A Simple Blood Vessel Detection on Retinal Image Using Image Processing Technique

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Abstract: Detection of blood vessel plays an important stage in different medical areas, such as ophthalmology, oncology, neurosurgery and laryngology. The significance of the vessel analysis was helped by the continuous overview in clinical studies of new medical technologies intended for improving the visualization of vessels. In this paper, a new blood vessel detection using a simple method of image processing was proposed. The main objective is to propose new method in order to detect the blood vessel on the degraded retinal input image (DRIVE dataset). A few Image Quality Assessment (IQA) such as sensitivity, specificity and accuracy was obtained to prove the effectiveness of detection methods.

Keywords: Blood Vessel, Detection, Extraction

1. Introduction

Blood vessel detection are commonly used in many field especially medical field. But recognition of blood vessels is a main troublesome in the automatic processing of retinal image In order to make work smoother and help patient in detecting their problems [1,2]. The detection of blood vessel using retinal really helping to detect some disease such as diabetic and glaucoma. The recognition of blood vessels is a main troublesome in the automatic processing of retinal image. The diagnosis of cardiovascular and ophthalmological illnesses such as diabetic retinopathy and glaucoma is considered to be critical [3]. Diabetic retinopathy is a complication of diabetes which affects the eyes [4,5]. The figures for this condition improve the health of the population and are also the cause of sight loss. Manual analyses are conducted periodically by reviewing a patient's photographs, as not all images show signs of diabetic retinopathy. Accurate retinal blood vessel identification is therefore essential.

In 2015, Dalwinder et al. [6] present about the blindness among diabetic patients which is because of the diabetic retinopathy disease because of the small vessel to retina having a leakage of blood. They proposed a new vessel of blood detection which is morphologically based to eliminate the background and enhance the blood vessel with phase preserving noise removal algorithm. STARE and DRIVE dataset have been evaluated because it provides ground truth precisely marked by an expert. In contrast, Kim et al. [7] suggest a method to comprise several basic image processing techniques for retinal blood vessel named as edge to be extracted.
The processing techniques is the object classification, noise removal, thresholding and an enhancement by a standard template. They also present a computational method to extract the blood vessel in retinal with simply and automatically. They collect the set of retinal images from the DRIVE database and analyze it with an advance performance to find the accuracy. The automatic morphological method used angiogram to extract a vascular tree was studied by Shaofeng et al. [8]. In this paper, they share all of the process in obtaining the vessel like vessel centerline. First is the vessels must be connected in a local linear pattern and decompose the vessel extraction problem in a few different patterns. Then, the background must be subtracted from the original angiogram to implement the contrast enhancement and background suppression. The multiscale morphology must be used to estimate the background. The algorithm simplified with a combination of the fuzzy morphological opening operation. To fit the vessel pattern, a linear rotating structuring element must be done. To produce an approximate vessel region, this filtering process was set to a threshold. Finally, to obtain an approximate vessel centerline, thinned vessel region as a marker for vessel structure, watershed techniques must be used.

Figure 1: Example of blood vessel detection on retinal image

In 2018, Mustafa et al. [9] published a paper in which they described a new way to automate the segmentation of blood vessels in the retinal image. They proposed a method based on a hybrid combination between Gray-Level and Moment Invariant Technique. Furthermore, the proposed method of effectiveness have been calculated using The Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR). The proposed method has a very high PSNR and very low MSE show that the improvable of image quality. Other than that, the method can be used to help the ophthalmologist especially in sense any crack or damage in the retinal image [10]. Next, their team found that a combination method of Kirsch’s templates and Fuzzy C-Means (FCM) for a new blood vessel detection more effective. This study is to improve the result of detection between those two methods in an effective way. They use images from (DRIVE) dataset and the result are been following the benchmark and compare with it [11]. According to an investigation by Mustafa et al. [12], a new approach by normalizing the background based on the two combinations of low pass and Gaussian filtering to correct the illumination was studied. As the luminosity and contrast variation is the reflection of light by the retinal surface, a new approach needs to be done. The data of non-uniform retinal images were obtained from (DRIVE) database. The last process is when the binarization image need to be found, the Otsu thresholding need to be applied. Lastly, Mustafa et al. [13] presented a comprehensive review of a few blood vessel detection. The aim is to find the best method of detecting blood vessels in the input image data set (DRIVE), and to prove the efficacy of each measurement method with a few image quality assessments (IQA) [13]. The vessel hold particular attributes such as diameter which may be the key displays in the development of particular disease. The appearance of the retinal blood vessels is a significant diagnostic indicator of numerous clinical disorders of the body and the eye. It raises the time and tips for improper judgement on the diagnosis of the disease. Automatic segmentation of the vasculature may save eye surgeons workload plus could help to represent the injuries discovered.

