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Novel Approach for Macula Localization Using Designed Wavelet and haar wavelet

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Abstract — *Location of macula is roughly in the center of the retina, and sequential to the optic nerve. Macula is very sensitive part of the retina which is responsible for the detailed central vision. At the center part of the macula there is fovea. Because of the macula we are able to see the detail things and we can able to perform task which require central vision like reading. Localization of Macula plays an important role to detect Diabetic retinopathy, macular oedema, glaucoma etc. For localization of macula we have used the novel approach. We have performed the steps like firstly RGB image is taken as input image, then green channel of RGB image is extracted. After green channel extraction contrast limited adaptive histogram equalization is done for image enhancement. Morphological opening and closing is applied on enhanced image. After Morphological operation thresholding is applied. Then multilevel two dimensional wavelet decomposition is done using new designed wavelet (named as DR wavelet) and haar wavelet and macula is extracted successfully. Using speed up robust feature localization of macula is done. For this work we have used three databases which are publically available that are DIARETDB0, DIARETDB1 and HRF database having 130, 89, 45 fundus images respectively.*

Keywords- *Diabetic Retinopathy, Macula, New Designed wavelet, haar wavelet, fundus image.*

I. INTRODUCTION

Location of macula is roughly in the center of the retina, and sequential to the optic nerve. Macula is very sensitive part of the retina which is responsible for the detailed central vision. At the center part of the macula there is fovea. Because of the macula we are able see the detail things and we can able to perform task which require central vision like reading, writing. [1]

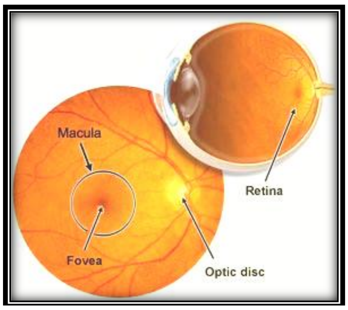

Figure 1: Macula

For localization of macula we have used the novel approach. We have performed the steps like firstly RGB image is taken as input image, then green channel of RGB image is extracted. We have use green channel because the intensity of green channel for macula is more as compare to red channel and blue channel respectively. After green channel extraction contrast limited adaptive histogram equalization is done for image enhancement. Morphological opening and closing is applied on enhanced image. After Morphological operation thresholding is applied. Then multilevel two dimensional wavelet decomposition is done using new designed wavelet (named as DR wavelet)and haar wavelet and macula is extracted successfully. Using speed up robust feature localization of macula is done.

II.RELATED WORK

Jiri Minar et al have done Automatic detection of the macula in retinal fundus images using multilevel thresholding they have utilizes the red channel of fundus image. Subsequently, the thresholded layers are preprocessed by application of median blur filter. Algorithm for ellipse detection from OpenCV library is used on all thresholding level. Then proposed technique analyzes detection and evaluates position of macula in fundus image. The precision of the method is evaluated on dataset from public fundus image library DRIVE. The results were 90% [2]

T. Ashok Kumar et. al has been proposed novel approach for detection of macula using bit plane decomposition. For the detection and subsequent extraction of macula, they first perform bit plane decomposition to the preprocessed image. The bit plane 0 and bit plane 1 are found to carry vital information of the location and boundary of macula. Then locate the exact boundary by means of mathematical morphology. The algorithm has been evaluated on a subset of MESSIDOR1 image database with various visual qualities. Robustness with respect to changes in the parameters of the algorithm has been examined [3]

.C.Marino et al have done Macula Precise Localization Using Digital Retinal Angiographies.For the macula and fovea localization, the morphological properties of the eye has been used. A candidate region for the localization of the macula is computed two optic disk diameters away from the optic disk center obtained in the previous stages. Once located this area, a search is performed through a correlation procedure, with a Gaussian kernel with the size determined by the optic disk size, since the macula is about the size of the optic disk. Obtained results show a successful percentage 99.25% in a test set of 135 digital retinal images [4].

