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# Detection of Proliferative Diabetic Retinopathy Using Retinal Imaging Techniques

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## Abstract

In this paper, a method for detection of microaneurysms using retinal imaging techniques is described. Diabetic Retinopathy is an eye disorder that primarily affects the fundus region. Microaneurysms arise due to high Blood Pressure and high Sugar levels in Blood. The clinical sign of Diabetic Retinopathy are microaneurysms that appear as dark lesions in fundus image. The number of microaneurysms is used to indicate the severity of the disease present in the retinal image. The severity of this disease is that it might eventually lead to blindness. Early detection of microaneurysms helps to reduce the occurrence of blindness. Here, we have discussed a method for the detection of Proliferative Diabetic Retinopathy by using retinal imaging techniques. The process used are Preprocessing, Feature extraction and Classification.

**Keywords:** Diabetic Retinopathy; Microaneurysms; Optic disk; Fundus image

## Introduction

### *A. Anatomy of eye*

The human eye is the organ which gives us the sense of sight, allowing us to observe and learn more about the surrounding world than we do with any of the other four senses. The light continues through the vitreous humor, the clear gel that makes up about 80% of the eye's volume, and then, back to a clear focus on the retina. The small central area of the retina is the macula, which provides the best vision. The center of macula is called fovea as shown in fig 1. This region of the retina is the most sensitive region. Optic disk or optic nerve head is the bright yellowish disk, from which, blood vessels and optic nerve fibers emerge. Optic disk transmits electrical impulses from the retina to the brain. Macula is the central area of the retina, temporal to the optic disk. It is responsible to have fine central vision and colour vision.

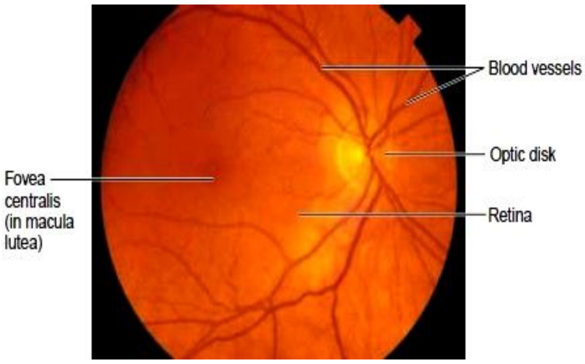



**Figure 1:** Anatomy of eye

***B. Diabetic Retinopathy***

Diabetic retinopathy is the name given to the changes in the retina, which occur over a period of time in diabetics. The walls of the blood vessels become fragile and it start to break, leaking blood around them. Sometimes the weakened area can be seen, before the walls break by the person who examines the eye, to have ballooned out. These are called micro-aneurysms. Despite these intimidating statistics, research indicates that at least 90% of these new cases could be reduced if there were proper and vigilant treatment and monitoring of the eyes. The longer a person has diabetes, the higher his or her chances of developing diabetic retinopathy.

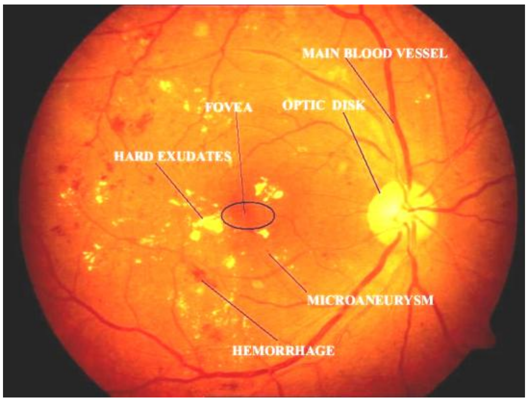



**Figure 2:** Diabetic Retinopathy Image

Several retinal abnormalities including micro aneurysms, hemorrhages, hard exudates and cotton wool spots are caused due to DR. Hard exudates are yellowish intra retinal deposits, made up of serum lipoproteins. Exudates are formed when lipid or fat leaks from abnormal blood vessels. Vision loss can occur if the exudates extend into the macular area.

***C. Retinal image processing***

The software used here is MATLAB to detect microaneurysms present in the fundus image. In the First process of pre-processing the input image(Fig 5a) is given to the green channel and it is converted into the gray channel and then a suitable Median filter is used and with the resulted image it subtracted with the green image in order to get normalized image. And the contrast of the image is enhanced and thresholding is done. Then Binarization is done by multilevel thresholding where optimum threshold value is chosen .Finally microaneurysms can be extracted through shape, size and intensity level and then they are segmented by separating from blood vessel whose count is finally done.

## Objectives

The objective of this study is: 1.To compare the normal and abnormal eye. 2.To identify the microaneurysms present in the fundus image and to count microaneurysms present in the in the fundus image 3.To classify Diabetic Retinopathy based on the count.

## Materials and Method

### A. Patient

A 52 year old woman, diagnosed as having diabetes for 10 years at right eye and a 60 year old woman, diagnosed with diabetes for 20 years in both eyes are considered. The image specification is presumed to be with a resolution of 512 x 512 image pixels.

