ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 7, Issue 1, pp: (176-182), Month: January - March 2019, Available at: www.researchpublish.com

DETECTION OF SEVERITY OF OPTICAL NERVE HEAD DAMAGE USING OPTICAL COHERENCE TOMOGRAPHY IMAGES

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Abstract: **Glaucoma is an eye disease that is the second most common cause of blindness in worldwide. The characteristic of glaucoma are high eye pressure, loss of vision gradually which can cause blindness and damage to the structure of retina. The damages which may occur for example are structural form changes of the Optic Nerve Head (ONH) and Retinal Nerve Fiber Layer (RNFL) thickness. Quantitative analysis of Retinal Nerve Fiber Layer (RNFL) via image processing of "Optical coherence tomography" images plays a major role in its early detection. The retinal ganglion axons are an important part of the visual system, which can be directly observed by OCT images. By using Entropy image processing method, extracted from the green and blue channel of OCT, images are correlated with corresponding RNFL thickness. Thus, this work aims to develop a system which will recognize the presence of glaucoma by the changes in the OCT image of an eye of a person and automatically quantify the RNFL defect using image processing techniques which aids in the diagnosis of glaucoma disease. Results show that , the performance of the Algorithm is appreciable compared with the clinical diagnosis.**

Keywords: **Glaucoma, Optic Nerve Head, Retinal Nerve Fiber Layer thickness, OCT images.**

I. INTRODUCTION

Eye is one of the most important sensory organs. The initial step in the process of vision is, the conversion of light into electrical impulses which can be interpreted in the brain. This conversion takes place in the retina, which is located in the back of the eye. The retina is the sensory membrane that lines the inner surface of the back of the eyeball shown in figure 1(a). The important ones include the photoreceptor layer, which is located further out (towards the periphery), and the ganglion nerve layer which lies most inward (toward the vitreous). Once light reaches the photoreceptors by passing through various layers the visual signal propagates back up to the ganglion nerves [1]. These ganglion nerves, in turn, course along the surface of the retina toward the optic disk and form the optic nerve running to the brain.

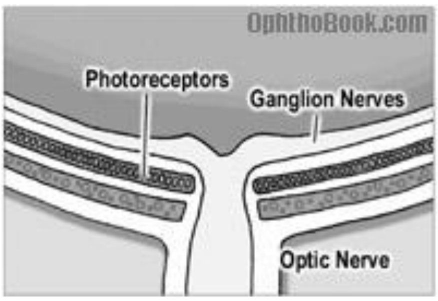


Fig 1(a) Retina image

The optic nerve, also known as cranial nerve II, is a paired nerve that transmits visual information from the retina to the brain. The authors in [2] developed diagnostic expert system with the help of Statistical Region Merging based image processing technique using a. The developed approach was demonstrated to achieve accurate retinal nerve fiber layer segmentation on retinal OCT images under low image contrast. The optic nerve is derived from optic stalks during the seventh week of development and is composed of retinal ganglion cell axons and Aglial cells. In humans, the optic nerve extends from the optic disc to the optic chiasm and continues as the optic tract to the lateral geniculate nucleus, pretectal nuclei, and superior colliculus. Glaucoma is an optic neuropathy characterized by specific and progressive injury to the optic nerve and retinal nerve fiber layer (RNFL). The article [3] developed image processing code to analyze the increase of Retinal nerve fiber layer thickness and its effect of glaucoma in eye. They implemented different kind of algorithms to estimate and detect the thickness of the images automatically.. Glaucoma results in field defects and irreversible vision loss. As interventions are available that halt or retard the natural progression of the disease, resulting in eventual blindness, early detection and diagnosis is very important. Change in the RNFL thickness is one of the most important findings for the early diagnosis and determination of glaucoma progression. Optical coherence tomography (OCT) [2] is a non-invasive, cross-sectional imaging technique that makes routine measurement of RNFL thickness possible. OCT has been shown to be a highly reproducible imaging modality that correlates with *ex vivo* histologic measurements of the retina.

