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EXTRACTION OF EXUDATE AND HEMORRHAGE IN OCULAR FUNDUS IMAGE USING MORPHOLOGICAL OPERATIONS

R.Sathya Priya, S.Kalyani

*Abstract***—** Diabetic Retinopathy is a major cause for blindness. The primary sign of these diseases are the formation of exudate or hemorrhage which may lead to sight degradation. The conventional method followed by opthalmogists is the regular supervision of the retina. As this method takes time and energy of the opthalmogists, a feature based algorithm for the detection of exudate and hemorrhage in color fundus image is proposed in this work. This method reduces the professionals work to examine on every fundus image rather than only on abnormal image. The method is based on segmenting all objects that have contrast with the background including the exudate and hemorrhage. The exudates are yellow lesions formed due to the leakage of proteins and lipids from the retinal blood vessels while the hemorrhages are red lesions formed due to the leakage of blood into the interior surface of eye. The optic disc that best appear in red component are detected using Hough transform while the blood vessels that best appear in green component are extracted using morphological operations and local entropy thresholding. The extracted features are removed in order to obtain the initial part of the exudate and hemorrhage. Then the final part of the exudate and haemorrhage are separated from the fundus image using morphological reconstruction algorithm using the statistical colour properties.

Keywords – Ocular Fundus Image, Diabetic Retinopathy, Exudate, Hemorrhage, Morphological Operations.

I. INTRODUCTION

Diabetic retinopathy, is (damage to the retina) caused by complications of diabetes, which can eventually lead to blindness. It is an ocular manifestation of diabetes, a systemic disease, which affects up to 80 percent of all patients who have had diabetes for 10 years or more. Despite these intimidating statistics, research indicates that at least 90% of these new cases could be reduced if there was 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. They may cause the degradation of eye by the formation of exudates, haemorrhage or micro-aneurysm.

Pus like fluid formed by the leakage of proteins and lipids from the blood stream into the retina via damaged blood vessel is called as exudates. They appear in the form of yellow lesions on the interior surface of the eye. While the haemorrhage appear as red lesions caused due to the leakage of blood from the blood streams.

Various methods have been adopted to extract the exudates and hemorrhages. Akara et al [4] use maximum variance to obtain the optic disk center and a region growing segmentation method to obtain the exudates. Blood vessel intersection property is used in [5], [6] to obtain the optic disk. Based on its color characteristics, the authors in [7] composed a simple Bayesian classifier to detect the exudates. Extraction of exudates and blood vessels by computing the difference map and k-means clustering is introduced in [8]. Color normalization and local contrast enhancement followed by fuzzy C-means clustering and neural networks were used by Osareh et al [1].

In this paper an efficient algorithm has been proposed to detect the exudates and hemorrhages automatically using morphological operations.

II.MATERIALS AND METHODS

The images used in this paper are ocular fundus images affected by exudates and hemorrhages.The fundus images are downloaded from the STARE DATABASE.

A. PRE-PROCESSING

Pre-processing is the initial step in all the case of image related diagnosis system. In case of diabetic retinopathy, the retinal images in the dataset are often noisy and poorly illuminated because of unknown noise and camera settings. Also the colour of retina has wide variation from patient to patient. Thus to remove noise and undesired region the images are subjected to pre-processing steps, which include green channel extraction, histogram equalization and contrast enhancement. The exudates

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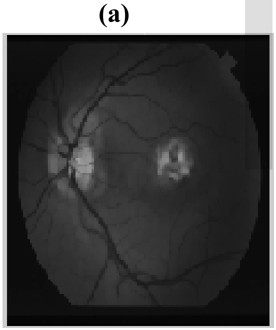
appear bright in the green channel compared to red and blue channels in RGB image. Hence green channel is used for further processing by neglecting other two components. Histogram equalization and contrast enhancement are used to increase the contrast between the exudates and the image background.

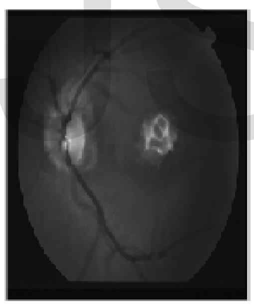
The top hat morphological operation of opening and closing is used to enhance the contrast of the image. The top hat opening and top hat closing are subtracted and then added with the green component of the original image.

(a)

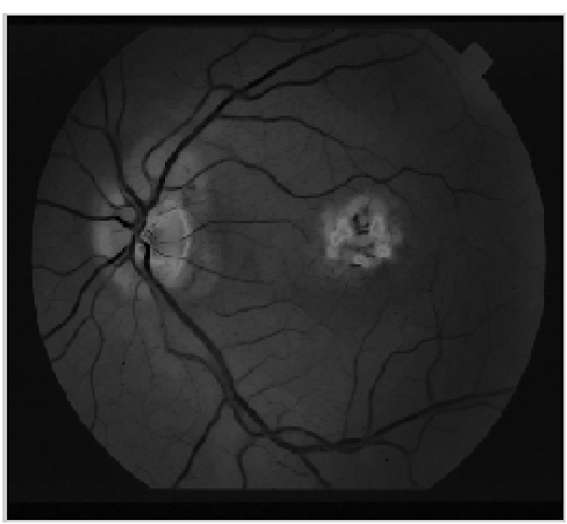
(b)



(c)



(d)

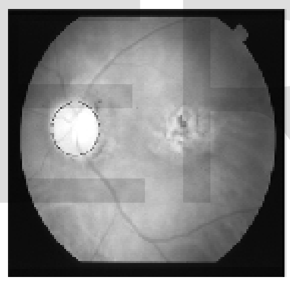


(e)

Figure1:Pre-Processing (a) original image, (b) Filtered image, (c) top-hat opening, (d) top-hat closing, (e) Enhanced image

B.OPTIC DISC EXTRACTION

The optic disc best appear in the red component. The optic disc is circular in structure so Hough transform is used. Hough transform is a feature extraction technique which is used to detect the circles present in the image. The edges are detected using edge detection (canny) technique. The detected edge forms the input to extract optic disc (which is circular in shape) using Hough transform. Initialize the parameters for detecting the circle. An accumulator space is created and then the values are incremented. Finally reposition the pixels values to fit the region required.



