International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 4, April - 2013

Detection Of Red Lesion In Diabetic Retinopathy Using Adaptive Thresholding Method

Deepashree Devaraj,
Assistant Professor, Instrumentation Department
RVCE Bangalore.
Nagaveena
M.Tech Student, BMSP&I, Instrumentation Department
RVCE Bangalore.

Abstract

Automated detection of lesions in the retinal images is an important step, in detection of diabetic retinopathy. The appearance and location of these lesions such as microaneurysms, hemorrhages, exudates and cotton wool spots are used for the assessment of diabetic retinopathy. The early sign of diabetic retinopathy is recognition of microaneurysm. The detection of lesions helps ophthalmologist to detect the emergence of its early symptoms and determine the next action step for the patient. A number of studies have been investigated on retinal fundus images for diabetic retinopathy. Although many algorithms have been developed, the accurate detection of lesions in retinal images is still a challenging problem. Automating this task, which is currently performed manually, would bring more objectivity and reproducibility. In this paper a local adaptive thresholding method to detect and identify red lesions in retinal images is introduced. This technique is tested on publicly available DIARETDBI database.

Index Terms: FUNDUS image, micro-aneurysm, hemorrhage, exudates, cotton wool spots, diabetic retinopathy (DR), Non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR).

1. Introduction

The diabetes affects the blood vessels throughout the body including kidneys and eyes. The long term diabetes can cause irreversible preventable severe eye disease called diabetic retinopathy. Diabetic retinopathy results when diabetes affects blood vessels in the eyes, producing abnormalities such as micro aneurysms, hemorrhages, exudates cotton wool spots and new blood vessels. This can cause loss of vision and even blindness.

These abnormalities are divided into two stages non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR). Non-proliferative diabetic retinopathy can be further classified as Mild NPDR, Moderate NPDR and Severe NPDR.

Mild NPDR is characterized by the presence of at least one microaneurysm. Moderate NPDR is characterized by the presence of hemorrhages, more micro aneurysms, soft exudates and venous beading. Severe NPDR has more hemorrhages, more microaneurysms and micro vascular abnormalities. PDR is an advanced stage. In PDR the signals sent by the retina for nourishment trigger the growth of new blood vessels. This may in turn cause neovascularisation of disc and it may result in severe vision loss and even blindness.

As increase in the number of diabetic patients, the number of ophthalmologists is not sufficient to cope with all patients. This limits the current diabetic retinopathy screening capabilities. Because the process of analyzing all retinal FUNDUS images is time consuming and repetitive. Many of these images may not have any abnormalities**.** Thus the requirement of the automating grading process by which more patients can be screened and if require can be sent to ophthalmologist for further examination. Several automated techniques are designed for diabetic retinopathy screening.

As explained above there are mainly three kinds of symptoms in the diabetic retinopathy. First one is red lesion that includes hemorrhages and microaneurysms. The second is white lesion such as exudates and cotton wool spots.

Third is new blood vessel. This paper focuses on the detection of red lesion (microaneurysms and haemorrhages) with their color similar to the blood vessels. Microaneurysms are small red dots and this may lead to big blood clots called hemorrhages. Figure 1 shows a retinal image with microaneurysms and hemorrhages marked.

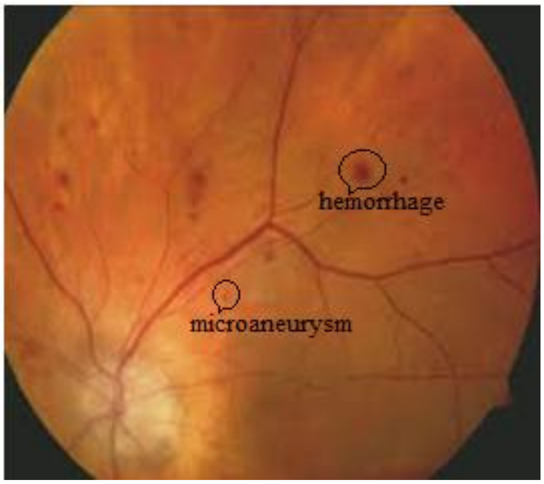

Fig.1 Retinal image with microaneurysm and hemorrhages

In This paper methodology is explained in section II. Conclusion in Section III.

2. Methodology

2.1. Database

Images were selected from the online DIARETDBI database.The images of DIARETDBI were downloaded from http://www2.it.lut.fi/project/imageret/diaretdb1/.The database consists of 89 color FUNDUS images of which 84 contain at least mild non-proliferative signs of the diabetic retinopathy and 5 are considered as normal which do not contain any signs of the diabetic retinopathy according to all experts who participated in the evaluation. Images were captured using the same 50 degree field-of-view digital fundus camera with varying imaging settings.

2.2. Preprocessing

A colored retinal image is made up of red, green and blue components. Among these, green channel shows the best vessel/background contrast [5],[7],[8], the blue channel tends to be empty and the red channel tends to be saturated. Furthermore, green component is less noisy compared to other two , it contains significant information that can be extracted from the FUNDUS image. Thus the green channel is useful in the feature detection of diabetic retinopathy. For further processing green channel is extracted from RGB. Fig 2 and 3 shows extraction of 2D and 3D red, green and blue components from RGB.

