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Comparison Between Median Filter and Wiener Filter to Get High Accuracy for Blood Vessel Image Extraction

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ABSTRACT

With today's advancing technology, support of developing hardware and software systems, the developments in the field of medicine have increased considerably. In particular, medical image analysis and processing systems have taken a considerable lead. The development of an automatic system could provide great convenience for doctors and practitioners in the field. The image processing techniques proposed in this study can contribute to more effective analysis and more accurate diagnosis, regardless of the individual levels of experience of the users or particular situations and conditions such as fatigue or image quality. This paper presents a robust method for retinal blood vessel segmentation and some automatic algorithms for analyzing the vessel network and pixel classification into vessel and non-vessel .The aim of the work extraction or segmentation of retinal blood vessels used computer vision and image processing for getting high accuracy (comparison with manual) .Also We used the preprocessing techniques for enhancement of the image .And used two types of filter for comparing result to get best scenario. Also for simulation result we used the matlab and implement on DRIVE database.

1 Introduction

Fluorescein angiography (Wright, Young, Read, & Chang, 2018) is an early method for taking photographs of the fundus, or back of the eye, required the injection of fluorescein into blood stream to enhance the contrast of retinal blood vessels. However, with regarding advances in information and communication technology during last decade, digital fundus photography of retina has been developed. Fundus imaging is the process of obtaining the projection of the 3-D semitransparent retinal tissue onto the imaging plane as a 2-D representation using the reflected light and the image intensities to represent the amount of a reflected quantity of light. There are several reasons why digital fundus images have been widely used in many projects. Firstly, the publicity available databases have used fundus photographs of patients. Secondly this kind of photography is very useful for population-based and diagnose various type of systemic diseases such as diabetics, arteriosclerosis, and hypertension. Lastly and the most important advantage of corresponding images is possibility of precise measurement and monitoring of width and tortuosity of retinal blood vessels. The retina is a capillary semi-transparent and slightly pink-red color that covers the inside of the eyeball. The retina is a layer of the eye at the back of the eye that contains light-sensitive cells and nerve fibers that carry visual information to the brain and perform visual function.

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The retina is basically made up of two main layers, the inner sensory layer (neurosensory) and the outer pigment layer. The inner sensory layer is composed of 10 separate cellular layers. The point where the picture falls is in the 9th floor. The diameter of this spot is about 1 mm. In addition, the retina, called the reticular layer, completely covers the inner posterior wall of the eyeball and is made up of millions of visual cells and neurons to which they are attached. The extensions of these nerve cells come together to form the visual nerve. The veins feeding these cells are also located in the retina layer as shown in (figure1).

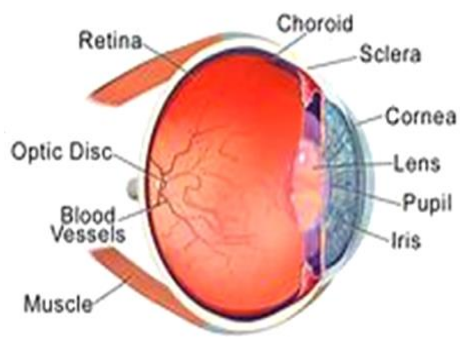


Figure 1. Anatomy of the Eye (Dolz-Marco et al., 2017)

Manual segmentation of the retinal blood vessels is arduous and time-consuming, and making a detailed segmentation can be challenging if the complexity of the vascular network is too high. Thus, segmentation extraction of blood vessel images is valuable, as it decreases the time and effort required, and in the best-case scenario, an automated algorithm can provide as good or better segmentation results as an expert by manual labeling. Automated blood vessel segmentation has faced challenges related to low contrast in images, wide range of vessel widths and variety of different structures in retinal images such as retinal image boundaries, optic disc and retinal lesions caused by diseases.

1.1 Related work

(Nguyen, Bhuiyan, Park, & Ramamohanarao, 2013) proposed a method of blood vessel segmentation using multi-scale line detection. The proposed method is based on changing the length of the line detector, and as a result of this process, multiple line detectors with different measurement values are collected. In order to maintain the efficiency of this method and eliminate the shortcomings of each individual line detector, the final segmentation of each retinal image is performed by linearly connected variable measurements. The performance of this method has been evaluated on 3 available declared databases, which are DRIVE, STARE and REVIEW. The proposed method achieves high accuracy on DRIVE and STARE databases compared to other existing methods. The precision for DRIVE is 0.9407 and for STARE it is 0.9324. These results are collected where there is a high density of vessels and difficult segmentation.