### B. Schematic of the study

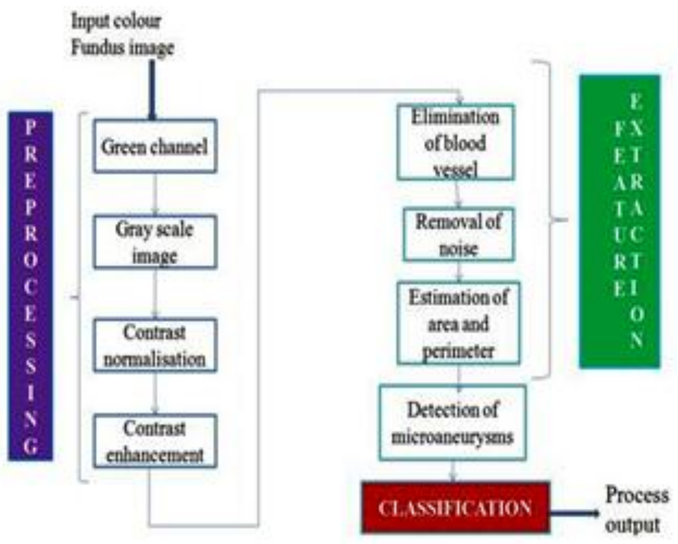



**Figure 3:** Schematic of work flow

### C. Software used in image analysis

#### 1. Pre-processing

The aim of pre-processing is to increase the contrast and to de-amplify the noise. In Fundus image, the image processing technique is applied in order to enhance its brightness and contrast. The fundus image has Red, Green and Blue channels of which the green channel exhibit the contrast between vessels and background and displays Hemorrhages, microaneurysms and Blood Vessels in dark color of the gray scale, while the Red and Blue channel tend to increase the noise. Hence green channel is used for further processing.

And the next step is conversion of green channel into a gray scale image(Fig 5c) and then Median Filter is applied to the gray image(Fig 5d) since it preserve the boundaries and it de-amplify the noise and the result image is subtracted with green channel to get the normalized image(Fig 5e). Adaptive Histogram Equalization is applied for contrast enhancement after which dark regions are dominant. Finally the gray threshold is selected to determine the microaneurysms and Blood Vessels.

Contrast Limited Adaptive Histogram Equalization (CLAHE) is an adaptive extension of histogram Equalization followed by thresholding which helps in local characteristics of an image

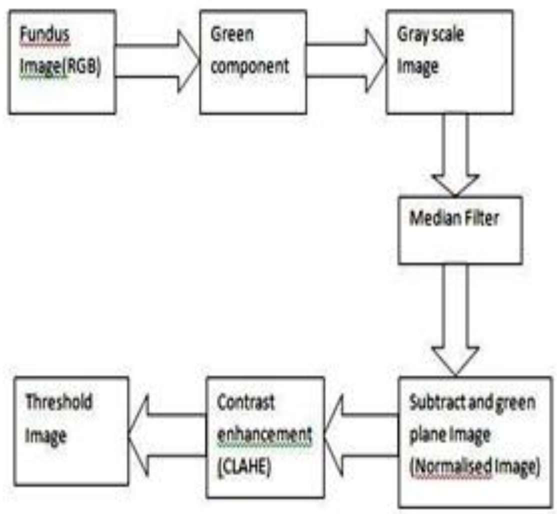
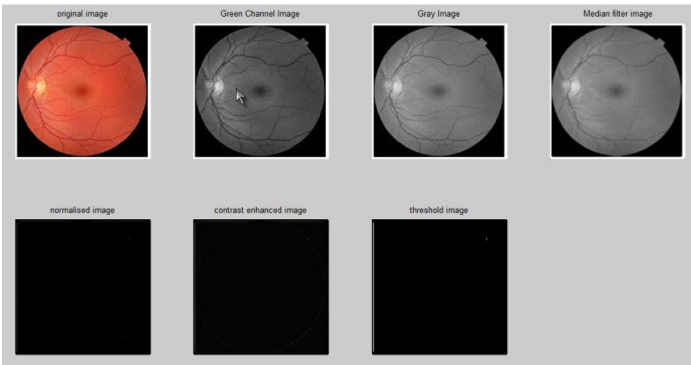



**Figure 4:** Preprocessing flowchart

**A) Normal condition**

a b c d

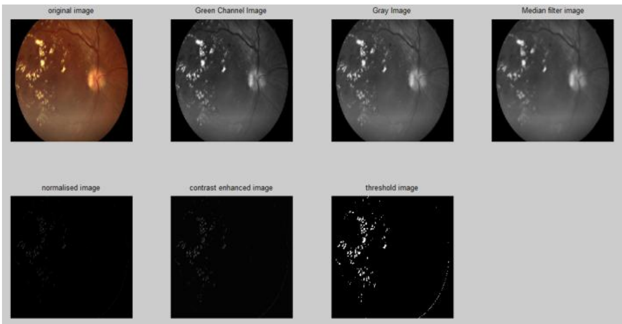



e f g

**Figure 5:** Normal image processing a) Original image b) Green channel c) Conversion of gray scale d) Appling Median filter e) Normalization Image f) Contrast enhancement image g) Thresholded image

