A significant progress of computer aided diagnosis system using automated glaucoma screening

Yerramsetti V Rao*1, Murthy V S S N1, Eswari V2, Aruthra2

1Department of Anesthesia, Konaseema Institute of Medical Sciences Research Foundation, Amalapuram, Andhra Pradesh, India
2Department of Pathology, Meenakshi Academy of Higher Education and Research, Chennai, Tamil Nadu, India

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ABSTRACT

The automatic retinal image examination will be developing and significant screening device for initial recognition of eye diseases. This research proposes a computer aided diagnosis framework for initial recognition of glaucoma through Cup to Disc Ratio (CDR) measurement utilizing 2D fundus images. The system uses computer based analytical methods to procedure the patient data. The Glaucoma is chronic & progressive eye disease which damages optic nerve (ON) caused by improved intraocular pressure (IOP) of eye. The Glaucoma mostly affects on optic disc (OD) by enhancing cup size. It might lead to blindness whether not recognized initially. The glaucoma detection through “Heidelberg Retinal Tomography (HRT) optical Coherence Tomography (OCT)” have been more costly. This system proposes an efficient technique to recognize glaucoma utilizing 2D fundus image. The physical analysis of OD is a normal process utilized for identifying glaucoma. In this manuscript, we suggest automatic OD parameterization method is based on segmented OD and optic cup (OC) region attained from fundus retinal images. To automatically extract OD and optic cup, we used K-means clustering technique, SLIC (Simple linear iterative clustering) method, Gabor filter and thresholding. To reshape the attained disc and cup boundary ellipse fitting (EF) is applied to obtained image. We also propose a novel method which automatically calculates CDR from non-stereographic fundus camera images. The CDR is initial clinical indicator for glaucoma assessment. Also, we have calculated OD and cup area. These features are validated by classifying image either normal or glaucomatous for given patient.

INTRODUCTION

Glaucoma is chronic and irreversible neurodegenerative disease. It is disease of ON categorized by retinal ganglion cell death & equivalent nerve fiber layer loss. It also caused due to enhanced eye IOP. The Glaucmatous damage might consequence in loss of visual field and eventually causes blindness. As Glaucoma might not be cured detecting disease in time is very significant. The better path to tackle the glaucoma is to recognize initially. The Glaucoma might impact all age group, but, main danger element contains age, glaucoma
family history, being short sighted & diabetics. In common, glaucoma might be recognized through diverse models by examining physiological factors of eye. The image processing method utilized for retinal fundus images, Ultrasound images & OD photographs are used by numerous investigators to recognize glaucoma in Figure 1. The main symptoms of glaucoma comprise Rainbow hallows with light Headache, Blurred vision, Vomiting with Red Eye, Severe pain in eye, & Brow pain Nausea (Thomas, 2011).

Figure 1: Medical Image of Normal and Glaucoma affected eye

A function test through vision loss needs special equipment which is currently only in territory hospitals. So it is inappropriate for glaucoma screening. Another approach is ON head assessment which is very much talented and greater than IOP dimension & visual field testing but it might be done manually by trained ophthalmologist. As manual examination is more costly & time taking. Hence automatic nerve head assessment (ANHA) might be valuable. In ANHA image features utilized for binary classification among healthy subject & glaucomatous. In this approach, features selection & classification approach is problematic and stimulating.

Figure 2: The region among blue & red line is neuro-retinal rim area

Literature Survey

Many surveys are stated in review for direction of OD classification detection of glaucoma. This work is as follows:

The work Bock et al. (2010) suggests a new automatic acquisition approach of glaucoma recognition framework is low-cost & extensively circulated on digital color FI utilizing cataract after processing numerous particular generic feature kindsan arrowed reduction presence-based method dimension.

The work Bock et al. (2010) suggests feature set, which has been calculated from "Color Fundus Imaging (CFI)" & 2 class categorizations will be worked to state the provided image as glaucomatous or normal. These features have been calculated at image level without executing OD & cup segmentation selection of feature & classification approach is problematic & challenging.

The work Joshi et al. (2011) suggests a disc parameterization with molecular CFI in monocular CFI provides 2D projection of retinal structure while OD seems as elliptical region or bright circular partly occluded by blood vessels that highlights both OD & OC regions.

Hancox (1999) suggested the work on “online retinal FI database” for glaucoma examination & survey those goals to share clinical RI with public. The journalist had upgraded method constantly with more clinical ground truth images (Harizman, 2006; Xu et al., 2007).

Cheng et al. (2013) suggested a semi-automated technique for glaucoma recognition utilizing ISNT & CDR of FI.

Anusorn et al. (2013) suggested a work on glaucoma recognition with disc parameterization utilizing stereo CFI, OD & cup region has been divided to evaluate relevant disk factors. As against molecular CFI a stereo set of CFI permits capture of partial depth data that supports in best cauterizing region inside OD, cup, neuroretinal rim & substantial body of work in disc parameterization are utilizing stereo CFI (Abramoff et al., 2007).

Proposed Methodology

Figure 3 shows the proposed system framework for computer aided system for glaucoma assessment through automatic CDR measurement. In order to estimate vertical CDR first OD and OC have to be segmented from retinal images (Stapor et al., 2004).

