Early Stage Glaucoma Detection in Diabetic Patients: A Review

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Abstract-Glaucoma is the most common cause of visual impairment and blindness is because of diabetes retinopathy hypertension and glaucoma. Many people suffer from eye diseases in all over the world. Glaucoma is the second leading cause of permanent blindness worldwide. The method proposed for the detection of optic disc and optic cup segmentation using morphological operations. The aim of this paper is to find the cup to disc ratio of glaucoma patient and check the level of disease. If the cup to disc ratio exceeds 0.3 it indicates high glaucoma for the tested patient.

Keywords: Glaucoma detection, Optic disc segmentation, Optic cup segmentation, Cup to disc ratio, Morphological operation

I.   Introduction

Glaucoma is a chronic eye disease in which the optic nerve is progressively damaged. It is the third leading cause of permanent blindness. As the symptoms only occur when the disease is quite advanced, glaucoma is called the 'silent thief of sight'. Glaucoma cannot be cured, but its progression can be slowed down by treatment. Therefore, detecting glaucoma in time is critical. However, many glaucoma patients are unaware of the disease until it has reached its advanced stage. In many countries, more than 90% of patients are unaware that they have this condition.. Since glaucoma progresses with few signs or symptoms and the vision loss from glaucoma is irreversible, screening of people at high risk for the disease is vital.

There are three methods to detect glaucoma: - 1) assessment of raised intraocular pressure (IOP), 2) assessment of abnormal visual field, 3) assessment of damaged optic nerve head. The IOP measurement using noncontact tonometry is neither specific nor sensitive enough to be an effective screening tool because glaucoma can be present with or without increased IOP. A functional test through vision loss requires special equipments only present in territory hospitals and therefore unsuitable for screening. Assessment of the damaged optic nerve head is both more promising, and superior to IOP measurement or visual field testing for glaucoma screening. Optic nerve head assessment can be done by a trained professional. However, manual assessment is subjective, time consuming and expensive. Therefore, automatic optic nerve head assessment would be very beneficial. Diabetic retinopathy, hypertension, glaucoma, and macular degeneration are some of today's most common cause of visual impairment and blindness.

The optic disc is the location where ganglion cell axons exit the eye to from the optic nerves.The optic disc (OD) segmentation is a key process in many algorithms designed for the automatic extraction of anatomical ocular structures the detection of retinal lesions, and the identification of other fundus features. Initially, the OD location helps to avoid false positives in the detection of exudates associated with diabetic retinopathy, since both of them are spots with similar intensity. Secondly, the OD margin can be used for establishing standard and concentric areas in which retinal vessel diameter measurements are performed. Thirdly, the relation between the size of the OD and the cup (cup-disc-ratio) has been widely utilized for glaucoma diagnosis. Numerous OD segmentation methods, OD-boundary detectors, have been reported in the literature. As for algorithms based on mathematical morphology, most of them detect the OD by means of watershed transformation, generally through marker-controlled watershed.

Some of the existing techniques, such as Multi-thresholding Segmentation to detect the optic cup, optic disc and Cup to Disc Ratio (CDR) but the problem is that in which technique they detect CDR is complex process due to unclear color texture between the optic cup and optic disc [23], In this Super pixel Classification technique In which the segmentation of cup ,optic disc and cup to disc ratio but the problem is that the cup boundary at the nasal side of the cup is often difficult to be determine due to the presences of blood vessels[5],In this Automatic OD parameterization technique based on optic disc ,cup segmentation the problem is that the cup deformation shall not be uniform due to variation in vessels[11]. The normal cup to disc ratio is 0.3 if the ratio is large then those patient are glaucoma patient otherwise normal patient [23].

The method proposed in this paper is mainly based on mathematical morphology the mathematical morphology is a nonlinear image processing methodology based on minimum and maximum operations whose aim is to extract the relevant structures of an image. Their purpose is to expand the light or dark regions, respectively, according to the size and shape of the structuring elements. These morphological operators that complement the previous ones are geodesic transformations, using the geodesic reconstruction; a close-hole operator can be defined. The grey-scale image, is

considered a whole any set of connected points surrounded by connected components of value strictly is greater than the hole values. This operation can fill all holes in an image that do not touch the image boundary.

