Localization of Optic Disc and Macula using Multilevel 2-D Wavelet Decomposition Based on Haar Wavelet Transform

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Abstract: **Diabetic retinopathy is one type of condition in which increased blood sugar level causes swelling in the blood vessels, and it leak in retina. We can say that it is effect of diabetes on the eye. In the first stage we have to localize the optic disc and macula. There is need of localizing the optic disc because it is the origin where blood vessels are grown. Ophthalmologist use to study the area near to the optic disc, by observing these they come to know that the retinal blood vessels are normal or abnormal .Optic disc detection helps to detect macula. Macula is dark area on the retina which is near to optic disc, there are no blood vessels are present on the center of the macula .Macula is responsible for sharp vision. We have to localize the macula to study the normality and abnormality of macula. For localization we have use Multi-level 2-D wavelet decomposition. For this work we have use HRF database. For the evaluation of result we have used Receiver Operating Characteristic (ROC) curve, and we have achieved 95% accuracy for localization of optic disc and 93 % accuracy for localization of macula**

Keywords: Optic disc, macula, 2-D wavelet decomposition, ROC, HRF

1. I. INTRODUCTION

Optic disc is the bright part of the retina and Optic disc is origin were blood vessels are grown [1]. Optic disc is the raised part on the retina which is at the entry part of optic nerve. Optic Disc is yellow in color and it sends the signal towards brain [1].Macula is dark in color, and it is responsible for the central vision [2]. For localization of optic disc followed two steps in preprocessing RGB image is converted in to the green channel image, all the work is done on the green channel image because green channel shows the higher intensity as compare to the red and blue respectively. On green channel image we have apply multilevel 2D wavelet decomposition and with help of speed up robust feature localize optic disc. For localization of macula we followed the step as firstly RGB image is converted in to the green channel image then histogram equalization and after image enhancement apply multilevel 2D wavelet decomposition and with speed up robust feature macula is localized. We have localized the Optic disc and Macula by applying multilevel 2-D wavelet decomposition. The filter used for decomposition is haar wavelet. We have total 45 images of HRF database. Out off 45 images we have localized 43 optic discs and 42 Macula. We have achieved 95% accuracy for localization of optic disc and 93 % accuracy for localization of macula.

A. Database

For this work we have use High Resolution Fundus (HRF) Image database. This database is publically available. We can download it from http://www5.cs.fau.de/research/data/fundus-images/. There are totally 45 images in this database.15 images are of Healthy patients, 15 images are of glaucomatous patients, and 15 are of Diabetic retinopathy patients. The database is provided by the Pattern Recognition Lab (CS5), the Department of Ophthalmology, Friedrich-Alexander University Erlangen-Nuremberg (Germany), and the Brno University of Technology, Faculty of Electrical Engineering and Communication, Department of Biomedical Engineering, Brno (Czech Republic).

B. Work Flow for Localization Optic Disc and Macula:

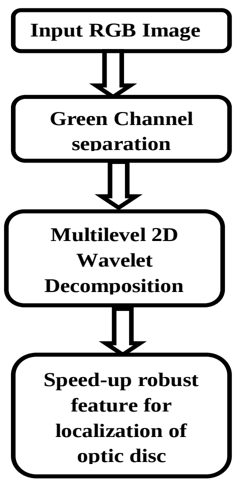

Fig.1. Work flow for Localization of optic disc using Multi-level 2D wavelet Decomposition

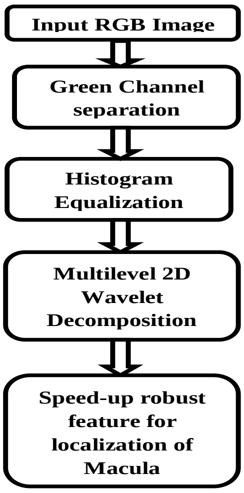

Fig.2. Work flow for localization of macula using Multi-level 2D wavelet Decomposition

C. *Methodology*

a) RGB Image

Images use from the HRF database is of RGB type. RGB images sometimes referred as a true color image [3]. In our experiments we have work on the Green channel images. We are using green channel images because the intensity of green channel image is more than the red and blue channel.

