Segmentation vessel in Fundus with Isotropic Undecimated Wavelet Transform (IUWT) and Fuzzy Hysteresis Thresholding (FHT)

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***Abstract*— Segmentation of blood vessels in fundus can used to detect diabetic retinopathy disease by looking at the characteristic of blood vessel characteristic of thin and thick blood vessels. In this research, the combination of isotropic undecimated wavelet transform (IUWT) and fuzzy hysteresis thresholding (FHT) are used for blood vessel segmentation to segmented for thin and thick vessels . In this research Accuracy value 0.95, precision 0.88, TPR 0.62, FPR 0.008.**

Keywords—segmentation vessel, isotropic undecimated wavelet transform, fuzzy, and hysteresis thresholding.

I. INTRODUCTION

Diabetic is a disease that can be caused by heredity and unhealthy food, to know diabetic from the beginning can be seen from the structure of blood vessels in the fundus, but manual observation is very difficult because it requires precision and expertise, therefore needed a tool that can automatically detect the eye image.

This research is referenced from some previous research that is " Isotropic Undecimated Wavelet Transform Fuzzy Algoritm for Retinal Blood Vessel Segmentation", the result can't detect thin blood vessel properly, therefore in this research combining isotropic undecimated wavelet transform (IUWT) and fuzzy thresholding method for segmentation thin and think vessel well. The results of this research have resulted in good accuracy and good segmentation in visual.

From several studies on segmentation vessel [1], [2], [3], [4] it can be concluded that the effect of the segmentation process is the preprocessing process. In this research to produce a good segmentation results, first choose green channel for input process because the green channel has a high contrast value than with other channels.

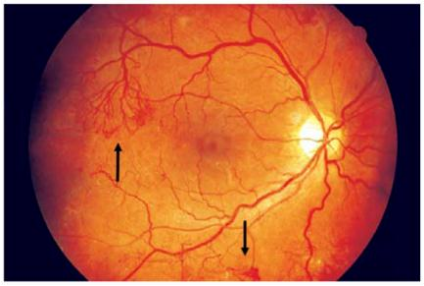
Isotropic undecimated wavelet transform (IUWT) method is used to detect the existing edges of blood vessels because IUWT is good performance for segmented the blood vessel then others [6], and than in this research combining with fuzzy hysteresis thresholding to completed the process of segmentation.

II. BACKGROUND

A. Retina

Retina is a layer of nerve cells that are useful for converting light into the eye for visual signals then sent to the brain through the visual nerve. There are several diseases that exist in the retina is a diabetic proliferative (Eye Clinic Nusantara, 2008).

Diabetic proliferative is the growth of new blood vessels because retina has a high sugar content and make retina damaged, The picture of the growth of new blood vessels can be seen in Figure 2.1.



Gambar 2 1 Figure thin vessel in vundus (https://www.google.co.id/search?q=gambar+pembuluh+darah+fundus)

The consequence of diabetic proliferative will lead to continuous contraction of the vitreous corpus, which may result in the formation of tight fibro vascular bands that attract the retina and cause continuous contraction of the vitreous corpus. This can lead to retinal detachment, the release of the retina covered by vitreous corpus bleeding. When the contraction of the vitreous corpus is complete, proliferative retinopathy tends to enter the involucional stage (Rodiah, 2007).

B. Input Data

The input data is the initial data to be processed. The input data is a fundus with size 565x584 image on the drive dataset.

C. Step for preprocessing

Retinal image can provide information about the structure of the retinal blood vessels. By observing the changest the structure of the retinal blood vessels will be able to be used for the detection of abnormalities in the retina from the beginning. However, not all retinal images can be directly processed so that abnormalities are found in the blood vessels. Some images have a low quality so it is difficult to distinguish between foreground and background 2.1

Before masking process, the first process is changed in green channel. The picture of green channel which can be seen in Figure 2.1

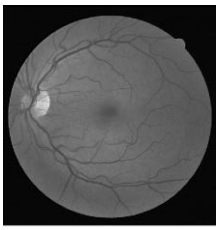


Figure 2.1 Green channel

D. Isotropic undecimated wavelet transform

After preprocessing and masking process is done, then segmantation process are IUWT and Fuzzy hysteresis thresholding:

Isotropic Undecimated Wavelet Transform (IUWT) steps in [8]:

- Each iteration to j calculate the coefficient C_j is used to calculate the lowpass filtering.
- Scaling coefficient (C_j) by calculating the average of the original signal from the image, so the information is translated in two domains, among others: spatial domain and frequency domain. The scaling process can be seen in equation (2.1).

$$c_{j+1} = c_j * h^{\uparrow j} \tag{2.1}$$

$h^{\uparrow j}$ = Filter used to calculate scaling cone with coefficient value $\frac{[1,4,6,4,1]}{16}$ of the algoritm *cubic B-spline*.