This method produces an accurate segmentation process on the central reflector vessel and it can be verified by visual inspection. On the other hand, the performance on the REVIEW database is also extremely accurate and close to the measurement provided by the experts. In addition, the proposed method has many advantages such as; rapid, primitive and stable segmentation stress to be overcome with high resolution retinal images. (Roychowdhury, Koozekanani, & Parhi, 2015) Proposes a method of segmentation of blood vessels based on the extraction of primary vessels and further classification. The proposed method presents a novel three-step vascular segmentation algorithm with the use of background images. In the first step, the green plane of the bottom image is accumulated and this image is processed before removing a directly concatenated image after high pass screening and what else is duplicated image for areas of vessels enhanced by morphological reconstruction. Key vascular regions are indicated as the intersection between the threshold version of preprocessed retinal images such as to phasic images and filtered images. Regions common to the high pass filter and the morphologically reconstructed image are ejected as primary veins.

The numbers of pixels specified are the main circuits which can increase or decrease when the pixel threshold value is changed. Furthermore all of the residual pixels from both binary images are classified with the aid of a Gaussian Mixture Model (GMM). After that A Gaussian Mixture Model classifier with 2-Gaussian is used for identifying the decent vessel pixels. This classifier uses a set of 8 features. These 8 features are extracted from neighbor pixel and first-second order gradient images. Subsequently the major parts of vessels will be combined with the classified vessel pixels. This proposed method requires short segmentation time while achieving well accuracy on retinal images. The accuracy of this proposed method is %95.2.

This method was tested on 3 avowedly available datasets, DRIVE, STARE and CHASE_DB1. This proposed method outperforms nearly most of the existing methods. Additionally required segmentation time of this method is approximately 8 seconds. The proposed method by (Marín, Aquino, Gegúndez-Arias, & Bravo, 2011) requires a time of 90 seconds to complete the process , while this proposed method by (Roychowdhury et al., 2015) needs one in ten time compared to Marin's method. (Lam, Gao, & Liew, 2010) proposes a vessel division procedure utilizing regularization and in view of multi concavity displaying. Recognizing vein in retinal pictures that has shiny and dim sores is a testing undertaking. To overcome this problem this proposed method uses multi concavity modeling. This method uses both line-shaped concavity measure and differentiable concavity measure. The task of discriminable confocality is to treat bright lesions while line confocal deal with dark lesions that have a different intensity structure from the vessels in the retinal image which have a line pattern. Since the luminous lesions are of excessive intensity, the luminous lesions can be effectively separated from the circuit and not the circuit by measuring the level of the condenser. Vascular has a line-like intensity structure while dark lesions have an unstable shape.

The line curve is shown to cut the smoldering wound while preserving the position of the veins. To manage inappropriate agitation due to different circle strength in retinal images and to normalize the quality of noise release, a separately standardized gravimetric measurement is described. These 3 condensates measurements are relevant to a specific end goal of discriminating vessels in retinal imaging. Experimental sequelae of the proposed strategy give the best performance compared to existing strategies on distorted retinas, and the accuracy of this technique beats human witnessing ability, which those other existing strategies have not been able to implement. This proposed method can even show very remarkable effects on pathological retinas. The proposed method has an accuracy of 0.9556. MATLAB software was used for this method. The execution time for this method is 13 minutes. The result of this method is that most of the light and dark lesions are removed. (Al-Rawi, Qutaishat, & Arrar, 2007) proposed an improved matched filter for detecting blood vessels from retinal images.

In this proposed method matched filter's performance is improved by committing preferable filter coefficients. These improved filter coefficients were found by optimization methodology on retinal images that taken from DRIVE database. The original matched filter mainly had 3 parameters that control its response.

