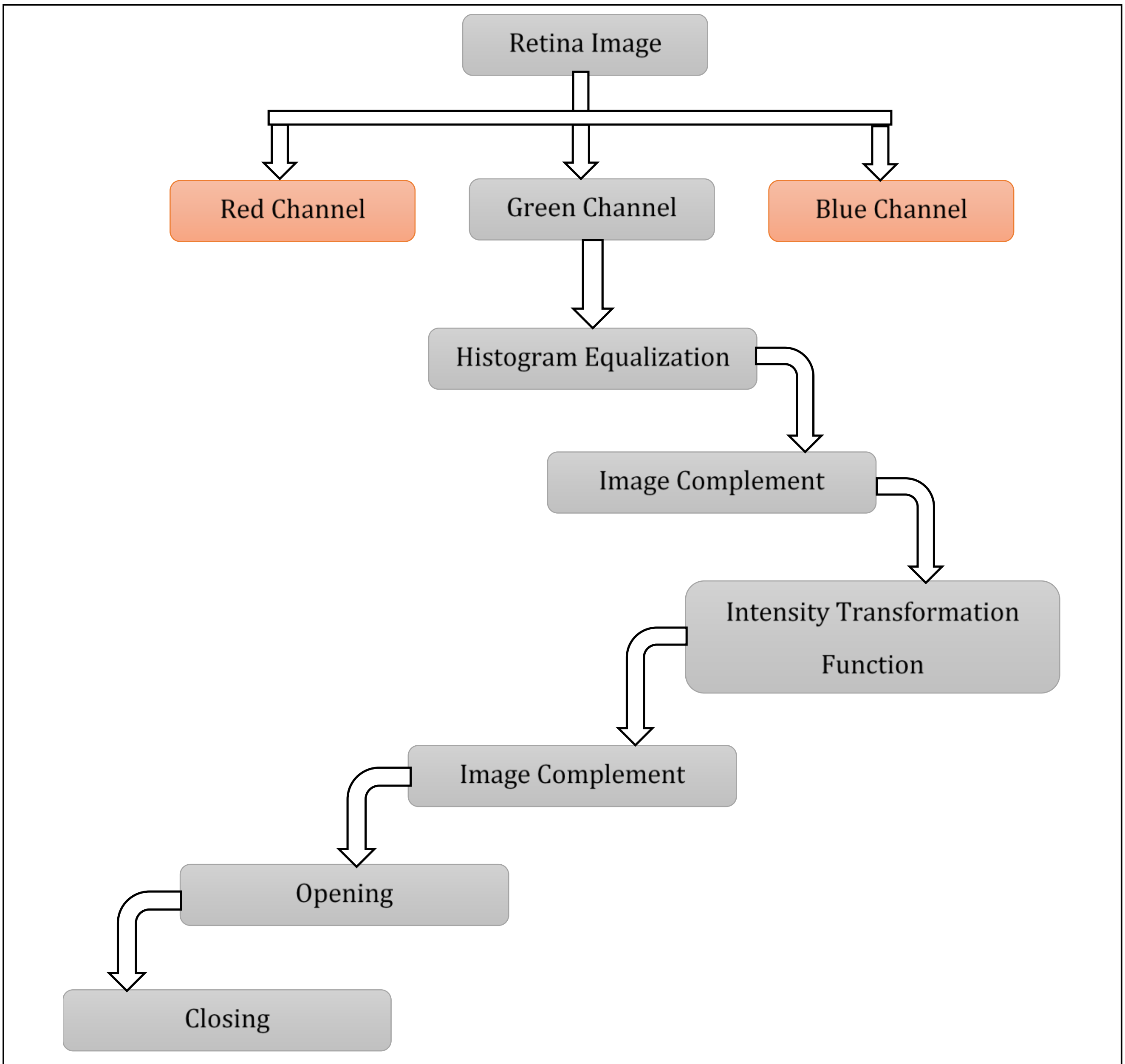

Figure 1: Flow for detection of Blood Vessels Extraction Using Digital Image Processing Techniques

b. Histogram Equalization:

$$h(v) = \text{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-1)\right) \qquad (2)$$

Here cdf_{min} is the minimum value of the cumulative distribution function, M × N gives the image's number of pixels and L is the number of grey levels. Histogram equalization is used for enhancement of a green channeled image for extracting more fine details of fundus image.

