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A Survey Based On Glaucoma Detection.

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ABSTRACT

Glaucoma is one of the causes of injury in eye vision and gets worse over time. It is because of build up pressure inside the eye. Optical Coherence Tomography (OCT) is the highest valuable advance in retinal diagnostic imaging. There are different techniques involved in detection of Glaucoma like using optic nerve, blood vessel, optic disc and macular edema. The focus of this paper is on understand the procedure of different techniques involved in glaucoma identification in diabetic retinopathy and why it is extraordinary. There are different technologies involved in it by using different parameter as input. It also gives information of available public data set on which algorithms are tested and trained.

Keywords: Glaucoma, OCT, Retinal diagnostic imaging, Macular edema, Diabetic retinopathy.

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INTRODUCTION

Diabetic eye disease relates to a group of eye hitch that people having diabetes may face as a complication of diabetes. This can leads to severe vision loss or even myopia. Glaucoma refers to a group of related eye disorders that all cause damage to the optic nerve that passes data from the eye to the brain. Glaucoma is an ophthalmologic disease characterized by an enlargement in intraocular pressure (IOP) which if left untreated causes irreversible damage to the optic nerve and retinal fibers resulting in a continuous, permanent visual loss or myopia. It is the second prime cause of blindness. Any disproportion between the production and drainage of the aqueous will lead to an increase in IOP. General IOPs of most people falls between 8 and 21 mmHg. Glaucoma is an optic nerve disease resulting in loss of vision. It is because of linking with increased pressure of fluid present inside the eye. Glaucoma usually has less or no initial symptoms. Glaucoma can be nearly split up into two main types: open angle glaucoma (OAG) and closed angle glaucoma (CAG).

The iridocorneal angle betwixt the iris and the cornea is the key to differentiate OAG and CAG. When the iridocorneal angle is said to be open, it is OAG. When the iridocorneal angle is narrow or even closed, it is CAG. OAG accounts for more than 90% of glaucoma patients. It is typically chronic and enlightened gradually. OAG is a leading cause for blindness. It is distinctly dangerous as it can progress gradually and go unnoticeable for years. CAG affects less than 10% of patients with glaucoma. Fig (1) presents the retinal image.

Retinal image analysis has been making steady progress regarding applications in clinical practice. The system is assumed to do this by capturing the retinal images using a fundus camera. These images are to be precisely segmented to extract the sensitive objects in the retina such as the blood vessel tree, iris, the optic disk and the region between the optic disk and the macula. The positions of laser shots are to be hand out in the rest of the retina. Also a robust registration technique is to be applied to notice the motion parameters of the retina to upgrade the positions of laser shots accordingly.

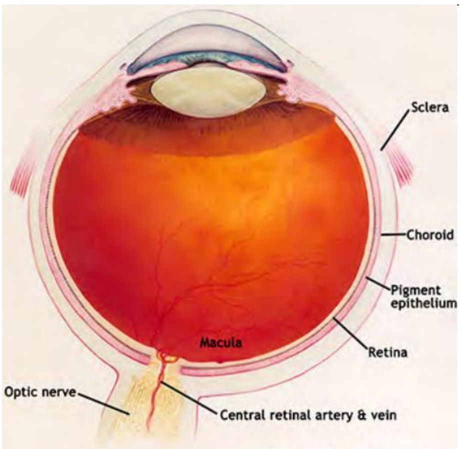


Fig (1): Retinal Image

DIFFERENT METHODOLOGY

There are different methods used to detect the presence of Glaucoma in human eye. By using optic disk, optic nerve head, macular edema and so on.

Blood Vessel and Optic Disc:

Shradha, Sharangouda (2015), in their paper[1] uses optic disc and extrication of blood vessels to detect the appearance of glaucoma. Here ROI extraction and disk boundary perception is used to segment the optic disk. The input given to the paper is 2D Fundus image. The extraction of CDR is calculated by tracking vessel detection technique. Later blood vessel extraction is detected using edge detection technique, the distorting angle is calculated. In Jun Cheng, Jiang Liu's paper[14] use focal edge association to glaucoma diagnosis. Initially this extraction from paper[1] extracts the green channel and then performs histogram process. The region growing technique is used to check for the seed points towards all feasible bends in the blood vessels. The final perfection of this paper is nearly to 95% in extraction of blood vessels and optic disc.

