Application of False Removal Algorithm Specially for Retinal Images with Exudates in Diabetic Retinopathy Detection

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Abstract: *Diabetic retinopathy (DR) is a disease with an increasing prevalence and the main cause of blindness among working-age population. The risk of severe vision loss can be significantly reduced by timely diagnosis and treatment. Systematic screening for DR has been identified as a cost-effective way to save healthservices resources. Automatic retinal image analysis is emerging as an important screening tool for early DR detection, which can reduce the workload associated to manual grading as well as save diagnosis costs and time. Many research efforts in the last years have been devoted to developing automatic tools to help in the detection and evaluation of DR lesions. However, there is a large variability in the databases and evaluation criteria used in the literature, which hampers a direct comparison of the different studies. This work is aimed at summarizing the results of the available algorithms for the detection and classification of DR pathology. A detailed literature search was conducted using PubMed.*

Key words: *Semi Automated analysis system, diabetic retinopathy, retinal image*

1. INTRODUCTION

Diabetic retinopathy is a chronic disorder which is considered as a major source of vision loss in patients suffering from diabetes. It is characterized by the destructive of blood vessels that nourish the retina. However, early detection of such disorder through regular diagnosis, vision loss can be avoided. In order to reduce the diagnosis cost and enhance the automated analysis, modern image processing tools are used to detect the existence of disorders in the retinal images acquired during the initial process of screenings. This paper presents a methodology for the extraction of exudates within blood vessels from fundus images using Fuzzy c-Means (FCM) clustering algorithm. Matched filter was applied for vessel extraction with the help of adaptive histogram equalization, thresholding method and segmenting method, which incorporates spatial neighborhood information into the FCM clustering algorithm. A standard diabetic retinopathy database was used in this study to test the proposed algorithm. This methodology showed improved sensitivity and accuracy of the segmented result. The proposed method seems to be promising as it can also detect the very small areas of exudates. Such an image processing technique can reduce the work of ophthalmologists and help in patient screening, treatment and clinical studies.

Retina is a thin clear structure including of several layers. The cells within the retina includes three major components: (1) neuronal component which contribute the retina its visual function by converting light to electrical signals; (2) Glial components are the supporting column of the retina; and (3) Vascular components which delivers the inner retina while the outer retinal is being delivered by diffusion from choroidal circulation [5]. Diabetes will produce its result on both neuronal and vascular components of the retina.

In eyes, exudates are formed in retinal image due to the damage in retinal blood vessels. Exudates are randomly spread over the retina and appear as yellow-white patches of varying sizes and shapes which are basically a broken vessels leaks the lipids and proteins around the retina [3]. Development of MA, HMA & exudates in the eye determine the intensity of disease with which a person is ill. The movement of exudates towards the macular region of the eye shows the symptoms of total loss of vision [6].

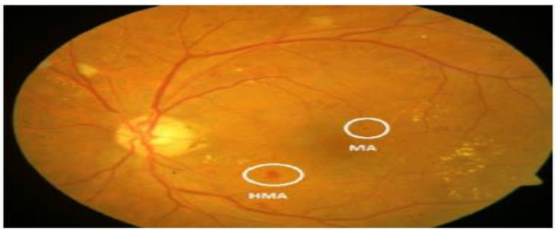


Figure 1. Retinal image showing Mas and HMAs

Semi-automated hessian-based candidate selection (SHCS) algorithm very is popular among other algorithms. After applying SHCS on retinal images with exudates, it is found that, the algorithm gives lots of false negative. In order to solve it, error elimination algorithm has been proposed. The proposed has been successfully eliminated false negative around exudates. SHCS algorithm followed by proposed algorithm gives much better result in retinal images with exudates to find MA & HMA as compared to SHCS algorithm alone.

2. SHCS ALGORITHM

In Semi-automated DR detection algorithm, first image pre-processing is applied in which green-channel image is taken out of the input retinal coloured image as it is analysed by researchers that the contrast of the HMA &MA appears high in the green component of the image. In order to reduce the noise in the image,LPF is applied on it [1].

