DETECTION OF ANATOMICAL STRUCTURES IN OPTICAL FUNDUS IMAGES

B.Vinoth Kumar[1], P.Swathika[2], M.Pradhiba Selvarani[3] , S.Karpagam[4]

[1] *Department of Computer Science and Engineering, RVCE (Sivakasi), India.*
[2,3,4] *Department of Computer Science and Engineering, KCET(Virudhunagar), India.*

ABSTRACT

To implement a computer system for the automatic detection of important anatomical structures in digital fundus retinal images such as blood vessels, Optic Disc (OD) and macula. Blood vessel tracking provides a map of the retinal vessel of the eye, from which a reference frame may be derived that can ease the process of positioning other fundus objects and lesions with respect to a natural "co ordinate systems". Segmenting the OD is key-processing element in many algorithms designed for automatic extraction of anatomical structures and detection of retinal lesions. Macula encircling helps establishing statistics regarding lesions position for disease gradation. Diabetic retinopathy is considered as the root cause of vision loss for diabetic patients. However, if the symptoms are identified earlier and a proper treatment is provided through regular screenings, blindness can be avoided. Exudates are a major indicator of diabetic retinopathy that can possibly be quantified automatically. The purpose of the work is to describe and evaluate a machine learning-based, automated system to detect exudates in digital color fundus photographs, for early diagnosis of diabetic retinopathy.

Keywords--Diabetic retinopathy, Fundus image analysis, Macula detection, Optic nerve detection, Optic Disc Detection

I. INTRODUCTION

The World Health Organization estimates that 135 million people have diabetes mellitus worldwide and that the number of people with diabetes will increase to 300 million by the year 2025 . More than 18 million Americans currently have diabetes and the number of adults with the disease is projected to more than double by the year 2050. Visual disability and blindness have a profound socioeconomic impact upon the diabetic population and diabetic retinopathy (DR) is the leading cause of new blindness in working-age adults in the industrialized world.

Retinal image analysis is a key element in detecting retinopathies in patients. It assists in the automatic detection of pathologies such as diabetic retinopathy (DR), macular degeneration, and glaucoma. Optic Disc (OD), macula and retinal vasculature are all important anatomical structures in the retina. Diabetic-related eye diseases are the most common cause of blindness in the world.

II. RELATED WORKS

The method described in [1] was used to detect Optic Disc Detect From Retinal Images by a Line Operator. This orientation can be used to locate the optic disc accurately. The drawback in this technique is, it can't handle small

images having OD darker than the surrounding pixels. This technique can't handle retinal images that do not have a clear circular brightness structure around their OD.

The method described in [2] was used to detect Optic Disc from Normalized Digital Fundus Images by Means of a Vessel. The drawback in this technique is, OD was not detected correctly due to uneven crescent-shaped illumination.

The method described in [3] was used to detect Optic Disc in Retinal Images by Means of a Geometrical Model of Vessel Structure**.** The drawback in this technique is, the model based on the availability of a good portion of the structure, and independent of the actual visibility.

The method described in [4] was used to detect Anatomic Structures in Human Retinal Imagery. In this technique the segmentation of the vasculature(retina) followed by the determination of spatial features describing the density, average thickness, and average orientation of the vasculature in relation to the position of the optic nerve. The algorithm fails due to slight misdetection in optic nerve and macula.

The method described in [5] was used to detect Optic Disc (OD), Blood Vessels and Macula in digital fundus retinal images. OD localization was done using Principle Component Analysis (PCA) followed by an active contour based approach for accurate segmentation of its boundary

III. PROPOSED SYSTEM

In this paper, there is an increasing interest for setting up medical systems that can screen a large number of people for sight threatening diseases, such as diabetic retinopathy. This paper presents a method for automated identification of exudates pathologies in retinopathy images based on Machine Learning Algorithm. The color retinal images are segmented using following some preprocessing steps, i.e., color normalization and contrast enhancement. The entire segmented images establish a dataset of regions. To classify these segmented regions into exudates and non-exudates, a set of initial features such as color, size, edge strength, and texture are extracted.

