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Automatic Imaging Method for Optic Disc Segmentation using Morphological Techniques and Active Contour Fitting

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Abstract

Optic disc segmentation is a crucial step in diagnosis of various ocular diseases like Glaucoma and Diabetic Retinopathy. This work proposes a technique for automatic detection of optic disc from the fundus images using edge based and active contour fitting method. The proposed work has used image processing techniques such as smoothing filters for removal of blood vessels, morphological operations to correctly segment the optic disc and reject the false positives, active contour snake based model for smoothing of optic disc boundary. The results of optic disc segmentation obtained from the proposed work are compared with the ground truth marked by the ophthalmologists. The results are convincing and segmentation results show that the method has good accuracy. An average overlapping score of more than 90% is obtained for the fundus images under test.

Proposed Algorithm

The proposed method of OD segmentation is divided into three subsections which deal with localization of OD, OD segmentation using morphological techniques and OD boundary smoothening using active contour method.

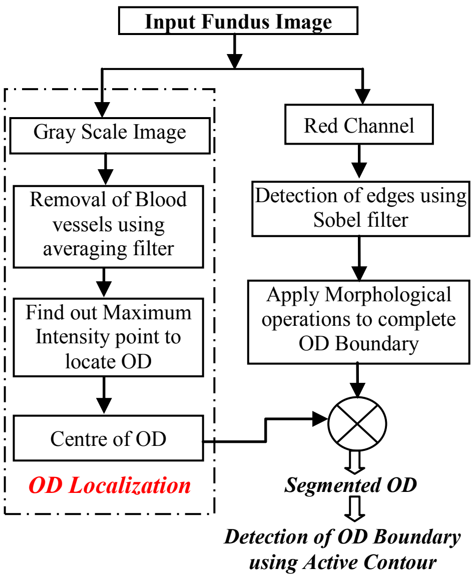

Fig.1. Flow Diagram of Proposed Algorithm

A. Localization of Optic Disc:

Optic Disc comprises of the brightest intensity pixel of the fundus image. In the proposed work, OD is localized using by finding the same. For this the grayscale image of the input fundus image has been used. An averaging filter is then applied on it in order remove the blood vessels and lesions. Then from the resulting image the brightest point is found out and hence the OD center is located.

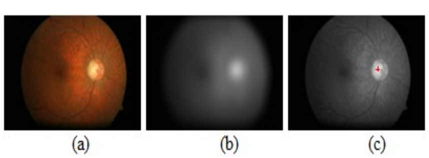

Fig.2 Optic Disc Localization (a) Input Image (b) Smoothed Grayscale Image (c) OD Localized

B. Optic Disc Segmentation using morphological operations:

Red channel of the colored fundus image is selected for optic disc segmentation. A median filtering is performed to remove blood vessels from the red channel of the image. The filtered red channel is subjected to edge detection using sobel operator to highlight the edges at the boundary of the optic disc. The detected edges may not complete boundary of optic disc, hence, a dilation operation is performed on the edge detected image to complete the boundaries of optic disc. The dilation operation may add some neighboring pixels to the OD boundary, so a skeletonization operation is performed to find the exact boundary and remove the extra pixels from OD boundary. The skeletonized image is subjected to filling operation to fill the holes. The OD region is then selected from the holes filled image using the center of optic disc which is located earlier.

C. OD Boundary smoothening using active contour method:

The optic disc region is segmented from the fundus image as explained earlier. The boundaries of the segmented OD are not smoothed as it contains noise due to dilation operation. So, active contour method is used for boundary smoothing. The active contour used in the proposed work is a snake based active contour model.