In the next step, eigen value analysis which is based on hessian matrix is performed to find MA & HMA in the eye. Hessian matrix can be taken as a matrix of 2nd order partial differentiation derived functions. As the intensity curve surface of input image is approximated by the partial derivative function then the Hessian matrix can be shown as

Here * represents convolution operator,*Img(x,y)* is the pre-processed image, GAUxx(x,y),GAUxy(x,y), GAUyx(x,y), GAUyy(x,y) are the 2ndorder partial derivative functions of the Gaussian function inall direction [1]. Where Gaussian functioncan be equated as

$$H(x,y)=\begin{bmatrix} L_{xx}(x,y) & L_{xy}(x,y) \\ L_{yx}(x,y) & L_{yy}(x,y) \end{bmatrix}$$

$$L_{xx}(x,y)=G_{xx}(x,y)*I(x,y)$$

$$L_{xy}(x,y)=G_{xy}(x,y)*I(x,y)$$

$$L_{yx}(x,y)=G_{yx}(x,y)*I(x,y)$$

$$L_{yy}(x,y)=G_{yy}(x,y)*I(x,y)$$

$$G(x,y)=\frac{1}{2\pi\sigma^2}\exp\left(-\frac{x^2+y^2}{2\sigma^2}\right)$$
,

Where σ is the parameter to determine the scale of the Gaussian function.

In order to find dark blob like structure, green channel fundus image is inserted in the Hessian operator and if they exhibit strong derivatives in the two orthogonal directions then it is considered as detected. Eigenvalues are calculated from the obtained Hessian matrix. With pre-definedeigen values, model it belongs to and resulting behaviour of the eigenvalues, the structure can be searched by proper analysing the voxel. The region of interestcan be determined by comparingeigen values λ1 &λ2 with the pre-defined threshold values. Table 1 below summarizes the relation between λiand their respective structure orientation in the image [1].

It is possible a false detection because of the fixed threshold value because eigen values of different MA may different at different part of the eye [8].

Table 1. Hessian matrix Eigen values threshold (**λ1 &λ2**) determining image structure& orientation

λ1	λ2	Structure orientation
L	L	Noise
L	L	Bright sheet-like-structure
L	L	Dark sheet-like-structure
L	H-	bright tubular structure
L	H+	dark tubular structure
H-	H-	bright blob-like structure
H+	H+	dark blob-like structure

As in our work, it is required to detect dark blob like structure therefore threshold is selected as **λ1=1 &λ2=1**.

3. PROPOSED ALGORITHM

Firstly Semi-automated DR detection is applied on the retinal image with exudates. The results of SHCS has lots of errors due to the presence of exudates, therefore this image is passed through proposed error elimination algorithm as shown in flowchart f.

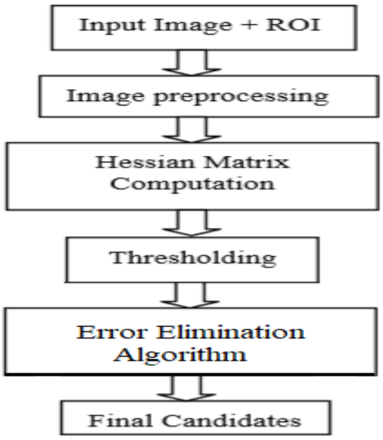


Figure 2. Flowchart of SHCS DR Detector

In our error elimination algotithm We have used the fact if all the neighbouring pixels are less than a particular threshold value T then it means they all are dark in colour as the exudate are close to red in color and then are true positive else if anyone of the neighbouring pixel is lighter in colour then it means it is a part of exudate which is wrongly detected and thus discarded by proposed algorithm.

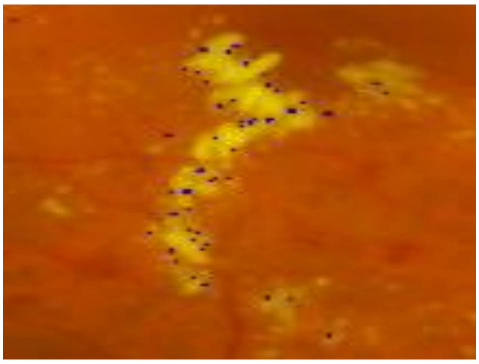
4. SIMULATION RESULT

Below are the simulation results which are simulated in MATLAB.For experimentation, images are taken from online retinopathy challenge database [10]. The performance parameter to determine the quality of work is TPR (true positive rate). TPR can be defined as a number of correct positive results obtained during the test from all the available positive samples under consideration. True positive rate can be equated as,

TPR (True positive rate) =(TP/TP+FN)*100 (5)

(a)

(b)

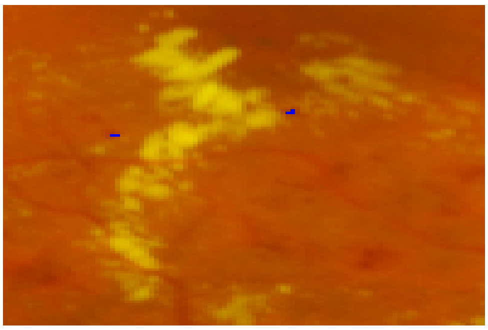


(c)

Figure 3 Previous work output (a) coloured (b) segmentation (c) zoom image

(a)

(b)



(c)

Figure 4. Proposed work output (a) coloured (b) segmentation (c) zoom image

Figure. 3 shows the results out of SHCS algorithm where (a) contains the final output with HMA & MA, (b) shows the segmentation output and (c) shows the zoom version of exudate part of the image to compare it with proposed work.