**B) Severe condition**

a b c d




e f g

**Figure 6:** Abnormal image processing**,** a) Original image b) Green channel c)Conversion of gray scale d) Appling Median filter e) Normalization Image f)Contrast enhancement image g)Thresholded image

**2. Feature extraction**

The objective of Feature extraction is to detect number of microaneurysms present in the Pre-processed image as shown in figure 6 so it represent as abnormal image processing. The features of microaneurysms can be extracted based on shape, intensity level and size ranges from 10 to 100 microns in diameter. Both microaneurysms and blood vessels appear as dark reddish colour but microaneurysms will not occur in blood vessels, hence based on area microaneurysms can be identified. Blood vessels are large in area and to remove blood vessels object having area greater than threshold value are eliminated. And canny edge detection is applied on the resulting image. And finally it is binarised. Based on area and perimeter each object is calculated and it results in simple metric it indicates the roundness of an object .This metric for one circle it is equal to one and it is less than one for any shape. And metric closer to one indicates the presence of microaneurysms.

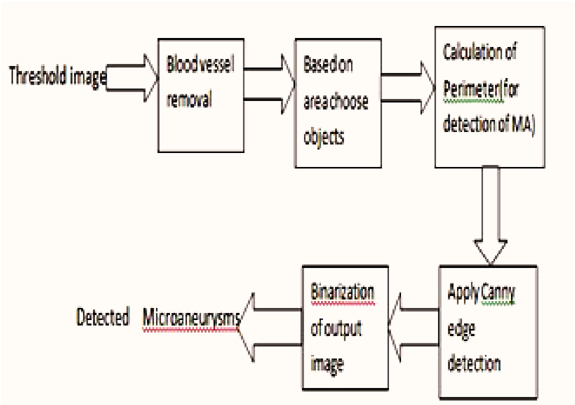
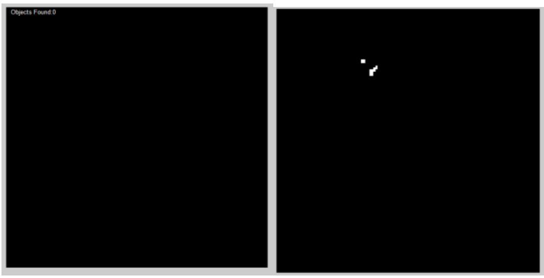
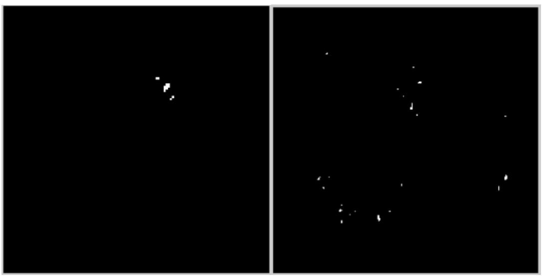



**Figure 7:** Feature extraction flow chart



Object found:0 Object found:4



Object found:7 Object found:21

**Fig 8: Number of microaneurysms detected**

## 3. Classification

After the Microaneurysms are detected, classification procedure groups the optic images as either diseased or normal depending on its count. Classification then grades the DR into four stages as no DR, mild DR, moderate DR, and severe DR as shown in the table I.

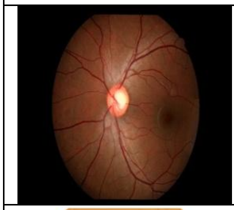
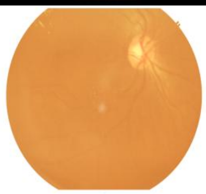
**Table 1:** Grading of Diabetic Retinopathy

| Grade | Count of MA | Severity |
|---|---|---|
| 0 | 0 | Normal |
| 1 | 1<MA<5 | Mild |
| 2 | 5<MA<15 | Moderate |
| 3 | MA>15 | Severe |

## Result and Discussion

Classification was performed showing the extracted exudates and the retina is classified as either normal or abnormal depending upon the existence of the exudates in the retina. The below table II shows about the list of images acquired and the number of microaneurysms present in it and it is classified based on its count.

**Table 2:** Tabulation based on the number of microanuerysms detected

| Image Acquired | Age | Gender | Number of Microaneurysms Detected | Grade Classification | Severity |
|---|---|---|---|---|---|
|  | 33 | Male | 0 | 0 | Normal |
|  | 52 | Female | 4 | 1 | Mild |
|  | 56 | Female | 7 | 2 | Moderate |
|  | 45 | Male | 21 | 3 | Severe |

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