International Journal of Modern Trends in Engineering and Research
www.ijmter.com
e-ISSN No.:2349-9745, Date: 2-4 July, 2015

A Statistical Approach for Blood Vessel Segmentation in Retinal Images for Personal Identification

Prashantha G. R.[1], Dr Chandrasekhar M Patil[2]

[1] *SKSVMACET/Information Science, Laxmeshwar, India Email: prashanthagr.sjce@gmail.com*

[2] *VVCE/Electronics & Communication, Mysore, India Email: patilcm@vvce.ac.in*

Abstract— Biometrics are the personal physiological and behavioral characteristics which are mostly widely used for personal recognition. Today biometric based security systems such as fingerprint, iris, and face recognition are used everywhere especially in high security areas. Human retina is another source of biometric system which provides the most reliable and stable means of personal identification. In this paper we are proposing a statistical approach for blood vessel segmentation, extraction, and then they have been thinned by a morphological operation, which helps in extracting the vascular pattern and then forms a feature vector for personal identification. The experimental results show that our method is quite effective.

Keywords- Retina image, Blood vessel, Statistical approach, Morphological Operations Segmentation.

I. INTRODUCTION

A biometric system is a pattern recognition system that recognizes a person on the basis of a feature vector derived from a specific physiological or behavioral characteristic that the person possesses. The problem of resolving the identity of a person can be categorized into two fundamentally distinct types of problems with different inherent complexities: (i) verification and (ii) identification. Verification (also called authentication) refers to the problem of confirming or denying a person's claimed identity (Am I who I claim to be?). Identification (Who am I?) refers to the problem of establishing a subjects identity. The personal attributes used in a biometric identification system can be physiological, such as facial features, fingerprints, iris, retina scans, hand and finger geometry; or behavioral, the traits idiosyncratic of the individual, such as voice print, gait, signature, and key stroking. The retina is a thin layer of cells at the back of the eyeball of vertebrates. It is the part of the eye which converts light into nervous signals. It is lined with special photoreceptors which translate light into signals to the brain. The main features of a fundus retinal image were defined as the optic disc, fovea, and blood vessels. Every eye has its own totally unique pattern of blood vessels. The unique structure of the blood vessels in the retina has been used for biometric identification. The main objective of this paper is to detect blood vessel in the retina for personal identification. A simple and user friendly interface is necessary as the user might not be proficient in programming code. Hence GU is developed. The remainder of the paper is organized as follows. In section 2, a system methodology of our work is proposed. The proposed algorithm for detection of blood vessels is described in Section 3. After that, experimental simulation and result analysis is discussed in section 4, and we draw our conclusion in the last section.

II. SYSTEM METHODOLOGY

@IJMTER-2015, All rights Reserved

The fundus images are converted to either green component or grayscale for detection of blood vessel.

2.1. Image Pre-processing

Pre-processing is essential to minimize the effects of noise and contrast of these images tend to be bright at the center and diminish at the side. And also obtain a more uniform image. It suppresses the irrelevant distortions and enhances the important features for detection of blood vessel.
(i) RGB to Gray/Green conversion:
Color fundus image is first converted into a gray-scale/green-channel image in order to facilitate the blood vessels segmentation. From visual observation, blood vessels generally exhibit the greatest contrast from the background in the green band. Also red lesions have the highest contrast with the background in the green color plane. Thus information from the red and blue color planes will not be used in this step. Gray-scale image provides only the luminance information from the color image after eliminating the hue and saturation. Most of the information needed is contained in the intensity matrix.
(ii) Contrast Enhancement:
Low contrast images occur due to several reasons like poor or non-uniform lighting condition; non-linearity or small dynamic range of the imaging sensor, i.e., illumination is distributed non-uniformly within the image. Therefore, it is necessary to improve the contrast of these images to provide a better transform representation for subsequent image analysis steps. It increases the dynamic range of image. CLAHE, contrast limited adaptive histogram equalization technique is adopted to perform the contrast enhancement. This method processes small regions in the image called tiles, using histogram specification for each tile individually. Neighboring tiles are then combined using bilinear interpolation to eliminate the artificially induced boundaries. The contrast especially in homogeneous areas of intensity can be limited to avoid amplifying noise.