c. Complement: -

$$A^c = \{\omega \mid \omega \notin A\} \qquad (3)$$

Here A^c is a complement ω is the element of A, ∉ stands for not an element of A and A is set. Complement function is used on histogram equalization for enhancement.

d. Intensity Transformation Function: -

$$s = T(r) \qquad (4)$$

Where T is Transformation and r is Intensity. Intensity transformation function is used on complement image for extracting the Microaneurysms.

e. Threshold: -

$$T = \frac{1}{2}(m1 + m2) \qquad (5)$$

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Here m1 & m2 are the Intensity Values. Threshold function is used for feature extraction of the fundus image.

f. Morphological Opening: -

$$A \circ B = (A \ominus B) \oplus B \qquad (6)$$

The opening of A by B is obtained by the erosion of A by B, followed by dilation of the resulting image by B

g. Morphological Closing: -

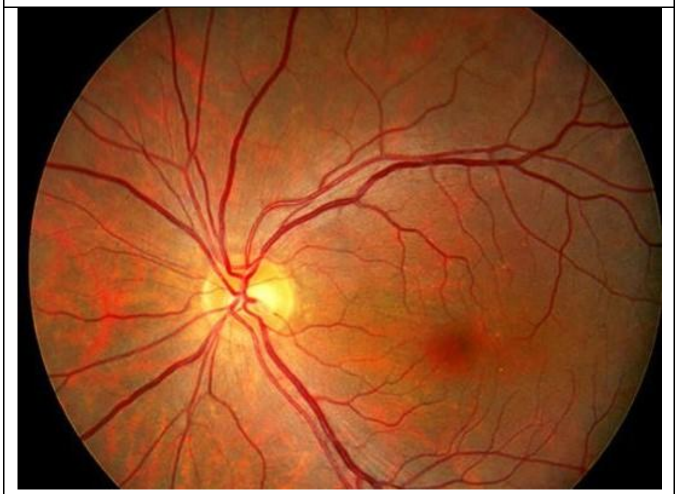
$$A \circ B = (A \oplus B) \ominus B \qquad (7)$$

The closing of A by B is obtained by the dilation of A by B, followed by erosion of the resulting structure by B.

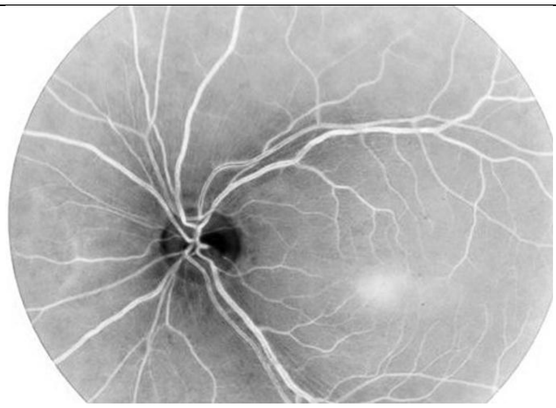
III. RESULT

For extraction of retinal blood vessels we use Digital Image Processing techniques and MATLAB 2012a. First of all we extracted the red, green and blue channel from color fundus image. We selected the green channel because this channel shows the high intensity pixels as compare to red and blue. Afterwards apply histogram equalization for image enhancement afterwards apply image complement function, intensity transformation and so on, as describe in figure 1. Following figure shows the output of retinal blood vessels using digital image processing techniques.

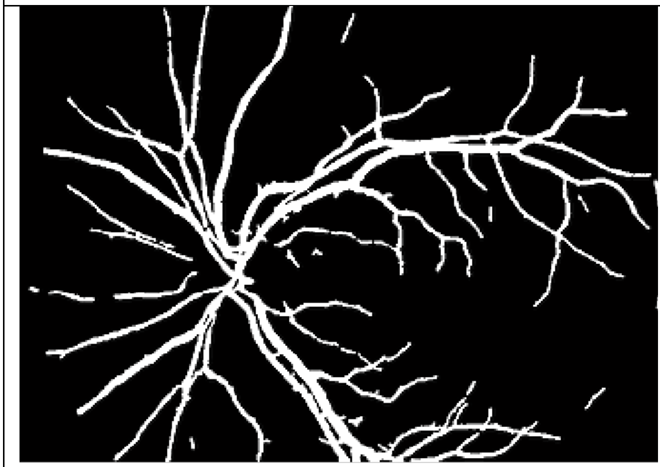
Input Image



Pre-Processing



Extracted Blood Vessels



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