International Journal of Electronics, Electrical and Computational System
IJEECS
ISSN 2348-117X
Volume 6, Issue 8
August 2017

Academic Science

Detection of Diabetic Macular Edema in Retinal Images

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Abstract—Macular edema is an advance stage of diabetic retinopathy which affects central vision of diabetes patients. The main cause of edema is the appearance of exudates near or on macular region in human retina. Early detection of Diabetic retinopathy is very important for saving vision impairment and for effective treatment. An automated system for early detection of macular edema is proposed. The method has been proposed to detect the macula centre which is independent of optic disc location. In this method search region for detection of macula is adaptive to the size of image. Independency from optic disc detection to detect the macula is an efficient method because it is unaffected by wrong detection of optic disc position under the presence of noises and reflections. The proposed method is tested on different retinal images and achieves probable accuracy.

Keywords—Diabetic macular edema, Macula Detection, Hard exudates, Severity of DME.

I. INTRODUCTION

MACULA is a very important part of retina, for sharp color vision the centre fovea of macula is responsible. Diabetic Macular Edema (DME) is a severe case of Diabetic Retinopathy (DR). DR is one of the very severe complications of diabetes. DR is classified into four different stages: mild NPDR (non-profilerative diabetic retinopathy), moderate NPDR, severe NPDR and PDR (profilerative diabetic retinopathy). The different abnormalities of NPDR are hard exudates (HE), hemorrhages, Macular Edema (MA) etc. An indirect method of detection of DME is Detection of hard exudates in macular region. DME can also be classified as mild DME, moderate DME and severe DME. The risk of DME increases as hard exudates approaches to the macula. The complexity of DME is when hard exudates are very near to macula. Detection of hard exudates in different regions of retina according to macula is considered as a standard method to detect DME.

Hard exudates are accumulation of fluid which leaks from blood vessels and it is present in retina as yellowish spots. Macula fovea is about 1.5 mm in diameter, and its center is located about 2.5 times of Optic disc (OD) diameter away from the OD center. Early Detection of DME from hard exudates may reduce or prevent the loss of vision by some percentage. Fundus image of an eye consists of different parts like optic disc, fovea, vessels etc and different abnormalities as bright and dark lesions which are labeled in Fig. 1.

In this area some research has been carried out for detection of DME from hard exudates. Most important part of this process is detection of DME. NamitaSengar et. Al [1] proposed a method to detect the centre of macula which is independent of optic disc location. Grading of DME is done by

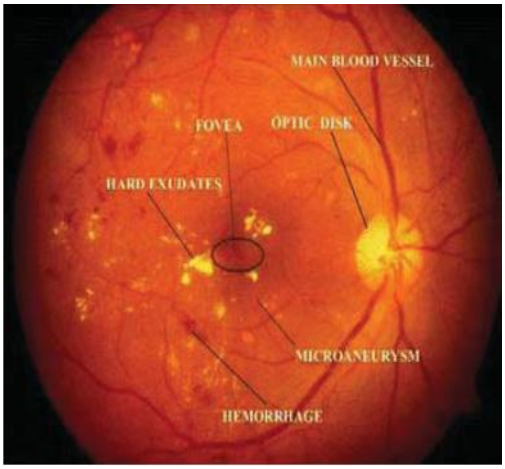

Fig.1. Fundus image of an eye

dividing the image of retina in different regions according to the international standard. Disease severity is accessed using scaling of brightlesions in macular regions. K. Sai Deepak et. Al [2] proposed a two-stage method for detection and classification of severity of DME. DME detection is done using a

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IJEECS
ISSN 2348-117X
Volume 6, Issue 8
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supervised learning approach.Sreejini K. S. et.Al [3] proposed an automatic unsupervised method to classify severity of diabetic macular edema in color fundus images. Optic disc and fovea are detected using mathematical morphology. This method has the advantage over previous papers that it is independent of reflections or imaging conditions. The proposed method is adaptive to the size of image. For the experimental validation a database is used and we have achieved probable accuracy. The further paper is divided in different sections as: part A consist of preprocessing, part B consist of removal of tags, part C consist of optic disc detection, part D consist of macula detection, part E consist of Division of Regions, part F consist of Detection of hard Exudates, Part G consist of the severity of DME..

