Review on Methods Designed for Automated Detection of Glaucoma using Fundus Images

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Abstract: Glaucoma is an optical disorder which is progressive and causes irreversible damage to the optical nerve, further if left untreated leads to blindness. Currently the non invasive techniques used for diagnosis by the ophthalmologist are optical coherence tomography (OCT), Heidelberg retinal tomography (HRT), scanning laser polarimetry and color fundus images (CFL). The first three imaging techniques are expensive and need experienced ophthalmologist for detecting the presence or absence of glaucoma and also to grade its severity. As an alternative technique which is less expensive is fundus imaging, this fact motivated to design and develop novel algorithms for accurately detecting glaucoma using fundus images. Hence, a review of the state of art in this felid is presented in this paper.

I. INTRODUCTION

New insights revealed by WHO have demonstrated that glaucoma is presently the second driving reason for visual impairment
all around, and it is evaluated to be in charge of 12 percent of worldwide visual deficiency [1]. An exploration report distributed by British Journal of Ophthalmology called attention to that the worldwide toll of the impairing eye causing by glaucoma is coming to 60.5 million by 2010, and ascending to just about 80 million by 2020. Particularly, female and individuals living in Asia, Africa, and India will be most gravely influenced [2]. Hence an early and timely recognition of glaucoma assumes a key part for anticipating irreversible harms in eyes.
Three basic anatomical components can be seen in the back shaft of the retina fundus picture including macula, optic disc (optic nerve head), and the vascular system as shown in figure 1.

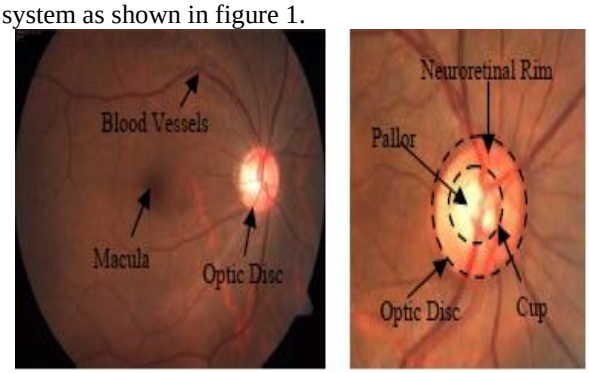

Figure 1: Fundus image marked with anatomical parts

Fundus images capture all these structures efficiently where optic disc is a large bright portion of the image with intensity ranging from yellow to white. Optic cup is situated within optic disc it is the brightest central part of optic disc. The retinal nourishment is provided by the blood vessel network [14]. The retinal fibres are concentrated at the optic disc to form optic nerve head. The vascular system is made out of the thicker veins with darker red and the more slender conduits with lighter rosy tone. A optic cup is displayed as an unfilled space in the center piece of the optic disc encompassed by optic nerve filaments. With the loss of nerve strands from glaucoma assault, the cup zone winds up plainly bigger step by step as a result of less space possessed by remaining nerve filaments. A healthy optic nerve has copious nerve strands going through it (roughly 1.2 million filaments [3]), and it is normally showed up as a little empty space. Consequently, the extent of a container breadth as for its optic disc distance across is frequently depicted by the ophthalmologist and named as a "disc to cup ratio". Due to indeterminate fringes and subjective recognitions, quantitative count of cup to disc ratio amid routine examination of a patient is difficult to be predictable, and it prompts indeterminate determination comes about even recognized by experienced ophthalmologists [4]. In this way, an instinctive, productive and target strategy for naturally grouping computerized fundus images into either normal or glaucomatous sorts is earnestly required for encouraging ophthalmologists. U. Rajendra Acharya, Automated diagnosis of glaucoma utilizing surface and higher spectra energy feature, is proposed higher request spectra (HOS) include from computerized fundus images and SVM for classification with precision of 91% [5]. Gwenole Quellec proposed classification of glaucoma is non-glaucomatous and glaucomatous based on false positive and false negative and ideal channel structure for recognizing target lesions in retinal images [6]. Linlin Shen and Sen Jia were proposed 3-D Gabor wavelet based approach for pixel-based hyperspectral symbolism arrangement with most extreme accuracy of 96.04% and 95.36% [7]. ChengHsuan Li were proposed Spatial-Contextual support vector machine for remote detected picture with general order precision of the hyperspectral images of the IPS informational index with 16 classes is 95.5%. The kappa precision is up to 94.9%, and the normal precision of each class is up to 94.2% [8]. Fereidoun A. Mianji proposed numerically advanced for unmixing issues with from the earlier known data disregards a few measurable properties of

