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Review Article

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# Diabetic Retinopathy Detection Using Walter-Klein Contrast Enhancement

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## Abstract

*When sugar level (glucose) in the blood fails to regulate the insulin properly in human body, diabetic is occurred. The effect of diabetic on eye causes diabetic retinopathy. Diabetic retinopathy (DR) is a serious eye disease that originates from diabetes mellitus and is the most common cause of blindness in the developed countries. Therefore, much effort has been made to establish reliable computer aided screening systems based on color fund us images. Diabetic Retinopathy is one of a complicated diabetes which can cause blindness. It is a metabolic disordered patients perceive no symptoms until the disease is at late stage. So early detection and proper treatment has to be ensured. To serve this purpose, various automated systems have been designed.*

*We propose an ensemble-based framework for retinal lesion detection. Unlike the well-known approach of considering the output of multiple classifiers, we propose a combination of of Retinal Lesion detectors, namely preprocessing methods and candidate extractors. The presence of micro aneurysms in the eye is one of the early signs of diabetic retinopathy. We analzye the input retinal images of the Diabetic patients and we can classify that the patient is affected by DR or not. If not affected, they are normal patient. If they are affected, further it classifies the different stages of diabetic retinopathy affected patients such as Mild, Moderate and Severe.*

## Introduction

### Diabetic Retinopathy and Glaucoma

Diabetic Retinopathy (DR) is a serious eye disease that originates from diabetes mellitus and is the most common cause of blindness in the developed countries. Therefore, much effort has been made to establish reliable computer aided screening systems based on color fundus images.

The development of a telemedicine system for screening of retinal disease depends on identification of retinal lesions in images which includes fundus. Diabetic retinopathy (DR) is occurred mainly due to reduction in the sugar level. The present survey behind the cause of blindness says that it is due to DR in aging population. DR may be managed using available methods of treatment, which are effective if diagnosed early. DR is metabolic and disordered patients will not find any symptoms till the disease occurs at severe phase. Thus early revealing and better treatment has to be taken care.

The survey on screening of diseases according to "World Health Organization" (WHO) specifies that in the year 2010 around millions of people were visually became blind globally. Based on these estimation it is said that 80% cases for visual blindness are preventable or treatable. DR and age related macular degeneration (AMD) is two most frequently observed diseases which lead to loss of a visualization. Thus quick diagnosis provides a better treatment, which reduce costs rather then they are in advanced phases which may also become severe.

It is expected that, in 2025, 333 millions diabetic patients worldwide will require retinal examination each year. Considering the limited number of ophthalmologists, there is an urgent need for automation in the screening process in order to cover the large diabetic population while reducing the clinical burden on retina specialists. Automation can be achieved at two levels: first, in detecting cases with DR, and second, in grading these cases.

### Proposed System

In this paper, we propose an effective MA detector based on the combination of preprocessing methods and candidate extractors. We provide an ensemble creation framework to select the best combination. During testing stage, the selected best combination of preprocessing and candidate extractors is applied for the given input image to detect MA's. An exhaustive quantitative analysis is also given to prove the superiority of our approach over individual algorithms. We also investigate the grading performance of our method, which is proven to be competitive with other screening systems.

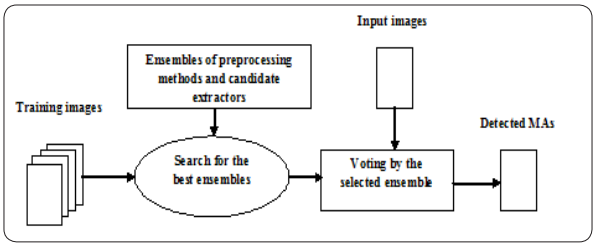



**Figure 3.4:** Flow Chart of the Ensemble-Based Frame Work

## Preprocessing

In this section, we present the selected preprocessing methods, which we consider to be applied before executing MA candidate extraction. The selection of the preprocessing method and candidate extractor components for this framework is a challenging task. Comparison of preprocessing methods dedicated to MA detection has not been published yet. Since preprocessing methods need to be highly interchangeable, we must select algorithms that can be used before any candidate extractor and do not change the characteristics of the original images (unlike, e.g., shade correction. We also found some techniques to generate too noisy images for MA detection (histogram equalization adaptive histogram equalization or color normalization. Thus, we have selected methods which are well-known in medical image processing and preserve image characteristics. Naturally, the proposed system can be improved in the future with adding new methods. In detecting abnormalities associated with fundus image, the images have to be preprocessed in order to correct the problems of uneven illumination problem, nonsufficient contrast between exudates and image background pixels and presence of noise in the input fundus image. Aside from aforementioned problems, this section is also responsible for colour space conversion and image size standardization for the system.