Region of Interest (ROI) Detection

To extract OD and cup ROI around cup disc should be described. The fundus image (FI) with highest intensity will be chosen as OD center as exposed in Figure 2. Main structure of OD: region enclosed by red line is OD & central bright zone enclosed by blue line is OC.
Image Preprocessing

In this input image is taken from fundus camera is utilized for preprocessing. The image preprocessing includes organizing image for classification feature extraction. Primarily, we have to improve image. We might either apply basic filter methods or we might utilize histogram equalization methods for image improvement. The image processing includes noise removal, adjustment, & segmentation might be executed by preprocessing. In this system, we used adaptive histogram equalization technique for image preprocessing as shown in Figure 4. It also comprises RGB separation, RBG to HSV conversion, RGB to CMY conversion, Histogram representation and channel selection. From RGB, HSV & CMY color space best channel has to be selected which describes OD, cup & blood vessels in. The OD signifies most brilliant locale inside retina and OC is white area inside OD. By assessing every channel it is discovered that value channel portrays most splendid district in FI and utilized for OD division. The magenta channel in CMY color space portrays white cup & blood vessels in FI so this channel is chosen for OCS.

Super pixel Generation

Numerous methods have been suggested for super pixel classification. These are valuable in image segmentation. This manuscript utilizes SLIC method to generate super pixel. It is easy & effective technique to decompose image in visually homogeneous region and adherence to image boundaries on Berkeley benchmark. SLIC is easy to utilize with only 1 factor that is number of desire super pixel k. K-mean clustering technique performs a main character in feature extraction phase to calculate one of features for CDR. The K-means clustering will be a technique of cluster examination purposes to divide and observation into k clusters in every observation exists to cluster with nearest mean. Then group comprises only edge recognition of disc boundary is designated in Figure 5.

Optic Cup Segmentation (OCS)

After attaining the disc, the disc minimum bounding box will be utilized for cup division. When contrasted with extraction of OCS, OD is very challeng
Optic cup smoothing

After identifying cup boundary, EF might be employed to remove few cup boundary unexpected variations in curvature. The EF becomes valuable whereas part of blood vessels in neuro-retinal rim outside a cup is comprised with detected boundary. The segmented optic cup is shown in Figure 6.

CDR calculation

After attaining cup & disc, diverse features might be calculated. In this suggested framework, we follow clinical convention to calculate CDR. The CDR is significant pointers for glaucoma calculation. Due to whereas will be at development phase, increasing cup area that occupies maximum disc area & there will no modification for OD. Therefore, increment in CDR specifies pathological situation. The CDR might be calculated as ratio of “vertical cup diameter” to “vertical disc diameter”.

\[ \text{CDR} = \frac{\text{VCD}}{\text{VDD}} \]

The calculated CDR will be utilized for glaucoma screening. While CDR is higher than threshold it is glaucomatous else it is deliberated as healthy one. CDR value of healthy eye is 0.3 to 0.6. The Table 1 represents the CDR value for glaucoma affected & normal eye.

| Subject            | CDR Value |
|--------------------|-----------|
| Normal Eye         | 0.235     |
| Glaucomatous Eye   | 0.586     |

Experimental Results

The suggested technique was tested on data set of RI gathered from ongoing pilot survey in collaboration with local eye hospital. Our experiment uses 40 fundus images collected from Atharva Netralya and Research Center and National Institute of Ophthalmology (NIO) Pune. The IOP is measured for these eyes. Between these images, cup & disc boundaries from given data set with dimension 3072*2048 are manually marked by trained professional in past surveys for cup & disc segmentation.

Various factors like rim volume, cup volume & area, disc area and volume and CDR is calculated to examine the captured RI of patients in hospital. The CDR measurement is completed utilizing flow graph pro-
vided in sample image is deliberated for CDR calculation shown in Figure 7.

The glaucoma risk will be calculated relied on CDR value and if value is higher than 0.65 specifies high risk of glaucoma. The numerous parameters for glaucoma calculation obtained from Stratus OCT machine from Atharva Netralay and Research Center Pune, India. The various images are compared their CDR value with clinical method and proposed method for glaucoma classification. It is noticed that assessed value are much near to clinical value and correctness is confirmed with ophthalmologist. Also, it is noticed that glaucoma level varies from 1 eye to another eye, independent of age & relied on physical factor of eye.

CONCLUSIONS

This research proposes an efficient technique for automated glaucoma screening. We introduced super pixel classification based technique for OD and cup segmentation. The CDR will be a significant indicator in glaucoma diagnosis. In this survey, we have introduced a technique to estimate CDR mechanically from color FI. For calculation of CDR, first we have segmented OD using SLIC and K-means clustering approach. Then optic cup is segmented using color component examination and thresholding level set technique. We proposed EF approach to reshape disc & cup boundary which is an approximation to actual boundary. Comparing with clinical values, the established method attains best CDR value to diagnosis glaucoma precisely. As outcome, this survey has best potential in automated screening scheme for initial recognition of glaucoma. The next improvements for survey are to improve the presentation of cup segmentation technique by comprising a technique of vessel impainting & detection. Furthermore, in future work numerous kernel learning will be applied for improvement.

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Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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