III. PROPOSED ALGORITHM

Accurate retinal blood vessel extraction is required as a pre-processing component of an automatic diagnosis/screening system. The proposed algorithm is designed for retinal blood vessels segmentation. Input to the system is a color fundus image of human retina acquired by a fundus camera and the output is a binary image which contains only the blood vessels. The contrast of the fundus image tends to be bright in the center and diminish at the side, hence preprocessing is essential to minimize this effect and have a more uniform image. After which, the green channel of the image is applied with morphological image processing to remove the optical disk. Image segmentation is then performed to adjust the contrast intensity and small pixels considered to be noise are removed. Another green channel image is processed with image segmentation and combined with the mask layer. These two images are compared and the differences are removed. The obtained image would represent the blood vessels of the original image. Figure 1. Has shown the architecture of the proposed algorithm for the detection of Blood Vessels.

@IJMTER-2015, All rights Reserved

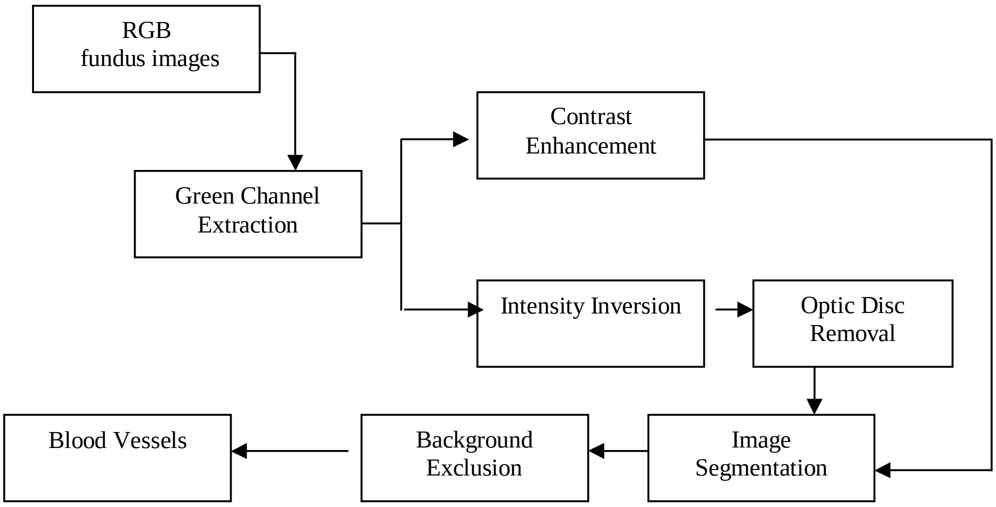


Figure 1: Block Diagram for the detection of Blood Vessel

3.1. Extraction of Blood Vessels :

In this paper, the fundus image is first preprocessed to standardize its size to 576x720. The intensity of the green channel is then inversed before adaptive histogram equalization is applied.

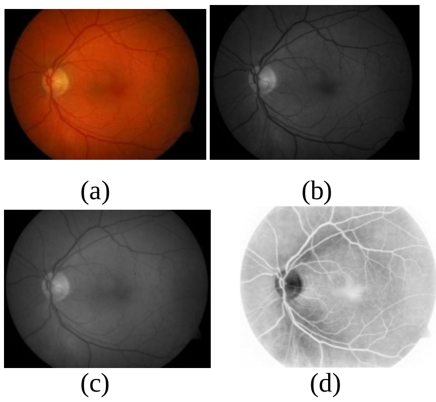
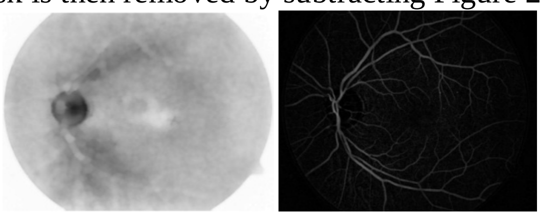


Figure 2. (a) Original fundus,(b) Green channel image, (c) Gray scale image, (d) Intensity inversed image after histogram equalization.

