Performance Analysis for the Combination of Histogram based Thresholding And Morphological Watershed in comparison to other Existing Optic Disc Detection Techniques

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***Abstract*— Several methods have been introduced in the last decades to detect the optic disc in retinal images that is the most fundamental step in the prognosis and diagnosis of various eye disorders. This paper presents the various techniques which are beneficial in disc detection and attempt to provide a comparison between several detection methods. An important aspect of our study is to highlight the advantages of the combination of histogram based thresholding and morphological watershed transform while pointing the shortcomings of other methods.The combined approach is able to detect the Optic Disc in 99.31% of tested cases.The approach is tested on 6 different databases.**

***Keywords*— optic disc, morphology, watershed transform, thresholding**

I. INTRODUCTION

The digital fundus photography is widely used in the prognosis, diagnosis and treatment of various eye disorders such as diabetic retinopathy and glaucoma. Medical image analysis and processing holds great significance in the field of medicine, particularly in non-invasive treatment and clinical studies. Normally fundus images are manually evaluated by specially trained human observers such as a clinical ophthalmologist in a time-consuming and resource-exhaustive process. A computer-assisted fundus image analysis could provide an immediate detection and characterization of retinal features before any specialist inspection. It automatically and precisely computes the values of position, place and area of the contour and anatomical structures of the image as required by ophthalmologists. However, Segmentation in medical imaging is the challenging job for the researchers. An efficient detection and location of optic disc in retinal images is a significant task for automated diagnosis of various serious ophthalmic pathologies. Its detection is indispensable for the segmentation of other normal and pathological features. The timely diagnosis and referral for management of diabetic Retinopathy can prevent 98% of severe visual loss and can provide extensive cost savings to Public health systems. Most methods, however, require identification of retinopathy by expensive and specifically trained personnel. A completely automated approach involving fundus image analysis by computer could provide an immediate classification of retinopathy without the need for specialist opinions[9].Optic disc is the brightest part in the normal fundus image which can be seen as a pale yellow, round or vertically slightly oval disc. It is the region which marks the entrance of blood vessels and optic nerves to the retina and its detection is essential since it often works as a landmark and reference for the other features in the fundus image and in correct classification of exudates. Most of the algorithms developed for OD detection are especially applicable to normal and

healthy retinal images. It is a cumbersome task to detect OD in all types of retinal images, that is, normal, healthy images as well as abnormal, that is, images affected due to disease. This paper presents the various flaw points of methods used for detection in the past. In the subsequent section, some of the disc detection methods along with their shortcomings are discussed. In the further section, advantages of histogram based thresholding are explained along with relevant examples.

II. ALGORITHMS FOR DISC DETECTION

This section discusses the various techniques which can be used for locating the optic disc in retinal images.

A.Based on principal component Analysis(PCA)

Sinthanayothin et.al[3] find the location of the optic disc using the variation in intensity between the optic disc and adjacent blood vessels. The optic discs were located by recognising the area with the highest variation in intensity of adjacent pixels. Blood vessels were identified by means of a multilayer perceptron neural net, for which the inputs were derived from a principal component analysis (PCA) of the image and edge detection of the first component of PCA. However, this algorithm often fails for fundus images with a large number of white lesions, or strongly visible choroidal vessels. Augmented to this, accuracy of PCA algorithm is based on number of training images used for matching intensity pattern. Major drawback of PCA algorithm is that the time complexity of this algorithm is very high [2]

B. Based on hough Transform

S. Sekhar et.al[5] describes a new method to automatically localise the optic disk. The method consists of two steps: in the first step, a circular region of interest was found by first isolating the brightest area in the image by means of morphological processing, and in the subsequent step, the Hough transform is used to detect the main circular feature that is the optical disk. However we have not retained this method because of the computer intensiveness of the Hough transform[3] .

C. Based on Hausdorff-based approaches

Marc Lalonde et.al[1] discussed the design and test of an image processing algorithm for the localization of the optic disk (OD) in low-resolution color fundus images. The design relies on the combination of two procedures that are Hausdorff-based template matching technique and a pyramidal decomposition. However a priori information should be exploited in order to guide the search for the OD in a specific portion of the image. Moreover , the Hausdorff-based approaches fail on images where OD contour is very diffuse[1].

D. Based on line operator

Shijian et.al proposed technique makes use of the unique circular brightness structure associated with the OD, i.e., the OD usually has a circular shape and is brighter than the surrounding pixels whose intensity becomes darker gradually with their distances from the OD centre. A line operator was designed to capture such circular brightness structure, which evaluates the image brightness variation along multiple line segments of specific orientations that pass through each retinal image pixel. The orientation of the line segment with the minimum/maximum variation has specific pattern that can be used to locate the OD accurately. Again the introduced technique had several shortcomings. First, the proposed line operator was designed on the basis of assumption that the OD is more or less brighter than the surrounding retinal pixels and, therefore, cannot handle a very small number of retinal images whose OD is darker than the surrounding pixels. Second, the proposed technique cannot handle the retinal images that do not have a clear circular brightness structure around their OD[8].

