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New Preprocessing approach for Images in Diabetic Retinopathy Screening

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Abstract
The development of an automatic telemedicine system for diabetic retinopathy depends on detection of red lesion in color images. This paper presents image preprocessing and optic disc removal methods for detection of microaneurysms and hemorrhages. Microaneurysms and hemorrhages occurs at the first stage of Diabetic Retinopathy. Lesions are hardly visible, proposed method improves the ability to distinguish between lesions and non-lesions.

Keywords: Microaneurysms, Hemorrhages, Lesions, fundus images.

Introduction

Diabetic Retinopathy(DR) is complication of diabetes that can lead impairment of vision and even blindness. In working-age population it is most common problem of blindness [6]. If diabetic retinopathy is diagnosed early it can be managed using available treatments. Regular eye fundus examination is necessary because Diabetic retinopathy do not presents any symptoms until late in disease.
Diabetic Retinopathy has 4 stages:
1. Mild non-proliferative DR: At this stage, microaneurysms occur. Microaneurysms are small areas of ballon like swelling in the retina blood vessels.
2. Moderate non-proliferative DR: As the disease progress, some blood vessels that nourish the retina are blocked.
3. Severe non-proliferative DR: Many more blood vessels are blocked, depriving several areas of the retina blood supply. These areas of the retina send signals to the body to grow new blood vessels for nourishment.
4. Proliferative DR: At this advanced stage, the signal sent by the retina for nourishment trigger the growth of new blood vessels. These new blood vessels are abnormal and fragile. They grow along the retina and along the surface.

In 2025, it is expected that 333millions diabetic patients over the world will require retinal examination each year due to the increasing prevalence of diabetes and increasing population [9]. There is need of automation in screening process due to the limited number of ophthalmologists to cover a large number of diabetes patients and reducing burden on retina specialists. Automation can be carried out at two levels, first, to identify persons with Diabetic Retinopathy, second, grading persons according to severity [1]. Research focuses on the development of an automatic telemedicine system for computer-aided screening and grading of Diabetic Retinopathy. Computer processing cannot replace clinician work but the system identifies color fundus images with lesions and sorts them according to severity. Hence the clinician can start with most severe case. The specialists burden and examination time can be reduced with such an automatic system which also provides additional advantages of reproducibility and objectivity [8].
A computer based screening and grading system helps in automatic detection of red lesions. Retinal image of Diabetic Retinopathy person shows red lesions which are microaneurysms and hemorrhages, and bright lesions such as exudates and cotton wool spots. In this project we detect microaneurysms and hemorrhages which occurs at the first stage of Diabetic Retinopathy.
In this paper Image pre-processing and optic disc removal methods are studied to detect microaneurysms and hemorrhages.

Methods

A. Image Preprocessing

Leading to contrast variation and local luminosity, the illumination of retina is not uniform. The illumination can be more at some part and less and some part. In low contrast or low brightness lesions may not be visible. Moreover images may vary in terms of color and quality. So it is necessary to perform image preprocessing steps to overcome these problems. There are four image preprocessing steps

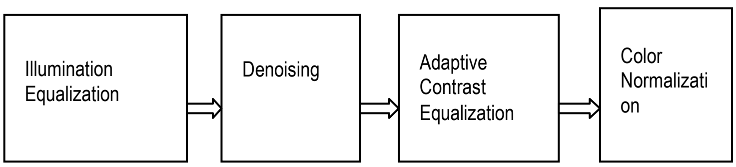

Figure 1: Preprocessing steps

1. Illumination Equalization: Most of the times due to light fall-off image corners are darken compared to the center, this

is known as vignetting effect. Illumination equalization method is used to overcome vignetting effect [8].
In this method, a large mean filter (f_{m1}) of diameter d_1 is applied to each color component of original image I to estimate its illumination. After that to correct potential shade variation resulting color image is substracted from original image. Finally to keep the same color range as in original image average intensity μ of the original channel is added.