The optical disk is a black patch in the image as shown at Figure 2. (d). Morphological opening which consists of erode followed by dilate is applied. Erode function protects the small blood vessels by reducing their sizes while dilate function blows up the larger remaining details which are intended to be removed. The optical disk is then removed by subtracting Figure 2.(d) with Figure 3.(a)



(a) (b)

Figure 3. (a) Image after Morphological opening, (b) Image after optical disk removed

The image Figure 3.(b) is then converted to a binary image using the function "im2bw". The pixels of the input image are converted to binary 1 (white) for values greater than the selected threshold and

@IJMTER-2015, All rights Reserved

to binary 0 (black) if otherwise. The converted binary image at this point is still noisy and function "bwareaopen" is applied remove the small area of pixels considered to be noise.

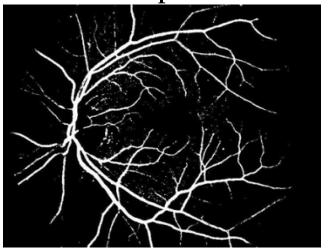
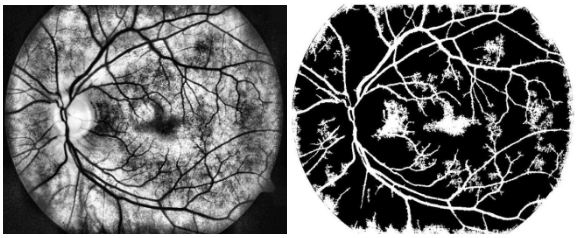


Figure 4. Binary image after Image segmentation

The green component image Figure 2.(b) is also applied with adaptive histogram equalization and image segmentation to select the blood vessels area. Small pixels which are considered as noise are also removed.

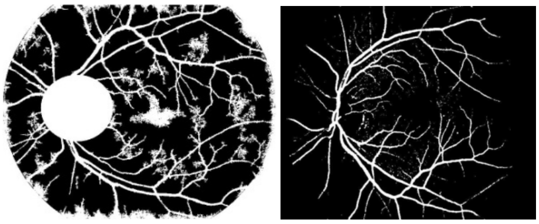


(a) (b)

Figure 5. (a) Image after histogram equalization, (b) Blood vessels after image segmentation and removal of "noise".

Some blood vessels are lost at the optical disk region after applying image segmentation. Hence, a mask is created to retain those blood vessels located when AND logic is applied. The creation of the mask is further discussed in the following section.

The image Figure 5.(b) is combined with the mask and compared with the earlier blood vessel image Figure 4. Using AND logic. The similar pixels are output as binary 1(white) and represent the blood vessels.



(a) (b)

Figure 6. (a) Mask at the optical disk area, (b) Blood vessel image with noise

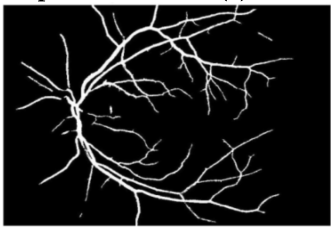


Figure 7. Combined image after removing "noise"

The final blood vessels image Figure 8. is obtained after the removal of the circular border. The creation of the border is further discussed in the following section.

@IJMTER-2015, All rights Reserved

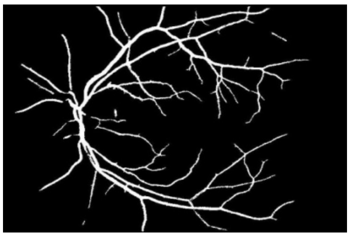


Figure 8. Image of Blood vessels

3.2. Border Formation

There are two methods in detecting the circular border of the image. Both methods are essential as each method could not work for a few of the images due to their intensity contrast. Deploying both methods allows the detection of all the images. Border formation is to clean off the noisy edges.