Fig.3. RGB image from HRF database

b) Green channel extraction

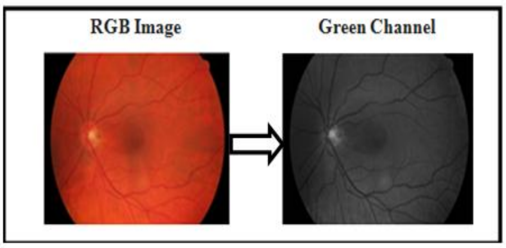

Fig.4. RGB to Green Channel Conversion

Firstly we have done the process of taking green channel from RGB image; the formula for green channel [4] [5] is as follows:

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

Where g= is a Green channel, R=Red, G=Green, B=Blue.

c) Histogram Equalization:

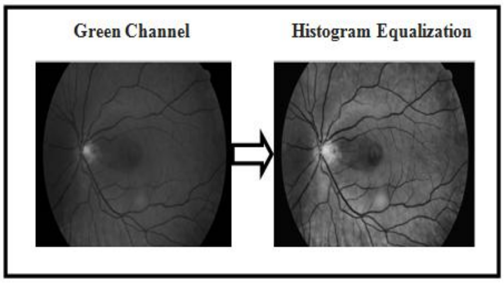

Fig.5. Histogram Equalization of Green Channel

After the Green channel we have applied histogram equalization [4] [5] for image enhancement.

$$h(v) = \text{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-1)\right) \quad (2)$$

Where, cdf_{min} is the minimum value of the cumulative distribution function, M * N gives the image's number of pixels L is the number of grey levels. With the help of this histogram equalization we can enhance the image. We are enhancing the image for Macula Detection.

d) Multilevel 2D wavelet Decomposition:

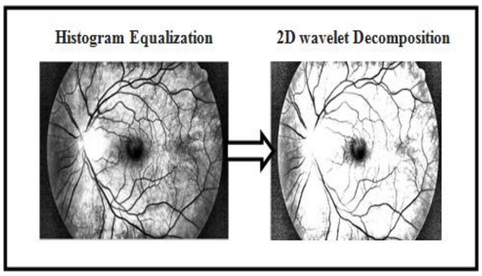

Fig.6. Multilevel 2D wavelet Decomposition

We have done multilevel two-dimension wavelet decomposition. The image is decomposing on second level. How the decomposition is done is given as follows:

ISSN: 2278-0181
Vol. 3 Issue 7, July - 2014

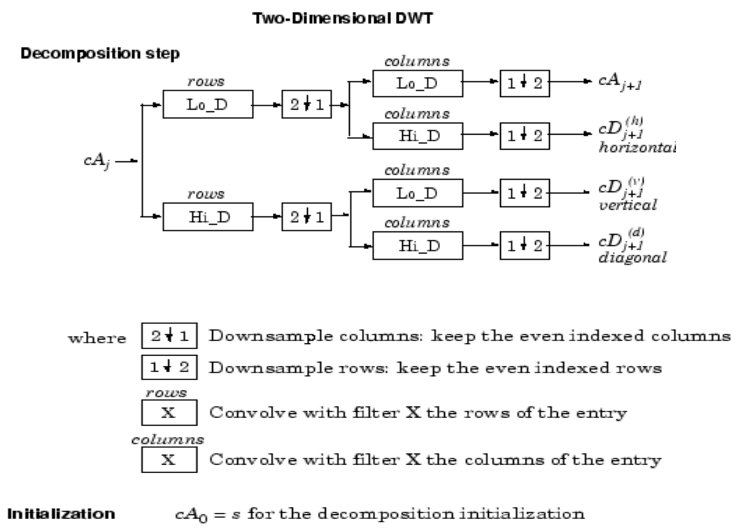

Fig.7. Decomposition steps of Two Dimensional Discrete Wavelet Transform

The filter used for the decomposition is haar wavelet; the mathematical detail is given as follows:The Haar wavelet's mother wavelet function $\psi(t)$ can be described as

$$\psi(t) = \begin{cases} 1 & 0 \le t < 1/2, \\ -1 & 1/2 \le t < 1, \\ 0 & \text{otherwise.} \end{cases} \quad (3)$$

Its scaling function $\phi(t)$ is given as

$$\phi(t) = \begin{cases} 1 & 0 \le t < 1, \\ 0 & \text{otherwise.} \end{cases} \quad (4)$$

e) Speed up robust feature

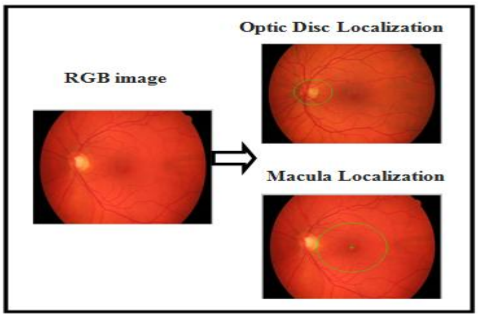

Fig. 8. Localization of optic disc and macula

After decomposition we got the enhanced image and on the enhanced image speed up robust feature is applied

$$I_{\Sigma}(x,y) = \sum_{i=0}^{i \le x} \sum_{j=0}^{j \le y} I(x,y) \quad (5)$$

On 45 images this technique is applied and localization of optic disc and macula is done.