The outcome of this proposed matched filter is a sustained image. The new improved matched filter shows superior performance when compared to other matched filter containing methods. Output of this improved matched filter will be a sustained image, consequently a thresholding methodology should be evaluated in order to segment blood veins. Threshold value can be estimated experimentally. While the average value of threshold is working efficiently, a mechanized method for estimating the threshold valuation with utilizing the Euler number in the images and additionally it predicts the threshold valuation with utilizing the number of components that are in connection. Briefly the output of this sustained matched filter's image will be thresholded as long as initial regional minima occur. With using this proposed method, the accuracy of %95.1 is reached. (Xu & Luo, 2010) proposed a new method for detection of blood vessels in retinal images. This proposed method uses a method known as adaptive thresholding to generate a binary image and then large connected components such as large circuits will be extracted as well as the thinnest circuits. Most thin ships are classified using Vector Support Machines. With the use of a carrier vector machine, thin circuits with poor contrast can be identified.

The advantage of this proposed method is that it does not require heavy computation and additional manual intervention. This proposed method is tested on DRIVE database and reach mean sensitivity of %77 meantime reaching mean accuracy of %93.2. The comparison of their methods with other methods is shown in (Table1). Comparison of proposed methods' Average Accuracy (AAC).

Proposed method by	AAC
Marin et al (Marín et al., 2011)	0.9489
Shah et al (Shah, Tang, Faye, & Laude, 2017)	0.9479
Badsha et al (Badsha, Reza, Tan, & Dimyati, 2013)	0.9731
Miri et al (Miri & Mahloojifar, 2011)	0.9458
Ali et al(K. Ali, Jalil, Gull, & Fiaz, 2011)	0.9600
Nguyen et al (Nguyen et al., 2013)	0.9407
Akram et al (Akram & Khan, 2013)	0.9485
Roychowdhury et al(Roychowdhury et al., 2015)	0.9515
Lam et al(Lam et al., 2010)	0.9472
Fan et al (Fan, Lu, & Rong, 2016)	0.9580
Ali et al(A. Ali, Zaki, & Hussain, 2017)	0.9425
Eladawi etal (Eladawi et al., 2017)	0.9541
Ricci et al (Ricci & Perfetti, 2007)	0.9572
Zhang et al (Zhang, Zhang, Zhang, & Karray, 2010)	0.9484
Soares et al (Soares, Leandro, Cesar, Jelinek, & Cree, 2006)	0.9466
Bhuiyan etal (Bhuiyan, Nath, Chua, & Kotagiri, 2007)	0.9961
Al-Rawi etal (Al-Rawi et al., 2007)	0.9352
Xu et al (Xu & Luo, 2010)	0.9320

Table 1. The comparison of their methods with other methods

2. Materials and Methods

2.1 Sensitivity, Specificity and Accuracy

There are several terms that are commonly used along with the description of sensitivity, specificity and accuracy) Fawcett, 2006(. TP indicates positive pixels which have correctly been labeled positive, FP indicates incorrect negative pixels which have been labeled positive, FN indicates positive pixels which have incorrectly been labeled as negative pixels and TN indicates negative pixels which have correctly been labeled as negative. If a disease is proven present in a patient, the given diagnostic test also indicates the presence of disease, the result of the diagnostic test is considered true positive (TP). If a disease is proven absent in a patient, the diagnostic test suggests the disease is absent as well, the test result is true negative (TN). Both (TP) and (TN) suggest a consistent result between the diagnostic test and the proven condition (also called standard of truth). However, no medical test is perfect. If the diagnostic test indicates the presence of disease in a patient who actually has no such disease, the test result is false positive (FP). Crossing and branching in the veneer can complicate the image model. Most medical images pose significant problems in removing blood vessels, such as signal noise, image intensity shift, and image contrast mishandling.

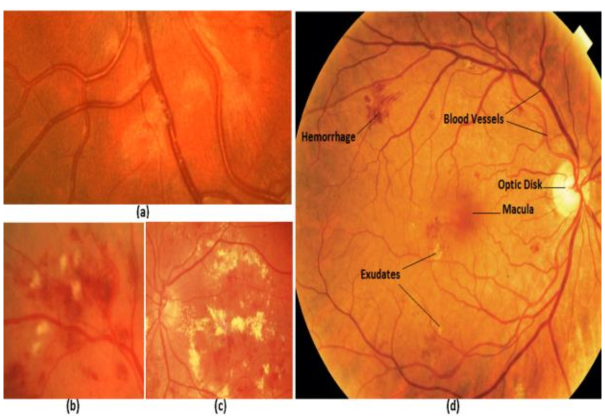


Figure 2. Morphology of retinal images: a) Central Vascular Reflex and Background Irregularity b) Cotton Wool Spots, c) Stiff Axes, d) Retinas an Atomic Structures.