the extricated tests and prompts a imperfect answer for genuine circumstances [9]. Sumeet Dua was proposed wavelet based vitality include for glaucoma grouping with exactness of 93% [10]. N. Dissolve proposed wavelets, Principal segment investigation (PCA) and probabilistic neural system (PNN) with 90% of PCA-PNN and 95% of DWT-PNN [11]. Heidelberg Retina Tomography (HRT) is utilized for analysis of Glaucoma; it is a confocal laser examining

Frame work created by Heidelberg Engineering. It examines 3-diminish images of the retina. Along these lines any adjustments in nerve head, called papilla, can be quantitatively portrayed [8, 12]. Due to increase in optic cup area the brightness of the image increases hence, additional features such as image entropy, mean, variance, intensity and textural information may also be considered. Therefore locating optic disc in the fundus image is an important step.

The proposed work presents an outlined assistant determination framework which can naturally compute and examine the cup to disc ratio and is organised into three parts - review of methods used for – ii) locating optic disc, iii) detecting optic disc boundary and optic cup boundary iv) Proposed methodology v) conclusion.

II. METHODOLOGY TO LOCATE LOCATING OPTIC DISC

Reliable and efficient optic disc localization and segmentation is an important task in automated screening system. Optic disc localization is required as a prerequisite for further stages in algorithm for identifying retinal pathologies. Anatomically the optic disc appears to be circular in shape but its size and shape may vary [14]. In [15], the constant distance between optic disc and macula is used as prior knowledge for locating macula. It is 2.5 times of its diameter far from the macula. Locating macula in fundus images is performed as a prerequisite step to locate optic disc [13]. Akara Sopharak et. al. [18] and Feroui Amel et. al. [19] located optic disc by creating a mask around the brightest pixel extracted from a luminance channel of CEILAB color image. Morphological reconstruction is performed and the resultant image is subtracted from the original image to obtain the ROI containing the optic disc. G. G. Rajput et. al. [17] considered brightness, shape and size to extract the optic disc. Region containing optic disc was extracted using correlation coefficient. A comparison of methods used for detecting optic disc from fundus images are summarized in table 1.

Table 1: Comparison table of features considered for OD localization

Sl No	Authors	Features used	Outcome
1	Akara Sopharak et. Al	Brightness and masking method	Fails to locate the optic correctly in cases where exudates are more prominent than OD (figure. 2)
2	Feroui Amel et. al.		
3	H. Li and O. Chutatape	Distance between macula and OD center	overhead of locating macula prior to locating optic disc

III. METHODS ADOPTED TO LOCATE OPTIC DISC AND CUP BOUNDARY

Detecting optic disc boundary is complex because of variations in its size, shape, color and outgoing blood vessels that makes boundary discontinuous. The fact that blood vessels are concentrated around optic disc is considered as a base to detect optic disc [14]. Circle fitting approach using Hough Transform with radius between 45 to 55 pixels was adopted after extracting the optic disc using correlation coefficient [16, 20, 21]. A semi automated technique that involves marking of 4 points on optic disc boundary manually followed by constructing snake between those points was attempted [22]. A wavelet energy feature, CDR and threshold value based approach is employed to train ANN for classifying glaucomatous and non-glaucomatous fundus images [23]

IV. PROPOSED METHODOLOGY

The optic disc and cup are the brightest part of fundus images that are been explored by many authors [18, 19, 24]. By considering the parameters like, the threshold or mean values which in turn lead to misclassification of prominent exudates and optic disc as shown in the figure 2. So here an attempt is made to proposed methodology can estimate the performance metrics to improve the quality of the cup to disc ratio.

