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A Simple Approach for the Detection of Microaneurysms Using Morphological Transforms

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ABSTRACT: The microaneurysms are the first clinically observable lesions in the Diabetic Retinopathy (DR). Early detection of these microaneurysms (MA) can prevent the DR. This paper presents a simple method for the detection of MAs from the retinal images. Detection method uses computer vision and morphological image processing techniques. The blood vessels are extracted after the pre-processing stage. Subtracting these blood vessels from the reconstructed green channel image yields the microaneurysms along with some noise. Then the resulting image is compared with the groundthruth values available in the database.

KEYWORDS: Diabetes, Diabetic retinopathy, microaneurysms, morphological transforms, blood vessels, fundus images.

I. INTRODUCTION

Diabetic mellitus is a major health problem in India. A patient who has had Diabetes for more than 20 years will have severe Diabetic Retinopathy (DR) which leads to a complete blindness. An early diagnosis and continuous monitoring of DR is required for effective treatment. Though the manual inspection had been used for decades, it's been tedious and demands more resources. A system that automatically detects DR should be a good replacement for this.

In an automatic detection system, extraction of retinal blood vessels is important because certain pathologies have been evolved from the properties of blood vessels. These vessels are in different sizes. Some of these are large enough for segmentation but, some amateur vessels are very small and not easy for segmentation. These amateur tiny vessels swell and rupture that leads to leak the blood into the tissue. The swelling of tiny vessels is referred to as microaneurysms (MA). If there are crossings of thin blood vessels then that falsifies us as MAs. So these pixels are also to be removed carefully. Once the blood vessels are removed, the retinal image contains only MAs. The noise present in this stage is very less if the appropriate pre-processing methods were performed.

II. RELATED WORK

Chandani Nayak et al. extracted the blood vessels using Gabor wavelet method and Euclidian distance method. The Gabor wavelet was used to enhance the vasculature and to filter out the background noise present in the image. Euclidian distance was used for false edge detection.

Nidhal K E Abbadi et al. applied mathematical morphology and extracted the blood vessels. The Top-hat transform was applied on Histogram Equalized image then opening-closing reconstruction followed by Watershed algorithm were applied and tested on set of images.

Renuka Devi M. and Priyadarshini B. H. proposed Filter Algorithm consists of Sobel filter, Wiener filter, Median filter and Gabor filter. This combination is implemented to extract vasculature and thin blood vessels.

Aniruddha L. Pal et al. used the morphological methods to separate the blood vessels, exudates, MAs and haemorrhages from the retinal images.

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Akara Sopharak et al. approached the extended minima transform to extract the MAs. Here, detected exudates and vascular tree are subtracted from the extended minima transform image. The resulting image contains MAs and non-MAs. Finally, the objects which are less than or equal to 10 pixels are selected as MAs.

III. PROPOSED METHOD

A. Pre-processing:

The DIARETDB1 database provides retinal Fundus images. Colour image is converted to grayscale image. Or, green channel is extracted from the colour images because the local contrast between the background and the foreground will be high. It is then resized to 576x750 pixels. Next, the mask is generated using thresholding. Here, threshold value is set by trial and error method. The optimal thresholding value for DIARETDB1 database images is 5 (python-opencv tool is used). The benefit of mask generation is to remove the pixels value outside the Field of View (FOV). The mask is multiplied with green channel image. A median filter of size 3x3 is performed on the masked green channel image, (Ig). It removes salt and pepper noise, and smoothen the image.

B. Shade correction:

A 35x35 median filter is applied on the Ig image. Next, from the median filtered image and the Ig, the maximum intensity values at each pixel location are taken to get the background image, Ibg. A shade corrected image Isc is then obtained by subtracting the Ig from Ibg and adding 128 to it.

C. Blood vessels detection:

The blood vessels and the red lesions are both red in colour; the blood vessels have to be extracted out of the Isc image. This is done by using morphological opening transforms. Initially, 12 linear structuring elements (SE) having the size of 15x1 pixels and radial resolution of 15° are considered. The method is not limited to use these SEs only. One can use the different size and radial resolution of SEs. But the length of the SEs should be larger than the biggest red lesion. A size of 15x1 pixels gives the best balance between red lesions and vessel segmentation. Next, 12 opening transforms are performed on the shade corrected image separately. In all 12 images, the maximum pixel value is taken at each pixel location to form the vasculature tree.