Vaanathi Sundaresan et al. have done Integrated approach for accurate localization of optic disc and macula. The location of three main anatomical structures in the retina namely the optic disc, the vascular arch, and the macula is significant for the analysis of retinal images. They have presented novel method that uses an integrated approach to automatically localize the optic disc and the macula with very high accuracy even in the presence of confounders such as lens artifacts, glare, bright pathologies and acquisition variations such as non-uniform illumination, blur and poor contrast. Evaluated on a collective set of 579 diverse pathological images from various publicly available datasets, achieves sensitivity > 99% and normalized localization error < 5% for optic disc and macula localization [5].

III. DATABASE

For this work we have used three databases like DIARETDB0, DIARETDB1, and HRF image database.

Table 1: Database

Name of Database	**Image Dimension**	**Field of View (FOV)**	**Total Images**
HRF	3504*2336	45	45
DIARETDB0	1150*1153	50	130
DIARETDB1	1150*1153	50	89
Total	**264**		

IV. WORK FLOW

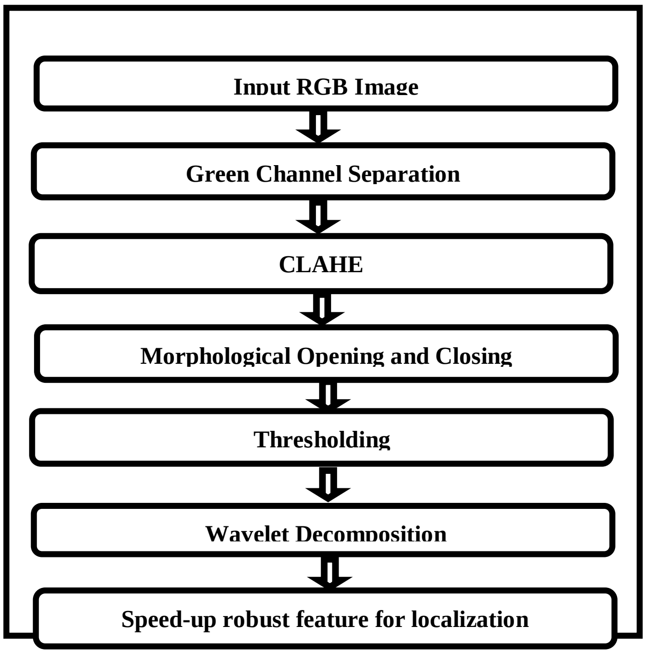

Figure 2: Work flow for localization of Macula using wavelet

V. METHODOLOGY

5.1. RGB image:

Figure 3: RGB Image

Images are uses from the databases are of RGB type. RGB images sometimes referred as a true color image [6]

5.2. Green Channel Separation:

Figure 4: Green Channel conversion

We have converted the RGB image in to red, green and blue channel .In green channel output the contrast for macula is more as compare to red channel and blue channel. The formula for green channel [7] is as follows:

$$g = \frac{G}{(R+G+B)} \dots\dots\dots\dots\dots\dots (1)$$

Where g= Green channel, R=Red, G=Green, B=Blue. R, G, B have been normalized so that they are in between [0, 1].

5.3. Contrast Limited Adaptive Histogram Equalization (CLAHE):

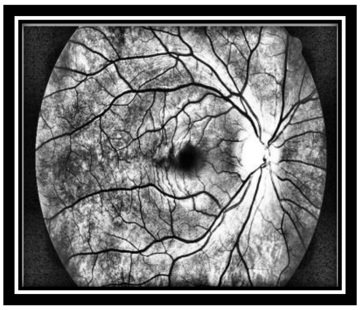

Figure 5: Image Enhancement

Contrast limited adaptive Histogram Equalization is done on the green channel image.

$$g = [g_{max} - g_{min}] * P(f) + g_{min} \quad \dots\dots\dots. (2)$$

Where g_{max} = Maximum pixel value

g_{min} = Minimum pixel value

g = computed pixel value

$P(f)$= CPD (Cumulative probability distribution)

By using this contrast limited adaptive histogram equalization function we have enhance the quality of image. The CLAHE algorithm partitions the images into contextual regions and applies the histogram equalization to each one. This evens out the distribution of used grey values and thus makes hidden features of the image more visible [8].