2. Methodology

The new approach began with the image acquired from the online DRIVE database. The original image was read by the ‘uigetfile’ option in MATLAB. As the true image read, to classify color features, using complement to remove noise and can reverse black and white, complement intensity image and complement of a color image. How many texture areas in the image segmented was inferred by the only prior knowledge.
Furthermore, the image processed visualized using ‘label2rgb’ segmentation, bwareaopen, contrast adjustment, brightness adjustment, imfilter and threshold level to produce the ‘segmented image’. The result is to transform the images to a grayscale image and then apply the threshold to the binary colour frame. The 'bwareaopen' was then added to delete objects with less pixels. To fill the hole in the vessel, this function was added. Figure 2 presents the process flow of the proposed method.

![Figure 2: Blood vessel detection flow diagram](image)

Figure 2 shows the system process flow started with the blood vessel images database collected from the DRIVE database in order to acquire the process of image processing. Then, the acquired images will be through the process of image pre-processing process. The adaptive of the filter was applicable to remove the remaining noise when enhancing edge sharpness. So, the pre-processing tends to refer to all conversions on raw information once it is fed into the natural language processing method. Furthermore, the overall filter used in this proposed method are Median Filter in order to reduce noise in the image. In addition, the Morphological operation consists of dilation and erosion also take place in order to add and remove pixels on the object boundaries.

2.1 The Performance of Image Analysis

The performance of the system was evaluated compared to the benchmark by observing the specificity, sensitivity and accuracy of the segmented image. This entire analysis investigates the correctness of the segmented images [14, 15]. As in code, the confusion matrix observed to assign the Specificity, Accuracy and Sensitivity by using TP (True Positive), TN (True Negative), FP (False Positive), and FN (False Negative). The terms referred as below:

a) True Positive (TP): Pixels correct segmented as foreground.
b) True Negative (TN): Pixels false segmented as foreground.
c) False Positive (FP): Pixels correct segmented as background.
d) False Negative (FN): Pixels false segmented as background.

The Specificity related to the classifier’s ability to identify negative results which also known as ‘True Negative’ or negative predictive value. The higher the percentage of specificity, the higher the pixels correct segmented as background (black) of the image. The equation as below:

\[
Specificity = \frac{TN}{TN + FP}
\]
Accuracy is the simplest score metric, which calculates the total proportion of True Positive and True Negative cases which are counted correctly as truthful and complete. The higher the accuracy, the greater the “truth” of the process. The equation below:

\[
\text{Accuracy} = \frac{(TP + TN)}{(TP + TN + FP + FN)}
\]

Sensitivity is a proportion of real positive values that are defined correctly as "true positive" or as a positive predictive attribute. The higher percentage of sensitivity in this test indicates the right pixels of the image's front/white object. The following is the equation:

\[
\text{Sensitivity} = \frac{TP}{TP + FN}
\]

3. Results

The variations between the segmented image and the benchmark image of the 20 retinas have been addressed in this section. In this analysis the difference of the approach built for the reference image is to be discussed in order to decide if the segmented image is likely to be used for the reference image. It showed that the approach and benchmark image proposed are nearly the same, while noise could not be removed in general. An overview of the data in the tables was organised after the output images were displayed. For overall getting data, most of the result for the segmentation image is better than the benchmark image. The resulting performance of proposed method are illustrated in Figure 3.