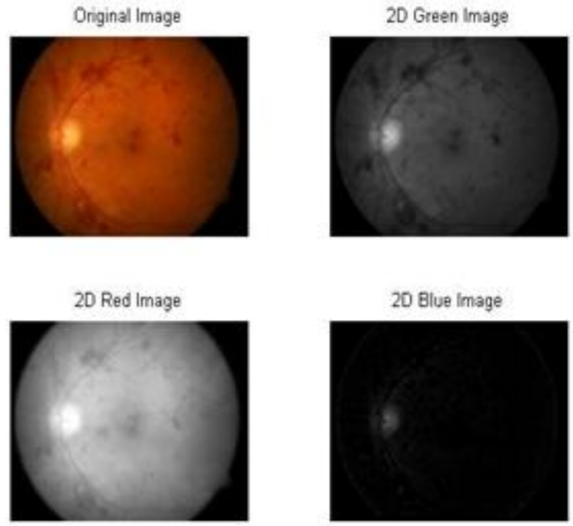

Fig 2 2D images

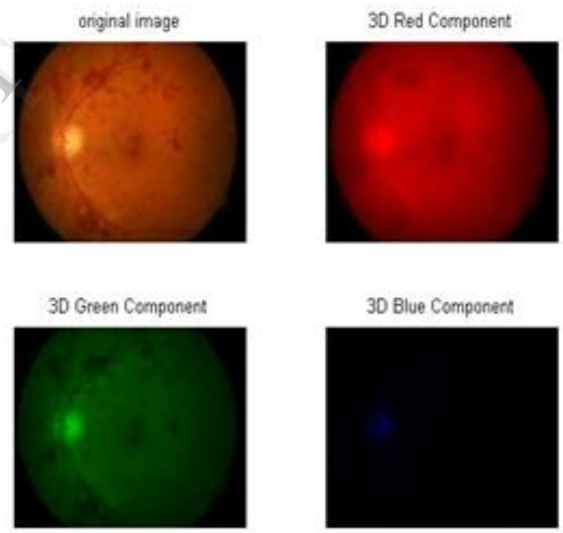

Fig 3 2D images

2.3. Detection of red lesions

Since the lesions are leaks from the side of swelling tiny blood vessels [3], they tend to have spherical shape with diameters greater than the feeding blood vessels. They have particular pattern shapes extremely different from other retinal features, like blood vessels.

To detect red lesions, firstly morphological operation erosion is used to remove the vasculature, leaving the other small structures representing the MAs shown in fig 4 c). Erosion [1] shrinks or thins the objects in a binary image by the use of structuring element. The mathematical representation of erosion is as shown below.

$$A \Theta As = \{z|(As)z \cap Ac \neq \Phi \}$$

This morphological operation[4],[6],[9] gives high degree of discrimination between linear and circular shapes and then is suitable for discriminating red lesions from blood vessels.

Secondly Median filtering is applied on eroded image shown in fig 4 d). Median filtering is a nonlinear operation often used in image processing to reduce "salt and pepper" noise. Median filtering also used to remove illumination [2] variations in the image, a shade correction operation. This is carried out by smoothing the green channel image with a median filter of a large scale neighborhood window size, applied on the main image to approximate the background. Then subtracting the eroded image from the filtered image shown in fig 5 a). This operation has the effect of leaving features whose scale is smaller than the filter scale such as red lesions. The size of the window in median filter must be considered larger than the size of the largest vessel in the set of entire images.

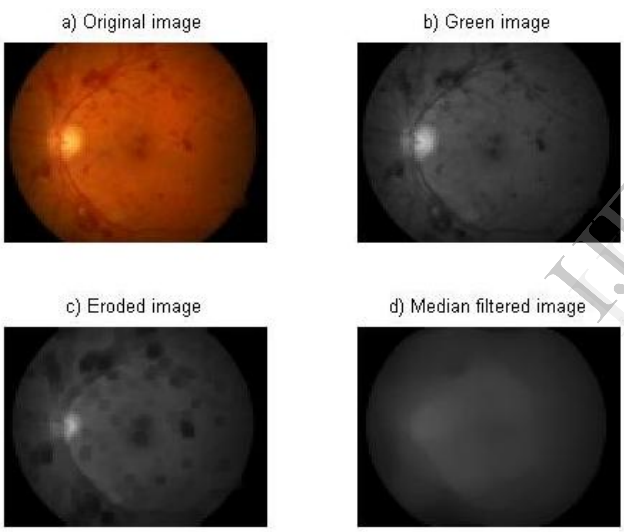

Fig 4 a) Original image b) Green image c) Eroded image d) Median filtered image

The estimate of the background called Ibg is obtained by median-filtering eroded green channel image Ig. Then eroded green channel image Ig is subtracted from Ibg with correction factor as follows:

$$I=Ibg-Ib-C$$

Where C is correction factor.

