Volume 4, Issue 1, January 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Detection of Macula in Retinal Images using Morphology

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Abstract— — The detection of the Optic Disc (OD) and macula in fundus retinal image is an important aspect of medical image processing. In manual analysis, due to unavailability of trained ophthalmologists, the diagnosis of retinal diseases becomes difficult. Thus, automatic analysis of fundus image is very much essential and will help to facilitate clinical diagnosis. An automatic system for the detection of various features of retinal image which includes the blood vessels, optic disc, macula and fovea is carried out by morphological operations. Macula is one of the important features of a fundus retinal image. The algorithm consists of various morphological operations and finally detection of macula region. The time consumed for detection of macula is less. It is simple and efficient. It performs well on different images and is robust also. The extracted macula region will help in further diagnosis of related eye diseases by eye specialists.

Keywords— blood vessels; optic disc; macula; fovea; morphology; ophthalmology.

I. INTRODUCTION

A. Human Eye and Fundus Image

The human eye has been called the most complex organ in our body. It's amazing that something so small can have so many working parts. The basic structure of the human eye is shown in Fig. 1

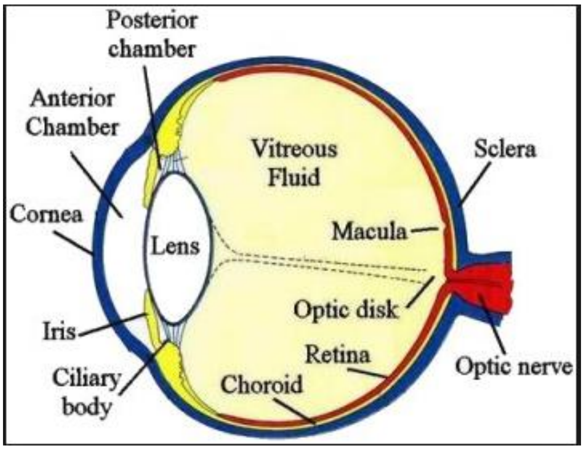

Fig. 1 Basic structure of the human eye.

The individual components of the eye work in a manner similar to a camera. Each part plays a vital role in providing clear vision. The eye acts as a camera with the cornea, behaving much like a lens cover. As the eye's main focusing element, the cornea takes widely diverging rays of light and bends them through the pupil, the dark, round opening in the center of the colored iris. The iris and pupil act like the aperture of a camera. Next in line is the lens which acts like the lens in a camera, helping to focus light to the back of the eye. Note that the lens is the part which becomes cloudy and is removed during cataract surgery to be replaced by an artificial implant nowadays. The very back of the eye is lined with a layer called the retina which acts very much like the film of the camera. The retina is a membrane containing photoreceptor nerve cells that lines the inside back wall of the eye. The photoreceptor nerve cells of the retina change the light rays into electrical impulses and send them through the optic nerve to the brain where an image is perceived. The center 10% of the retina is called the macula. This is responsible for the sharp vision or reading vision. The peripheral retina is responsible for the peripheral vision. The human eye is remarkable. It accommodates to changing lighting conditions and focuses light rays originating from various distances from the eye. When all of the components of the eye function properly, light is converted to impulses and conveyed to the brain where an image is perceived.

The colour fundus images, an example is shown in Fig.2, are used to keep track of the eye diseases by ophthalmologists. Developing automatic fundus image analyzing and diagnosing system help to facilitate clinical diagnosis. Extraction of the normal and abnormal features in colour fundus images [7] is fundamental and useful to automatic understanding of fundus images. The normal features of fundus images include optic disk, fovea and blood vessels. Fundus is the interior lining of the eyeball, including the retina (the light-sensitive screen), optic disc (the head of the nerve to the eye), and the macula (the small region in the retina where vision is keenest).

