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A SURVEY ON GLAUCOMA ANALYSIS TECHNIQUES USING 2-D RETINAL IMAGES

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ABSTRACT

Glaucoma is a chronic eye disease and is also called as silent theft of sight that leads to a vision loss. It is not curable and but we can slow down through treatment. However many patients are unaware of this disease because it progresses slowly. The main cause of this disease is increase of Intraocular Pressure (IOP). Screenings of glaucoma based on retinal images have been performed in the past few years. There are several image processing techniques to detect glaucoma. The general techniques are image segmentation, image fusion, image enhancement, morphology, image classification, analysis and statistical measurements. The main idea of this paper is to describe the several image segmentation techniques and classification techniques for glaucoma detection.

KEYWORDS: *Glaucoma Screening, Cup-to-Disc ratio, superpixel, support vector machine, feature extraction.*

1. INTRODUCTION

Glaucoma is chronic eye disease that leads to blindness and it is predicted to affect 80 million people by 2020 [1]. As the disease progressed without any visual symptoms. Intraocular pressure (IOP) is a pressure on eye. When this IOP increases it causes severe damage to the optic nerves [2]-[4]. This damage leads to low vision and eventually blindness. At the early stage of this disease 60-90% people are unaware until it reached its advanced stage of risk. Manual analysis of glaucoma disease was time consuming and was only done by trained professionals. Currently automatic glaucoma detection techniques are used to detect the risk of glaucoma disease at low costs using 2-D fundus image. The 2-D fundus image was acquired at very low cost

because fundus camera was available in all eye hospitals and even at optical shops. The automatic glaucoma detection technique processes this 2-D fundus image and identifies the Cup-to-Disc ratio. The image processing techniques such as image acquisition, image segmentation, image enhancement, image feature extraction and image classification are used to screen the glaucoma. Now-a-days the automatic screening techniques were most efficient and time consuming but challenge is to correctly identify the optic disc and optic cup in the given 2-D fundus image.

In 2-D fundus image the optic disc region was divided into two regions the centre bright region called optic cup and the outer peripheral region called the neuroretinal rim. They are shown in the following images.

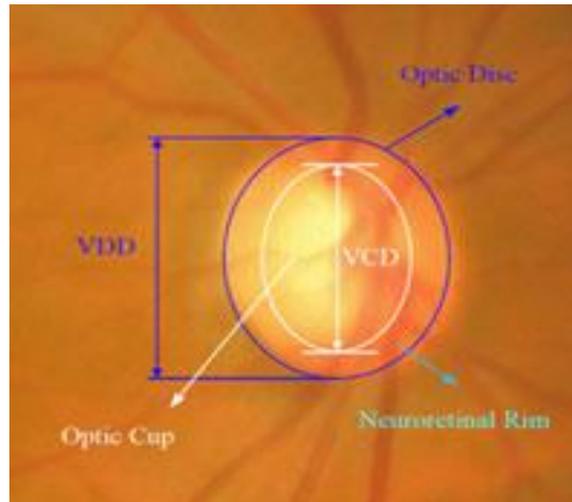


Figure 1. Structure of an optic disc: optic disc boundary (blue), optic cup (white), neuroretinal rim (cyan)

1.1 Types of Glaucoma:-

1.1.1 Primary Open Angle Glaucoma:-

The open angle glaucoma is the most common and symptoms are slow to develop. It results in objects missing out of the side or corner of the eye. This type of glaucoma is mainly due to drainage canals that become clogged over time or the eye over-produces aqueous fluid which causes the pressure inside the eye to build to abnormal levels. The inner eye pressure (IOP) rises because the correct amount of fluid cannot drain out of the eye. It's affecting 70% to 80% of those who suffered from the disorder and it is painless and does not have acute attacks.

1.1.2 Angle Closure Glaucoma:-

It is also known as Acute Narrow Angle Glaucoma and accounts for less than 10% of glaucoma cases in the United States. This problem occurs more commonly in farsighted elderly people, particularly in women and often occurs in both eyes. Angle Closure Glaucoma occurs primarily in patients who have shallow space between the cornea at iris that lies just behind the cornea. As the eye ages, the pupil grows and become smaller, restricting the flow of fluid to the drainage site. As fluid builds up and blockage happens, a rapid rise in intraocular pressure can occur. This kind of Glaucoma is normally very painful because of the sudden increase in pressure inside in the eye.

1.1.3 Secondary Glaucoma:-

The above open angle glaucoma and angle closure glaucoma can be primary or secondary conditions. Primary conditions are when the cause is unknown, unlike secondary conditions which can be traced to a known cause. Secondary glaucoma may be caused by a variety of medical conditions, medications, eye abnormalities and physical injuries. The treatment of secondary glaucoma is frequently associated to eye surgery.

2. LITERATURE REVIEW

A. Optic disk feature extraction via modified deformable model technique for glaucoma analysis:-

In this paper J. Xu [5] proposed a modified deformable model technique that extract feature from optic disc for glaucoma analysis. This method extends the original snake method based on two aspects they are knowledge based clustering and smoothing updates. The initial contour are deformed and are clustered into two groups that is edge point group and uncertain point group. These are then updated based on the combination of local and global information as a result of this the optic disc boundary was identified. The optic disc boundary is necessary to identify the optic cup region. The same modified deformable model is applied to identify the cup boundary but keeping the disc boundary as a initial contour. After cup and disc boundaries

are identified the CDR ratio was calculated to analyse glaucoma. The experimental result shows that this method achieves accuracy of 94% when compare to other method. The CDR error of 0.084 was estimated based on manual CDR calculation.