Nerve fiber layer thickness can be evaluated with the "Fast RNFL Thickness" scan. This is a circular scan that requires the operator to place the circle so that the center of the circle is centered on the optic nerve head as shown in figure 1(b).

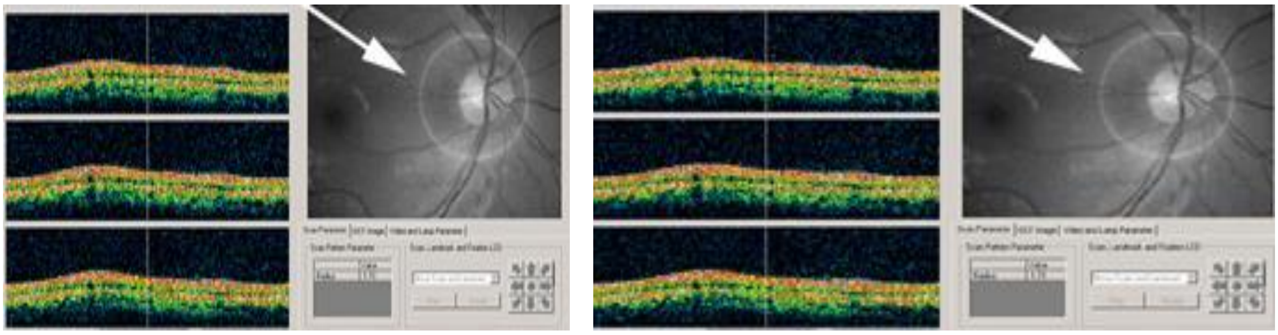
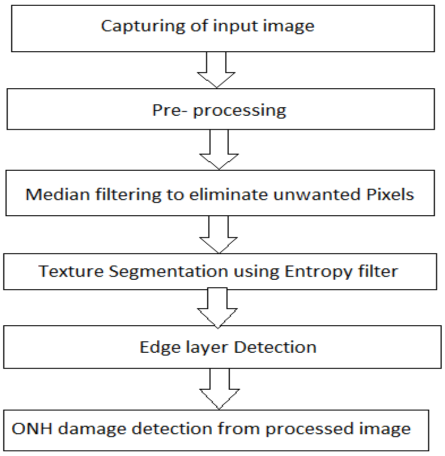


Figure 1(b) OCT image of RFNL

The work aims at analyzing the damage of optical nerve head and retinal nerve fibre layer thickness using optical coherence tomography images. Article [5] developed a system which can recognize the presence of glaucoma by changes in the fundus image of the eye of the person and automatically quantify the RNFL defect using image processing tool. The authors in [6] implemented morphological techniques to find out the changes of thickness within the image by applying the edge detection algorithms

II. METHODOLOGY

The detection of Glaucoma in the eye is determined by analyzing RNFL thickness using a image processing tool. This process includes various processing steps, which are preprocessing, edge detection and filtering methods as shown in flow diagram below



Flow chart of detection of RNFL thickness

A. Original OCT image

Optical coherence tomography is an established medical imaging technique that uses light to capture micrometer - resolution, three-dimensional images from within optical media Optical coherence tomography is based on low-coherence interferometer, typically employing near infrared light. The use of relatively long wavelength light allows it to penetrate into the scattering medium confocal microscopy, another optical technique, typically penetrates less deeply into the sample but with higher resolution .The optical coherence tomography image is given as input image .

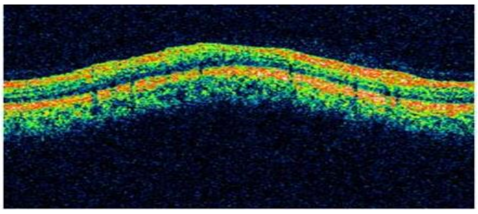


Fig 2(a) Original image of RNFL

B. Pre processing

Pre-processing consists of the following steps:

1) The RGB image is converted to a green channel or grayscale image.

