

Image Processing Analysis on Retina Blood Vessel for Detecting Glaucoma: A Review

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Abstract — Glaucoma is a neurodegenerative disorder of the optic nerve, which causes partial or permanent loss of vision. Glaucoma is the second leading cause of blindness worldwide. Glaucoma is caused due to an increase in intraocular pressure within the eyes. This disease cannot be diagnosed by the naked eye; therefore, by using different image processing techniques like image processing in enhancement, fusion, registration, segmentation, feature extraction, pattern matching, morphology, statistical measurement and analysis etc. This method can help to diagnose the exact problem of the patient.

Key Words — Glaucoma, Fundus camera image, Image processing, Cup to disc ratio, Optical nerve, Neural network.

I. INTRODUCTION

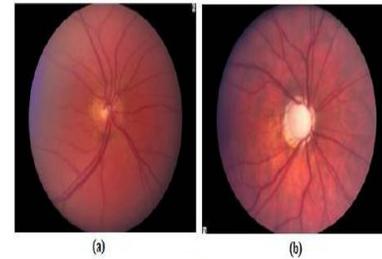
Glaucoma is one of the leading causes of blindness worldwide. The word glaucoma emanates from an ancient Greek word, meaning 'Clouded or blue-green hue'. Glaucoma is a neurodegenerative disorder which damages the optic nerve and causes problems like partial or permanent loss of vision [10]. Glaucoma is caused due to an increase in intraocular pressure of fluid known as aqueous humor. It is also called a silent thief of sight because glaucoma does not have major symptoms. But patients must have symptoms like eye pain, usually blurred vision, pain is often accompanied by nausea and sometimes vomiting.

Increase in age and thyroid problems increase the risk of glaucoma. The optic nerve carries image information to the brain [1]. Due to damage of a large number of nerve fibers, a blind spot is created leading to loss of vision [1]. Also, the major glaucoma-affected patients have to transplant their eyes due to permanent loss of vision, the image processing has a solution over it with the help of image processing techniques we can diagnose the exact problem of the patient.

Due to glaucoma, the shape of the optic nerve changes and using image processing we can detect it, which is as shown in figure (b). Clinically, the diagnosis of glaucoma can be done by measuring CDR, defined as the ratio of vertical height of the optic cup to the vertical height of the optic disc [2].

For a normal eye, the cup-to-disc ratio is 3.0 to 0.5. For a glaucoma-affected eye, the ratio of cup to disc is 0.8. The CDR value that is greater than 0.65 indicates a high glaucoma risk. The image of the eye is captured by using a device known as

ophthalmoscope. This image can be captured with the help of fundus camera.



(a) Normal optic nerve - 0.3 C/D ratios (b) Glaucomatous optic nerve - 0.9 C/D ratios.

Figure (a): CDR of normal and glaucoma-affected eye

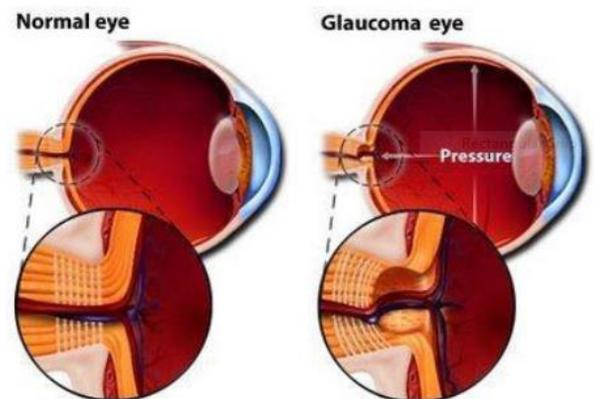


Figure (b): Change in shape of optic nerve of normal and glaucoma-affected eye.

On the basis of the available data, we estimate there are approximately 11.2 million persons aged 40 years and older with glaucoma in India.

II. TYPES OF GLAUCOMA

A. Primary open angle glaucoma (Chronic glaucoma):

The term angle means the distance between the iris and cornea [9]. Open angle glaucoma, the most common form of

glaucoma. Accounting for at least 90% of all glaucoma cases. Is caused by slow clogging of the drainage canals, resulting in increased eye pressure. It is most common type of glaucoma, affecting about 3 million Americans. Primary angle glaucoma is estimate to affect 6.48 million person in India [18].

B. Angle closure glaucoma:

Angle closure glaucoma, a less common form of glaucoma. Is caused by blocked drainage canal resulting in a sudden rise in intra ocular pressure. A closed or narrow angle between the iris and cornea. This kind of glaucoma has major pain because of sudden increase in pressure inside in the eye. The estimated number with angle closer glaucoma is 2.54 million [18].

C. Pigmentary glaucoma:

This is type of open angle glaucoma and typically develops during early or middle adulthood. Pigment cells, which arise from the iris, are dispersed within the eye. If these cells build up in the channels that drain fluid from the eye, they can upset the normal flow of fluids in the eye, leading to rise in eye pressure.