(i) Grayscale image is used in the border detection. The first method uses canny edge detection to detect the edges before enclosing the circular region with a top and bottom bar. Function "imfill" is then applied to fill the region. The circular border is obtained after subtracting the dilated image with the eroded image.

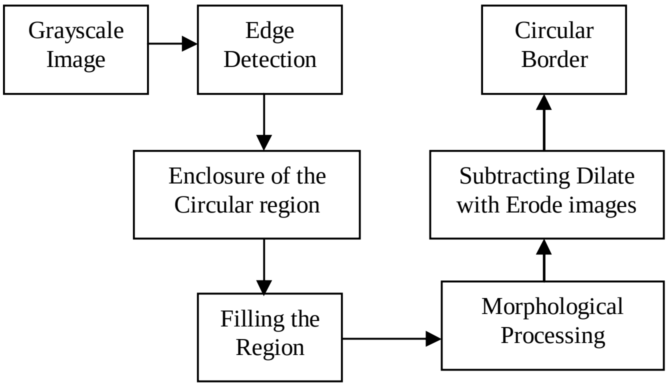


Figure 9. Block diagram for border formation –Method

(ii) It is activated when a noisy image is obtained from method 1instead of a circular border. This method inverses the intensity of the image first before image segmentation is applied with the function "im2bw". The circular region is filled as a result and the circular border is obtained after subtracting the dilated image with the eroded image.

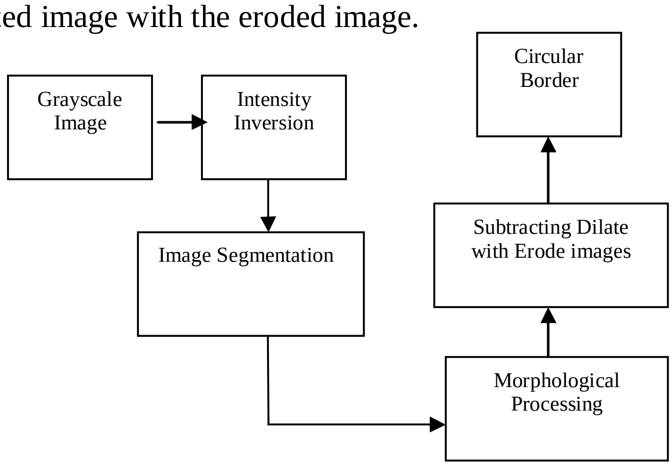


Figure 10. Block Diagram for Border Formation - Method 2.

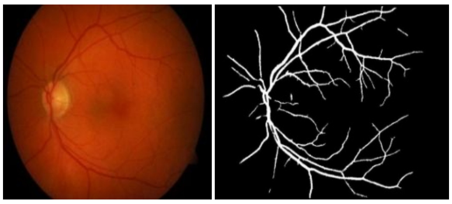
Figure 11. Circular border

3.3. Mask Creation for Optical Disk

As the optical disk is made up of a group of bright spots, it is not suitable to use loops and locate the largest value. This would only point to one spot and most likely to be on the side of the optical disk. The mask required to cover the optical disk would be inefficient as it would be much larger and covers more details. Mask creation is used in the detection of blood vessels, exudates and micro aneurysms. The grayscale image is used. The brightest pixel is first found in the image. The coordinates of all brightest points are then determined and the median is found. With this point as center a circular mask is created. A simple square mask may be easy to create but this would result in error when the optical disk is close to the border of the image.

VI. EXPERIMENT SIMULATION AND RESULTS ANALYSIS

To verify the performance of the proposed Statistical approach we experiment with color images from different database. We show results of some of these experiments. Figure 12. Shows some typical results of our color images. The area of the blood vessels is obtained by using two loops to count the number of pixels with binary 1 (white) in the final blood vessel image.