2) Adjust the intensity values in the image, using 'imadjust' function

In photography and computing, a grayscale or greyscale digital image is an image in which the value of each pixel is a single sample, that is, it carries on intensity information. Images of this sort, also known a black and white are composed exclusively of shades of gray varying from black at the weakest intensity to white at the strongest

There is an extensive dissimilarity in the colour of the Oct images taken from different patients. This dissimilarity is strongly correlated to the person's skin pigmentation and iris colour. Other reasons like intrinsic attribute of lesions, decreasing colour dispersion at the lesion periphery and lighting disparity, etc. This may result color of the lesion of some images to be lighter than the background colour. Under these conditions, there is every possibility that these lesions may erroneously be classified as background colour. Therefore, colour normalization is necessary to be performed.

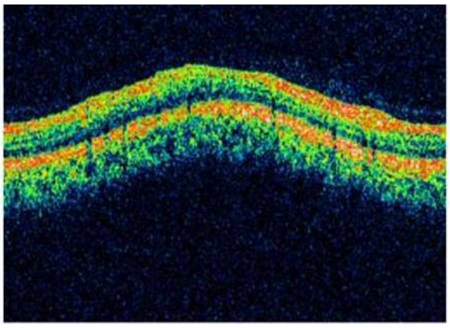


Fig 2(b) Original image

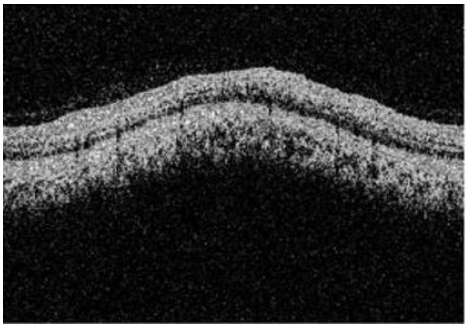


Fig 2(c) Pre-processed image

C. Application of median filter to gray scale image

The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. Median filtering is a nonlinear method used to remove noise from images. It is widely used as it is very effective at removing noise while preserving edges. It is particularly effective at removing 'salt and pepper' type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighboring pixels. The pattern of neighbors is called the "window", which slides, pixel by pixel over the entire image 2 pixel, over the entire image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value. On the left is an image containing a significant amount of salt and pepper noise On the right is the same image after processing with a median filter median filter.

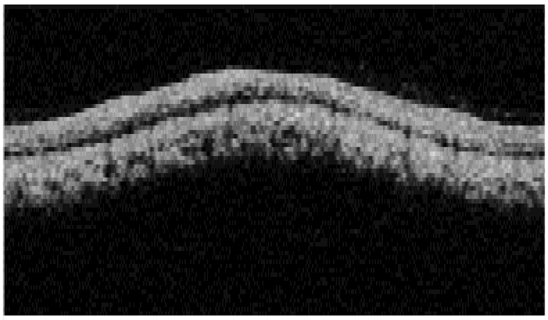


Fig 2(d) RNFL image after the applying median filter

D. Texture segmenatation with entropy filter

The regular repetition of an element or pattern on a surface it is called as texture. It is used to identify different textured and nontextured regions in an image. To classify/segment different texture regions in an image.To extract boundaries between major texture regions. Texture is a difficult concept to represent. The identification of specific textures in an image is achieved primarily by modeling texture as a two-dimensional gray level variation. The relative brightness of pairs of pixels is computed such that degree of contrast, regularity, coarseness and dirctry.

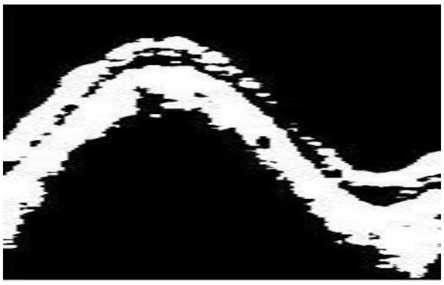


Fig 2(e) Entropy filtered image

Fig 2(f) Thresholded image

E. Edge detection

A principled theory of edge detection is offered that is based on the structure of the 2-jet of the image at a certain scale. In this theory there is no such a thing as an "edge detector", edges are defined in terms of the 2-jet as a single object.