![Figure 3: The result image of proposed method.](image)

Therefore, the image looks much clearer and less noise compare to the benchmark image. Moreover, as 'bwareopen' and 'imfill' have removed the noise in the frame. The image that has been segmented are actually has been filtered using a filter and a few types of function in order to give the best look other than the benchmark image. However, some noise in the database like a small vessel cannot be eliminated all, this is because the appearance of the vessel look likes the bigger vessel. But still, the segmented image can be considered qualified and clear to show the appearance of blood vessel.

The result of the proposed method then compared with the benchmark images in order to find the Specificity, Accuracy and sensitivity. Nevertheless, those same performances of analysis are evaluated.
utilizing the Specificity, Accuracy and Sensitivity. So that, the collected data from result analysis will be analyzed and study in order to get the system accuracy.

Table 1: The comparison resulting between proposed method and benchmark images.

| Cell Number | Specificity | Accuracy | Sensitivity |
|-------------|-------------|----------|-------------|
| 1           | 50.456      | 91.159   | 98.971      |
| 2           | 58.797      | 91.429   | 94.850      |
| 3           | 59.297      | 91.385   | 93.904      |
| 4           | 51.275      | 92.216   | 96.364      |
| 5           | 65.337      | 91.420   | 94.117      |
| 6           | 47.005      | 91.282   | 96.056      |
| 7           | 51.260      | 92.127   | 96.237      |
| 8           | 70.238      | 88.858   | 90.611      |
| 9           | 61.273      | 91.927   | 94.630      |
| 10          | 61.983      | 91.592   | 94.247      |
| 11          | 56.017      | 91.821   | 95.341      |
| 12          | 67.048      | 91.079   | 93.350      |
| 13          | 51.651      | 91.242   | 95.532      |
| 14          | 53.728      | 92.627   | 96.049      |
| 15          | 73.528      | 91.139   | 92.496      |
| 16          | 48.239      | 91.542   | 95.840      |
| 17          | 22.562      | 91.924   | 98.318      |
| 18          | 51.782      | 92.257   | 95.740      |
| 19          | 62.080      | 91.921   | 94.620      |
| 20          | 76.901      | 90.101   | 91.149      |

In table 1, the data analysis collected based on twenty cell images database. The data collection analyzed between the images segmented by the proposed method with the benchmark images. Based on the result analysis above, the best value of sensitivity is 98.971% on image number one. The higher value of accuracy is 92.627% at image number 14 and the higher value of specificity is 76.901% at image number 20. However the specificity of the image is up and down follow by the accuracy and sensitivity. It is because, the image are different due to brightness, contrast and also having different noise that cannot be eliminate all.

4. Conclusions

In conclusion, a blood vessel recognition is a big problem in the processing of retinal image. In this paper, a simple method for blood vessel detection of retinal image has been proposed. To be expected that, as the image of retina processed in the MATLAB software, the blood vessel will be detected whether it is affected or not in following the process to achieve the efficiency of Image Quality Assessment. As analysis, the image quality assessment such as specificity, sensitivity and accuracy was calculated. Last but not least, blood vessel detection of Retinal Image can be seen important in the future because it really helps in many ways in clinical studies to improve the visualization of vessels. Thus the comparison of the purpose, method to the DRIVE dataset has been done successfully. The foregoing discussion implies that this study can actually benefit researchers in such a region to see all the issues and state-of-the-art methods and have a good beginning to get off the field to solve it. The method blood vessel detection of retinal image should be promoted and should be exposed to help the hospitalization process in identifying the problems with the blood vessel that lead to a certain disease. It is important to point out that, the health centre and the hospital may show an important role
in needing to improve the existing method to help in earlier diagnosis to save many people’s lives.

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