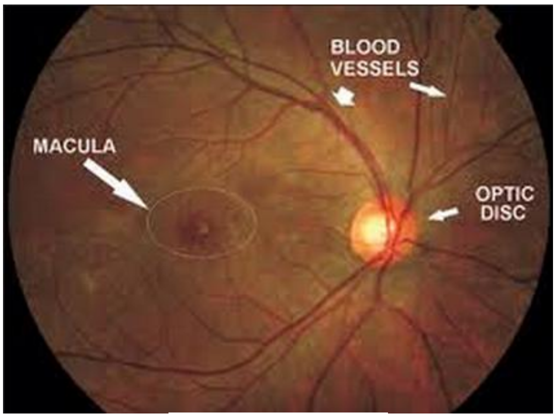

Fig. 2 Fundus image

The fundus is the portion of the inner eye that can be seen during an eye examination by looking through the pupil.

B. Importance of Macula

The macula is located roughly in the center of the retina, temporal to the optic nerve. It is a small and highly sensitive part of the retina responsible for detailed central vision. The fovea is the very center of the macula. The macula allows us to appreciate detail and perform tasks that require central vision such reading. The macula can be affected by a number of pathologies including trauma, infection, degeneration, vascular and inflammatory problems, etc. Macula is important for central vision, fine visualization and color differentiation. Patients suffering from macular diseases may present with:
Blurring of central vision, Image distortion. If any of the symptoms occur, immediate consultation is required. The eye doctor may advise to help monitor progress of macular disease. Since there are so many different types and causes of macular diseases, treatments depend on the cause, location and extend of the macular involvement. Patients should seek advice from eye doctor for specific treatments of their macular problems. The macula lutea is the small, yellowish central portion of the retina. It is the area providing the clearest, most distinct vision. When one looks directly at something, the light from that object forms an image on one's macula. A healthy macula ordinarily is capable of achieving at least 20/20 ("normal") vision or visual acuity, even if this is with a correction in glasses or contact lenses. Not uncommonly, an eye's best visual acuity is 20/15; in this case, that eye can perceive the same detail at 20 feet that a 20/20 eye must move up to 15 feet to see as distinctly. Some people are even capable of 20/10 acuity, which is twice as good as 20/20. Vision this sharp may be due to there being more cones per square millimeter of the macula than in the average eye, enabling that eye to distinguish much greater detail than normal.

The center of the macula is called the fovea centralis, an area where all of the photoreceptors are cones; there are no rods in the fovea. The fovea is the point of sharpest, most acute visual acuity. The very center of the fovea is the "foveola." Because the fovea has no rods, small dim objects in the dark cannot be seen if one looks directly at them. For instance, to detect faint stars in the sky, one must look just to one side of them so that their light falls on a retinal area, containing numerous rods, outside of the macular zone. Rods detect dim light, as well as movement. Starting at the outskirts of the fovea, however, rods gradually appear, and the absolute density of cone receptors progressively decreases. The high spatial density of cones accounts for the high visual acuity capability at the fovea. This is enhanced by the local absence of retinal blood vessels from the fovea [3], which, if present, would interfere with the passage of light striking the foveal cone. If an object is large and thus covering a large angle, the eyes must constantly shift their gaze to subsequently bring different portions of the image into the fovea (as in reading).Surrounding the foveal pit is the foveal rim, where the neurons displaced from the pit are located. This is the thickest part of the retina. The only photo-receptors located in the fovea of most humans are three kinds of cone photo receptors. The red, blue, and green allow the eye to see the colours that humans need for survival. The rods are located on the fovea's periphery. This assists the eye in seeing in the dark.

II. PROBLEM FORMULATION

For non- invasive treatment, great effort from ophthalmologists is required Diagnostics of retinal diseases include complex examination by retinologist and fundoscopy. With the help of high-precision equipment and noncontact fundus lenses applied when the pupils are dilated, the doctor will examine the retina for pathological changes and their severity. Normally fundus images are manually graded by specially trained clinicians in a time resource intensive process. If the details of the image are identified correctly, or if the fovea is identified accurately, the diagnosis will be accurate and treatment can be done accordingly.

