Retinal blood vessels extraction using 2D median filter

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Abstract

The changes in retinal blood vessels Structure and progression of diseases such as diabetes, hypertension and retinopathy of prematurity (ROP) has been the subject of several large scale clinical studies. This paper represents the fresh algorithm for the detection and measurement of blood vessels of the retina, which is general enough that it can be applied to high resolution fundus photographs. Firstly, we performed pre processing operations on fundus images, then we have describe the simple vessel segmentation technique, formulated in the language of 2D Median Filter that is used for retinal vessel detection, for performing this function we have used database from Dr. Saswade, this segmentation achieves a true positive rate of 100%, false positive rate of 0%, and accuracy score of 1. In this algorithm, the classification is done through the diameter of the retinal vessels, like 25 mm is the standard value for the normal blood vessel, if below the range of 25 mm, the new blood vessels are nourishing the retina and if above range of 25 mm, the blood vessels get swell or rupture.

Keywords: Blood Vessels, 2D Median Filter.

1. Introduction

Variations in blood vessel diameters occur as part of the autonomous control of blood flow in healthy subjects and at different stages in the pulse cycle [1]. In this algorithm we have use the Image Processing techniques for extraction of retinal blood vessels. Firstly we have performed the preprocessing operation on high resolution fundus images, then 2D median filter for blood vessel extraction, for classification of extracted blood vessels we have calculated the diameter of the retinal vessels. For observing the result we have taken the database form the Dr. Saswade, in this database total 28 images, fourteen are high resolution fundus images and another fourteen are fluorescein angiograms. We have experimented on the high resolution fundus image.

2. Method

In this algorithm for enhancement of retinal blood vessels we have used some Image Processing techniques. We have taken Green channel from rgb image because Green channel has high intensity as compared to Red and Blue.

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

Here g is a Green channel and R, G and B are Red, Green and Blue respectively.

Then we have use the complement function for enhancing the blood vessels of the retina.

$$A^c = \{\omega \mid \omega \notin A\} \qquad (2)$$

Here A^c is a complement, ω is the element of A, ∉ stands for not an element of A and A is set.

Then we have use Histogram equalization function for enhancing the complementary image.

$$h(v) = \text{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L - 1)\right) \qquad (3)$$

Here cdf_{min} is the minimum value of the cumulative distribution function, M × N gives the image's number of pixels and L is the number of grey levels.

Then we have use the Morphological structuring element for highlighting the blood vessels of the retina.

$$I_{dilated}(i, j) = \max_{f(n,m)=true} I(i + n, j + m) \qquad (4)$$

$$I_{eroded}(i, j) = \min_{f(n,m)=true} I(i + n, j + m) \qquad (5)$$

Then we have use the Morphological open function for thickening the retinal blood vessels.

$$A \circ B = (A \ominus B) \oplus B \qquad (6)$$

Here $A \circ B$ is morphological opening, ⊖ is Erosion and ⊕ is Dilation.

Then we have use 2D median filter for highlighting and removing noise from the Morphological open function.

$$y[m, n] = \text{median}\{x[i, j], (i, j) \in \omega\} \qquad (7)$$

Here ω Represents a neighborhood centered around location (m, n) in the image.

Then we have use the Threshold function for extracting the retinal blood vessels.

$$T = \frac{1}{2}(m1 + m2) \qquad (8)$$

Here m1 & m2 are the Intensity Values.

At the end for calculating the diameter of the retinal blood vessels we have used one mathematical function for finding the diameter as shown below

$$d = \text{square root}\,(A/pi) \qquad (9)$$

Here d is a diameter and A is an area.

3. Result

For this algorithm we have designed one GUI in MATLAB, for result analysis we have used Receiver Operating Characteristic (ROC) curve, this algorithm achieves a true positive rate of 100%, false positive rate of 0%, and accuracy score of 1. Figure1 of GUI for retinal blood vessels extraction.

4. Figures and Tables

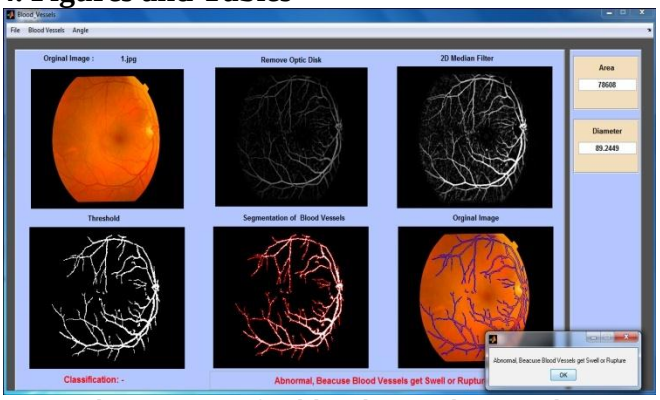

Figure 1: GUI for blood vessel extraction

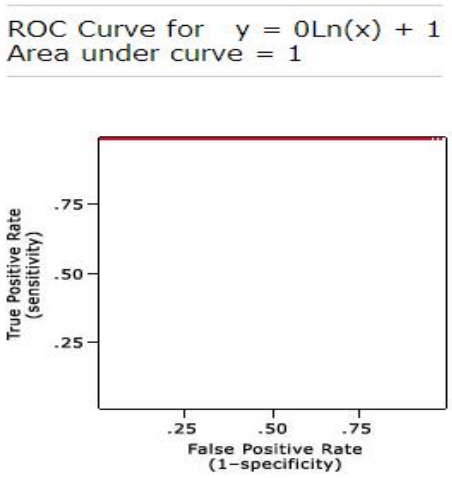

Figure 2: ROC curve for retinal blood vessels extraction

5. Discussion

For this algorithm we have used Image processing techniques like Green channel from RGB image because Green channel have high intensity as compare to Red and Blue, Complement function for highlight the Green channeled image, Histogram equalization for enhancement for the complemented image, Morphological structuring element, Morphological opening for thickening the retinal blood vessels, 2D Median filter for removing noise and extracting blood vessels of the retina, Threshold for extracting the retinal blood vessels and at the last for finding the diameter of retinal blood vessels and for manipulating this techniques we have used MATLAB 2012a and with the help of this tool we have design one GUI for retinal blood vessels.

6. Conclusion

In this algorithm we have used Image processing techniques for extracting the blood vessels of the retina, for performing these techniques we have used database from Dr. Saswade, and this algorithm achieves a true positive rate of 100%, false positive rate of 0%, and accuracy score of 1. In this algorithm we have perform only the overall area of the retinal blood vessels our future scope is to convert this algorithm for infected area of the retinal blood vessels.

7. Acknowledgments

We are thankful to University Grant Commission (UGC) for offering the Major Research Project titled as "Development of Color Image Segmentation and Filtering Techniques for Early Detection of Diabetic Retinopathy" F. No.: 41 – 651/2012 (SR) and also for providing us a financial support.

7. References

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