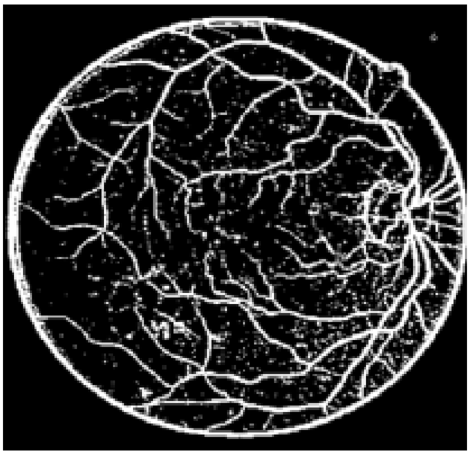


Fig (2): Extracted Image of Blood Vessel

The extracted image of blood vessel will be like Fig (2). The image has to be smoothening, so that the distorted and the noise are removed for perfect segmentation of the vessels.

Oakar Phyo, AungSoe Khaing (2014), in this paper[2] the extraction of OD and blood vessel based on the mathematical morphology on Fundus image. In the pre-processing stage, it converts the color image from RGB to HSI by contrast-limited adaptive histogram equalization (CLAHE). The paper deals with unlike filtering technique as of Median filter, Averaging filter and Wiener filter. Among these three filter, Oakar finds Median filter is effective to lower the noise in image. The resultant image is used for enhancing the Histogram equalization and Adaptive histogram equalization. By inspecting both the technique, adaptive histogram is more effective than histogram equalizer. The mathematical morphology operator includes Dilation, Erosion, Closing and Opening process. Finally Otsu's thresholding technique is applied to the image in order to detection of the desired area. These techniques help in eliminating the blurred image and provide better output. Many paper deals with histogram features, the advantage of histogram feature is explained in [18].

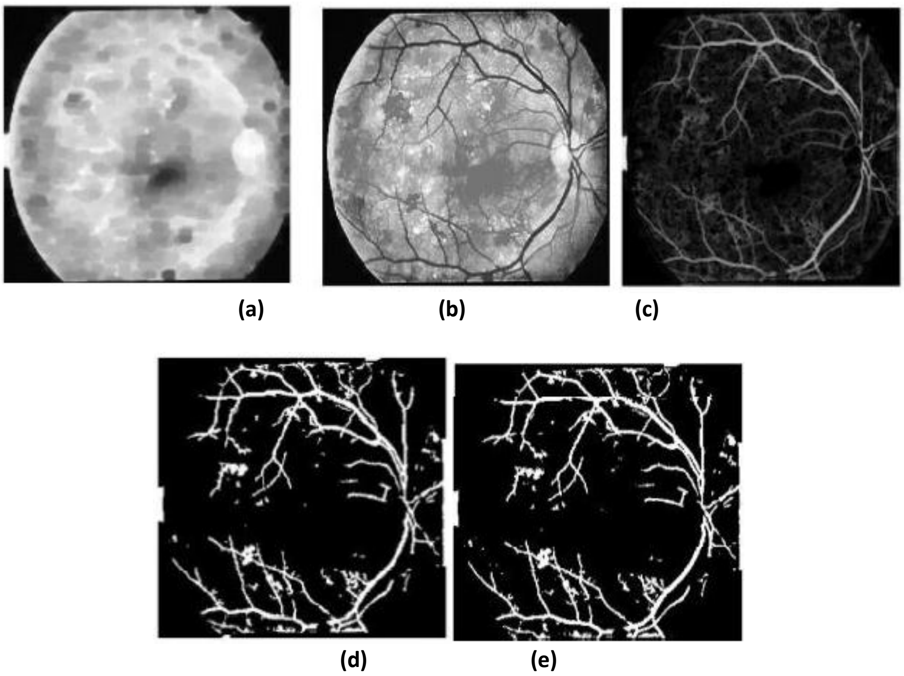


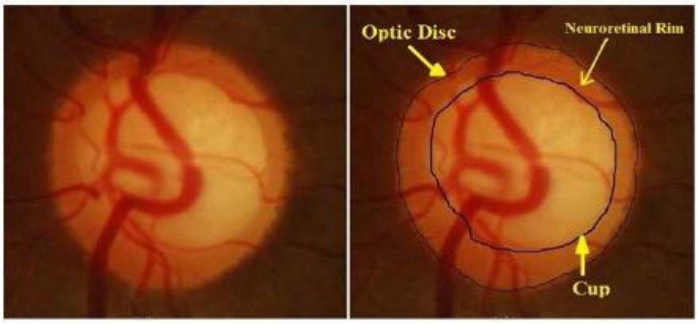
Fig (3): (a) Closing (b) Filling (c) Difference (d) Thresholding (e) Detected Blood Vessels

The results of the blood vessels perception are shown in Fig.3 (a), (b), (c), (d) and (e). The outcome of the closing and the filling of the images are shown in Fig.3 (a) and Fig.3 (b). To get the blood vessels area, Otsu algorithm applied to the difference image between the closing and the filling images. The conclusion images are shown in Fig.3 (c) and (d). The blood vessels detected area is shown in Fig.3 (e).