The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. It can be shown that under rather general assumptions for an image formation model, discontinuities in image brightness are likely to correspond to:

- Discontinuities in depth,
- Discontinuities in surface orientation,
- Changes in material properties and
- Variations in scene illumination.

A one-dimensional image f which has exactly one edge placed at $x = 0$ may be modeled as:

$$f(x) = \frac{I_r - I_l}{2}\left(\operatorname{erf}\left(\frac{x}{\sqrt{2}\sigma}\right) + 1\right) + I_l.$$

At the left side of the edge, the intensity is $I_l = \lim_{x \to -\infty} f(x)$, and right of the edge it is $I_r = \lim_{x \to \infty} f(x)$. The scale parameter σ is called the blur scale of the edge. Ideally this scale parameter should be adjusted based on the quality of image to avoid destroying true edges of the image

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Fig 2(g) output image after edge detection

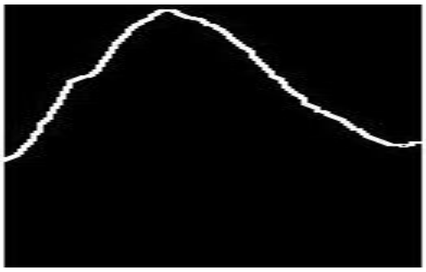


Fig 2(h) Final layer detection

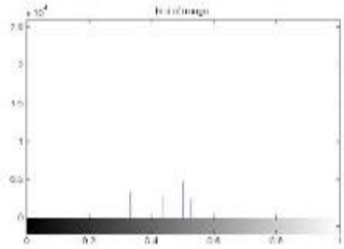
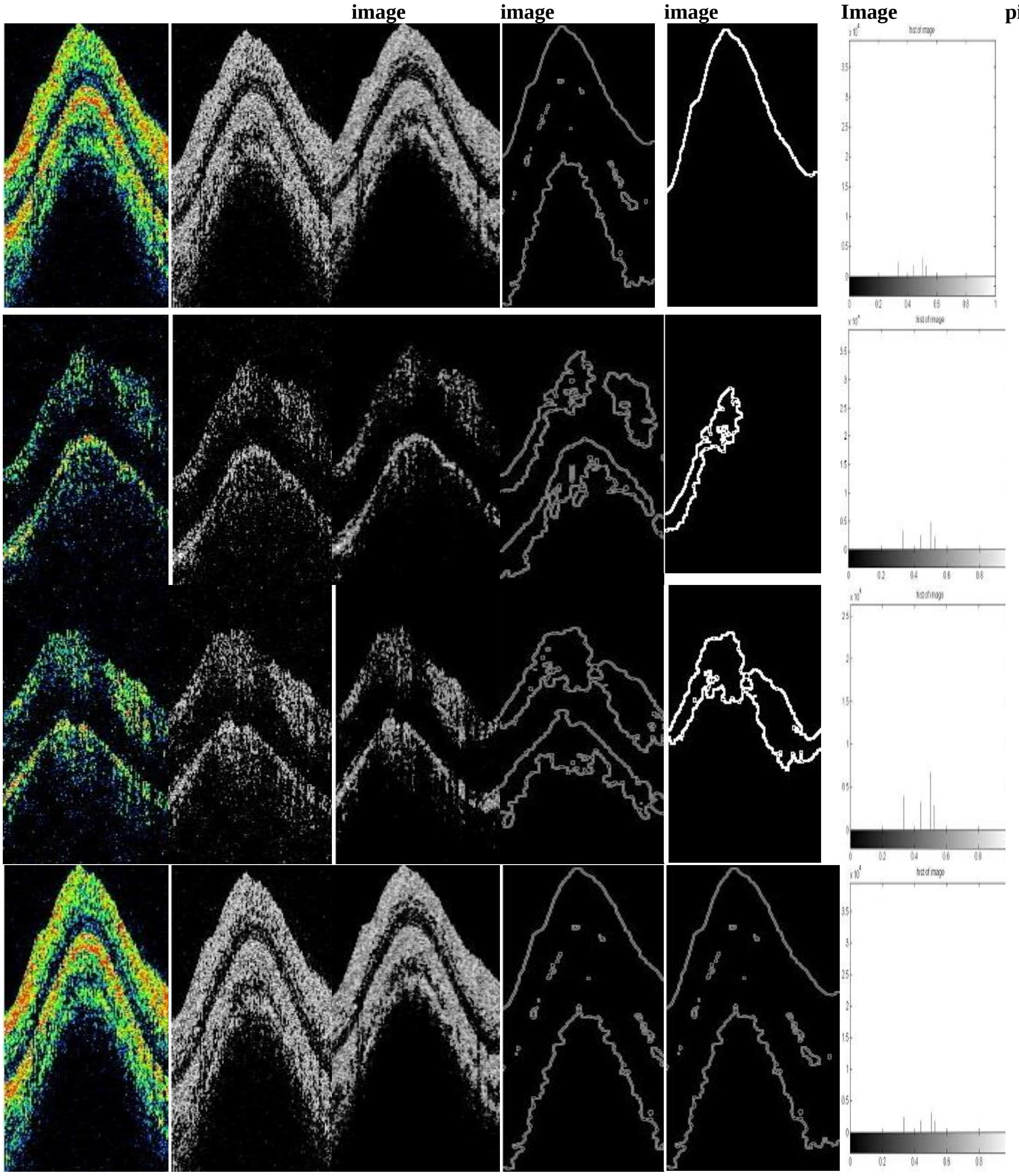