Similarly, Fig. 4 shows the results out of proposed algorithm where (a) contains the final output with HMA & MA, (b) shows the segmentation output and (c) shows the zoom version of exudate part of the image to compare it with previous work.

Table 2. Results of previous and proposed work

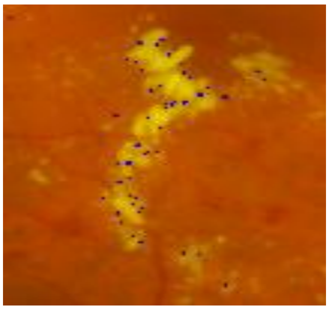
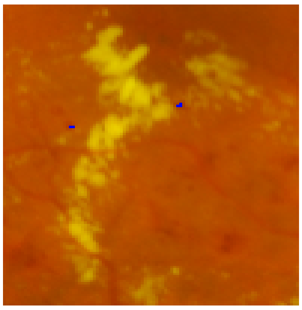
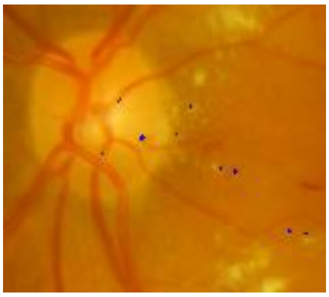
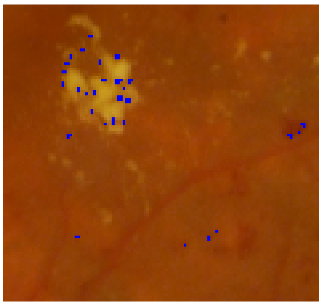
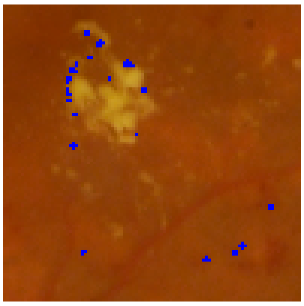
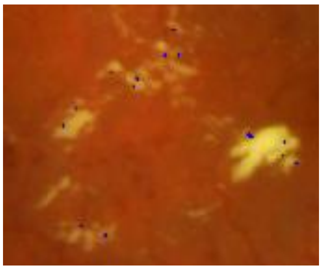
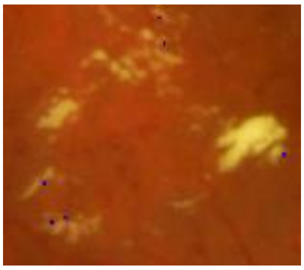
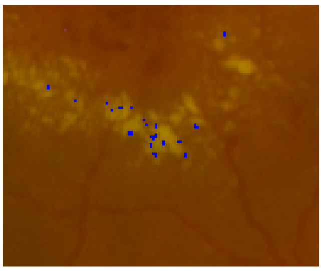
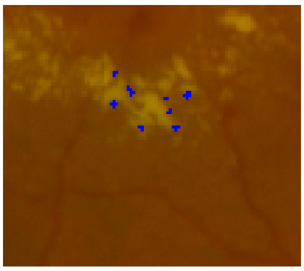
S.NO.	Previous work output	Proposed work output
1		
2		
3		
4		
5		

Table 2 shows the output images of both previous and proposed work. Images have been zoomed for comparison of the results. It can be clearly seen that proposed algorithm is successful in removing error or false detections.

5. CONCLUSION

SHCS algorithms based on analysis of eigen values of hessian matrix is popular in detection of MA, HMA and Exudates. But for the retinal image with exudates it wrongly detects MA and HMA around exudates. The proposed error elimination algorithm is effective to improve the results of the SHCS by removing false detections. TPR for retinal image with MA & HMA is calculates as 0.28 by using previous work algorithm while for proposed work it has significantly improved for the image with exudates. Due to the presence of exudates, false negative of the image increases which is successfully removed by our proposed error elimination algorithm.

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