- Calculates the wavelet coefficients of the difference between scaling coefficients or the difference between 2 different sets of scaling. The equation of wavelet coefficient can be seen in (2.2) and the reconstruction in (2.3).

$$w_{j+1} = c_j - c_{j+1} \tag{2.2}$$

$$f = c_n + \sum_{j=1}^{n} wj \tag{2.3}$$

E. Fuzzy Hysteresis Thresholding

In this research combining fuzzy with hysteresis thresholding because hysteresis thresholding is a type of thresholding that is suitable for fundus dataset and to optimize the result of segmentation, the hysteresis thresholding is combined with fuzzy to segmentation thin and think vessel in fundus. The formula of fuzzy can see in [7].

III. METHODOLOGY

Isotropic undecimated wavelet transform (IUWT) and Fuzzy hysteresis thresholding in this research used to segment the blood vessels thin and thick blood vessels.

A. Research Planning

At the planning stage of this research about segmentation vessel in fundus using isotropic undecimated wavelet transform (IUWT) and fuzzy hysteresis thresholding (FHT) to produce good segmentation results that can be used to detect diabetic retinopathy disease. Flowchart can be seen in Figure 3.1

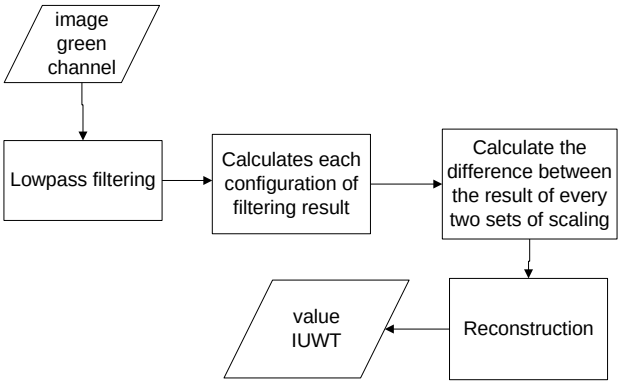
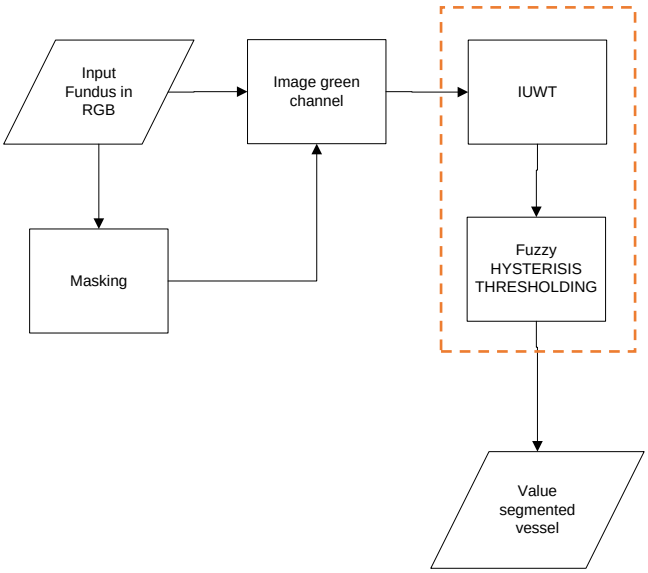


Figure 3.1 flowchart isotropic undecimated wavelet transform



Gambar 3.2 flowchart segmentation vessel in fundus

In Figure 3.2 it can be seen that before the process of segmentation, there are preprocessing step process to choose green channel, then the next step is masking. The last step segmentation are with combining Isotropic Undecimated Wavelet Transform (IUWT) and Fuzzy Hysteresis Thresholding (FHT) so that blood vessel detection can be better than previous method.

B. Result And Analysis

Vessel fundus segmentation process results can be seen in Figure 3.3, Figure 3.4, Figure 3.5, Figure 3.6, Figure 3.7.

Figure 3.3 input Fundus

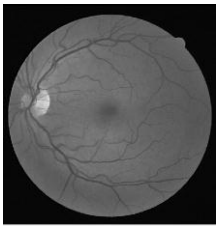


Figure 3.4 green channel

The next step is edge detection using isotropic undecimated wavelet transform (IUWT). The results of IUWT can be seen in Figure 3.5.

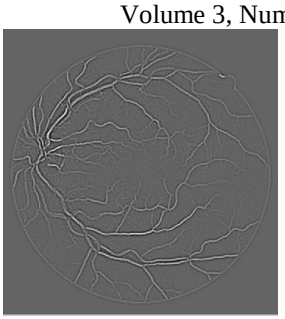


Figure 3.5 Result of Isotropic Undecimated Wavelet Transform

The next process is segmentation with fuzzy hysteresis thresholding. The result of segmentation can be seen in Figure3.6.