$$I_{ie} = I + \mu - I^* f_{m1}$$

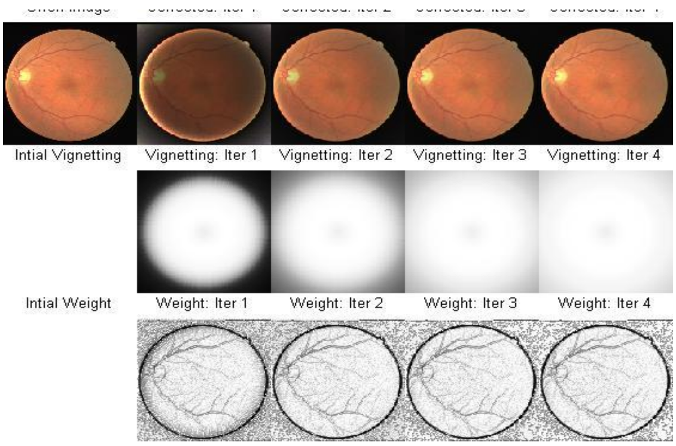

Figure 2: Vignetting effect is corrected in four iterations

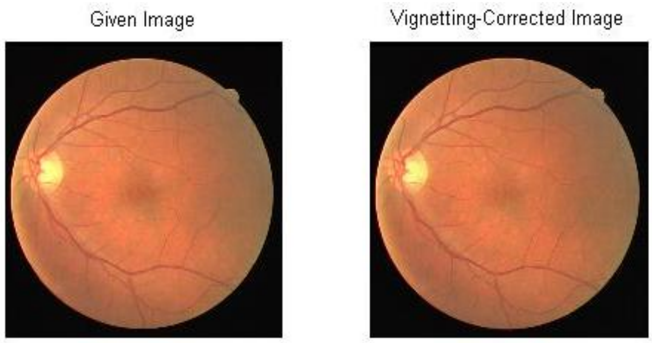

Figure 3: Vignetting- corrected image.

2. Denoising: Noise is generated from compression and acquisition steps. In order to attenuate this noise, a small mean filter(f_{m2}) of diameter d_2 is applied to each color channel of the resulting image I_{ie} without smoothing the lesions.
I

Figure 4: Filtered image after denoising

3. Adaptive Contrast Equalization: Using the local standard deviation the contrast drift is approximated, computed for each pixel in neighborhood of diameter $d_{1,}$ for each color channel (I_{std}). Areas that have low standard deviation indicate low contrast or smooth background. We sharpen details in these regions, to enhance low contrast areas using following equation for each color channel separately:

$$I_{ce} = I_{dn} + (I_{dn} * (1-f_{m3}))/ I_{std}$$

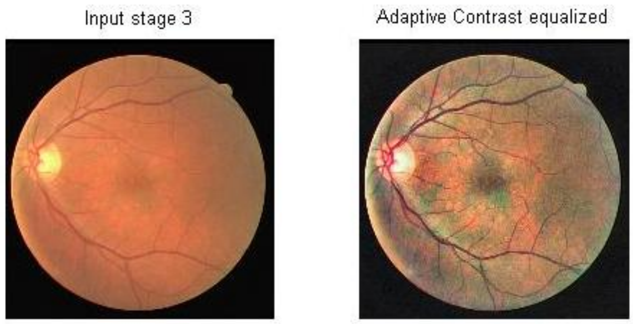

Figure 5: Adaptive contrast Equalized image.

4. Color Normalization: To obtain images with standardized color range color normalization is necessary. Here we perform histogram stretching to each color channel of I_{ce}, and clipping in the range of μ ± 3σ, where σ and μare the standard and mean deviation of the color channel.

Figure 6: Color Normalized image

B. Optic Disc Removal

The removal of OD is necessary because it is significant source of false positives in red lesion detection [2,12].
On the preprocessed image we use an entropy based approach to find the location of OD's center. In the high intensity region where the vessels have maximal directional entropy, OD is located. An optimization step then finds OD's radius. OD's final radius and center position are selected as the radius and position of the matched filter that minimizes the convolution.
Here the preprocessed image is separated in red, green and blue plane. Next that binary green image is obtained. After the convex hull is obtained to find the location of OD. Then optic

nerve is outlined in the original color image. And finally optic disc is removed.