(a) (b)

Figure 12. (a) Original fundus image, (b) Blood vessels image

CONCLUSION

Each person has a unique blood vessels tree and its segmentation may be useful for the biometric person identification and for medical registration methods.

This work presents a computationally efficient method designed for automatic segmentation of color images with varied complexities. Masking at the optical disk is essential for AND logic as some of blood vessels is lost after applying adaptive histogram equalization and image segmentation. It is noted that some of the images have noise within the mask area and detect as blood vessels but it is still trivial to affect the overall value.

REFERENCES

[1] Gerald Liew, Tien y. Wong, Paul Mitchell, Jie Jin Wang. "Retinal vascular imaging –A New Tool in Micro vascular disease Research", Advances in Cardiovascular Imaging, 2008.
[2] KittipolWisaeng, NualsawatHiransakolwong and EkkaratPothiruk. "Automatic Detection of Exudates in Diabetic Retinopathy Images", Journal of Computer Science 8 (8): 1304-1313, 2012 ISSN 1549-3636 © 2012 Science Publications.
[3] Neelapala Anil Kumar, Mehar Niranjan Pakki. "Analyzing the Severity of the Diabetic Retinopathy and Its Corresponding Treatment", International Journal of Soft Computing and Engineering, ISSN: 2231-2307, Volume-2, Issue-2, May 2012.
[4] Tomi Kauppi, Valentina Kalesnykiene, Joni-Kristian Kamarainen, Lasse Lensu, Iiris Sorri, Asta Raninen, Raija Voutilainen, Hannu Uusitalo, Heikki Kalviainen and Juhani Pietil . "DIARETDB1 diabetic retinopathy database and evaluation protocol".
[5] Iqbal .M.I, Aibinu .A.M, Gubbal .N.S, Khan.A. "Automatic diagnosis of Diabetic Retinopathy using Fundus images", October 2006.
[6] Akara Sopharak, Bunyari Uyyanonvara, Sarah Barman and Tom Williamson. "Automatic Micro aneurysm Detection from Non-dilated Diabetic Retinopathy Retinal Images", Proceedings of the World Congress on Engineering 2011 Vol II WCE 2011, July 6 - 8, 2011, London, U.K.
[7] V. Vijayakumari and N. Suriyanarayanan. "Survey on the Detection Methods of Blood Vessel in Retinal Images", European Journal of Scientific Research, ISSN 1450-216X Vol.68 No.1 (2012), pp. 83-92.
[8] M. Ramaswamy, D. Anitha, S. Priya Kuppamal, R. Sudha and S. Fepslin Athish Mon. "A Study and Comparison of Automated Techniques for Exudate Detection Using Digital Fundus Images of Human Eye: A Review for Early Identification of Diabetic Retinopathy", ISSN: 2229-6093, Tech. Appl., Vol 2(5)
[9] Shilpa Joshi and Dr P.T. Karule. "Retinal Blood Vessel Segmentation", International Journal of Engineering and Innovative Technology (IJEIT), Volume 1, Issue 3, March 2012.
[10] Selvathi D, N.B.Prakash and Neethi Balagopal. "Automated Detection of Diabetic Retinopathy for Early Diagnosis using Feature Extraction and Support Vector Machine", International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, Volume 2, Issue 11, November 2012.
[11] Dr. H.P. Sinha and Jaspreet Kaur, "Automated Detection of Vascular Abnormalities in Diabetic Retinopathy using Morphological thresholding", International Journal of Engineering Science & Advanced Technology, Volume-2, Issue-4, 924 – 931.
[12] Hussain F. Jaafar and Asoke K. Nandi, and Waleed Al-Nuaimy, "Detection of Exudates from digital fundus images using a Region-based segmentation Technique", 19th European signal processing Conference, Barcelona, Spain August 29 - September 2, 2011.