However, no medical test is perfect. If the diagnostic test indicates the presence of disease in a patient who actually has no such disease, the test result is false positive (FP) (Rahebi & Hardalaç, 2014).

The sensitivity (TPR), specificity (TNR) and accuracy (ACC) are shown as equation (1), (2) and (3) respectively ()Fraz et al., 2012().

*Sensitivity (TPR) = TP / (TP + FN) (1)

*Specificity (TNR) = TN / (TN + FP) (2)

*Accuracy (ACC) = (TP + TN)/(TP + FN + TN +FP) (3)

2.2 DRIVE Database

The DRIVE (Digital Retinal Images for Vessel Extraction) is a publicly available database. The photographs for the DRIVE database were obtained from a diabetic retinopathy screening program in The Netherlands. The screening population consisted of 400 diabetic subjects between 25-90 years of age (Staal, Abràmoff, Niemeijer, Viergever, & Van Ginneken, 2004).(Figure 3) shows retina images from the DRIVE database

(a)

(b)

(c)

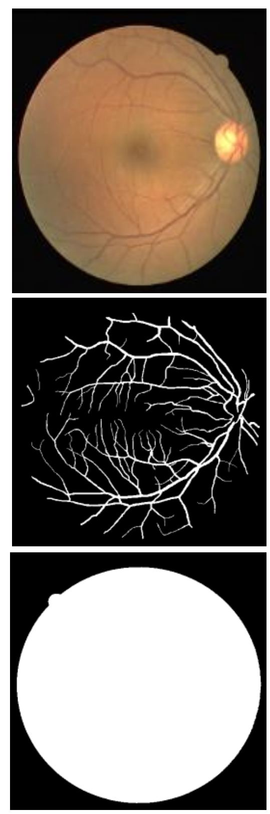


Figure 3. Retinal fundus image 02 from test set of the DRIVE database. a) Original RGB image b) Manual segmentation of blood vessels known as a ground

2.3 Proposed Method

The summary of method is shown in (figure 4).

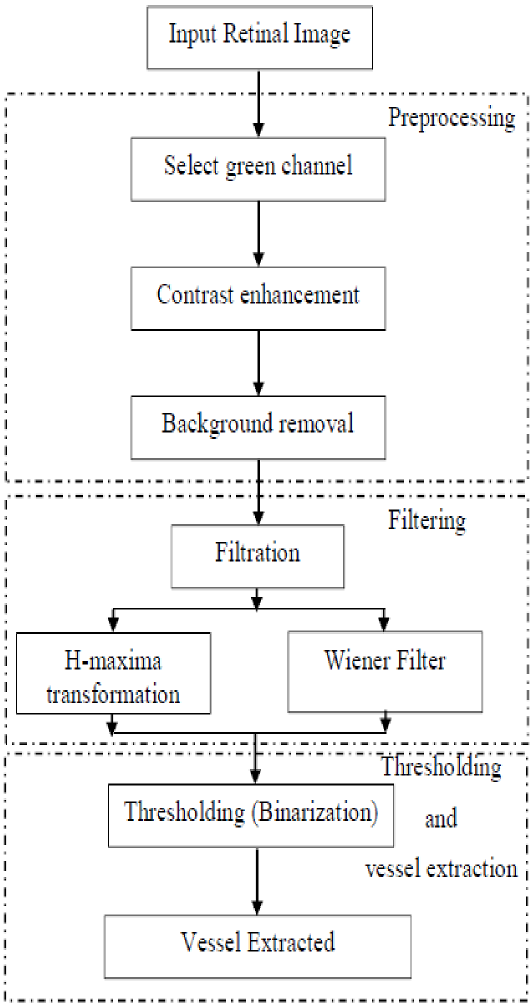


Figure 4. The summary of method

The steps of this flow chart are as following steps:

a. Input retina image from DRIVE database

b. Preprocessing:

- **Select green channel** an image from a standard digital camera will have a red, green and blue channel.
- **Contrast enhancement** for enhancement we used the Morphological structuring element.
- **Background removal** the light reflex of the retinal vessel is formed by the reflection from the interface between the blood column and vessel wall. For getting the foreground the median filter.

c. Filtration

Filters are commonly used to extract a desired signal from a background of random noise or deterministic interference. An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions so we used two types of filters for do comparing:

- **Median filtering with size 3*3**
  The median filter is a non-linear digital filtering technique, often used to remove noise from an image .The image obtained from top-hat transformation stage is further filtered using median filter to decrease the noise present.

- **Wiener filtering with size 3*3**
  The Wiener filter is a filter used to produce an estimate of a desired or target random process by linear time-invariant (LTI) filtering of an observed noisy process. Wiener filters are developed using time-domain concepts. They are designed to minimize the mean-square error between their output and a desired or required output.

d. Thresholding and vessel extraction

- Thresholding replace each pixel in an image.
- If Pixel values that are less than or equal to the threshold background.
- If Pixel values greater than the threshold foreground (vessels).
-

For getting high performance the vessel the binarization method is used.

The simplest way to use image binarization is to choose a threshold value, and classify all pixels with values above.

3. Results

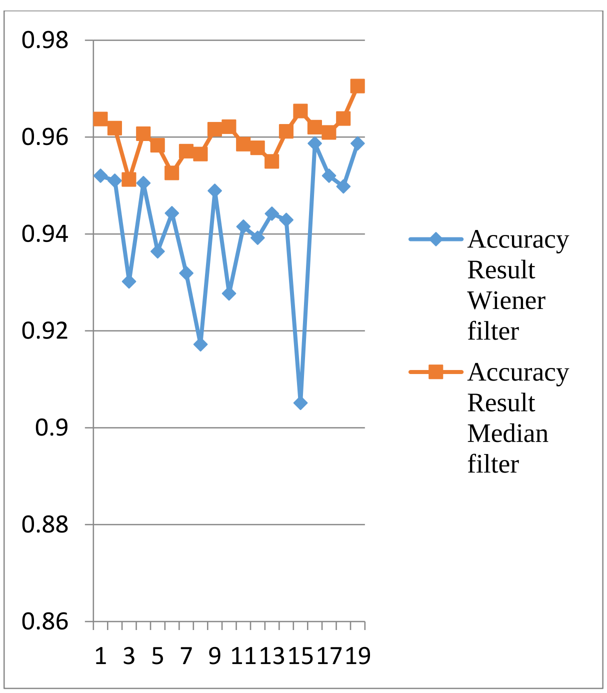
This paper used 20 images from a ready-made DRIVE database to make the comparison process to get a better scenario when using two types of filters, where we found the best accuracy for the process of segmentation when using the median filter

The result for DRIVE database is shown in (table 2).

Image number	Accuracy Result Wiener filter	Accuracy Result Median filter
1	0.9520	0.963711
2	0.9510	0.961823
3	0.9302	0.951209
4	0.9505	0.960659
5	0.9364	0.958283
6	0.9443	0.95257
7	0.9319	0.957068
8	0.9172	0.95648
9	0.9489	0.961604
10	0.9277	0.962123
11	0.9415	0.958528
12	0.9392	0.957755
13	0.9442	0.954958
14	0.9429	0.96115
15	0.9051	0.96535
16	0.9587	0.962023
17	0.9520	0.960944
18	0.9498	0.963823
19	0.9587	0.970506
20	0.9391	0.963753

Table 2. Result for DRIVE database

The comparison between accuracy result wiener filter and median filter is shown in (figure 5).