D. Result and Discussion

In this experiment we have localize the optic disc and macula using multi-level 2D wavelet decomposition. Decomposition is done on the second level .For this work we have use HRF database. There are total 45 images in the database. We have done all the work in MATLAB 2013a.For the evaluation of result we have used Receiver Operating Characteristic (ROC) curve, Following table shows the result of the Optic disc detection

TABLE 1: LOCALIZATION OF OPTIC DISC USING MULTILEVEL 2-D WAVELET DECOMPOSITION BASED ON HAAR WAVELET TRANSFORM

Sr.no	Image Name	TP	TN	FP	FN
1	O1_h	Y			
2	02_h	Y			
3	03_h	Y			
4	04_h	Y			
5	05_h	Y			
6	06_h	Y			
7	07_h	Y			
8	08_h	Y			
9	09_h	Y			
10	10_h	Y			
11	11_h	Y			
12	12_h	Y			
13	13_h	Y			
14	14_h	Y			
15	15_h	Y			
16	01_dr	Y			
17	02_dr	Y			
18	03_dr	Y			
19	04_dr	Y			
20	05_dr	Y			
21	06_dr	Y			
22	07_dr	Y			
23	08_dr			Y	
24	09_dr	Y			
25	10_dr	Y			
26	11_dr	Y			
27	12_dr	Y			
28	13_dr	Y			
29	14_dr	Y			
30	15_dr			Y	
31	01_g	Y			
32	02_g	Y			

ISSN: 2278-0181
Vol. 3 Issue 7, July - 2014

33	03_g	Y			
34	04_g	Y			
35	05_g	Y			
36	06_g	Y			
37	07_g	Y			
38	08_g	Y			
39	09_g	Y			
40	10_g	Y			
41	11_g	Y			
42	12_g	Y			
43	13_g	Y			
44	14_g	Y			
45	15_g	Y			

The evaluation method is done by the following terms

$$Sensitivity = \frac{TP}{(TP + FN)} \quad (6)$$

$$Specificity = \frac{TN}{(TN + FP)} \quad (7)$$

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{(\text{TP} + \text{FN} + \text{TN} + \text{FP})} \quad (8)$$

Where TP=True Positive Value

TN= True Negative

FP=False Positive

FN=False Negative

Result of ROC curve is as follows

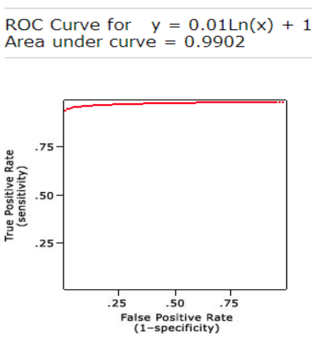

Fig.9. Roc curve for localization of optic disc using multilevel 2-d wavelet decomposition based on haar wavelet transform

Following table shows the result of the Macula detection

TABLE 2: LOCALIZATION OF MACULA USING MULTILEVEL 2-D WAVELET DECOMPOSITION BASED ON HAAR WAVELET TRANSFORM

Sr.no	**Image Name**	**TP**	**TN**	**FP**	**FN**
1	O1_h	Y			
2	02_h	Y			
3	03_h	Y			
4	04_h	Y			
5	05_h	Y			
6	06_h			Y	
7	07_h	Y			
8	08_h	Y			
9	09_h	Y			
10	10_h	Y			
11	11_h	Y			
12	12_h	Y			
13	13_h	Y			
14	14_h	Y			
15	15_h	Y			
16	01_dr	Y			
17	02_dr	Y			
18	03_dr	Y			
19	04_dr	Y			
20	05_dr	Y			
21	06_dr	Y			
22	07_dr	Y			
23	08_dr	Y			
24	09_dr	Y			
25	10_dr	Y			
26	11_dr	Y			
27	12_dr			Y	
28	13_dr			Y	
29	14_dr	Y			
30	15_dr	Y			
31	01_g	Y			
32	02_g	Y			
33	03_g	Y			
34	04_g	Y			
35	05_g	Y			
36	06_g	Y			
37	07_g	Y			
38	08_g	Y			

