Segmentation of Blood Vessels from Retinal Images using Image Processing

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Abstract— In this paper a method for segmenting blood vessels from retinal images is presented. In this work the retinal image is preprocessed and then converted to Hue, Saturation, Intensity image. The blood vessels are then extracted using Image processing technique. For a patient with diabetic retinopathy there is presence of abnormal blood vessels along with normal blood vessels. The presences of abnormal blood vessels indicate the condition of diabetic retinopathy in patients.

Key words: Diabetic Retinopathy, Blood vessels, binarization

I. INTRODUCTION

Medical image Processing is the technique which is used for the human body to diagnosis or check the disease in medical science to study of normal physiology and anatomy of human body which can include organ and tissues. one of the major challenges of medical image processing is to remove noise or restore the image while pre-processing in the study of medical imaging techniques. Along with noise the other problem faced in medical image processing is that to extract the required feature, the correct knowledge about the anatomy of the object is required. This work deals with the human eye. therefore the knowledge about the structure of the eye, the various objects present inside the eye, the colour of the required object, the distinguishable feature of the required object etc is very much required.

The problem of diabetes is affecting a lot of people all over the world. When the diabetes attack human eye then it is called as Diabetic Retinopathy. Diabetic Retinopathy affects the optic disk present in the eye. There are many other eye related diseases such as Glaucoma, Papilledema, hypertension etc along with diabetic retinopathy which affects the human eye. Such problems cause visual problems to the affected person. If not diagnosed and treated at proper time, this problem could cause complete blindness. The basic indication of diabetic retinopathy is the damage to the tiny blood vessels present in the retina. Due to the damage to the blood vessels the eyes cannot provide required blood supply. To overcome this problem there is formation of abnormal blood vessels in the eye, Image Processing technique is used to detect the abnormalities present in the retinal images.

II. DESCRIPTION

The retinal colour images is analysed to detect the presence of any abnormalities that indicate diabetic retinopathy. The main problem of diabetic retinopathy is that reduces or damages the eye sight. Diabetic retinopathy is the main cause of blindness for people suffering with diabetes and it happens due to formation of new blood vessels in the retina. Therefore by detecting blood vessels from the retinal images, one can know about the presence of Diabetic retinopathy in a person.

III. PROPOSED METHODOLOGY

The blood vessels are dark red colored and have visibly distinguishable structures. The blood vessels are detected from the retinal images using morphological operations. The morphological operations have better results as compared to matched filters method. For detecting the blood vessels the green channel from the RGB image was first obtained. The image intensity of the green channel image were inverted. For improving the contrast of the image the adaptive histogram equalization is performed on the inverted image.A morphological 'opening' operation is conducted on the equalized image using the 'ball' structuring element. This operation has two functions. This is done to smooth the background and to highlight the blood vessels of the image Each image is subtracted from the equalized image.This resulting image shows higher intensity values at the blood vessels compared with the background. Then the image is binarized by the thresholding method. Median filtering is conducted on this binarized image to remove the noise. A border is created around the image for extracting blood vessels. Then the remaining noise within the image is eliminated. The intensity values of image with only borders are subtracted from the inverted intensity values of this image to eliminate the edges. Then the pixel values of the images are inverted to obtain the final image with only blood vessels. Each step is explained in detail below.

A. Retinal Image Acquisition:

In this work the retinal images are collected from DIARETDB1 database from internet .DIARETDB1 database is a standard database for diabetic retinopathy. This database is a benchmark for detecting diabetic retinopathy of digital images. This database is used worldwide for different methods used for detecting diabetic retinopathy .And so various methods can be tested and compared using a standard benchmark. In this work the Image taken from this database is first resized to get uniform rows and columns.

B. RGB to HSI Conversion:

The image acquired from DIARETDB1 database is RGB colour image. This colour image is first converted to HSI image to convert it into gray scale. The brightest portion of the Intensity component of the retinal image is enhanced here. The RBG image denotes a colour image where R stands for Red,G stands for Green and B stands for Blue colour. The 24 bit colour is represented in the range from 0 – 255.The colour black is depicted as(0,0,0) and colour white is depicted as (255,255,255).The RGB image is converted into HSI image where H stands for Hue,S stands for saturation and I stands for Intensity.