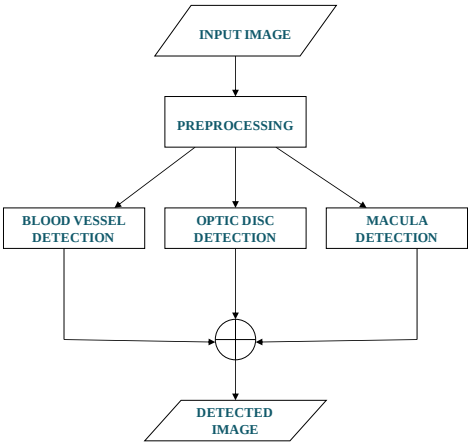

Fig. 1 : Block diagram for overall system

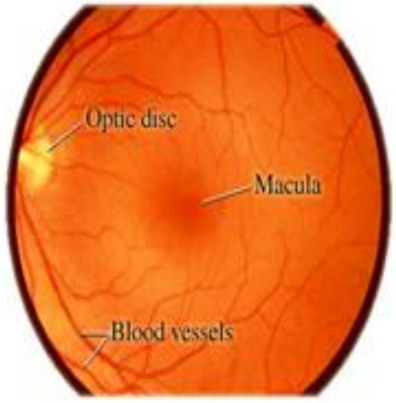

Fig. 2: Anatomical structure of retina

IV. BLOOD VESSEL DETECTION

Blood vessel detection in an essential step in medical diagnosis of fundus images as it aids in the diagnosis of ocular diseases. Other applications of retinal vasculature extraction include the treatment of age related macular degeneration, registration algorithms and personal identification in security application. Vessels appear darker than the background, their width is always smaller than a certain value, they are piecewise hold only approximately. Due to the presence of noise, the vessels are often disconnected, and not each pixel on a vessel appears darker than the background. The vessel borders appear often unsharp.

Diabetic retinopathy is influenced particularly by the disorders in the blood vessels which are very thin and fragile. quantitative analysis of retinal blood vessel images in terms of length, width, twists and turns branching pattern, can provide new intuitive understanding of the truth about vessels provide valuable information for diagnosis and study the stage of disease. With the advent of computing techniques, the automated segmentation an d analysis is expected to support the ophthalmologist in the clinical decision making process.

V. OPTIC DISK DETECTIOIN

The OD localization and segmentation is a crucial task in an automated retinal image analysis system. It is required as a prerequisite for the detection of exudates and also helps in macula detection, as macula is the darkest area in the neighborhood of OD. OD region is found by means of a multi-scale analysis pyramidal approach using a simple haar-based wavelet transforms. The brightest pixel that appears in a coarse resolution image at an appropriate resolution level depending on the initial image resolution and the OD average dimension is assumed to be part of the OD. This global OD localization serves as the starting point for a more accurate OD localization obtained from a template-based matching that uses the hausdorff distance measure on a binary image of the most intense canny edges.

VI. MACULA DETECTION

Macula is highly sensitive region of the ratina responsible for detailed central vision. Macular oedema is a special of DR caused by the leakage of blood vessels in the macula region. Macula oedema can be treated with laser if detected early en ough. Identifying the macular oedema. Macula encircling helps establishing statistics regarding lesions position for disease gradation. The relatively constant distance between the OD and the macula center can b e used as a priori knowledge to help positioning the macula. This darkest pixel in the coarse resolution image corresponds to the region occupied by the macula in the origin al image. The exact center to the macula is then found by searching in the vicinity for the darkest pixel on the original fine resolution image. A circle with a diameter equals to twice the OD diameter is then drawn around that point.

VII. EXUDATES DETECTION

The exudates can be noticed on the ophthalmoscope as areas with hard white or yellowish colors and varying sizes, shapes and locations, near the leaking capillaries within the retina. Hard and soft exudates can be distinguished due to their colour and the sharpness of their borders. There is an extra feature in the images that appear as bright

patterns, like the optic disc and – because of changes in illumination – ordinary background pixels. Besides, they are not the vessels is high as the one caused by the exudates. Exudates detection is our main purpose. We have developed a machine learning algorithm that can detect bright lesions in retinal colour photographs and can differentiate among exudates.

VIII. MACHINE LEARNING ALGORITHM

The machine learning algorithm is as so-called supervised algorithm, and therefore needs a set of annotated lesions to learn how to detect bright lesions. For this purpose, DR images originally read as containing bright lesions were selected. All pixels in all these images were segmented by retinal specialist as to whether they were (part on) an exudates or background retina.