III. IMPLEMENTATION

Macula is the most important part of the retina for human vision. Destruction of the macula will lead to blindness. Manual detection of macula by ophthalmologists takes large amount of time. Due to unavailability of experienced ophthalmologists, automation is very much essential. In fundus retinal images macula, the center of which is the fovea, is the darkest part approximated by a circle. This analysis is based on the structure of the blood vessels around the macula region. The blood vessels structure information [12] around the macula region and some information of the OD [5] are used here.

A. *Steps for Macula Identification*

First the input fundus image given is colored image or RGB image. The color fundus image is converted to gray scale image. It is also known as black and white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. Next is morphological opening on an image. The Morphological Open System performs an erosion operation followed by a dilation operation using a predefined neighborhood or structuring element. This is done to remove small noises. Following is the Morphological closing operation on an image that performs a dilation operation followed by an erosion operation using a predefined neighborhood or structuring element. This operation removes the vessel structure. The morphological top-hat transformation is done which gives two information. One is blood vessels and other is totally dark region. This subtracts morphological opened image from the original image. This can be used to enhance contrast in an image. Binarization is done on the image in order to clearly understand the intensity of the image. The image is binarized by considering zero as the threshold value. Here the macula region is approximated by binarization. The circular portion obtained is the macula region.

IV. RESULTS

By using this software, automatic detection of macula is achieved within short period of time. Thus accuracy and efficiency is increased than manual detection. It performs well on fundus images of varying characteristics. Normal retinal images and affected images were used for the experiment. The above images were obtained when simulation using MATLAB for normal images and infected images were done.

Fig. 3 Input and detected macula for normal retina

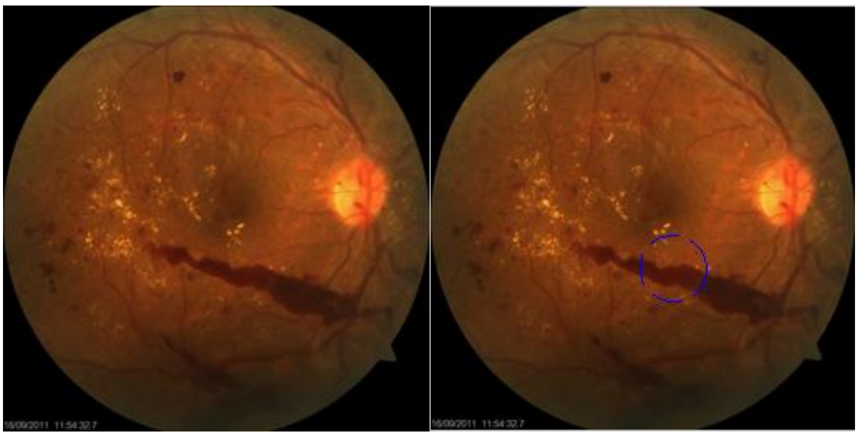

Fig. 4 Input and detected macula for infected retina

V. CONCLUSION AND FUTURE ENHANCEMENT

In this paper, an efficient method to determine the macula region in retinal fundus image is described. It performs well on images with variation. Thus, the method is robust also. The extracted macula may help in further diagnosis of related diseases. Macula identification was performed for both normal and affected retinal images. From this research, we were only able to understand the accurate macula region. Using the fundus image, grading of Diabetic retinopathy which is the most common disease affecting the retina of diabetic patients, can be implemented.

ACKNOWLEDGMENT

The authors would like to thank Dr. Raj Kumar Maheswari, Medical Director and Dr. M. V. Sathyajith, Asst. Medical Director, Ahaliya Foundation Eye Hospital, Palakkad for their valuable suggestions and help in obtaining the images used in this research.