C. CLAHE Algorithm

Contrast Limited Adaptive histogram equalization (CLAHE) is a technique used to improve contrast in images. Histogram equalization is one of the well-known enhancement techniques. In histogram equalization , the

dynamic range and contrast of an image is modified by altering the image such that its intensity histogram has a desired shape. This is achieved by using cumulative distribution function as the mapping function. The intensity levels are changed such that the peaks of the histogram are stretched and the troughs are compressed.

D. Morphological Operations

Morphological operators are the fundamental part of the detection of the particular object from the Binary image. This type of the operations is used to find particular object of the shape .Morphological operations are applied on binary images normally black& white images – Images with only 2 colours: black and white. These operations are used in pre or post processing step in detection of the particular shape.

E. Binarization Approach

Binarization is the final step of the detection of the blood vessel. In this approach number of white pixels is extracted from the black and white image and this approach checks the presence of the blood vessel from retinal image. The presence of blood vessel is decided based on the number of the white pixels. Combination of the two approaches Binarization and morphological together will help find the blood vessels from the retinal Image.

F. Thresholding

Threshold is one of the widely methods used for image segmentation. It is useful in discriminating foreground from the background. By selecting an adequate threshold value T, the gray level image can be converted to binary image. The binary image should contain all of the essential information about the position and shape of the objects of interest (foreground). The most common way to convert a gray-level image to a binary image is to select a single threshold value (T). Then all the gray level values below this T will be classified as black (0), and those above T will be white (1). The segmentation problem becomes one of selecting the proper value for the threshold T. A frequent method used to select T is by analyzing the histograms of the type of images that want to be segmented. The ideal case is when the histogram presents only two dominant modes and a clear valley (bimodal). In this case the value of T is selected as the valley point between the two modes. In real applications histograms are more complex, with many peaks and not clear valleys, Threshold technique is one of the important techniques in image segmentation.

G. Median Filtering

The median filter considers each pixel in the image in turn and looks at its nearby neighbours to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighbouring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighbourhood into numerical order and then replacing the pixel being considered with the middle pixel value. removing noise. Median filtering also helps to sharpen the contrast and also to highlight the contours. It is particularly effective at removing 'salt and pepper' type noise. Pixel values of images are inverted to obtain image with only blood vessels. The flowchart of the proposed method is as shown below.

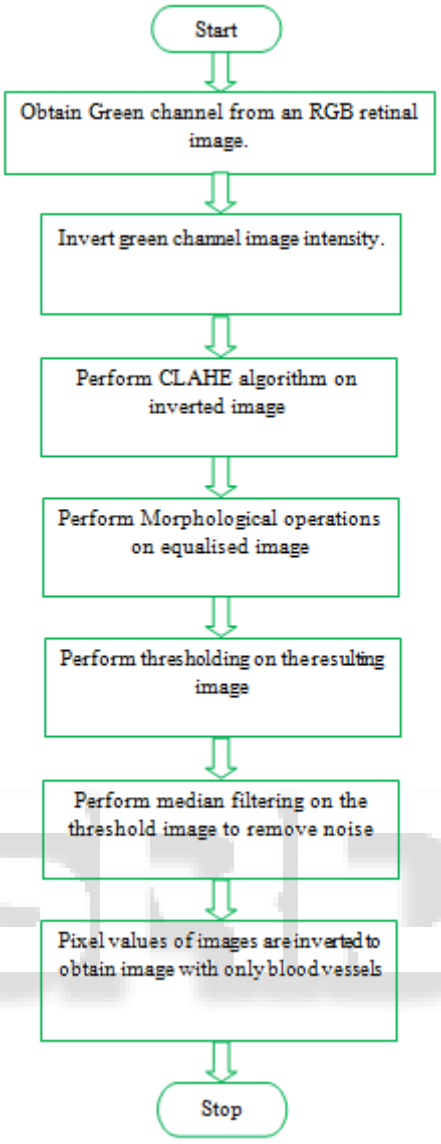

Fig. 1: A Flowchart depicting blood vessel segmentation process

IV. SOFTWARE

MATLAB Software is used for the Project Development and simulation in this Research work. The acronym of MATLAB stands for matrix laboratory for technical computing .MATLAB is the combination of mathematics, Calculations, Computer vision, and programming in an easy-to-use environment. The main reason for using MATLAB for the development of this research work is its toolboxes and it's easy to use functions. MATLAB Toolboxes allow users to learn and apply specialized technology to their research work. So due to these advantages in our Project Development and Simulation MATLAB Version 7.10.0.499 (R2010a) is used.