Then resulting image is converted to a binary form with a threshold ,shown in fig 5 b) followed by complimenting the image shown in fig 5 c) .The threshold image converts the grayscale image to a binary image. The output of threshold image replaces all pixels in the input image with luminance greater than threshold with the value 1 (white) and replaces all other pixels with the value 0 (black). Specify threshold in the range [0, 1], regardless of the class of the input image.

In the complement of a binary image, zeros become ones and ones become zeros. In the complement of intensity, each pixel value is subtracted from the maximum pixel value supported by the class (or 1.0 for double-precision images) and the difference is used as the pixel value in the output image. In the output image, dark areas become lighter and light areas become darker.

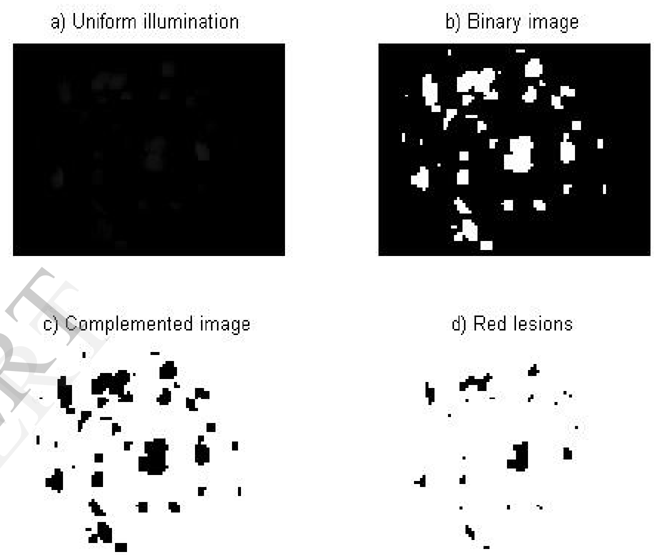

Fig 5 a) Uniform illumination b) Binary image c) Complemented image d) Red lesions

Finally dilation[4],[6],[9] used for thickening objects in a binary image shown in fig 5 d).The extent of this thickening is controlled by the Structuring Element (SE) which is represented by a matrix of 0s and 1s.Mathematically, dilation operation can be written in terms of set notation as below:

$$A \oplus As = \{z|(As)z \cap A \neq \Phi \}$$

Where Φ is an empty element and As is the structuring element .

3. Conclusion

In this work, adaptive thresholding for detection of red lesions is proposed. Morphological operation erosion is used to remove the vasculature, leaving the other small structures representing the MAs give the good result .The retinal image contrast was improved and prepared better for detection step.The proposed method is simple and the images used for detecting red lesion are obtained from FUNDUS camera. The algorithm is developed on DIARETDBI images, tested on 25 images of DIARETDBI and found satisfactory result.

4.References

[1] Jaspreet Kaur , Dr. H.P.Sinha "An efficient blood vessel detection Algorithm for retinal images using local Entropy thresholding" , IJERT , Vol. 1 Issue 4, June – 2012.

[2]Malaya Kumar Nath and Samarendra Dandapat, "Detection of Changes in Color Fundus Images due to Diabetic Retinopathy", CISP|Proceedings|81, 2012.

[3]Facts about diabetic retinopathy, National Eye Institute, available from:http://www.nei.nih.gov/health/ diabetic/ retinopathy.asp .

[4]Karnowski TP, Govindasamy VP, Tobin K W, Chaum E, Abramoff MD. "Retina Lesion and Microaneurysm Segmentation using Morphological Reconstruction Methods with Ground-Truth Data". ConfProc IEEE Eng Med BioI Soc 1 :5433-5436,2008.

[5]Quellec, M. Lamard, P. M. Josselin, G. Cazuguel, B. Cochener, and C. Roux, "Optimal wavelet transform for the detection ofmicroaneurysms in retinaphotographs," *IEEE Trans. Med. Imag.*, vol. 27, no. 9, pp. 1230–1241, Sep. 2008.

[6]A. M. Mendonça and A. Campilho, "Segmentation of retinal blood vessels by combining the detection of centerlines and morphological reconstruction," *IEEE Trans. Med. Imaging*, vol. 25, pp. 1200–1213, September 2006.

[7]A. D. Fleming, S. Philip, K. A. Goatman, J. A. Olson, and P. F. Sharp,"Automated microaneurysm detection using local contrast normalization and local vessel detection," *IEEE Trans. Med. Imag.*, vol. 25, no. 9, pp. 1223–1232, Sep. 2006.

[8]M.Niemeijer,B. van Ginneken, J. Staal, M. S. A. Suttorp-Schulten, and M.D. Abramoff, "Automatic detection of red lesions in digital color fundus photographs," *IEEE Trans. Med. Imag.*, vol. 24, no. 5, pp. 584–592, May 2005.

[9]P. Soille, *Morphological Image Analysis: Principles and Applications*,2nd ed. Berlin, Germany: Springer-Verlag, 2003.