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A Color Based Method to Identify Microaneurysms in Mild Stage of Non-Proliferative Diabetic Retinopathy

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Abstract
Diabetic retinopathy (DR) is a diabetes related eye disease which occurs when blood vessels in the retina become swelled and leaks fluid which ultimately leads to vision loss. Several image processing techniques including Image Enhancement, Segmentation, Image Fusion, Morphology, Classification, and registration has been developed for the early detection of DR on the basis of features such as blood vessels, exudes, hemorrhages, and microaneurysms. The damage caused by diabetic retinopathy can be prevented by the early detection of microaneurysm in the retina. Microaneurysms are first medical sign of DR and they seem like red small dots in fundus image [1]. Presence of microaneurysms describes the levels of DR. Timely recognition of microaneurysms can reduce the risks of loss of sight. The proposed paper has discussed about the identification of microaneurysms using colors in digital image of fundus using different preprocessing and feature extraction technique.

Keywords: Diabetic Retinopathy, Microaneurysms, Fundus Image

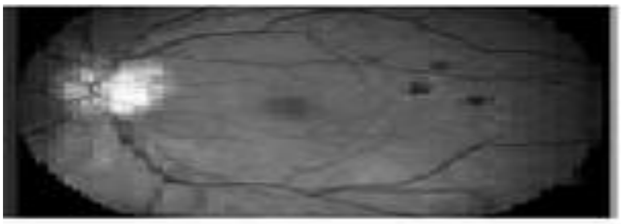
Introduction
Microaneurysms detection is very important, because these structures constitute the earliest recognizable feature of DR. The detection of this smaller structure is great importance since these are the structures present during the early stage of diabetic retinopathy. At earlier stages, these structures appear as smaller round red dots varying from 15 to 60 microns. For the accurate detection of the microaneurysms, it is necessary to eliminate the optic disc. From the green channel extracted images the edges are detected and the regions are filled. The elimination of the circular border is done and the larger areas are removed from the image. To obtain the microaneurysm affected regions, it’s essential to eliminate exudates [9].Exudates are removed from the obtained image by adaptive histogram equalization twice and then comparison of the image with the image obtained during the last operation. Thus exudates get eliminated from the resultant image. The blood vessels and optic disc is eliminated to obtain an image containing only microaneurysms. The original image is represented by Fig.1 (a).

(a)

Fig. 1 (a) Original Image

Green Channel Image

Image pre-processing is the initial step in automated retinal pathology diagnosis. It includes techniques such as contrast enhancement, gray/green component, image de-noising, etc. In a binary image, white pixels are normally taken to represent foreground regions, while black pixels denote background. In case of Gray scale image, the intensity value represents height above a base plane. Thus, the Gray scale image represents a surface in three-dimensional Euclidean space [7]. In the RGB images the green channel exhibits the best contrast between the vessels and background while the red and blue ones tends to be more noisy. Since the retinal blood vessels appear darker in gray image, the green channel is used to convert the intensity of the image. The given original image is converted into green channel image. The green channel image is represented by Fig. 2(a).

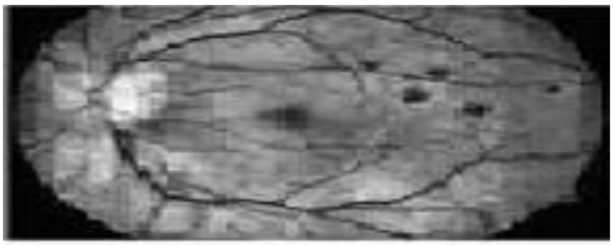


(a)

Fig. 2: (a) Green Channel Image

Histogram Equalization

Histogram equalization is a constant enhancement technique which provides an enhanced method for modifying the dynamic range and contrast of an image by altering the image. It is finding of cumulative distribution function for a given probability density function. The small area of pixels, considered to be noise, is removed after applying morphological operations. Post the transformation, the probability density function of the output will be uniform and the image will have high contrast. Histogram specification is a two-stage process [4].First, the histogram of each channel is equalized and then an inverse transformation function is applied to determine the desired histogram for each color channel in the output image. The histogram equalization image is represented by Fig.3.

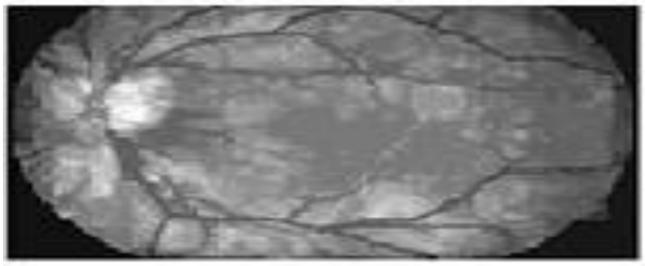


(a)

Fig. 3: (a) Histogram Equalization Image

Morphological Filling

Besides microaneurysms detection, the larger area, bright lesions such as exudates, treated as noise are also removed for perfect detection of microaneurysms. Mathematical morphological methods [9] are applied here for removing larger area than microaneurysms. The border eliminated before the image filled up with enclosed area. The area (i.e.microaneurysms) obtained by subtracting away the edges with image. Next, the larger areas are removed by morphological operation. The holes in the output image are filled by imfill function. The image after morphological filling is represented by a Fig.4 (a).

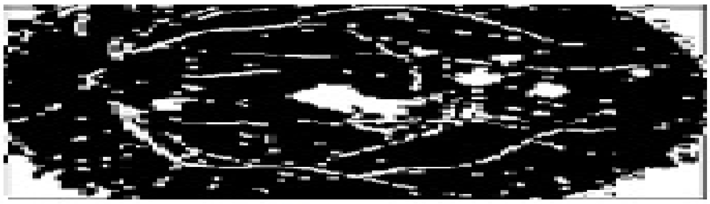


(a)

Fig. 4: (a) Morphological Filling Image

Binary Image

The new binary image is received after the removal of objects that have fewer than some constant pixels (p) from old binary image. The new binary image is represented by Fig.5 (a).The new binary image is subtracted from old binary image. Then the vessels are extracted from the retina by using some constant threshold value in histogram equalization image. The eroded image is received through the binary erosion. Then the each element in the eroded image is multiplied with each element in the original image. The morphological operation is performed in the output image. The image after morphological operation is converted into binary image.

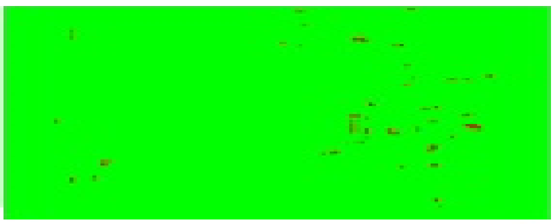


(a)

Fig. 5: (a) Binary Image

Microaneurysm Image

An area less than the range of 30 to 5000 pixels are regarded as a background noise. The microaneurysms image is received by using threshold values. Then the image is converted into RGB image. Here the microaneurysms are identified using red color which is represented by a Fig.6 (a).



(a)

Fig. 6: (a) Microaneurysm Image

Conclusion

Eye deceases like Diabetic retinopathy (DR) is responsible for blindness in human eye. Therefore it is necessary to detect such deceases at early stage with the help of image processing technologies and methods. Here the microaneurysms are identified using red colors. In future we can know the level of microaneurysms based on these red pixels.

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