V. SIMULATIONS & RESULTS

The various results are as follows:-

Fig. 2: RGB Image

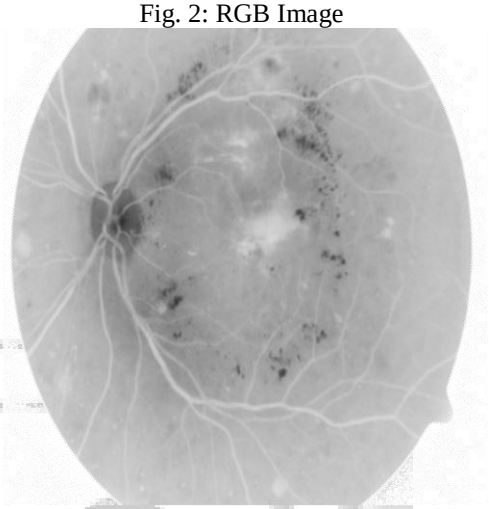

Fig. 3: Complement Image

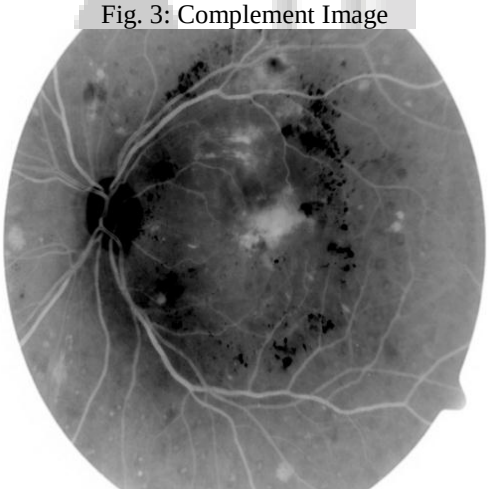

Fig. 4: Adjust Image

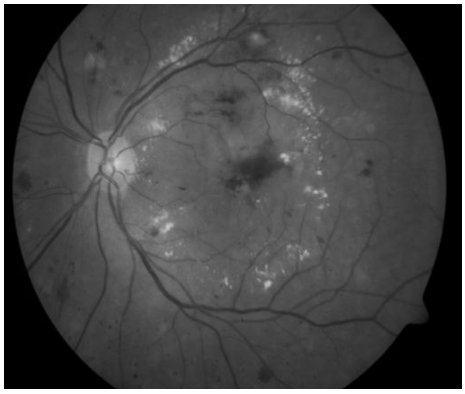

Fig. 5: Subtracted Image

Fig. 6: Green Channel Image

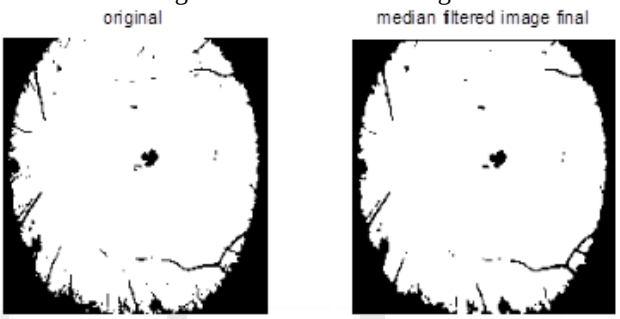

Fig. 7: Original and Median Filtered Image

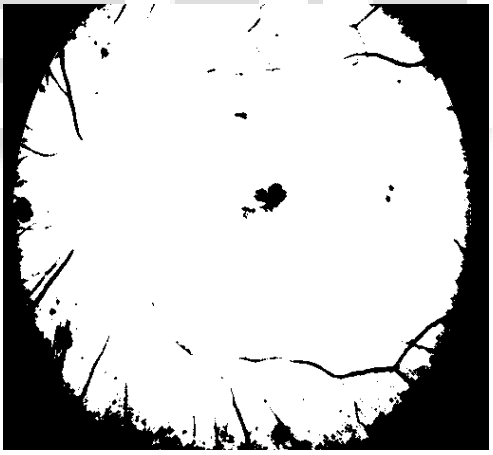

Fig. 8: Blood Vessel Detected Image

VI. CONCLUSION

In Medical Image segmentation techniques computation time is the most important issue. To implement a real time system, system should be faster and easy to understand. Slower segmentation models of the systems are avoided. So computation time should be as low as possible compare to the other existing techniques .In our research work slowest blocks are accelerated using some feature reduction methods. Hence in this work the blood vessel can be extracted efficiently with less computation time.

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