One of the problems associated with fundus images is uneven Illumination. Some areas of the fundus images appear to be brighter than the other. Areas at the centre of the image are always well illuminated, hence appears very bright while the sides at the edges or far away are poorly illuminated and appears to be very dark. In fact the illumination decreases as distance form the centre of the image increase. Many methods were tried in resolving this problem of un-even illumination, among which are the use of Naka Rushton method and Adaptive Histogram Equalization Method (AHEM). AHEM gives better performance, higher processing speed and work well for all images of different sizes, hence the reason for it being used as method of correcting un-even illumination.

## Contrast Limited Adaptive Histogram Equalization

Contrast limited adaptive histogram equalization (CLAHE) is a popular technique in biomedical image processing, since it is very effective in making the usually interesting salient parts more visible. The image is split into disjoint regions, and in each region local histogram equalization is applied. Then, the boundaries between the regions are eliminated with a bilinear interpolation.

The main objective of this method is to define a point transformation within a local fairly large window with the assumption that the intensity value within it is a stoical representation of local distribution of intensity value of the whole image. The local window is assumed to be unaffected by the gradual variation of intensity between the image centres and edges. The point transformation distribution is localised around the mean intensity of the window and it covers the entire intensity range of the image.

$$p_n = 255 . \left( \frac{[\emptyset_w(p) - \emptyset_w(Min)]}{[\emptyset_w(Max) - \emptyset_w(Min)]} \right)$$

Consider a running sub image W of N X N pixels centred on a pixel P (i,j), the image is filtered to produced another sub image P of (N X N) pixels according to the equation below

Where

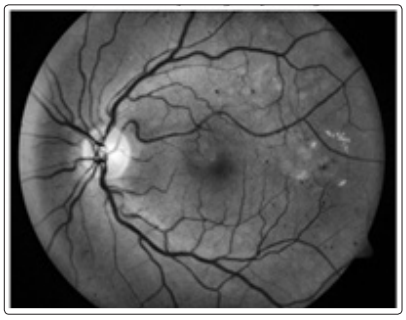
$$\emptyset_w(p) = \left[ 1 + exp \left( \frac{\mu_w - p}{\sigma_w} \right) \right]^{-1}$$

and *Max* and *Min* are the maximum and minimum intensity values in the whole image, while $\mu_w$ and $\sigma_w$ indicate the local window mean and standard deviation which are defined as:

$$\mu_w = \frac{1}{N^2} \sum_{(i,j) \in (k,l)} p(i,j)$$

$$\sigma_w = \sqrt{\frac{1}{N^2} \sum_{(i,j) \in (k,l)} (p(i,j) - \mu_w)^2}$$

As a result of this adaptive histogram equalization, the dark area in the input image that was badly illuminated has become brighter in the output image while the side that was highly illuminated remains or reduces so that the whole illumination of the image is same.

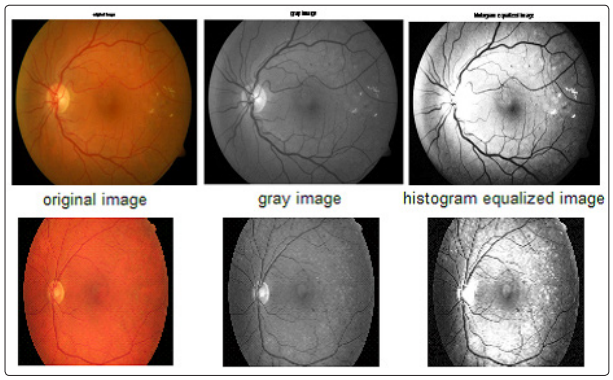


**Contrast limited adaptive histogram equilized image**

## Implementation Results

### Original Image

The noisy content present in the images was removed and further enhanced using preprocessing operation. Histogram Equalization was used as the enhancement technique.



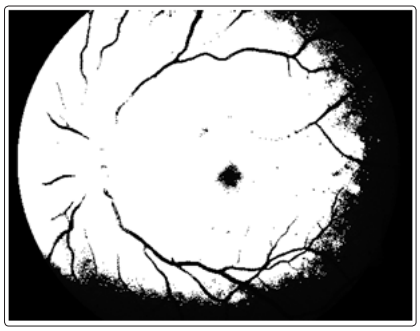

Histogram Equalization is a popular technique in biomedical image processing, since it is very effective in making the usually interesting salient parts more visible. The image is split into disjoint regions, and in each region local histogram equalization is applied.