B. Optic disk and cup segmentation from monocular color retinal images for glaucoma assessment:-

In this paper G. D. Joshi [6] proposed a algorithm for glaucoma assessment from monocular color image based on optic disc and cup segmentation. This method integrates the local image information around each point of interest region in multidimensional feature space and the cup region was segmented based on anatomical feature such as vessel bends. The estimated cup-to-disc ratio error for this method is 0.08.

C. Classifying Glaucoma with Image-based Features from Fundus Photographs:-

In this paper R. Bock [7] proposed a method that classifies glaucoma based on image features. This method applies the standard pattern recognition pipeline and several type of image features such as pixel intensity, FFT coefficient, histogram model and texture. Then these features are classified using support vector machine (SVC) classifier with an accuracy of 86% success rate and the estimated CDR mean error is approximately 0.076.

D. Glaucoma risk index: Automated glaucoma detection from color fundus images:-

In this paper R. Bock [8] proposed a appearance-based dimension reduction technique. Initially the pre-processing step was applied to reduce the variances that are not related to the diagnosis processes. In this paper the green channel is used for illumination corrections, vessel removal and optic nerve head normalization. The next step in this processes is feature extraction, the features such as FFT coefficient, pixel intensity value and B-spline value are extracted. These parameters are used to classify class label as glaucoma or not. In this paper the support vector machines are used but to get good benefit from the feature they need to be combined. The two-stage classifier used for this combination, in first stage the three features are classified separately and the probability for the features are determined. In second stage these probabilities are concatenated to one low-

dimensional feature vector. Probabilistic SVM processes this probability of generated vector as feature and outputs one glaucoma probability. The obtained Glaucoma Risk Index (GRI) reached a classification accuracy of 80% and the estimated mean error when compare to ground truth is approximately 0.085.

E. Optic Disc and Cup Boundary Detection using Regional Information:-

In this paper G. D. Joshi [9] proposed a method that estimates the relevant disc parameters from the OD and cup region. First stage of this process is optic disc boundary detection; this can be achieved by OD localization based on intensity information. Then followed by OD localization, in this paper they restore the disc region by reducing the distraction caused by the blood vessels. The blood vessels are removed by applying the morphological closing operation with specific structured element. After blood vessels are removed the region-based active contour is used to detect the Optic disc boundary and the color and structure information are used to detect the cup boundary. Based on the cup and disc diameter the CDR ratio was calculated. The mean CDR error estimated for this method is 0.100.

F. Superpixel Classification Based Optic Disc and Optic Cup Segmentation for Glaucoma Screening:-

In this paper J. Cheng [10] proposed a superpixel classification based optic disc and cup segmentation for glaucoma screening. At the first step the image was segmented into superpixels then each superpixel was classified based on the histogram and center surrounding statics to segment the disc and non-disc region. For cup segmentation in addition to histogram, center surrounding statics the location information are used. Then CDR ratio was estimated based on the diameter of the cup and disc region. The mean CDR error estimated for this method is 0.092, which is less compare to region based glaucoma screening method.

G. Efficient Reconstruction-Based Optic Cup Localization for Glaucoma Screening:-

In this paper Y.Xu [11] proposed a reconstruction based learning technique in fundus image for glaucoma screening. In this paper the optic disk was segmented by applying the active shape model and then normalized to get

standardised circle. The optic cup was localized based on the reconstruction based method. The estimated mean CDR error according to the ground truth value is 0.071 for this proposed reconstruction based method.

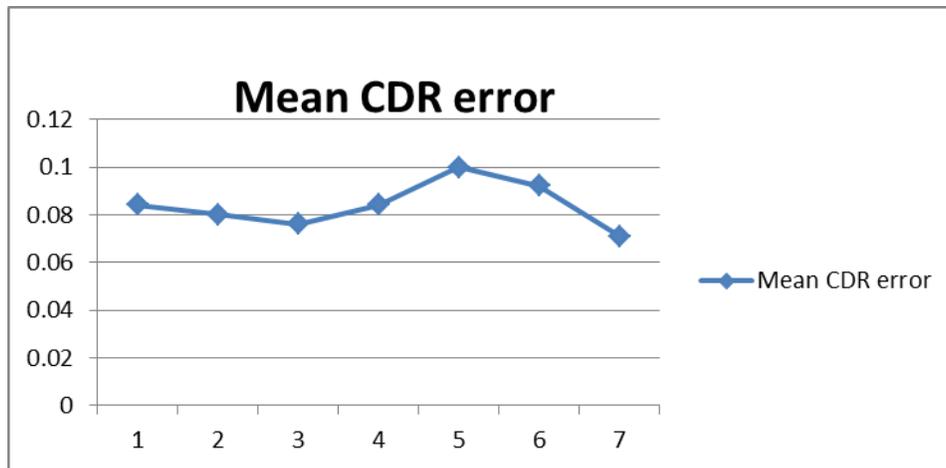
The following is the comparison chart of the above glaucoma detection methods based on the mean CDR error that was estimated based on the ground truth value that was manually calculated but the expert.

Table I: Comparison of Above Glaucoma Detection Technique Based on Mean Error Value

The following line graph shows the variations between mean error of different glaucoma diagnosis techniques.

Glaucoma Detection Techniques	Mean Error Value
Modified deformable model	0.084
OD and Cup segmentation from monocular color image	0.08
Image based feature	0.076
Glaucoma Risk index	0.084
Regional Information	0.100
Superpixel Classification	0.092
Reconstruction based method	0.071

Figure 2. Comparison of mean error value of above glaucoma detection techniques.



3.CONCLUSION

We have presented the literature survey of some papers to detect the glaucoma in 2D fundus retinal images with using several techniques. we have work with some segmentation ,feature extraction and classification technique to segment the optic disc, cup region and classifies the image based on their feature selection of the image. In this paper we conclude that efficient reconstruction based optic cup

localization is best suits to analyse glaucoma when compare to other methods.

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