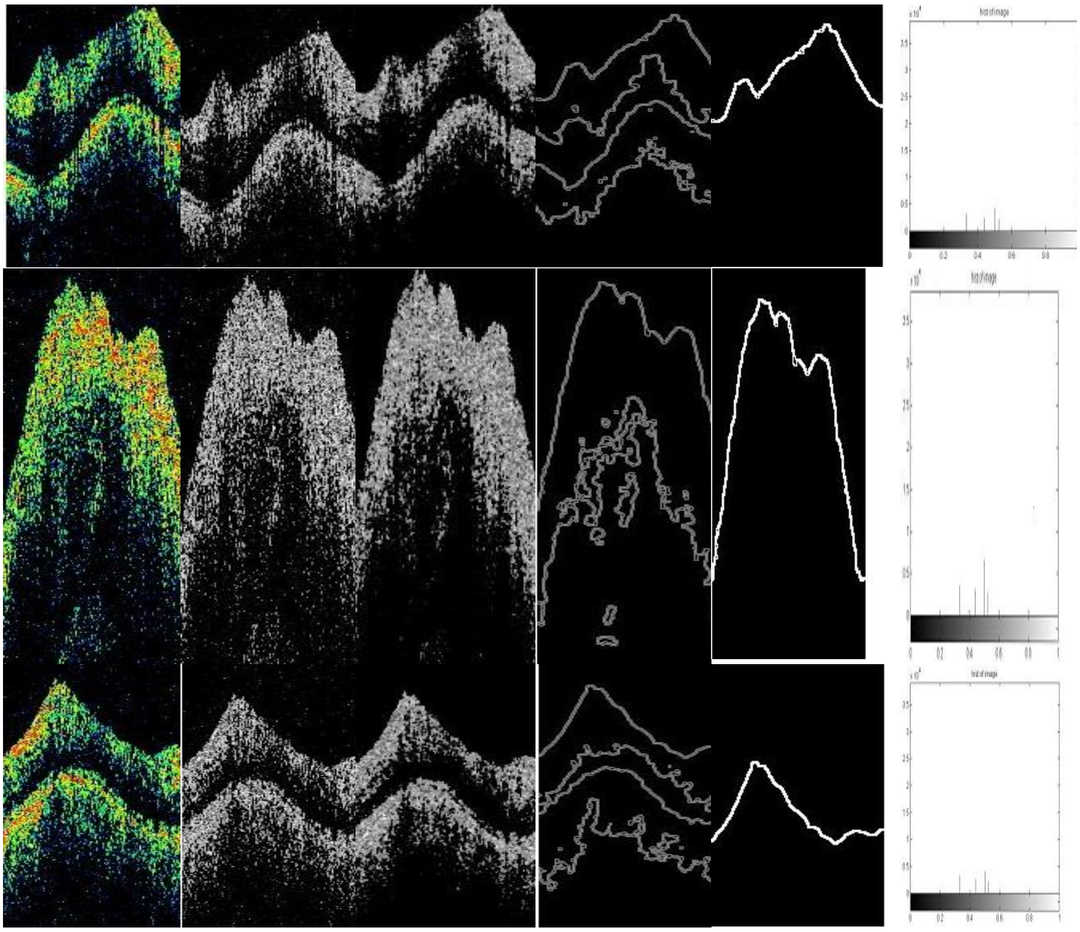
Fig 2(i) histogram of final image

III. RESULTS

A step by step approach has been performed for interpretation of accurate assessment of the optical coherence tomography (OCT) images and Optic nerve head damage and Retinal Nerve Fiber Layer (RNFL) morphology. Thickness of the RNFL decreased as the pressure increases that leads to Glaucoma is identified. Processing performed for various images is shown in fig 3(a).The White pixels indicate the affected area.



Input Image	Gray Image	Median filter image	Edge detection image	Final output image	Histogram of Image	Black pixels	White pixels
						05	1019
						08	1016
						10	1014
						06	1018



	05	1019
	07	1017
	05	1019

Thus, by using this approach, researcher in glaucoma diaeases could be helped to identify the disease earlier as soon as possible with 85% accuracy.

IV. CONCLUSION

This work concentrates on finding aefficient and accurate technique for automatically detection of optic nerve head problem in glaucoma diseased persons. A glaucoma disease is detected by using histogram operation. The histogram matching is based on the color feature and the edge detection technique. The color features extraction are applied on samples that are contained the healthy eye of human and the diseased eye of the human . This can be further used for classification of images into respective diseases using various clustering algorithms. Also can be used as one of the parameters for content based image retrieval systems.

