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Survey on Detection of Glaucoma in Fundus Image by Segmentation and Classification

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***Abstract*— Reliable glaucoma detection in digital fundus images is still an open issue in biomedical image processing. The detection of glaucoma in retinal fundus image is essential for preventing from the vision loss. Glaucoma is an irretrievable chronic eye disease which leads to blindness that caused due to the damage of optic nerves. The time of glaucoma detection is very important to be slowed down by treatment whereas glaucoma cannot be cured. Particularly there is no effective method for detection of glaucoma in current status. Nowadays many studies have shown that the detection or screening of glaucoma in 2D retinal fundus image. This paper addresses the survey on various methods of segmentation and classification technique to detect the glaucoma from the retinal images based on the Cup to Disc Ratio (CDR) evaluation of preprocessed image. This survey paper presents an image processing technique for segmentation of optic disc and cup as well as diagnosis of glaucoma using obtained the features from the image based on the study of adaptive thresholding technique and SVM classification technique compared to remaining or existing algorithms.**

Keywords*— Biomedical image processing; Optic Disc detection; SVM classification; Glaucoma detection; Cup to Disc Ratio (CDR), Adaptive threshold, Fundus image.

I. INTRODUCTION

This image processing is performs the operations like following Image Acquisition, Enhancement, Restoration, Morphological processing, Feature Extraction, Segmentation, Pattern recognition, Classification, Projection and Multi-scale signal analysis.

The medical imaging is one of the technique that process of creation of visual representation of interior of human body for clinical and medical analysis. In our research, we concentrate on the concept of glaucoma detection. Normally eye can be divided as two categories based on their characteristics of eye [1], [2].

1. Non-Glaucomatic eye (Normal or Healthy eye)
2. Glaucomatic eye

In normal healthy eye, the light rays enters to the eye via the cornea, pupil and lens. Those rays are fully focused onto the retina directly, then the light-sensitive tissue are lining the eye backside and retina converts those light rays into some impulses that can sent via the optic nerve to brain, at that time only they are recognized as image [1].

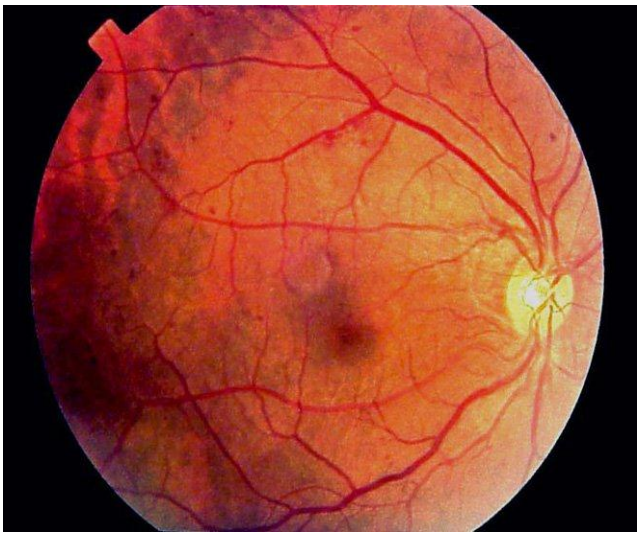

Fig. 1. An example of a fundus image showing signs of Glaucoma.

In glaucoma eye, blind spots are developed when the optic nerve fibers can occurred the damage and blind sports are usually unable to detect until optic nerve is damaged. The Early detection and treatment keys to preventing vision loss from glaucoma [2].

In general, Glaucoma occurs as a result of increased intraocular pressure (IOP) caused by a malfunction or malformation on of the eyes drainage system. Normally the eye have 19-21 inches of mercury of IOP [1], [2]. Whereas the compression of retina, progressive and permanent loss of eyesight if left untreated is caused by increased pressure. Glaucoma can be described and characterized by following conditions,

1. Raised intraocular pressure(IOP)
2. Optic Nerve Head(ONH) damage
3. Corresponding loss of visual field

The main highlight of this study is described as follows,

1. Analyse the optic head region for glaucoma detection.

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2. An Adaptive thresholding technique which is used to segment the optic disc and cup.
3. CDR, NRR and blood vessels are obtained as the features of retinal image.
4. SVM classifies achieves the result of accuracy and sensitivities are 94.11% and 100%

II. DISCUSSION ABOUT RETINAL PARTS

In the retinal image Optic Disc (OD) is one of the main features (Fig. 1). Here the methods are described for its detection of automatic [3], [4]. OD Detection is a key component of pre-processing in many algorithms specially designed for retinal anatomical structures automatic extraction. Hence, an associated module of most retinopathy screening systems. The OD usually gives as a landmark for other fundus image features like the quite constant distance between the macula-center (fovea) and optic disc. The changes in the color or depth of OD, size and shape is the main indicator of various ophthalmic pathologies particularly for glaucoma [6], hence the measurement of abnormal features used by OD dimensions as certain retinopathies, such as diabetic retinopathy as well as glaucoma [7]. The Identification and removal of OD improves the classification of exudates regions [8].