## Walter-Klein Contrast Enhancement

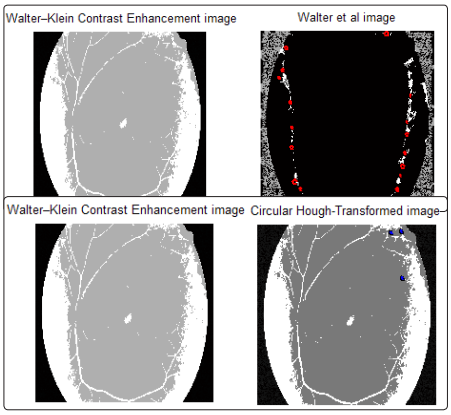
This preprocessing method aims to enhance the contrast of fundus images by applying a gray level transformation using the following operator:

$$f' = \begin{cases} \frac{\frac{1}{2}(f'_{max} - f'_{min})}{(\mu - f_{min})^r} \cdot (f - f_{min})^r + f'_{min}, f \le \mu \\ -\frac{\frac{1}{2}(f'_{max} - f'_{min})}{(\mu - f_{max})^r} \cdot (f - f_{max})^r + f'_{max}, f \ge \mu \end{cases}$$

Where {fmin, . . . , fmax}, {f_ min, . . . , f_ max} are the intensity levels of the original and the enhanced image, respectively, μ is the mean value of the original grayscale image and r ∈ R is a transition parameter.



Walter-Klein Contra Enhancement image




## Conclusion

In this section, we present the selected preprocessing methods, which we consider to be applied before executing MA candidate extraction. We also found some techniques to generate too noisy images for MA detection (histogram equalization adaptive histogram equalization or color normalization. Thus, we have selected methods which are well-known in medical image processing and preserve image characteristics. In detecting abnormalities associated with fundus image, the images have to be preprocessed in order to correct the problems of uneven illumination problem, nonsufficient contrast between exudates and image background pixels and presence of noise in the input fundus image. Many methods were tried in resolving this problem of un-even illumination, among which are the use of Naka Rushton method and Adaptive Histogram Equalization Method (AHEM). AHEM gives better performance, higher processing speed and work well for all images of different sizes, hence the reason for it being used as method of correcting un-even illumination [1-15].

## References


1. M Abramoff, M Niemeijer, M Suttorp-Schulten, MA Viergever, SR Russel, et al. (2008) Evaluation of a system for automatic detection of diabetic retinopathy from color fundus photographs in a large population of patients with diabetes. Diabetes Care 31: 193-198.
2. AD Fleming, KA Goatman, S Philip, GJ Prescott, PF Sharp, et al. (2010) Automated grading for diabetic retinopathy: A large-scale audit using arbitration by clinical experts. Br J Ophthalmol 94: 1606-1610.
3. HJ Jelinek, MJ Cree, D Worsley, A Luckie, P Nixon (2006) An automated microaneurysm detector as a tool for identification of diabetic retinopathy in rural optometric practice. Clin Exp Optom 89: 299-305.
4. M Abramoff, J Reinhardt, S Russell, J Folk, V Mahajan, et al. (2010) Automated early detection of diabetic retinopathy. Ophthalmology 117: 1147-1154.
5. M Niemeijer, M Loog, MD Abramoff, MA Viergever, M Prokop, et al. (2011) On combining computer-aided detection systems. IEEE Trans Med Imag 30: 215-223.
6. B Antal, I Lazar, A Hajdu, Z Torok, A Csutak, et al. (2010) A multilevel ensemble-based system for detecting microaneurysms in fundus images. in Proc 4th IEEE Int Workshop Soft Comput Appl 137-142.
7. B Antal, A Hajdu (2012) Improving microaneurysm detection using an optimally selected subset of candidate extractors and preprocessing methods. Pattern Recog 45: 264-270.
8. AAA Youssif, AZ Ghalwash, AS Ghoneim (2006) Comparative study of contrast enhancement and illumination equalization methods for retinal vasculature segmentation. in Proc Cairo Int Biomed Eng Conf 21-24.
9. T Walter, J Klein (2002) Automatic detection of microaneurysm in color fundus images of the human retina by means of the bounding box closing. Lecture Notes in Computer Science 2526: 210-220.
10. K Zuiderveld (1994) Contrast limited adaptive histogram equalization. Graphics Gems 4: 474-485.
11. S Ravishankar, A Jain, A Mittal (2009) Automated feature extraction for early detection of diabetic retinopathy in fundus images. in Proc IEEE Conf Comput Vision Pattern Recog 210-217.
12. A Criminisi, P Perez, K Toyama (2003) Object removal by exemplarbased inpainting. in Proc IEEE Conf Comput Vision Pattern Recog 2: II-721-II-728.
13. M Niemeijer, B van Ginneken, M Cree, A Mizutani, G Quellec, et al. (2010) Retinopathy online challenge: Automatic detection of microaneurysms in digital color fundus photographs. IEEE Trans Med Imag 29: 185-195.
14. T Walter, P Massin, A Arginay, R Ordonez, C Jeulin, et al. (2007) Automatic detection of microaneurysms in color fundus images. Med Image Anal 11: 555-566.
15. T Spencer, JA Olson, KC McHardy, PF Sharp, JV Forrester (1996) An image-processing strategy for the segmentation and quantification of microaneurysms in fluorescein angiograms of the ocular fundus. Comput Biomed Res 29: 284-302.