5.4. Morphological operations:

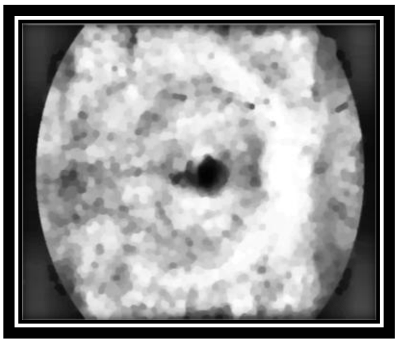

Figure 6: Morphological operation

After image enhancement using Contrast Limited Adaptive Histogram Equalization we have performed morphological operations such as morphological closing and morphological opening. We have performed both the closing and opening operation on image to remove the noise from an image. Opening operation performs the small objects removal and closing operation performs closing small holes.

Morphological opening can be described as an erosion operation followed by a dilation operation [9].

$$A \circ B = (A \ominus B) \oplus B, \qquad \dots (3)$$

Morphological closing is dilation operation followed by erosion operation [10]

$$A \bullet B = (A \oplus B) \ominus B, \qquad \dots (4)$$

Where $\ominus$ and $\oplus$ denote erosion and dilation, respectively

5.5. Thresholding:

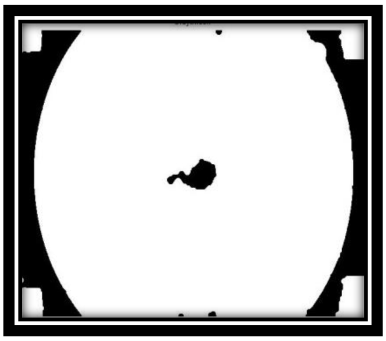

Figure 7: Thresholding

Thresholding method is applied on morphological output image. Thresholding techniques can be expressed as follows

$$T=T[x, y, p(x, y), f(x, y] \dots\dots\dots (5)$$

Where T is the threshold value. x, y are the coordinates of the threshold value point. p (x ,y) ,f(x, y) are points the gray level image pixels .Threshold image g(x,y) can be define:

$$g(x,y) = \begin{cases} 1, \text{if } f(x,y) > T \\ 0, \text{iff}(x,y) \leq T \end{cases} \dots\dots\dots (6)$$

Output using thresholding method is given in the figure 7.

5.6. Wavelet Decomposition:

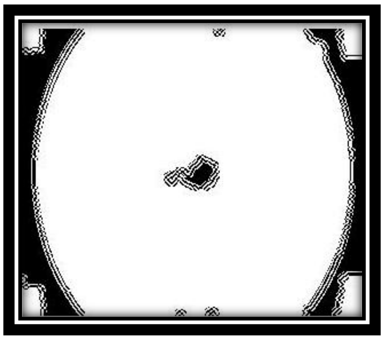

Figure 8: Wavelet Decomposition

After thresholding we have done wavelet decomposition using new designed wavelet named DR. Steps to design wavelet is as follows:

Step1: Create orthogonal wavelet of type 1
Step2: Create a filter
a=3;
sq =a*a;……(7)
DR = [(2+sq)(4+sq)(4-sq)(2-sq)]/16 ;….(8)

Step3: Add the new wavelet family to the stack of wavelet families.
Step 4: Display the two pairs of scaling and wavelet functions
Step 5: We can now use this new orthogonal wavelet to analyze a signal or image

We have applied DR wavelet decomposition on thresholded image and the result is shown in the figure 8.
We have also done wavelet decomposition using haar wavelet.