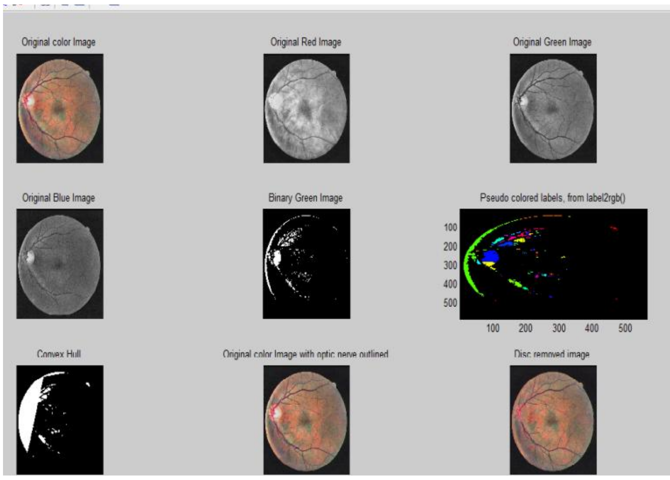

Figure 7: Results of OD removal steps

Figure 8: OD removed image

Results

The experimental results for the two techniques are shown in all above figures. Thecodes of these methods are executed in MATLAB software. For this MATLAB version 2014a was used. MATLAB is a data analysis and visualization tool designed to make matrix multiplication as simple as possible. In addition it has powerful graphics capabilities and its own programming language.

Conclusion

A new method for red lesion detection is proposed.The results of this method gives strong performance in detecting both microaneurysms and hemorrhages. The preprocessing steps makes lesions clearly visible. Also the optic disc removal contributes a great part in detecting false positives and true lesion.

References

[1] C. P. wilkinson *et al.*, “Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales,” *Opthalomogy*, vol. 110, no.9, pp.1677-82, 2003

[2] L. Seoud et al., “Automatic detection of microaneurysms and hemorrhages in fundus images using dynamic shape features,” in *Proc. IEEE 11th Int. Symp. Biomed. Imag.*, Beijing, 2014.

[3] J. Ding, “Current epidemiology of diabetic retinopathy and diabetic macular edema,” *Curr. Diabetes Rep.*, 2012

[4] J.W.Y.Yau*et al.*, “Global prevalence and major risk factors of diabetic retinopathy”, vol. 35, no. 3,2012

[5] C.I. Sanchez., “Evaluation of computer-aided diagnosis system for diabetic retinopathy screening on public data,” 2011

[6] N. Cheung, P. Mitchell, “ Diabetic retinopathy,” Lancet , vol.376, no.9735, pp. 124-36, 2010

[7] M. Neimejer*et al.*, “ Retinopathy online challenge : Automatic detection of microaneurysms in digital color fundus photographs,” *IEEE trans*, Jan 2010

[8] L. Seoud *et al*., “Red lesion detection using dynamic shape features for diabetic retinopathy screening,” *IEEE Trans. Med. Imag.*, vol. 35, no. 4, April 2016

[9] D. Gan, Ed., *Diabetes Atlas*, 2nd ed. Brussels: Internatio, 2003.

[10] S. Ravishankar, *et al.*, “Automated feature extraction for early detection of diabetic retinopathy in fundus images,” *in proc IEEE conf.*, 2009, pp. 210

[11] M. Niemeijer et al., “Automatic detection of red lesion in digital color fundus photographs,” *IEEE Trans. Med. Imag.*, May 2005

[12] A.D.Fleming *et al.*, “Automated microaneurysm detection using local contrast normalization and local vessel detection,” *IEEE Trans.Med.Imag.*, vol 25, no 9, pp. 1223-32, Sep 2006