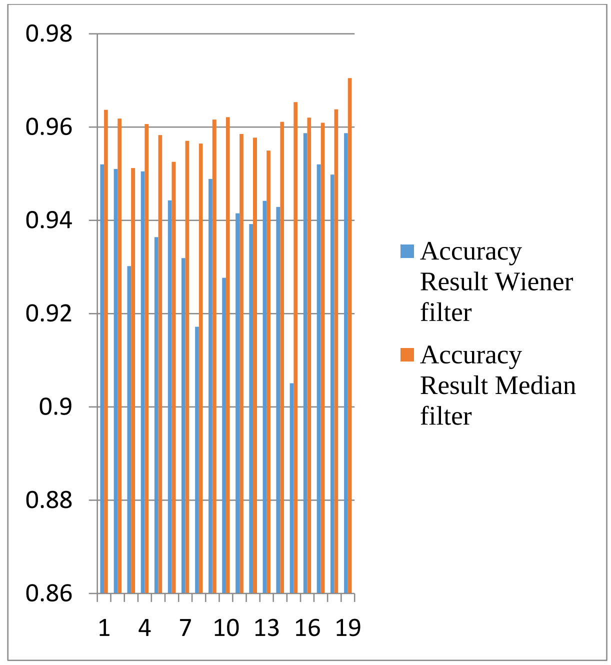


Figure 5. The comparison resulting between Wiener filter and Median filter

4. Discussion

This paper experimented on the database used and the differences were clear between the filters is shown in (figure 6):

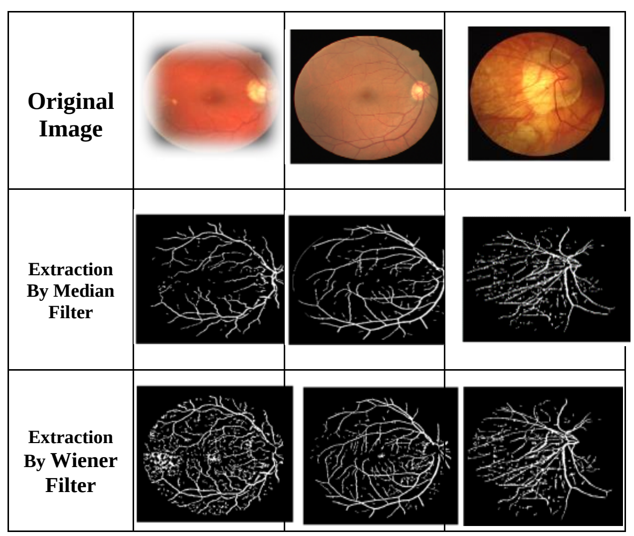


Figure 6. The result image of proposed method.

5. Conclusion

Extraction of blood vessels on retinal imaging will be of great benefit in the near future. These automated detection systems can reduce the workload for ophthalmologists. With the early detection system, patients can get real treatment at the right time. The preprocessing step must be processed to obtain a very precise value. During the preprocessing step, the contrast of the selected mesh image is enhanced to obtain a sharp image and remove an unwanted small object from the image. In addition, some of the grid images are noisy, indicating that this phase noise rejection problem is being solved. Pre-processing has been applied to the photos. We then corrected the changes in brightness in the grid image by applying the point processing described. As evidenced by simulation results, the results are better when using median filter to extract circuits.

Conflict of interest: The authors declare that there are no conflicts of interest.

References

Akram, M. U., & Khan, S. A. (2013). Multilayered thresholding-based blood vessel segmentation for screening of diabetic retinopathy. Engineering with computers, 29(2), 165-173.

Al-Rawi, M., Qutaishat, M., & Arrar, M. (2007). An improved matched filter for blood vessel detection of digital retinal images. Computers in biology and medicine, 37(2), 262-267.

Ali, A., Zaki, W. M. D. W., & Hussain, A. (2017). Blood vessel segmentation from color retinal images using K-means clustering and 2D gabor wavelet. Paper presented at the International Conference on Applied Physics, System Science and Computers.

Ali, K., Jalil, A., Gull, M. U., & Fiaz, M. (2011). Medical image segmentation using h-minima transform and region merging technique. Paper presented at the Frontiers of Information Technology (FIT), 2011.

Badsha, S., Reza, A. W., Tan, K. G., & Dimyati, K. (2013). A new blood vessel extraction technique using edge enhancement and object classification. Journal of digital imaging, 26(6), 1107-1115.

Bhuiyan, A., Nath, B., Chua, J., & Kotagiri, R. (2007). Blood vessel segmentation from color retinal images using unsupervised texture classification. Paper presented at the Image Processing, 2007. ICIP 2007. IEEE International Conference on.