II.   Related Work

In paper 2001 Lalonde M. et al. [18] "Fast and Robust Optic Disc Detection Using Pyramidal Decomposition and Hausdorff-Based Template Matching". The two approaches are tested against a database of 40 images of various visual quality and retinal pigmentation, as well as of normal and small pupils. This approach can also to investigate possible generalizations of this approach for the detection of non rigid shapes.

 In paper 2004 Lowell J. et al. [20] "Optic Nerve Head Segmentation". This paper presents an algorithm for the localization and segmentation of the optic nerve head boundary in low-resolution images the algorithm is evaluated against a randomly selected database of 100 images from a diabetic screening program .The limitation of this paper they will evaluate the method for use in detection of the rim in glaucomatous images.

In paper 2005 Kavitha D, Devi S.S. [14] "Automatic Detection of Optic Disc and Exudates in Retinal Images" .A fast reliable and efficient method for detecting the optic disc and exudates in the retinal funds images .The method has been tested on normal, abnormal retinal images. The Accuracy, Sensitivity(S) and Predictive Value (P) are also presented and found this algorithm promising results. This method can be used for determining classification and severity of the eye diseases after locating the macula is pending.

In this paper 2008 Kande B.G. et al. [15] "Segmentation of Exudates and Optic Disc in Retinal Images". The two efficient approaches for automatic detection and extraction of Exudates and Optic disk in ocular funds images. In Exudates detection the enhanced segments are extracted based on Spatially Weighted Fuzzy c-Means clustering algorithm. The proposed algorithm for optic disk detection produces 92.53% accuracy. Limitation of this approach is to classify the segmented regions into two classes, exudates and non-exudates patches either by using neural networks or by using Support Vector Machines.

In this paper 2010 Tan M.N. et al [26] "Mixture Model-based Approach for Optic Cup Segmentation". They propose an approach for optic cup segmentation based on Gaussian mixture models. In this paper to determine the contour of the cup area, due to the difficulties to determine an accurate optic cup boundary.

In this paper 2011 Gopal Dat Joshi et al. [11] "Optic Disk and Cup Segmentation from Monocular Color Retinal Images for Glaucoma Assessment "described cup-to-disc ratio (CDR) calculation by applying morphological operations and Hough transformation for detecting glaucoma. Within the optic region, cup is segmented using vessel bend and polar information. The limitation of this method is that signals the ambiguity in 2-D information and the importance of 3-D information in cup segmentation which will be still remains.

In this paper 2012 Deepak S.K. et al. [6] "Automatic Assessment of Macular Edema from Color Retinal Images". A two-stage methodology for the detection and classification of DME severity from color funds images is proposed .A feature extraction technique is capture the global characteristic of the images and discriminate the normal from DME images .Such global feature have not been used successfully earlier for hard exudates detection.

In this paper 2013 Noor M.N et al. [23] "Optic Cup and Disc Color Channel MultiThresholding Segmentation".
In this paper is to segment the optic cup and optic disc using MultiThresholding Segmentation and extracted feature such as cup to disc ratio .Detecting CDR measurement process is complex due to the unclearly defined color texture between the optic disc and optic cup.

In this paper 2013 Cheng jun et al.[5]." Super pixel Classification Based Optic Disc and Optic Cup Segmentation for Glaucoma Screening This paper proposes optic disc and optic cup segmentation using super pixel classification for glaucoma Sereening.In which the cup boundary at the nasal side of the cup is often difficult to be determined even manually due to the presence of blood vessels.

        In this paper 2013 German Sanchez T.J.A et al.[9]"Optic Disc Detection and Segmentation of Retinal Images Using an Evolution Strategy on GPU . In which the optic disc detection and segmentation approach based on evolution strategy .The major limitation related to this fact is the absence of standardization of technical characteristics for retinal image acquisition.