D. Microaneurysms detection:

The microaneurysms are circular in shape. The shade corrected image is used as preliminary image for detection of MAs. Firstly, Isc image should be binarized by thresholdong. Otsu's method gives the best result by automatically performing the cluster-based thresholding. The vascular tree should be subtracted from the binarized image. The resulting image contains MAs and non-MAs. Then the objects with a size smaller than or equal to 20 pixels are selected as MAs. Finally, they are compared with the groundthruth images.

IV. SIMULATION RESULTS

The input fundus image from the database DIARETDB1 is shown in figure 1a. This is scaled to 576x750 pixels. Then the green image is extracted from figure 1a. A 3x3 median filtering is applied to green image which is shown in figure 1b.

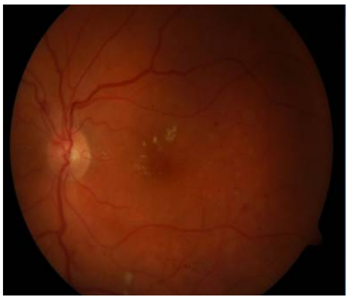

Fig. 1a Colour Fundus Image

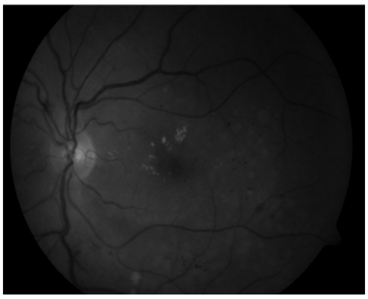

Fig. 1b Green Channel Image

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The shade corrected image, generated from Ig and 35x35 median filtered image, is shown in figure 2a. The shade corrected image is threshoded. The Otsu's thresholding output is shown in figure 2b.

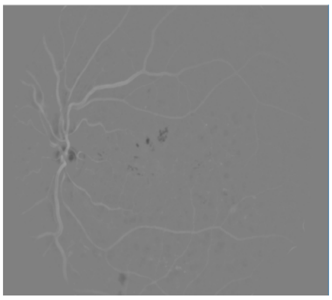
Fig. 2a Shade Correction

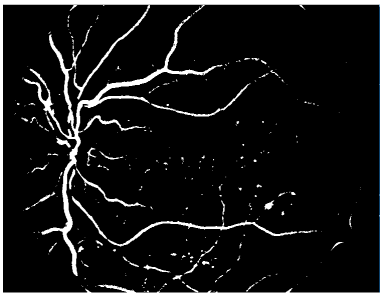
Fig. 2b Binarized Output

The maximum pixel values from the 12 morphological opening images are codified to form the vascular tree. This vascular tree is shown in figure 3a. The vascular tree is subtracted from the thresholded image. The resulting image contains MAs and non-MAs. The detected MAs are compared with the ground truth images and it is shown in figure 3b.

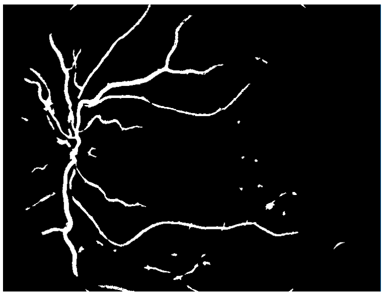
Fig. 3a Blood Vessels Extracted

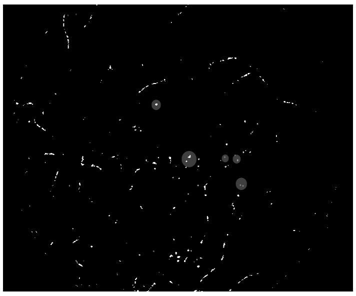
Fig. 3b MAs Detected

V. Conclusion and Future Work

The proposed morphological methods present a fast and effective way of detecting microaneurysms from the diabetic retinopathy images. But some of the MAs are missing and some non-MAs are present in the proposed method. Therefore classifiers or some other techniques should be used in addition to the above method to get the more accuracy.

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