Optic Cup and Optic Disc:

Muthusamy, Vijayalakshmi (2014), proposed paper[3] based on the classification of optic disc based on super pixel and optic cup using gradient method for screening the glaucoma presence. Using super pixels compute center surround statistics and unify them using histograms equalization for disc and cup segmentation. It gets prior information of the cup by computing location information for cup segmentation. Super pixel uses simple linear iterative clustering (SLIC) algorithm. It computes a self-assessment reliability score for better accuracy of disc segmentation result. Center surround statistics are calculated later the optic disc is classified using Support Vector Machine (SVM) classifier.

Gradient based optic cup segmentation takes place in this paper. Unlike region of interest, this algorithm it takes the accurate value. It overcomes the problem faced by ROI technique. Fig (4) shows the coverage of optic disc and optic cup.



Fig(4): Structure of optic disc and optic cup

Sheeba, Jithin George, Rajin, Nisha Thomas, and Sherin George (2014), detects the existences of Glaucoma by using Artificial Neural Network in paper[4]. Here neural network is trained to recognize the parameters for detection of different stages of the glaucoma. The neuron model has been developed using feed forward back propagation network. Mathematical morphology is used to analysis the extraction. Dilation and erosion operator is used in this paper. The erosion Shrinks object in the image. In morphological opening, erosion removes all the small objects and the shape of the objects are restored by subsequent dilation. In Jun Cheng paper[12] uses Superpixel Classification Based Optic Disc and Optic Cup Segmentation for Glaucoma Screening.

Using neural network, weights and biases are analysis the images and train the network. The gradient is determined using back propagation, which involves in performing computations backward through network. Here Intra Ocular Pressure, Central Corneal Thickness, Nerve Fiber Layer Thickness and Cup to Disc Ratio techniques are used as parameters. Matlab neural network toolbox provides a complete set of functions graphical user interface (GUI) for the design and simulation of neural networks. GUI can be used for creating, training and simulating neural networks. Using back propagation technique it provides the better accuracy of glaucoma presence. In Medha V. Wyawahare and Dr. Pradeep's paper[17] detects glaucoma by the performance evaluationof optic disc segmentation algorithmsin retinal fundus images.

Mahalakshmi, Karthikeyan (2014), used clustering based optic disc and optic cup segmentation for Glaucoma detection. This paper[5] deals with IOP (Intra Ocular Pressure) in eye and nerve head, the method used here is SLIC algorithm which provides promising output. It also uses K-Mean algorithm to detect the glaucoma presence. The method of segmentation is to obtain accurate boundary delineation. In disc and cup segmentation, histograms and centre surround statistics are the sequence of operation used to classify each super pixel as disc or non-disc, the location information is also included to boost the performance.

K-Means algorithm is an unsupervised clustering algorithm that classifies the input data locates into multiple classes based on their inherent distance from each other. Gabor filter is a linear filter used to detect the edge and it will reduce the noise. Gabor filter can be tuned for specific frequencies and orientations which are very useful for the edge detection. They act as low level oriented edge discriminators and also filter out the background noise of the image. In cup segmentation, use thresholding or binarization for optic cup segmentation process. This process will convert the image into a B/W (Black & White) image so that it can be easily segment the optic cup from disc region. After obtaining the disc and cup, the clinical convention is used to computing the CDR. It is the ratio between the Vertical Cup Diameter (VCD) &Vertical Disc Diameter (VCD).

Using structural features like CDR (Cut to Disc Ratio), the ratio value exceeds 0.6 shall be further analysis of a patient to the ophthalmologist. This technique leads to provide better output using K-Mean algorithm.

OCT Images:

Akram Belghith, Christopher Bowd, Linda M. Zangwill and Robert N. Weinreb (2014), this paper[6] deals with 3D optical coherence tomography input images. This approach deals by locating Bruch's membrane opening for estimating the optic disc area and rim area of 3D spectralis OCT images. The poor resolution image is overcome by the deconvolution approach. To estimate the optic disc size and rim area, new regression method is done based on the artificial neural network principal component analysis (ANNPCA).