(a)

(b)

Figure 2: Optic Disc Extraction, (a) extracted disc in red component, (b) extracted disc in original image.

C.BLOOD VESSELS EXTRACTION USING MORPHOLOGICAL OPERATION

In our approach, the input image is initially resized to a standard size of 768x576 pixels. Green channel is used to detect the blood vessel and exudates. They both are separated by morphological operations. The morphological closing is used in order to eliminate the small dark regions in an image. Consider two structuring elements (S1, S2) of different sizes and n step angles. S2 must be chosen higher value than the S1, in order to get thicker blood vessels. Morphological closing operation is applied for these two S1, S2. Then subtract the two closed

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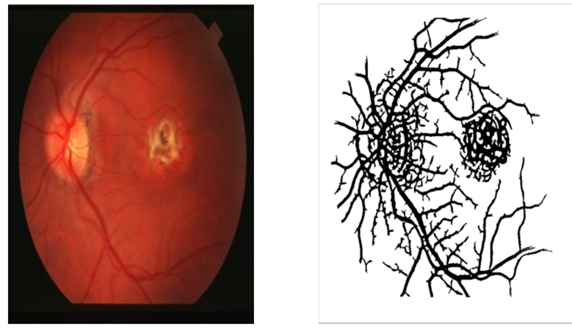
images and compare with a threshold value. Continue the iteration for different step angles. The final step is to use morphological opening in order to smooth the image.

(a) (b)

Figure 3: Blood vessels extraction using morphological operations, (a) Extracted vessels in gray scale image, (b) Extracted vessels in original image.

D.BLOOD VESSELS EXTRACTION USING LOCAL ENTROPY THRESHOLDING

In our approach a new technique has been adopted for extracting the blood vessels. The green component of RGB is taken as input image and converted into gray scale. Kernel function is taken and the maximum value is taken from the range. The orientation initially is for a single direction and later the angles are rotated along all the directions in order to grow the blood vessels.Then the original image is convolved in order to enhance the blood vessels.A threshold value is set and the maximum of the entropy value is considered. As a result the blood vessels are clearly segmented from the background. The entropy value is more quantitative.

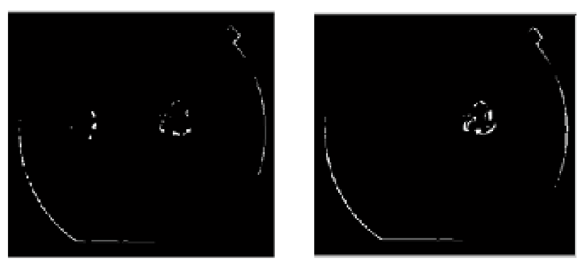


(a) (b)

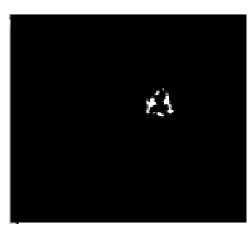
Figure 4: Blood vessels extraction using local entropy thresholding, (a) original RGB image, (b) extracted blood vessels using thresholding.

E.DETECTION OF EXUDATES AND HEMORRHAGES

The exudates and hemorrhages best appear in the green component of the image. The initial parts of the exudates and hemorrhages are obtained by eliminating the optic disc and blood vessels extracted. The exudates and hemorrhages are differentiated using their statistical colour properties.



(a) (b)



(c)

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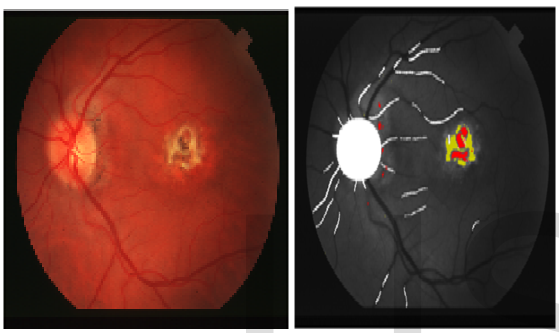
Figure 5: Initial part of exudates and hemorrhages, (a) removed blood vessels, (b) removed optic disc, (c) initial exudates and hemorrhages.

III.RESULTS AND DISCUSSIONS

The final parts of the exudates and hemorrhages are detected using morphological reconstruction. The obtained results are shown below with the variation in colour properties in which exudates appear as yellow lesions while hemorrhages appear as reddish lesions.



(a) **(b)**

Figure 6: Final part of exudates and hemorrhages, (a) original image, (b) final exudate and hemorrhage detected

IV.CONCLUSION

This paper automatically detects the exudates and hemorrhages present in the fundus image using morphological operations in order to detect the early stages of diabetic retinopathy.

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