Eladawi, N., Elmogy, M., Helmy, O., Aboelfetouh, A., Riad, A., Sandhu, H., . El-Baz, A. (2017). Automatic blood vessels segmentation based on different retinal maps from OCTA scans. Computers in biology and medicine, 89, 150-161.

Fan, Z., Lu, J., & Rong, Y. (2016). Automated blood vessel segmentation of fundus images using region features of vessels. Paper presented at the Computational Intelligence (SSCI), 2016 IEEE Symposium Series on.

Fawcett, T. (2006). An introduction to ROC analysis. Pattern recognition letters, 27(8), 861-874.

Fraz, M. M., Remagnino, P., Hoppe, A., Uyyanonvara, B., Rudnicka, A. R., Owen, C. G., & Barman, S. A. (2012). Blood vessel segmentation methodologies in retinal images–a survey. Computer methods and programs in biomedicine, 108(1), 407-433.

Lam, B. S., Gao, Y., & Liew, A. W.-C. (2010). General retinal vessel segmentation using regularization-based multiconcavity modeling. IEEE Transactions on medical imaging, 29(7), 1369-1381.

Marín, D., Aquino, A., Gegúndez-Arias, M. E., & Bravo, J. M. (2011). A new supervised method for blood vessel segmentation in retinal images by using gray-level and moment invariants-based features. IEEE Transactions on medical imaging, 30(1), 146-158.

Miri, M. S., & Mahloojifar, A. (2011). Retinal image analysis using curvelet transform and multistructure elements morphology by reconstruction. IEEE Transactions on Biomedical Engineering, 58(5), 1183-1192.

Nguyen, U. T., Bhuiyan, A., Park, L. A., & Ramamohanarao, K. (2013). An effective retinal blood vessel segmentation method using multi-scale line detection. Pattern recognition, 46(3), 703-715.

Rahebi, J., & Hardalaç, F. (2014). Retinal blood vessel segmentation with neural network by using gray-level co-occurrence matrix-based features. Journal of medical systems, 38(8), 85.

Ricci, E., & Perfetti, R. (2007). Retinal blood vessel segmentation using line operators and support vector classification. IEEE Transactions on medical imaging, 26(10), 1357-1365.

Roychowdhury, S., Koozekanani, D. D., & Parhi, K. K. (2015). Blood vessel segmentation of fundus images by major vessel extraction and subimage classification. IEEE journal of biomedical and health informatics, 19(3), 1118-1128.

Shah, S. A. A., Tang, T. B., Faye, I., & Laude, A. (2017). Blood vessel segmentation in color fundus images based on regional and Hessian features. Graefe's Archive for Clinical and Experimental Ophthalmology, 1-9.

Soares, J. V., Leandro, J. J., Cesar, R. M., Jelinek, H. F., & Cree, M. J. (2006). Retinal vessel segmentation using the 2-D Gabor wavelet and supervised classification. IEEE Transactions on medical imaging, 25(9), 1214-1222.

Staal, J., Abràmoff, M. D., Niemeijer, M., Viergever, M. A., & Van Ginneken, B. (2004). Ridge-based vessel segmentation in color images of the retina. IEEE transactions on medical imaging, 23(4), 501-509.

Wright, L., Young, R., Read, S., & Chang, E. (2018). Fluorescein Angiographic Evaluation of Peripheral Retinal Vasculature after Primary Intravitreal Ranibizumab for Retinopathy of Prematurity. Retina (Philadelphia, Pa.).

Xu, L., & Luo, S. (2010). A novel method for blood vessel detection from retinal images. Biomedical engineering online, 9(1), 14.

Zhang, B., Zhang, L., Zhang, L., & Karray, F. (2010). Retinal vessel extraction by matched filter with first-order derivative of Gaussian. Computers in biology and medicine, 40(4), 438-445.

Dolz-Marco, R., Gallego-Pinazo, R., Dansingani, K. K., & Yannuzzi, L. A. (2017). The history of the choroid. In J. Chhablani & J. Ruiz-Medrano (Eds.). Choroidal Disorders, 1(5), 1-5. Academic Press. https://doi.org/0.1016/b978-0-12-805313-3.00001-6

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