II. METHODOLOGY

Block diagram of proposed method for the detection of DME is shown below in Fig 2. It consists of various blocks such as Preprocessing, Removal of Tags, Optic disc detection, Macula Detection, Detection of Hard Exudates, Extraction and removal of OD and vessels and decision on which type of DME it is. Each block is described in detail in this section.

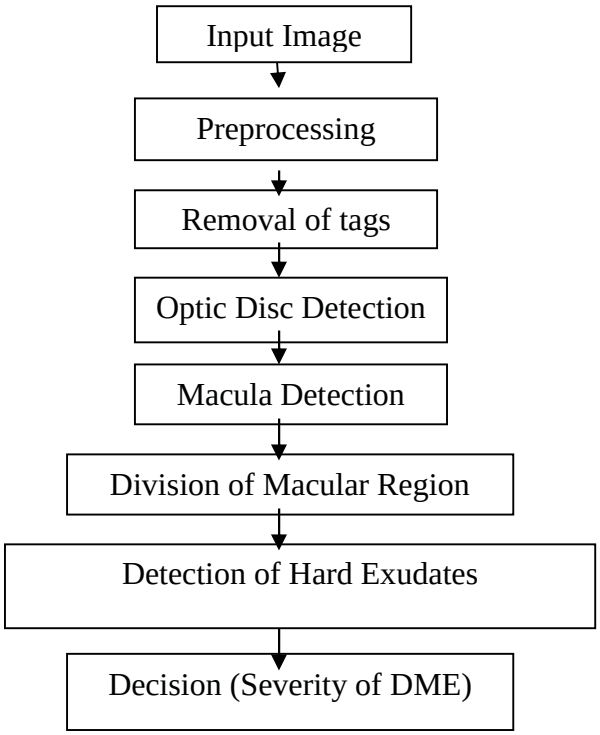


Fig. 2.Block diagram of proposed method

A. Preprocessing

The color image has been converted into gray scale image and the image is resized so that small dots would be visible. The contrast of the image is adjusted so that the exudates will be clearly visible.Then Adaptibe Histogram Equalisation (AHE) is performed for uniform intensity distribution which increases illumination or some negatives in an image therefore we use wiener filter for blurring and for removal of such negatives.

B. Removal of Tags

Thresholding is used here to remove small details in images such as date, logo, hospital name etc.

C.Optic Disc Detection

As macula is located at some fix distance from optic disc it is necessary to detect OD first for accurate results. Here AHE is performed again to reduce the intensity of enhanced borders because of previous operations. Image is then converted into binary by applying thresholding. Area opening is used to remove all connected components producing another binary image so that they should not interfere in OD detection. All the small details except Optic Disc are removed by using opening operation. Centroid of OD is calculated and OD is detected.

D. Macula Detection

First macula location is estimated and a circle of suitable radius is plotted on this location which will be a macula portion. Then a mask is created for macula segmentation. Meshgrid is used here. So macula is get segmented by plotting a circle in an image.

E. Division of Macular Region

Here the macular region of an image is divided into three different circular regions as region 1, region 2 and region 3. Let us consider (x1, y1) as the centre coordinated of the macula.

1. Region 1: From (x1, y1) a circular region is obtained radius ‘r1’ is chosen.
2. Region 2: From (x1, y1) a circular region is obtained of radius ‘r2’ – Region 1
3. Region 3: From (x1, y1) region is obtained of radius ‘r3’- (Region1+Region2)

F. Detection of Hard Exudates

Detection of hard exudates in different regions of image is one of the methods to find

severity of DME. In the proposed method, hard exudates are detected region wise so that it can be easily graded. In this step image is first converted into binary by applying thresholding. Then connected components in this binary image are detected and a set of properties for each connected component (object) in the binary image BW is measured. Area is calculated for each detected component which are hard exudates.

