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Optic Disc Segmentation in Diabetic Retinopathy using Image Processing

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ABSTRACT

Diabetic Retinopathy and Glaucoma are optic diseases that involve optic disk identification, which is a crucial phase in the current diagnostic tools that can be computerized. When these diseases are identified early by any screening applications, measures may be taken to avoid blindness. Early indicators of the numerous illness such as Macula Edema, Diabetic Retinopathy and Glaucoma are the changes in the anatomy structures in the retina of the human eye which also has the inclusion of the retinal vasculature. Of these, the Optic Disc is the most crucial feature, as its visible factors are essential for the identification of glaucoma and other disease-related assessments called Diabetic Retinopathy. In this paper, we present methods to detect the likelihood of Diabetic Retinopathy being present from fundus images. This technique starts with pre-processing on the optic retinal image to concentrate on the main area of the disease that we need to identify. Afterwards we apply Image processing algorithms to detect the optic disk. Detecting the optic disc is vital because it is the origin of all the nerves and detecting the position and radius of optic disc can be used as the reference for approximating fovea i.e. a pit like area responsible for vision. Size and shape of optic disc is responsible for diagnosing the disease. Therefore, this paper addresses the analysis of different techniques to detect the optic disc.

Keywords : Optic Disc, Retinopathy, Fovea, Diabetes, Image Processing.

I. INTRODUCTION

Diabetic retinopathy is an eye condition that could purpose vision loss and blindness in human beings who have diabetes. It influences blood vessels within the retina. People with diabetes will have a watch disorder known as diabetic retinopathy. That is when high amounts of blood sugar inside the retina cause damage to the blood vessels. This can swell and leak in the blood vessels. Alternatively, they could close, stop blood from passing through [2]. Odd new blood vessels often develop up on the retina. Both those changes will cause vision loss. The early levels of diabetic retinopathy commonly do not have any signs. Some people note modifications of their vision, like problem analysing or seeing far-flung objects. These changes may come and pass. In later levels of the disease, blood vessels in the retina start to bleed into the vitreous. If this happens, you could see darkish, floating spots or streaks that seem like cobwebs[1]. Sometimes, the spots resolve on their own — however it is vital to get remedy right away. Without treatment, the bleeding can occur again, worsen, or purpose scarring.

The diabetic retinopathy is treated according to the amount of disorder the level of disease spread[2]. Surgeries like Laser Surgical Operation are used to stop the blood vessels from leaking and hence blood vessels are sealed. This treatment is done to the people with diabetic retinopathy. The medical practitioner of optic diseases may inject some medicines in the eyes to reduce the amount of irritation caused due to the

disease and also to stop the forming of blood vessels. Although, for the people who are in the higher stages of the disease of diabetic retinopathy may require a surgery. For the purpose of removing and replacing the gel-like fluid in the back of the eye, this surgery is done. Also, repairing a retinal detachment requires surgery too. These can be done if and only if the optic disc is detected beforehand. This makes a major difference and can reduce blindness in many cases.

II. RELATED WORK

The methods, which are present, for detecting the Optic Disc are divided into two different parts-location and segmentation [8]. The location-based methodology presented by Synthanayothin et al. provided a technique in which the fundus images were passed through the pre-processing procedure[4]. The Optic Disc was detected by performing variation in the intensities of the contrast channels. They used an algorithm called fuggy convergence that is a voting-type algorithm to detect the vessel boundary. Another approach has been proposed via Foracchia et al that allows use of the vessels 'convergence to find the OD center. Further, based on the segmentation methods[5], Osareh et al. also detected the OD pixel with the help of boundary extraction methods and used segmentation for further extracting the OD pixel[9]. Due to the dark blood-crammed vessels, the visual difference in the normal OD area was distinguished through relatively rapid variability in strength. Sinthanayothin et al. detected the OD in order to evaluate the position with the best average difference between the adjacent pixels using a window length equal to the OD [4].Another method which showed good results was proposed by Niemeijer et al. who implemented a feature of pixel which was done for retinal vessel detection [11]. The method used by them was a Gaussian filter method which took a derivative filter bank and was based on the classification of the nearest neighbour [11]. Staal et al. came forward with a method which had a pixel feature based methodthatadditionallyfocused on analysing on the vessels and the structures of its surrounding to exactly detect the optic disc. Another approach suggested by Arturo Aquino et al. used the transformation of the circular hough and related methods of image processing [3]. These methods showed accurate results and had a high accuracy rate. Hence, it was concluded that the circular hough transform was better than other methods on the base of accuracy.

