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Segmentation of Retinal Images in Optic Disc

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ABSTRACT: The segmentation of fundus retinal image is very important for computer aided diagnosis. Earlier the detection of retinal diseases was done manually. Hence it consumed lot of time and subjected to the frequent manual errors. It is not possible to detect optic disc in large number of images manually. The diseases such as glaucoma, agerelated macular degeneration, degenerative myopia, diabetic retinopathy etc, can be detected from retinal images. The segmentation of optic disc plays a crucial role where in the features extracted from the segmented optic disc can be used for the automated diagnosis through machine learning approach. In this work four different segmentation algorithms are tested on retinal images for segmenting the optic disc present in it. The structural similarity Index measure is used to estimate the quality of the segmentation techniqueseffectively. The experimental results shows that the graph cut algorithm performed better in comparison to the traditional threshold based techniques, K- means algorithm and active contour technique.

KEYWORDS: Retinal images, optic disc, K-Means, Active contours, Graph cut segmentation.

I. INTRODUCTION

There are various diseases which affect the vision of the person.Eearly detection of such diseases can prevent the person from the vision loss.The digital image processing techniques on retinal images are used for identifying, locating, and analyzing the retinal landmarks which are the blood vessel, optic disc, and macula. The retina is an interior surface of eye which converts light rays into electrical signals and sends them to the brain through the optic nerve. Optic nerve is the cable connecting the eye to the brain.

Optic Disc: It is also known as optic nerve head or papilla. This is a circular area with bright white portion from where the optic nerve and major blood vessel enters the retina. The diameter of the optic disc comes about 2mm, 1.75mm horizontally and 1.93mm vertically. The optic disc does not contain any receptors and only cones are present, thus it is considered to be the blind spot of the eye.

Macula & Fovea: the macula is located near the center of the retina, which allows us to see object with great details. This computer-aided image analysis, in turn, facilitates the detection of the retinal lesions and abnormalities which significantly affect the general appearance of the retinal landmarks.. To successfully find abnormal structures in a retinal image, it is often necessary to mask out the normal anatomy from the analysis. These signals are then forwarded to the brain through the optic nerve .The importance of the optic disc segmentation in retinal images is elaborated in section II. The various segmentation methods used in this work are explained in detail in section III. Simulation results and performance analysis are presented in section IV. The conclusion is presented in Section V

II. IMPORTANCE OF OPTIC DISC SEGMENTATION

The main reason for segmentation of the optic disc is to developing the better screening system for eye diseases such as glaucoma, diabetic retinopathy. The detecting and locating the main anatomical structure such as optic disc is considered as an essential step towards detecting abnormalities and finding lesions in the retinal images. The example for the reason why the optic disc detection is necessary is because of the similarity between the exudates and optic disc create confusion for detecting the optic disc amongst the exudates. So in this case it is necessary to detect the optic disc and isolate it for better identification of the exudates within retinal fundus images

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III. PROPOSED WORK

Segmentatioin is the process of partitioning of image into several objects of interest either based on similarity or dissimilarity measures or distance based measures. There are several kinds of methods available in the literature, to name a few of them are edge based , region based, model based approaches. In this work, four different segmentation algorithms are used for segmenting the optic disc of retinal images. They are as follows:

1. Simple Threshold based segmentation
2. K means segmentatioin.
3. Active contour based segmentation
4. Graph cut based segmentation.

A. SIMPLE THRESHOLD BASED SEGMENTATION

In general, the acquired images are in RGB colour space. But single channel information is sufficient to extract the optic disc from the images. So in this work, red, green and blue components are segregated and different thresholds are applied separately on these three different colour channels to test their efficiency in detecting optic disc in retinal images. The results are presented in section IV.

B. K MEANS SEGMENTATION

It falls under the category of unsupervised clas of clustering algorithms. They are very good at segmenting the images based on their constituent colours. Most often it makes use of eucledian distance based measures for clustering the pixels. The algorithm of the K means segmentation is as follows:

1. Fix the number of clusters(k).
2. Compute the eucledian measure of each pixels to each of the cluster's center.
3. Assign the pixels to the cluster which is nearer to the pixel's current location.
4. Recompute the centroid of newly formed clusters.
5. Repeat the steps 2 to 4 as long as there are no movement of pixels taking place between the cluster groups.

In this work, the K values is fixed at three corresponding to the three different regions present in it. The results of K means algorithm are presented in section IV.

C. ACTIVE CONTOUR BASED SEGMENTATION

These are used to detect the boundary of the objects through the process of energy minimization technique. In this work, the objects are roughly located by simple contours marked on the object of interest. Through this interactive model the marked contours are evolved on to the boundary of the object by computing the various energies present within the image both on the internal and external regions of the contours that are marked initially. The results are given in section IV.