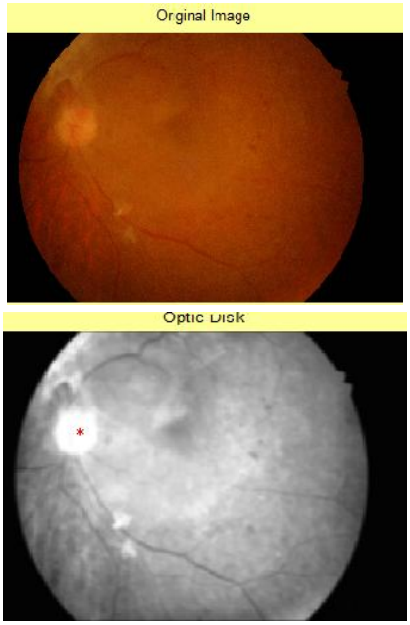
G. Decision on severity of DME

If hard exudates are detected in region 1 then it is considered as most severe type of DME, if detected in region 2 it is considered as severe type of DME and if detected in region 3 it is considered as the moderate type of DME.

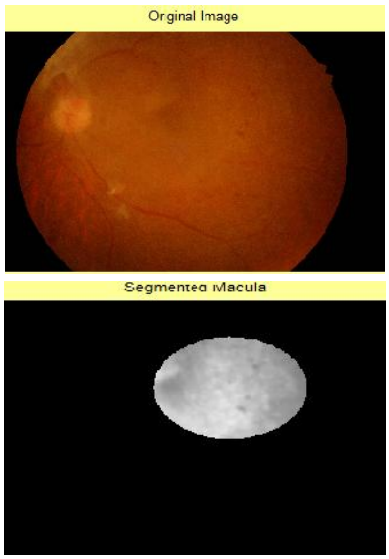
III. RESULTS

The proposed method is tested on Diaretdb database. Detection of macula is successfully done. Hard exudates are detected in every region of image as region division covered whole macular area..The method is tested on Diaretdb database. The results of various steps involved in the proposed method are given below. This involves results of the steps viz. Preprocessing, Tag removal, Optic Disc detection, Macula detection, division of an image and decision on severity of DME.

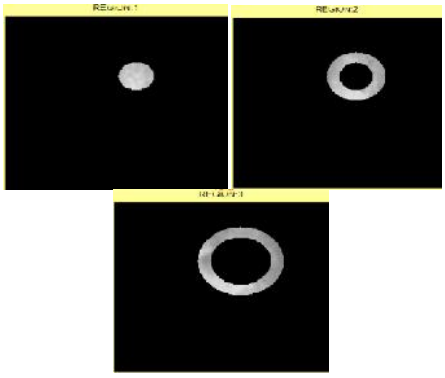
(a)



(b)



(c)



(d)

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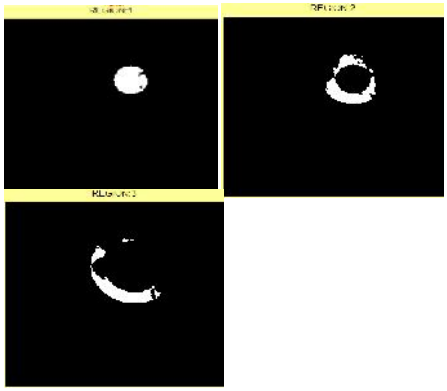

(e)

Fig 3.(a) Preprocessed image (b)OD detected image (d)Macula detected image (e) Division of macular region (f)Detection of hard exudates

Table below shows the accuracy of detection of DME.

Table 1. Accuracy of DME detection

Database	No. of Images	DME detected Images	Accuracy	Specificity	Sensitivity
Diaretdb1	53	42	86%	85%	80%

Table 2. Conditions for grading of macular edema

Grade	Condition	Class
0	No exudates present	Healthy
1	Few exudates present in region 3	Moderate
2	Few exudates present in region 2	Severe
3	Few exudates present in region 1	Most severe

IV. CONCLUSION

The proposed method is for detection of Diabetic Macular Edema (DME) which is an efficient approach as it detects Optic Disc (OD) for detection of macular location which correctly locates the macula region because it is located at some fixed distance from OD. This proposed method address one major challenge for detection of macula as it is invariant of different imaging conditions and noises. In this method macular region is divided into three different parts and hard exudates are detected region wise which helps in detection of severity of DME. The proposed method is less time consuming and less complex.

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