E.. Region based segementation

Syna Sreng et.al eliminated optic disc using Image binarization, ROI based segmentation and Morphological reconstruction. However the algorithm fails in cases containing large number of bright lesions[9].

F .Based on watershed segmentation

Sandra Morales et.al detected the optic disc using mathematical morphology along with principal component analysis (PCA) and operations such as watershed transformation. However this method was not applicable to all type of images. In addition to this, PCA algorithm requires set of training

images used for matching intensity pattern. Major drawback of PCA algorithm is that the time complexity of it is very high[4].

G. Based on Thresholding

Deepali A. Godse et.al discussed a method combining the steps based on different principles. Applying this threshold, all bright regions within image called clusters are detected. Then authors applied two different criteria on these clusters, a: area criterion and b: density criterion. In this algorithm, authors have considered pixel count for estimating the threshold which will vary from one image to another[5].

III. COMBINING THE THRESHOLDING AND WATERSHED TRANSFORM

The literature consulted so far reveals that every technique has its own specifications and limitations so we have merged two different techniques along with some changes in existing techniques which raise the probability of disc detection.The proposed algorithm is more effective than the others as it combines the two methods for OD detection. If the disc is detected falsely by the former,it will be reconfirmed and detected appropriately by the later i.e watershed followed by average thresholding. Also, there are some cases in which the histogram based thresholding fails to find the actual optic whereas the watershed transform gives the actual location of the optic disc.

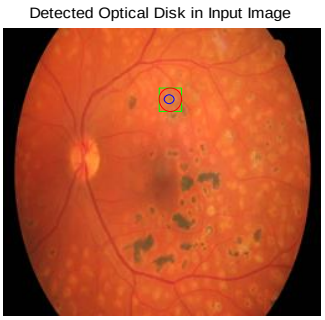

Fig1.False detection by histogram based threshold

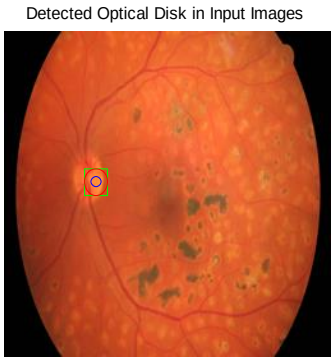

Fig 2. Accurate Detection by watershed followed by average thresholding

IV.COMPARISON

This section presents a comparison among several techniques

Table I

Results of proposed OD localization method

Test Database	**No. Of Images**	**OD Detected**	**% Accuracy**
Drionsdb	110	109	99.09
Diaretdb1	120	118	98.33
Drive	40	40	100
Messidor	20	20	100
Diaretdb0	130	128	98.46
Healthy images	25	25	100

Test Database	OD_{pd}	OD_{ed}	OD_{fv}	OD_{ef}	OD_{ht}	OD_{thresh}	Proposed Method
Diaretdb0	89.52%	77.56%	77.56%	95.29%	80.12%	98.46%	98.46%
Diaretdb1	88.99%	75.46%	75.46%	93.70%	76.41%	96.62%	98.33%
Drive	80.55%	97.22%	97.22%	98.61%	86.10%	100%	100%
Messidor	-	-	-	-	-	-	100%
Drionsdb	-	-	-	-	-	-	99.09%
Healthy	-	-	-	-	-	-	100%
Average	87.95%	79.88%	76.12%	95.26%	79.78%	98.45%	99.31%

Table II

Comparison of results obtained using different Method

OD_{pd}: Based on pyramidal decomposition [1]

OD_{ed}: Based on edge detection [5]

OD_{fv}: Based on feature vector [5]

OD_{ef}: Based on entropy filter [5]

OD_{ht}: Based on Hough transformation[5]

OD_{thresh} :Based on Thresholding[5]

IV. CONCLUSION

In this paper, a Comparison among various techniques to locate optic disc is presented. In addition, new approach for the automatic detection of the optic disc has been explained and shown. Compared to the approaches by other researchers, The proposed approach for OD detection yhat is the combination of histogram thresholding and watershed transform,has the advantage that it is applicable to all types of retinal images, healthy as well as abnormal, affected due to disease. The proposed algorithm is also more effective as it combines the two methods for OD detection. If the disc is detected falsely by the former, it will be reconfirmed and detected appropriately by the later i.e watershed followed by average thresholding.

On having keen glance on the table II, it is observed that the proposed method gives better accuracy in localizing the OD compared to other methods .The overall detection rate for the proposed method is the highest among all that is about 99.31%.

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