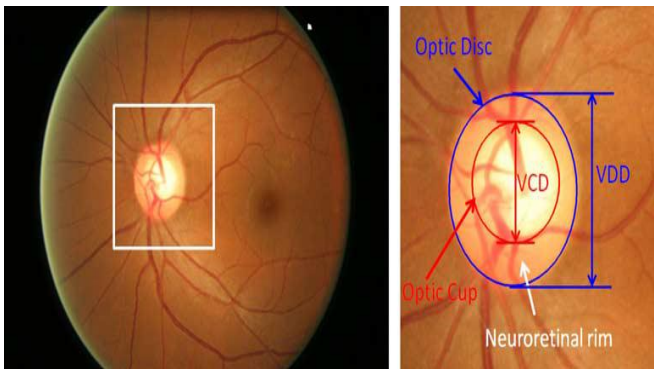

Fig. 2. Major structures of the optic disc. The region of optic disc is enclosed by blue line; the red line is enclosed the central bright zone region; and the region between the red and blue lines is the neuroretinal rim. Structure of an optic disc: optic disc boundary (blue), optic cup (white), neuroretinal rim (cyan), CDR is computed by VCD/VDD

The disc can be divided into a central bright zone and peripheral regions. A central bright zone is called as optic cup and the peripheral region is called as neuroretinal rim. The features are enumerated as the ratio of the following that is vertical cup diameter to the vertical disc diameter clinically.

Where,

VCD is Vertical Cup Diameter

VDD is Vertical Disc Diameter

The process of detecting/localizing the optic disc aims only to correctly detect the center point of the optic disc automatically [4].Effective treatments for glaucoma are available, through the continuous monitoring and early detection is needed to diagnosis the glaucoma for glaucoma patients. Vessel segments may be disconnected from the vascular tree, and appear as small, dark objects of various shapes.

III. WORKFLOW DIAGRAM

The workflow diagram shows the detection stages to identifying the problems found in retina which are provided with the set of modules. This overall workflow diagram for existing system to diagnosis the glaucoma screening.

Mostly the existing systems are implement the following modules as follows,

1. Image acquisition
2. Preprocessing (Morphological operations)
3. Region extraction & Segmentation
4. Feature extraction & Classification

These are the modules are followed by the existing systems to glaucoma detection.

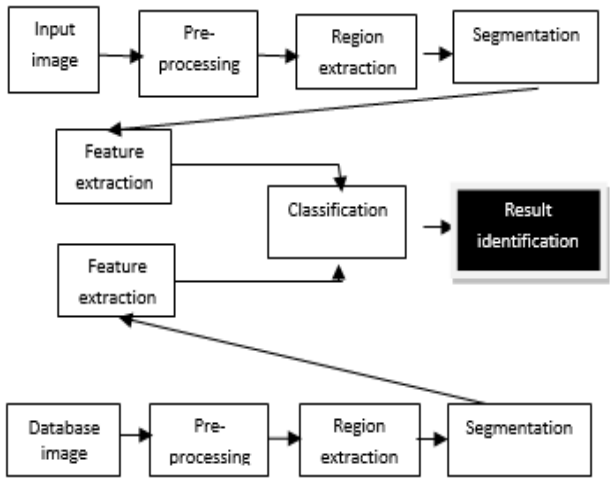

Fig. 3. Normal workflow of the proposed method.

IV. LITERATURE SURVEY ON GLAUCOMA DETECTION

We have referred various research papers issued by different researchers in the international journals and conferences. All these papers are described the basic ideas and concepts which we are implementing through our paper. The various algorithms are as follows.

A. Sparse Dissimilarity Constrained Coding for Glaucoma Screening

This paper presents about compute the CDR using the method of Sparse Dissimilarity-Constrained Coding (SDC) to locate and segment the disc from the image. The location of disc is finding approximately and sometimes very often to the disc which is based on their anatomical structures and brightness among the macula, blood vessels of retina and those anatomical structures [4]. In this paper, they proposed the self-assessment disc segmentation method of state-of-

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the art is used. It gives more accurate result of screening the glaucoma in retinal fundus image.

B. Superpixel classification based segmentation of optic disc and optic cup

The superpixel classification is a technique to classify the image based on their category as well as segment the specific region of the image. This paper mainly proposed the technique of segmentation which is used to segment the optic disc and optic cup in the given retinal image by using the superpixel classification technique [6], [7]. Here the automated optic disc segmentation quality is evaluated by the computation of a self-assessment of reliability score. The proposed segmentation techniques have been evaluated from database images and optic disc and optic cup boundaries are marked by trained peoples. Finally the experiment results are obtained as the error of average overlapping in optic disc and optic cup boundaries are 9.5% and 24.1%. The cup to disc ratio is computed through the segmented optic disc and optic cup for glaucoma screening [6].