REFERENCES

[1] B. Al-Diri, A. Hunter, and D. Steel. 'An Active Contour Model for Segmenting and Measuring Retinal Vessels', IEEE Transactions on Medical Imaging, vol. 24, no. 9, pp. 1488–1497, September 2009.

[2] S. Chaudhuri, S. Chatterjee, N. Katz, M. Nelson, and M. Goldbaum. 'Detection of Blood Vessels in Retinal Images Using Two-Dimensional Matched Filters', IEEE Transactions on Medical Imaging, vol. 8, no. 3, pp. 263–269, September 1989.

[3] O. Chutatape. 'Fundus Foveal Localization Based on Vessel Model', in Proceedings of the 28th IEEE EMBS Annual International Conference New York City, USA, pp. 4440–4444. 2006.

[4] Danu Onkaew, Turior R. and Bunyarit Uyyanonvara. ' Automatic Extraction of Retinal Vessels Based on Gradient Orientation Analysis', computer science and software engineering, 2011 Eighth international conference, pp. 102 – 107, 2011.

[5] M. Foracchia, E. Grisan, and A. Ruggeri., 'Detection of Optic Disc in Retinal Images by Means of a Geometrical Model of Vessel Structure', IEEE Transactions on Medical Imaging, vol. 23, no. 10, pp. 1189–1195, October 2004.

[6] J. Hajer, H. Kamel, and E. Noureddine., 'Localization of the optic disk in retinal image using the watersnake', in Proceedings of the International Conference on Computer and Communication Engineering, pp. 947–951, May 2008.

[7] Huiqi Li and Chutatape O. 'A Model- Based Approach for Automated Feature Extraction in Fundus Images', in Proceedings of the Ninth IEEE International Conference on computer vision, pp. 394 – 399, 2003.

[8] M.V. Ibaez and A. Simo. 'Bayesian detection of the fovea in eye fundus angiographies', in Pattern Recognition Letters, vol. 20, pp. 229–240, 1999.

[9] Niemeijer, M., Abramoff, M.D. and van Ginneken, B. 'Automated localization of the optic disc and the fovea', in 30th Annual International IEEE Engineering in medicine and biology society Conference, Canada, pp. 3538-3541, 2008.

[10] S. Samanta, S. K. Saha and B. Chanda 'A Simple and Fast Algorithm to Detect the Fovea Region in Fundus Retinal Image', Second International Conference on Emerging Applications of Information Technology, pp. 206-209, 2011.

[11] S. Sekhar, W. Al-Nuaimy, and A. K. Nandi. 'Automated Localisation of Optic Disk and Fovea in Retinal Fundus Images', in 16th European Signal Processing Conference, Lausanne, Switzerland, August 2008.

[12] J. Staal, M. D. Abramoff, M. Niemeijer, M. A. Viergever, and B. Van Ginneken. 'Ridge-Based Vessel Segmentation in Color Images of the Retina' in IEEE Transactions on Medical Imaging, vol. 23, no.4, pp. 501-509, April 2004.

[13] Xiayu Xu, Niemeijer, M., Qi Song, Sonka, M., Garvin, M.K., Reinhardt, J.M., and Abramoff M.D. ' Vessel Boundary Delineation on Fundus Images using Graph- Based Approach', in IEEE Transactions on Medical Imaging,vol.30, pp. 1184 – 1191, June 2011.

[14] Xu X., Niemeijer, M., Song, Q., Garvin, M.K., Reinhardt, J.M. and Abramoff M.D. ' Retinal Vessel Width Measurements Based on Graph- Theoretic Method', Biomedical Imaging from Nano to macro, IEEE International Symposium , pp. 641-644, 2011.

[15] A. A.-H. A.-R. Youssif, A. Z. Ghalwash, and A. A. S. A.-R. Ghoneim. 'Optic Disc Detection from Normalized Digital Fundus Images by means of a Vessel Direction Matched Filter' IEEE Transactions on Medical Imaging, vol. 27, no. 1, pp. 11–18, January 2008.