REFERENCES

[1] AninditaSeptiarini, Agusharjoko "Automatic glaucoma detection based on the type of features used:a review" Journal of Theoretical and Applied Information Technology 28th February 2015. Vol.72 No.3 1992-8645 www.jatit.org E-ISSN: 1817-3195 366

[2] Chandrappa S. DharmannaLamani S. Jagadeesha, PhD. Ranjan Kumar H.S. "Segmentation of Retinal Nerve Fiber Layer in Optical Coherence Tomography (OCT) Images using Statistical Region Merging Technique for Glaucoma Screening". NMAM Institute of Technology International Journal of Computer Applications (0975 – 8887) 2015

[3] J. Odstrcilik, R. Kolar, R. P. Tornow, A. Budai, J. Jan, P. Mackova and M. Vodakova"Analysis of the Retinal Nerve Fiber Layer Texture Related to the Thickness Measured by Optical Coherence Tomography"2014

[4] Prageeth P.G and David.J and K.Suresh" Early detection of Retinal nerve fiber layer defects using fundus image processing",IEEE 2011

[5] SDilraj S. rewal, MD,MitraSehi PhD,James D. Paauw MD, David S. Greenfield "Detection of Progressive Retinal Nerve Fiber Layer Thickness Loss with Optical Coherence Tomography Using Three Criteria for Functional Progression",,IEEE 2011

[6] Amit S. Paranjape, BadrElmaanaoui, Jordan Dewelle, H. Grady Rylander, "Automated method for RNFL segmentation in spectral domain",International Society of Optical Engineering 2012