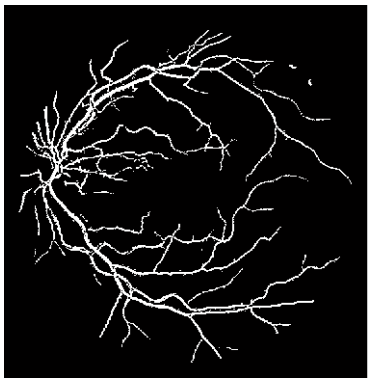


Figure 3.6 Result segmentation of fuzzy hysterisis thresholding

The method analysis in this research was compired with the IUWT method and fuzzy thresholding in Figure 3.7

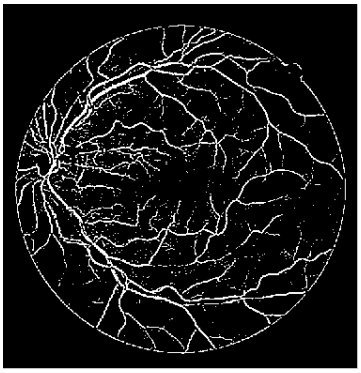


Figure 3.7 Result segmentation of FuzzyThresholding

In Figure 3.6 and 3.7 it can be seen that the IUWT method and fuzzy hysteresis thresholding (FHT) have better result compared to IUWT and fuzzy thresholding and IUWT fuzzy from [9] method because method in this research have

more better accuracy and can segmentation vessel thin and thick properly.

The segmentation can produce good result if the parameter in IUWT are changed or in the preprocessing process added method that matches the fundus character.

The drawback in this research is that the image still cannot remove the circle in image, so it can be affect the result of accurancy and segmentation in thin and thick blood vessel, the example of image that can not removed the circle properly in figure 3.8.

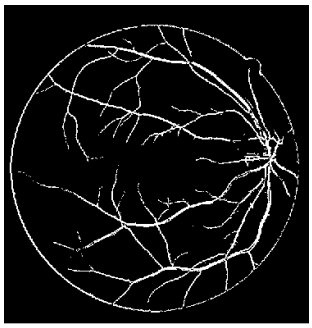


Figure 3.8 IUWT and FHT

Conclusion

In this study the method used has been able to segmentation thin and thick blood vessel on the fundus but there are several dataset that still produce a circle on the result of segmentation because there are no steps to eliminate the circle in IUWT and Fuzzy Hysteresis thresholding (FHT) method.

Acknowledgment

For further investigators the researchers should be able to improve the results of thin blood vessel segmentation by using other methods that can delete the circle in vessel, so that thin blood vessels can be segmentation well.

References

[1] BahadarKhan, K., Khaliq, A. A., & Shahid, M. (2016). A morphological hessian based approach for retinal blood vessels segmentation and denoising using region based otsu thresholding. *PLoS ONE*, *11*(7), 1–19. https://doi.org/10.1371/journal.pone.0158996

[2] Tagore, M. R. N., Kande, G. B., Rao, E. V. K., & Rao, B. P. (2013). Segmentation of retinal vasculature using phase congruency and hierarchical clustering. *Proceedings of the 2013 International Conference on Advances in Computing, Communications and Informatics, ICACCI 2013*, 361–366. https://doi.org/10.1109/ICACCI.2013.6637198

[3] Mapayi, T., Viriri, S., & Tapamo, J. (2015). Comparative Study of Retinal Vessel Segmentation Based on Global Thresholding Techniques, *2015*.

[4] Nazari, P., & Pourghassem, H. (2013). An automated vessel segmentation algorithm in retinal images using 2D Gabor wavelet. *2013 8th Iranian Conference on Machine Vision and Image Processing (MVIP)*, 145–149. https://doi.org/10.1109/IranianMVIP.2013.6779967

[5] Roychowdhury, S., Koozekanani, D. D., & Parhi, K. K. (2015). Iterative Vessel Segmentation of Fundus Images. *IEEE Transactions on Biomedical Engineering*, *62*(7), 1738–1749. https://doi.org/10.1109/TBME.2015.2403295

[6] Sabilla, W. I., Soelaiman, R., & Fatichah, C. (2015). Automatic Detection of Proliferative Diabetic Retinopathy with Hybrid Feature Extraction Based on Scale Space Analysis and Tracking, 95–96.

[7] Chia kang, Chung., June Wang, Wen., Hao Kang, Chung. (2012). Image segmentation with complicated background by using seeded region growing.Sciencedirect on AEU, 767-771.

[8] Starck, Jean-Luc., Fadili, Jalal., and Murtagh, Fionn. (2007). The Undecimated wavelet Decomposition and its reconstruction. IEEE Transaction on Image processing, Vol.16,No.2, February 2007.

[9] Jiang, Kui., Zhou, Zhixing.,Geng, Xingyun., Zhang, Xiaofeng., Tang, Lemin.,Wu,Huiqun.,&Dong,Jiancheng. Isotropic Undecimated Wavelet Transform Fuzzy algoritm for retinal Blood Vessel Segmentation. Journal of Medical Imaging and Healt Informatics, Vol.5, 1524-1527, 2015.