39	09_g	Y			
40	10_g	Y			
41	11_g	Y			
42	12_g	Y			
43	13_g	Y			
44	14_g	Y			
45	15_g	Y			

Result of ROC curve is as follows

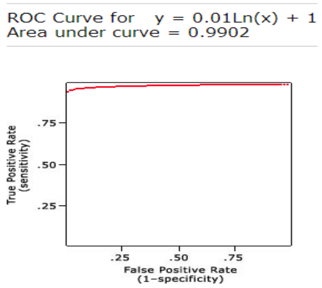

Fig.10. Roc curve for localization of Macula using multilevel 2-d wavelet decomposition based on haar wavelet transform

II. CONCLUSION

In this experiment we have localize the optic disc and macula using multilevel 2D wavelet decomposition which is based on HAAR wavelet.For localization of optic disc followed two steps in preprocessing RGB image is converted in to the green channel image, all the work is done on the green channel image because green channel shows the higher intensity as compare to the red and blue respectively. On green channel image we have apply multilevel 2D wavelet decomposition and with help of speed up robust feature localize optic disc. For localization of macula we followed the step as firstly RGB image is converted in to the green channel image then histogram equalization and after image enhancement apply multilevel 2D wavelet decomposition and with speed up robust feature macula is localized. We have got 95 % accuracy for localization of optic disc, and 93 % accuracy for localization of macula.

C. GRAPHICAL USER INTERFACE

Fig.11. GUI for Localization of optic disc and macula using multilevel 2-d wavelet decomposition based on haar wavelet transform

ACKNOWLEDGEMENT

We have used the database which is provided by the Pattern Recognition Lab (CS5), the Department of Ophthalmology, Friedrich-Alexander University Erlangen-Nuremberg (Germany), and the Brno University of Technology, Faculty of Electrical Engineering and Communication, Department of Biomedical Engineering, Brno (Czech Republic). And we are thankful to University Grant Commission (UGC) for providing us a financial support for the Major Research Project entitled “Development of Color Image Segmentation and Filtering Techniques for Early Detection of Diabetic Retinopathy” F. No.: 41 – 651/2012 (SR) also we are thankful to DST for providing us a financial support for the major research project entitled “Development of multi resolution analysis techniques for early detection of non-proliferative diabetic retinopathy without using angiography” F.No. SERB/F/2294/2013-14.

REFERENCES

[1] Yogesh M. Rajput, Ramesh R. Manza, Manjiri B. Patwari, Neha Deshpande, “Retinal Optic Disc Detection Using Speed Up Robust Features”, National Conference on Computer & Management Science [CMS-13], April 25-26, 2013, Radhai Mahavidyalaya, Auarngabad-431003(MS India).

[2] Anantha Vidya Sagar, S Balasubramanian, V.Chandrasekaran,” Automatic Detection of Anatomical Structures in Digital Fundus Retinal Images”, MVA2007 IAPR Conference on Machine Vision Applications, May 16-18, 2007, Tokyo, JAPAN

[3](Red,Green,Blue(RGB)Image) http://www.mathworks.in/help/matlab/creating_plots/image-types.html

[4] Yogesh M. Rajput, Ramesh R. Manza, Manjiri B. Patwari, Neha Deshpande, “Retinal Optic Disc Detection Using Speed Up Robust Features”, National Conference on Computer & Management Science [CMS-13], April 25-26, 2013, Radhai Mahavidyalaya, Auarngabad-431003(MS India).

[5] Amin Dehghani , Hamid Abrishami Moghaddam and Mohammad-Shahram Moin,” Optic disc localization in retinal images using histogram matching”, Dehghani et al. EURASIP Journal on Image and Video Processing 2012, 2012:19

[6] http://www.vassarstats.net/roc1.html

[7] Deepali D. Rathod, Ramesh R. Manza, Yogesh M. Rajput, Manjiri B. Patwari, ManojSaswade, NehaDeshpande,"Localization of Optic Disc using HRF database", IEEE's INTERNATIONAL CONFERENCES FOR CONVERGENCE OF TECHNOLOGY, Pune, India.

[8] Manjiri B. Patwari,Ramesh R. Manza, Yogesh M. Rajput, Deepali D. Rathod, ManojSaswade, Neha Deshpande, "Classification and Calculation of Retinal Blood vessels Parameters", IEEE's INTERNATIONAL CONFERENCES FOR CONVERGENCE OF TECHNOLOGY, Pune, India.