IX. EXPERIMENTAL RESULTS

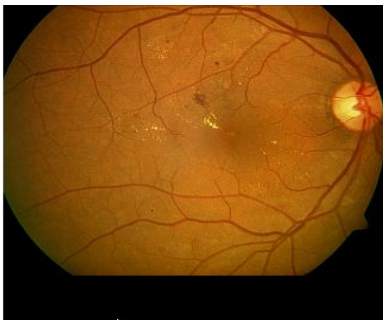

Fig. 3: Input Fundus Image of an Affected Person

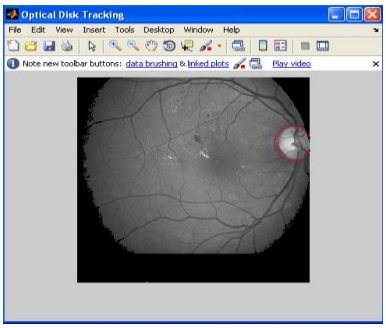

Fig. 4: Optic Disc Detected Image

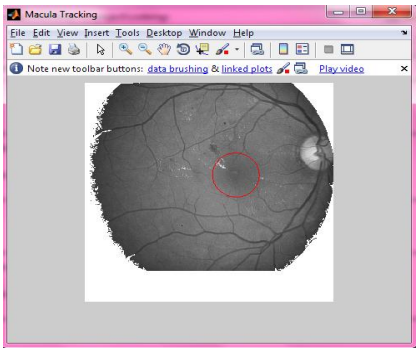

Fig. 5: Macula Detected Image

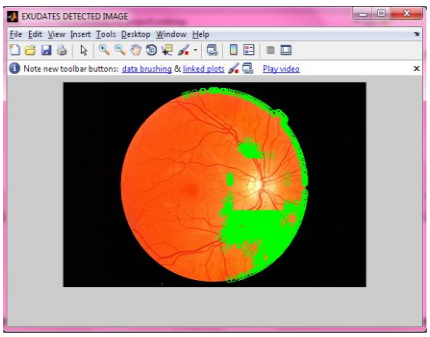

Fig.6 : Exudates Detected Image

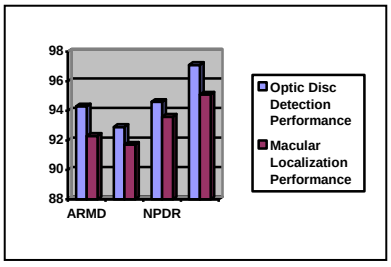

Fig. 7: Performance comparison for different Pathologies

X. CONCLUSION AND FUTURE ENHANCEMENT

In this work all important anatomical structures in color retinal images, the optic disk, the macula and the blood vessel and exudates are detected. The procedure has been tested on a database of more color fundus images which is a combination of normal, diabetic retinopathy and age related macular degeneration affected images acquired from a low resolution digital non-mydriatic fundus camera. The size of the images are 1280×1024. Test results show robustness against visual quality of the images and independently on the fact that the acquisition is macular optic disk-centered.

The proposed work helped in establishing the performance of the vascular network extractor, optic disc detection and macula detection. Future works include other extensive tests on other types of fundus images acquired from different fundus cameras.

REFERENCES

[1] Shijian Lu*, Member, IEEE, and Joo Hwee Lim, Member, IEEE "Automatic Optic Disc Detection From Retinal Images by a Line Operator" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 58, NO. 1, JANUARY 2011

[2] M. Foracchia, E. Grisan, and A. Ruggeri*, Senior Member, IEEE "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, OCTOBER 2004

[3] Aliaa Abdel-Haleim Abdel-Razik Youssif, Atef Zaki Ghalwash, and Amr Ahmed Sabry Abdel-Rahman Ghoneim* "Optic Disc Detection From Normalized Digital Fundus Images by Means of a Vessels" Direction Matched Filter" IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 27, NO. 1, JANUARY 2008

[4] Kenneth W. Tobin*, Senior Member, IEEE, Edward Chaum, V. Priya Govindasamy, Member, IEEE, and Thomas P. Karnowski, Member, IEEE "Detection of Anatomic Structures in Human Retinal Imagery " IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 26, NO. 12, DECEMBER 2007.

[5] Procedure to detect anatomical structures in optical fundus images – L. Gagnon, M.Lalonde.

[6] Gray-level grouping (GLG): An automatic method for optimized image contrast enhancement-part I:The Basic Method – Zhiyu chen.

[7] Gray-level grouping (GLG): An automatic method for optimized image contrast enhancement-part II: The Variations Zhiyu chen.

[8] Using a patient image archive to diagnose retinopathy – Michael D, Matthew T.S.

[9] Centers for Disease Control and Prevention National Diabetes Fact Sheet [Online]. Available: http://www.cdc.gov 2003

[10] A. A. Cavallerano, J. D. Cavallerano, P. Katalinic, A. M. Tolson, and L. P. Aiello, "Use of Joslin vision network digital-video nonmydriatic retinal imaging to assess diabetic retinopathy in a clinical program," *Retina*, vol. 23, pp. 215–223, April 2003.

[11] M. Larsen, J. Godt, and M. Grunkin, "Automated detection of diabetic retinopathy in a fundus photographic screening population," *Invest. Ophthal. Vis. Sci.*, vol. 44, pp. 767–771, 2003.