III. PROPOSED SOLUTION

Our proposed system aims at detecting the optic disc which can help us know about diabetic retinopathy, so that we can take precautions and necessary treatment beforehand. This system may just take the fundus image from the user and by applying the necessary image processing algorithms, we can detect the optic disc. And hence help in treating diabetic retinopathy beforehand. This system will be essential for detecting the optic disc as it can help for the diagnosis of the diseases. The system can be either used by the patient or either the doctor. This will save a lot of time during any follow up consultation. Detecting the optic disc is not an easy task. Hence, it will provide early detection and hence treatments can be done. Almost 60% cases are solved if the optic disc is detected beforehand. Our system will be available to everyone and easy to use. By taking the retinal image or the fundus image, we provide the optic disc as the output.

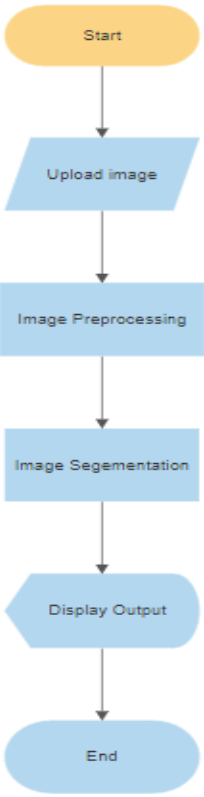

Fig. 1. System Architecture

The methodology used for locating the Optic Disc pixel also called as ODP that belongs to the Optic Disc. The methodology consists of three different and independent detection methods. Different Optic Disc Pixels are obtained by each different method. Hence, we get three different ODP. The selection of the final Optic Disc Pixel is done by selecting the three pixels and taking the average or also called as centroid of the locations and hence selecting the final ODP. Here, in this process, a voting process is used which is based on the application of the following cases.

1) If all the three pixels detected by the three methods are nearby the centroid i.e. closer to 1/5th part of the image, then the OD pixel which was selected is the centroid.

2) If the pixels from two approaches are near to centroid while the other is far from centroid, then the two pixels closest to the centroid are taken on average and the third pixel is ignored. Hence, the ODP becomes the average of the two nearby pixels.

3) Or else, the pixel which we select is the ODP with the most tests performed on it as shown in the methods below.

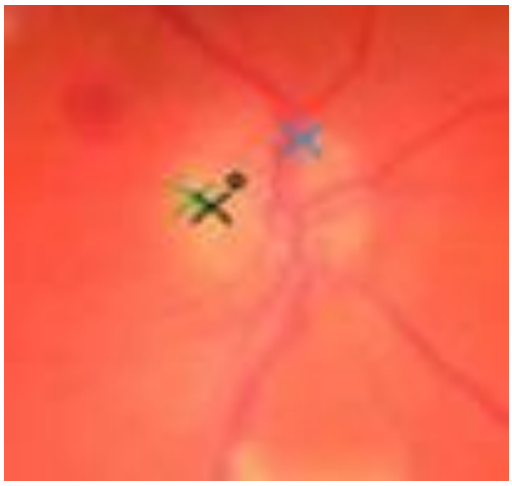

Fig. 2. OD Pixels obtained from different methods with their centroid.