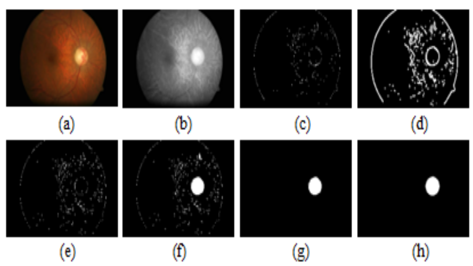

Fig.3 Optic Disc Segmentation (a) Input Image (b) Red Channel (c) Edge Image (d) Dilated Image (e) Skeletonized Image (f) Hole Filled Image (g) OD selected (h) Final segmented OD.

Experimental Results

A database of 60 fundus images from a local hospital has been used for experimentation and testing of proposed method. The database has retinal images with non-uniform illumination, bright and dark, low contrast, blurry images, choroid vessels and also has artifacts which occur during acquisition process. The proposed algorithm is competent enough to strategically segment the optic disc with exact boundaries. The doctors from the local hospital have marked the optic disc boundaries and these annotated images have been used to calculate an overlapping score between the ground truth and segmented OD. Fig. 4 shows the results of the proposed method for 10 samples from the database. Fig 4(a) shows the input image with ground truth marked by an ophthalmologist on image with green color. Fig 4(b) shows the input image marked with optic disc boundary segmented using the proposed work.

TABLE 1 OVERLAPPING SCORE AND COMPUTATION TIME FOR OD SEGMENTATION USING PROPOSED METHOD

Sample No.	Overlapping Score	Computational time (seconds)
Sample 1	0.9253	24.14
Sample 2	0.9174	25.09
Sample 3	0.9358	24.44
Sample 4	0.9323	23.00
Sample 5	0.9294	23.87
Sample 6	0.9428	24.24
Sample 7	0.921	23.43
Sample 8	0.9118	24.5
Sample 9	0.9495	24.22
Sample 10	0.9407	23.56
Sample 11	0.9129	25.61
Sample 12	0.9267	25.48
Sample 13	0.9174	23.15
Sample 14	0.9005	24.29
Sample 15	0.9384	23.73

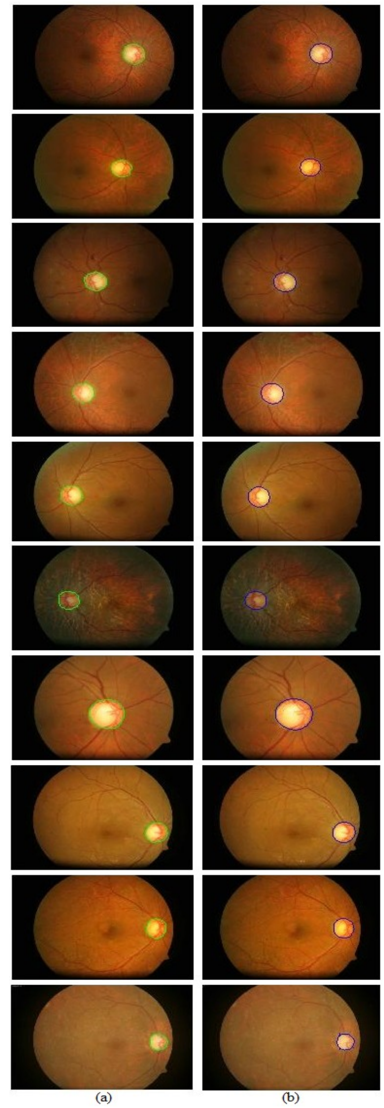

Fig.4 Results (a) Input Image with OD marked by Ophthalmologist (b) Input Image with OD segmented by proposed method

Conclusions

The accurate optic disc segmentation is an important task in identification of glaucoma to prevent vision loss at an early stage of the disease. In the proposed work, an automated method is used to detect the center and segment optic disc region from the fundus image. The center detection algorithm is an advantage as it can be competently used for selection of optic disc region from the many objects which are segmented using edge detection approach. Edge based detection method seems to be one of the many good choices for identification of optic disc boundary. The results obtained during testing the algorithm on various images have shown encouraging results. It is clear from the results that the optic disc is accurately segmented from the fundus images.

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