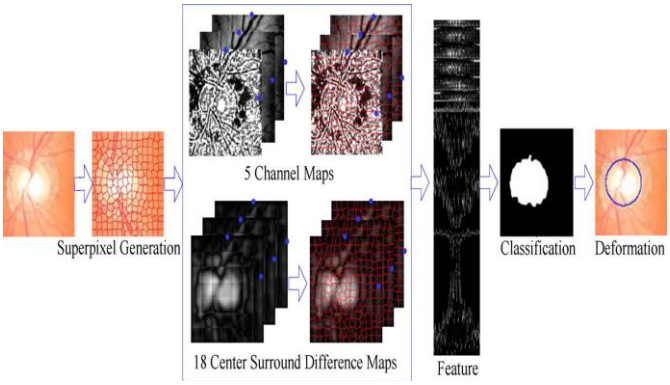

Fig. 4. Superpixel based optic disc segmentation. In superpixels based segmentation, each image has divided as superpixels, and the features are measured for classify the superpixel as disc or non-disc [7].

C. Segmentation of optic disk and cup from monocular color retinal images

This paper presents about the assessment of glaucoma from monocular color retinal images done by Optic Disk and Cup Segmentation [8], [11]. Contour model method which is used to segment the OD cup based on anatomical evidence like vessel bends at the boundary of cup [9], [10].

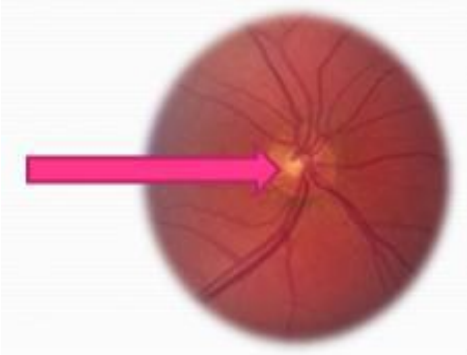

Fig. 5. Normal retina with Vessel bends inside OD

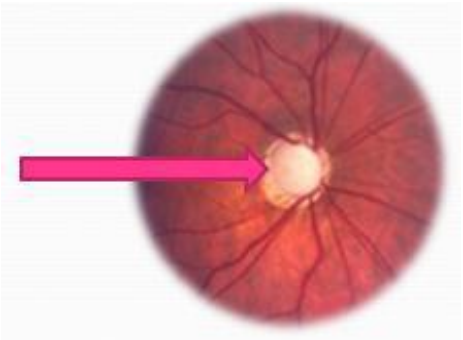

Fig. 6. Abnormal retina with no vessel bends inside OD

They don't have proper blood vessel bends in the retina shown in Fig. 6., thus it can unable to process with abnormal retina. Most of the glaucomatous OD Cup will have anomalous blood vessels [11].

D. Segmenting the Optic Disc in Retinal images using Adaptive Thresholding

This paper presents automatic approach for segment the optic disc in retinal fundus image using adaptive thresholding technique and boundary extraction. Here the retinal images are converted into grayscale image and the image enhancement is done by histogram equalization [5], [12]. The segmentation is done by using adaptive thresholding technique and the optical disk is extracted by morphological operators. It gives more efficient segmentation process which is compared by others [12].

Fig. 7. Results of segmented optical disc after the thresholding a) left column are input image, b) right column is threshold image

E. An adaptive threshold based image processing technique

This paper presents about detection of glaucoma from the retinal fundus images which based on an automatic image processing method. In this paper learning algorithm is used that can obtain the input image from following manner to glaucoma diagnosis. Glaucoma infections discriminatory parameters like Cup to Disc Ratio (CDR), area of Nero Retinal Rim (NRR) and different regions of blood vessels which is used as features and give as inputs to the learning algorithm for diagnosis of glaucoma.

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To improve the accurate identification, the classifier can be trained by discriminatory changes in these features with glaucoma occurrence [13], [14]. The adaptive thresholding technique which is used to segment the optic disc and cup based on the pixel intensities which uses segmentation of optic disc and cup by local features from the fundus image that making it invariant to quality of image.

The result of this experiment point out that those features are more significant which is compared to the textual or statistical features as considered in existing systems [5]. This work gives the accuracy and sensitivity of the result like 94.11% and 100%. Compared with existing methods this paper gives improvement of accuracy and sensitivity of detection of glaucoma from retinal fundus image [14].

V. CONCLUSION

We have present literature survey of some papers about the detection of glaucoma in 2D fundus retinal images with using several techniques. Here we have work with some segmentation and classification technique to segment the optic disc and classifies the image based on their feature selection of the image. In this paper, we conclude that the thresholding technique is best for segment the specific region in the retinal image[13], as well as SVM classifier is best for classifies the image based upon their category[4].These two techniques are very helpful to ophthalmologist to glaucoma assessment as efficient manner.

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