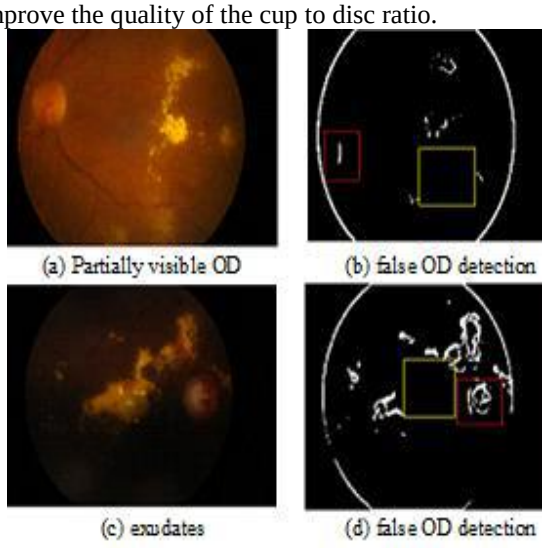

Figure 2: False OD Detection

Hence in the proposed method a statistical measure 3sigma is considered to classify the pixel under test to belong to either optic cup or optic disc and GV Snake contour will be implemented for marking the boundaries of optic disc and optic cup. Following are the image processing steps that will be adopted to implement the proposed methodology. In this proposed method, a novel method is proposed based on algorithmic approaches to make performance measures

to improve the quality of the image identification which help in diagnosing the disease.

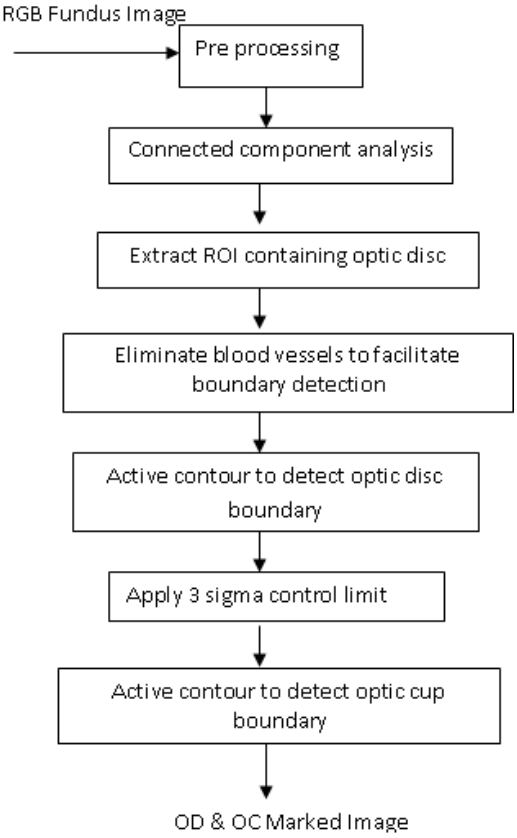

Figure 3: Block diagram of proposed method

V. EXPECTED RESULT

The proposed method is planned to be implemented using Matlab tool. The expected result include a) Reduction of misclassification of prominent exudates as optic disc- this is achieved by considering size, intensity and shape features of optic disc before employing connected component analysis. b) To increase accuracy of classification of pixels belonging to optic disc or optic cup- this is achieved by application of 3 sigma control limits. c) To reduce human intervention- this is achieved by developing a fully automated method.

VI. CONCLUSION

The literature survey clearly indicates that fundus imaging technique is a better alternative approach in diagnosing the glaucoma that is more efficient and cost effective. The review also indicated the following facts: i) Single intensity feature, masking and circle fitting fails to locate optic disc. (ii) Locating optic disc using macula as starting point comes with an overhead of locating macula prior to locating optic disc. (iii) There are no fully automated methods for disc and cup boundary detection. The proposed method has incorporated the solutions for above mentioned drawbacks obtained from the literature survey. The proposed method is expected to be more efficient and robust with no human intervention than the existing techniques.

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