5.7. Speed up robust feature:

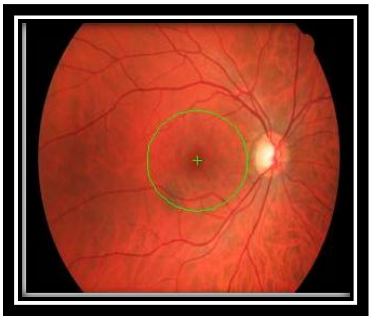

Figure 9: Localization of macula

$$I_{\Sigma}(x,y) = \sum_{i=0}^{i\leq x} \sum_{j=0}^{j\leq y} I(x,y) \dots\dots\dots(9)$$

After new wavelet decomposition we have applied speed up robust feature. With the help of speed up robust feature [7] we have localize the macula. I is the input image and a point (x; y) the integral image is calculated by the sum of the values between the point and the origin.

VI. RESULTS

In this experiment we have localize the macula. We have use the publically available databases that are DIARETDB0, DIARETDB1 and HRF database having 130, 89, 45 fundus images respectively. We have done all the work in MATLAB 2013a.For the evaluation result we have calculated the TP, TN, FP, FN value for the localization of macula, and calculated its accuracy.
True Positive (TP): There was macula and System shows macula.

True Negative (TN): There was no macula and system shows no macula.
False Positive (FP): If optic disc and lesion shows as macula.
False Negative (FN): If there was macula and system did not show macula.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad \dots\dots..(10)$$

Table 2: Result of localization of macula

Sr. No.	Database	No. of Images	Correctly Detected Macula(DR)	Accuracy	Correctly Detected Macula(Haar)	Accuracy
1	DIARETDB 0	130	119	**94%**	102	**79%**
2	DIARETDB 1	89	76	**94%**	73	**82%**
3	HRF(Healthy)	45	40	**89%**	44	**97 %**

Result of ROC is as follows

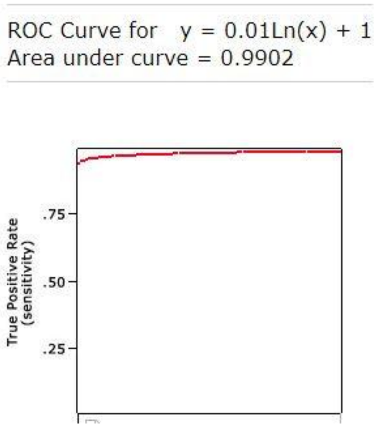

Figure 10: ROC Curve of new wavelet

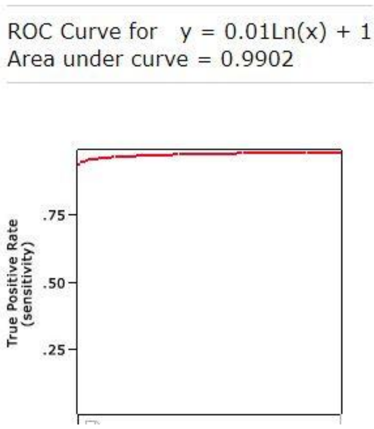

Figure 11: ROC Curve of haar wavelet

VII.CONCLUSION

In this experiment there is localization of the macula using new wavelet decomposition and haar wavelet decomposition on the DIARETDB0, DIARETDB1,HRF database having 130,89,45 fundus images respectively. We have calculated true positive, true negative, false positive, false negative values, and calculated accuracy. We have done all the work in MATLAB 2013a. We got overall 94%, 94%, 89% accuracy of the DIARETDB0, DIARETDB1, HRF databases respectively for the localization of macula using new wavelet. And 79%, 82%, 97% for the localization of macula using haar wavelet. We have got best result using new designed DR wavelet than haar wavelet. The result is shown in the table2.

VIII.ACKNOWLEDGEMENT

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[10](Morphological closing) https://en.wikipedia.org/wiki/Closing_(morphology)