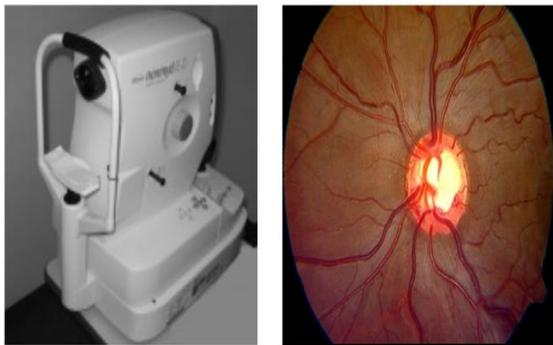


Fig. 1 Digital fundus camera and acquired retinal fundus image

Figure (c): Fundus camera and captured fundus image.

III. PROPOSED IMAGE PROCESSING METHODS

A. Image Enhancement:

Image enhancement includes varying brightness and contrast of image. It comes under step to enhance various features of image. And also it can darken that image to detect where is fault.

B. Image Registration:

Image registration is very important technique for varying detection in retinal image and most important diagnosis. This is a technique where two images are aligned onto a common co-ordinate system. These two images can be on different time and also with different imaging device. When

we diagnosed anything then it is essential that to combine data from different images and for suitable analysis and measurement of images are aligned geometrically [4].

C. Image Fusion:

Image fusion is a process of combining information occurred from different types of devices. The main aim this process is to integrate contemporary, multi sensor, multi-temporal into a single image containing overall information so to reduce the amount of information.

D. Feature Extraction:

It is the process of identifying and extracting region of interest from the image.

E. Segmentation:

Segmentation means segmenting or dividing an image into its constituent object and group of pixel which are homogeneous according to some criteria. The main need of segmentation is to extract various features of image which can be split or merged in order to built object of interest on analysis and interpretation can be performed. Segmentation algorithms are area oriented instead of pixel oriented. It include clustering, thresholding etc.

F. Morphology:

Morphology is deals with appearance, shape and size. Mathematical morphology is a collection of non-linear processes which can be applied to an image to remove details smaller than a certain reference shape. Various morphological operation are erosion, dilation, opening and closing.

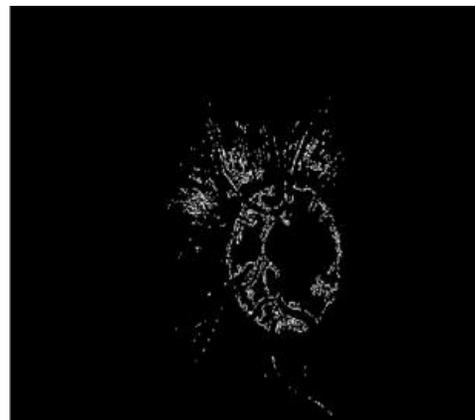


Figure (d): Morphological operation

IV. ALGORITHM

To diagnose glaucoma, cup-to-disc ratio is most widely accepted index. Early research was done for detection

And localization of optic disk. The various algorithms used in this direction are vessel's direction matched filter, Curve let transform, active contour model, fuzzy c-mean clustering, artificial neural networks, k-NN regressor, Pyramidal decomposition, edge detection, entropy filter and feature vector.

Other techniques include averaging filter, template matching technique and canny edge detector. Applied Hough transform

To detect Optic Disk. After preprocessing a binary image is obtained which can be used to

Find the contours of OD. Morphological closing is performed on ROI to calculate the magnitude gradient of edge

Detection and fill the vessels according to (1).

$$f \bullet B = (f \oplus B) \ominus B \quad (1)$$

For removing any peaks, morphological opening is applied according to (2).

$$f \circ B = (f \ominus B) \oplus B \quad (2)$$

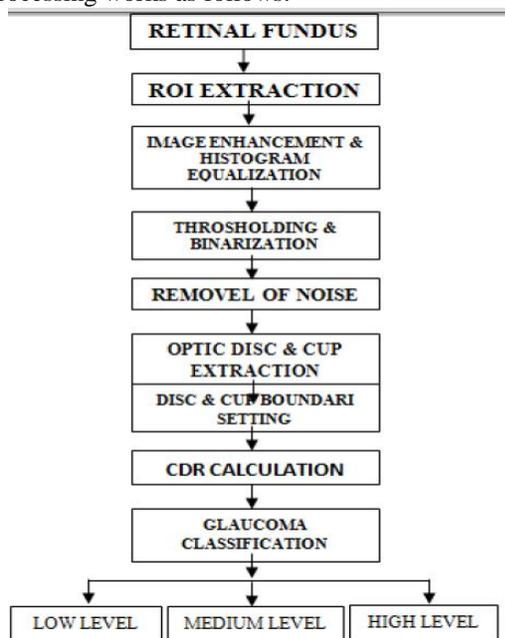
Where f is the gray scale image,
B is binary structuring element;

\oplus is dilation

\ominus is erosion operators [11] - [17].

V. FLOW CHART

The following flow chart shows how image different processing works as follows:-



CONCLUSION

In this paper, the diagnosis of glaucoma can be done with the help of image processing techniques. With the help of this type of technique we can detect the exact problem of patient. And also by calculating CDR and the changes occurred in shape of optic nerve we can decide whether the eye is normal or glaucoma affected. With the help of this type of technique doctor can cure patient fast because they know what is the exact problem of patient, and also patient have no need to transplant eye.

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