IV. MAXIMUM DIFFERENCE METHOD

The presence of Optical disk in the fundus image is in the brighter eye area. The structure shaped by the darker blood vessels that looks like a tree root like structure also appears different from the optic disk. This is the reason that there is a large amount of variation observed in the grey levels which are within the OD. This variation in the grey levels is used to select the optic disc pixel. A filter application of the maximum difference method i.e. median filter of 21 21 is A median filter of 21 21 is donepreviously for the purpose of removing the non- significant noises in the images[7]. Following the following equation, the optical disk pixel obtained from the maximum difference form is recorder:

$$P_{\mathrm{MDM}} = \arg\limits_{(i,j)} \left(\max \left\{ (I_M)_W^{\mathrm{MAX}} (i,j) - (I_M)_W^{\mathrm{MIN}} (i,j) \right\} \right)$$

where and are, respectively, the maximum and the minimum values of the pixels in within awindow of size 21 21 centred on a pixel.

V. MAXIMUM VARIANCE METHOD

The above stated method has the basis of the same method as the prior one. It works mostly with the help of the maximum difference method. A calculation of the variance of statistical changes for every pixel is done using a 71*71 window size. But, on the other part, Otsu method is used to obtain a set of bright pixels which can be done by thresholding[10]. These pixels are brighter. The maximum variance pixel makes other 10 pixels bright which are in its neighbourhood[10]. This is obtained from the maximum variance method. This is done by a window of size 101*101. The window sizes used depends on the size of the image and by performing on 1200 images it has been derived that 101*101 sized window is perfect.

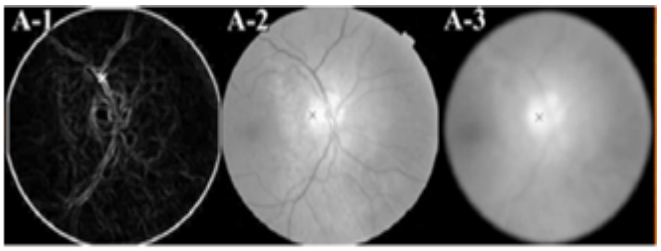

Fig. 3. Optic disc pixels generated by different methods where A-1 is by "maximum difference method", A-2 is by "maximum variance method" and A-3 by "low pass filter method".

VI. LOW PASS FILTER METHOD

The optic disc pixel obtained from this method is done by the usage of grey levels in a low pass filtered image. In spite of the fact that the optic disc pixel is generated in the brightest area of the fundus image [7], the highest grey level pixel could not be detected.In a large number of cases, this pixel maybe in the brightest region of the image. In order to remove this out, a Gaussian low pass filter was applied which extracted the main Optic disc pixel which is of our use by the following equation:

$$H(u,v) = \exp\left(\frac{-D^2(u,v)}{2D_0^2}\right)$$

Where, D(u,v) represents the Euclidean distance between the point (u,v) and the frequency plane origin, and represents the cutoff frequency of 25 Hz.

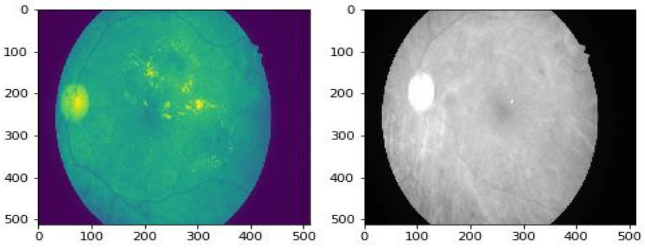

Fig. 4. Retinal Image.

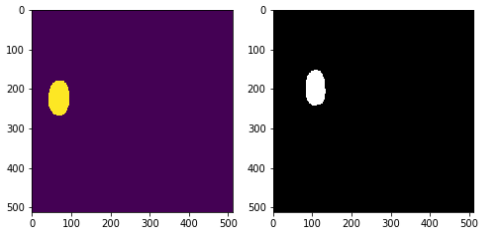

Fig. 4. Output obtained.

VII. CONCLUSION

There are many systems available in the market currently having good accuracy. The results provided in the paper by the proposed methods which are robust have an accuracy rate of 98.27% in almost all cases. Also, the output generated is quick. Our proposed system provides the optic disc as the output. This report can assist a medical practitioner in decision making and assessment of the human eye. This detection can help the medical practitioner to decide the further treatments or the surgeries based on the detected issues which needs to be done for the purpose of curing it. This will help in early detection of the disease and prevent blindness.

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