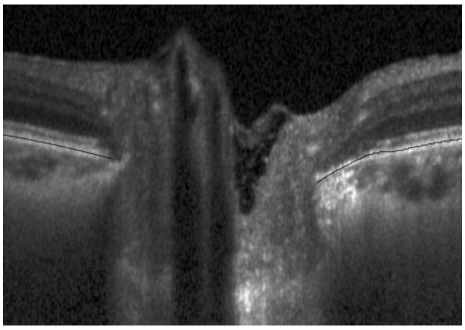


Fig (5): BM Segmentation

It is a hierarchical estimation of neuroretinal rim area using 3D-OCT images. Fig (5) shows the BMO segmentation in the OCT images. The diagnostic accuracy of rim area, and rim to disc area ratio were compared to Retinal Nerve Fiber Layer (RNFL) thickness measurements and the combination of rim area and RNFL thickness for glaucoma detection. This approach provides better output to the system.

Soe Ni Ni, Pina Marzilian and Hon- Tym Wong (2014), used fractal dimension index on SS-OCT images by defining Angle closure technique in paper[7]. The angle is measured by the Fractal Dimension for analyzing quantifies the complexity or changes of angle recess. The FD index with biometric parameters is used to classify open and closed angle. This approach provides better representation of the angle configuration. It uses computer aided diagnostic tool for ACG diseases. Even in Paul Y. Kim's paper[13] uses fractual feature based detection of glaucoma.

This approach deals with three steps, pre-processing, segmentation of anterior chamber and fractal dimension analysis. On segmentation, the anterior chamber, the iris, the cornea and the edges has to be detected by ACA apex localization and ROI detection. Fractal analysis of ACA is done by differential box counting method (DBCM). The paper[9] also deals with similar functionality by using Anterior Chamber Angle of eye.

Alain Coron, Ronald H. Silverman, Amena Saied and Pascal Laugier (2007), to localize the cornea, the lens and the iridocorneal angle in high frequency in vivo ultrasound acquisitions. The paper[8] says, by providing input images, noise removal and resampling is done. An image on Cartesian grid is taken aside, and detects the edges and ridges. At side of edges, edges are detected and marked. While at ridges, it selects ridges by Hough transform for detecting the circle. Three circles are detected, one for the each face of the cornea and one for the lens. Finally, ACA is detected by the edges and ridges.

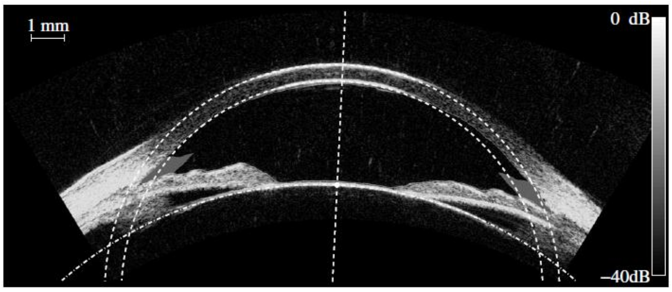


Fig (8): Detected circular approximation of the two faces of the cornea and the lens.

The detection and localization of the cornea is quite satisfactory. The detected circles are always very close to the apex of the cornea. Near the iridocorneal angle, the cornea faces are to be in rare cases at about 1 mm away from the circle. The lens is also well identified in its center part in all cases. But it may transpire that the circle that localizes the lens goes through the iris instead of passing behind it. So a circular approximation of the cornea and the lens makes sense. This helps at identifying cornea edges and ridges. Even M. Lepine Shaw in his paper[10] uses the ultrasound of eye image and Alain Coron paper[11] uses high frequency ultra sound image of eye.

The method does fail three times, because: it mixes up an artifact and the iris, an edge inside the iris is preferred to the anterior chamber/ iris true edge. Note that the iris is weakly echogeneous and the lens circle passes through the iris and not behind it and fails at detected a very flat left angle. On that image the anterior chamber is tiny and the iris comes into contact with the cornea. The automatic segmentation process will be complete; it will tackle the automatic measurement problem of the iridocorneal angle, and compare to automatic method with measurements done by an expert. In R.Youmaran, P. Dicorato's paper[15] & [16] uses Automatic Detection of Features in Ultrasound Images of the Eye.

CONCLUSION

The Survey paper proposed various methodologies to deal with detection of glaucoma. This has almost covered various methods of input to detect and faster way of analysising the presence. From various input like Fundus images, OCT images and ultrasound for recent trend were described here. The paper tries to cover the recognition of the diabetic tetinopathy and the vision system which affects due to the Diabetic retinopathy. Therefore there is a need for automated screening and detection system of various lesions, which may be occurring at the early stages of Diabetic retinopathy, so that preventive measures can be taken to prevent blindness.

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