III.   Need and Significance

The detection of glaucoma is particularly significant since it allows timely treatment to prevent major visual field loss. The diagnosis of glaucoma can be done through measurement of CDR (cup to disc ratio).The cup to disc ratio is evaluated by this Superpixel Classification technique ,The problem is that the cup boundary at the nasal side of the cup is often difficult to be determine due to the presence of blood vessels. And this multithresholding segmentation in which cup to disc ratio is detected but the problem is that the detection CDR measurement process is complex due to the unclearly defined color texture between the optic cup and optic disc. The OD boundaries cannot clear due to the presences of blood vessels. Due to the complexity of funds images their high number of elements makes a perfect segmentation difficult. In this paper I will use the Mathematical Morphology operations to overcome this problem and to detect better cup to disc ratio.
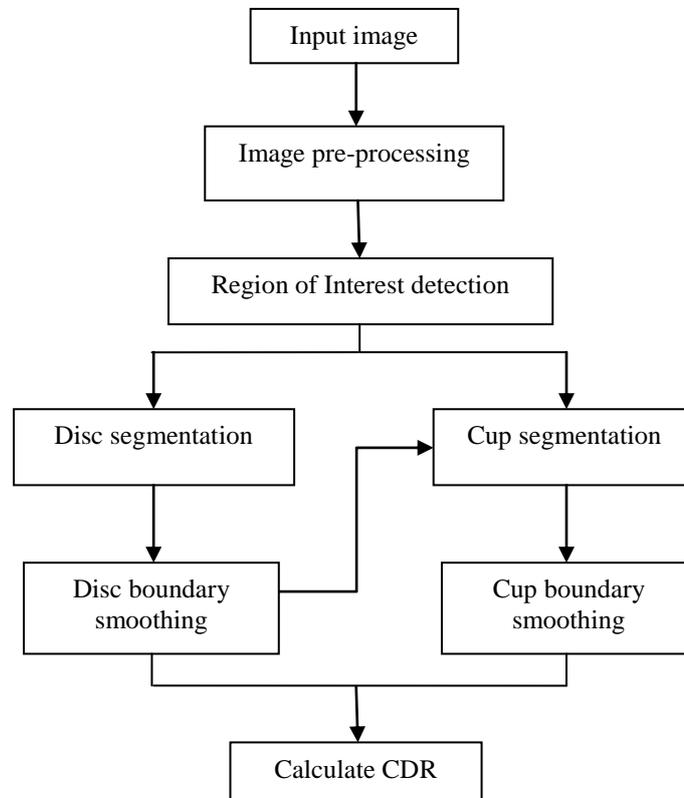
IV.   Proposed Methodology

The objectives of my work is to find the cup to disc ratio with efficient technique which will help to check the level of glaucoma in diabetic patients and then Comparison of results with existing techniques.
   a.   Select image: - Initially an image of eye is acquired from glaucoma patient.
   b.   Pre-processing of an image: - The original image is converted into gray level image as various operations can be applied easily on gray level image than RGB images.

c. Region of interest:-The particular region is cropped on which further segmentation is applied.
d. Segmentation: - Segmentation of Optic Disc and Optic Cup are done using various morphological operations to detect their boundaries and filling of holes.
e. Calculate CDR:-The Cup and Disc are measured to obtain the Cup to Disc value.

CDR=Cup Height/Disc Height

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                        │   Input image   │
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                        ┌────────▼────────────┐
                        │ Image pre-processing│
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                   ┌─────────────▼──────────────┐
                   │ Region of Interest detection│
                   └──────┬──────────────┬───────┘
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              ┌───────────▼──┐      ┌────▼──────────┐
              │Disc segmentation│    │Cup segmentation│
              └──────┬──────────┘    └────┬──────────┘
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              ┌──────▼──────┐      ┌──────▼──────┐
              │Disc boundary │      │Cup boundary │
              │  smoothing   │      │  smoothing  │
              └──────┬───────┘      └──────┬──────┘
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                        ┌──────▼──────┐
                        │Calculate CDR│
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V. Conclusion

The cup to disc ratio is an important indicator of the risk of the presence of glaucoma in diabetes patients. In this paper the segmentation of optic disc, optic cup and smooth their boundaries by morphological operations will be used. The morphological operations are efficient to detect the cup to disc ratio in glaucoma patients and normal patients and then check the level of disease. If the cup to disc ratio is more 0.3 then those patients are glaucoma patients and if the disc ratio is less than those are normal patient .This operations has been tested on a different funds images.

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