D. GRAPH CUT BASED SEGMENTATION

It is the process of segmenting an image into different objects based on graph theory.. A cut of a graph represents the division of vertices that are not connected to each other into two different subsets. Initially the images turned into graphs such that each pixel is connected to their neighbours and distinct fore ground and background nodes are fixed. The foreground nodes are called as source and the background nodes are called as sink. So the cut in simpler terms denotes the division of foreground and background regions in the image. Weights are usually assigned to the graphs that give an estimate of how far a pixel is related to the foreground or background regions.

In this work, Min-cut approach is used for segmentation. It is based on the lowest weight criterion. The results are presented in section IV.

IV. RESULTS AND PERFORMANCE ANALYSIS

The sample image used for the experimentation is given in figure 1 .in this image, the yellow coloured circular part seen at the center corresponds to the optic disc, the region of interest that is to be segmented.

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FIGURE 1. RETINAL IMAGE

The results of simple thresholding process performed on three different colour channels are given in Figure 2 to Figure 4. From these figures it is observed that varyining information in present in each of the color channels of RGB colour space. Also varying degrees of contrast between the optic disc region with respect to other regions on the retinal image in the three channels are noticed.Figure. 5, 6, 7 shows the segmentation results of the other 3 techniques.

FIGURE 2(b). THRESHOLDED RED COMPONENT OFRETINAL IMAGE.

FIGURE 2(a). RED COMPONENT OF RETINAL IMAGE

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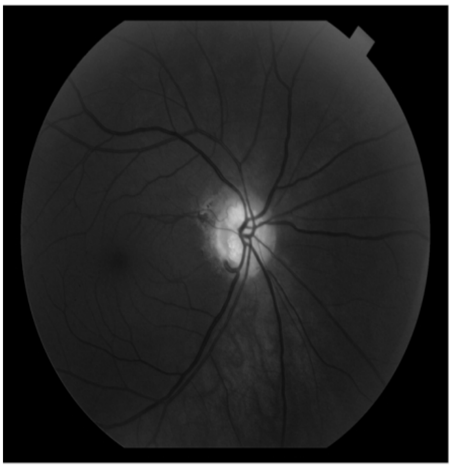

FIGURE 3(a). GREEN COMPONENT OF RETINAL IMAGE

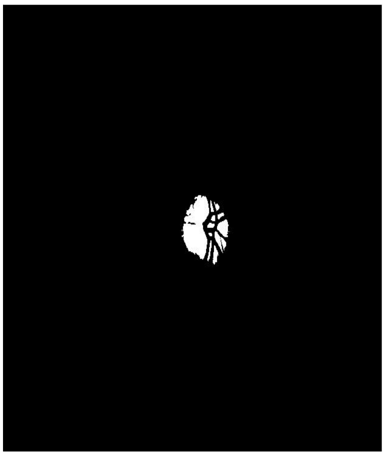

FIGURE 3(b). THRESHOLDED GREEN OF RETINAL IMAGE.

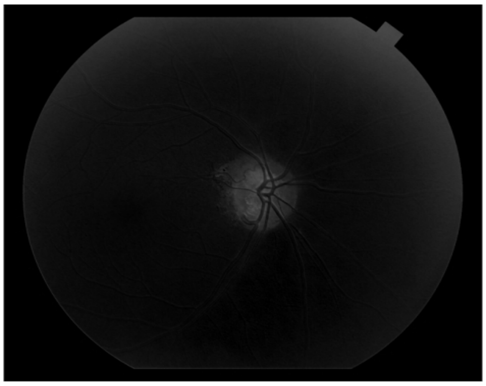

FIGURE 4(a). BLUE COMPONENT OF OF RETINAL IMAGE

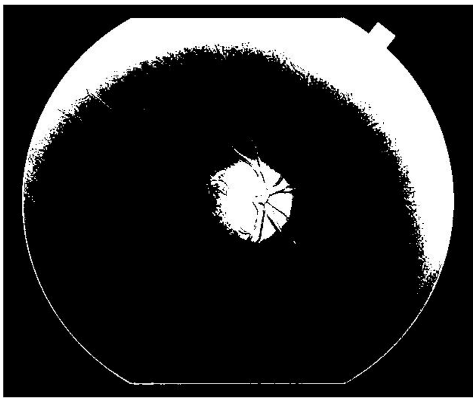

FIGURE 4(b). THRESHOLDED BLUE COMPONENT OF RETINAL IMAGE

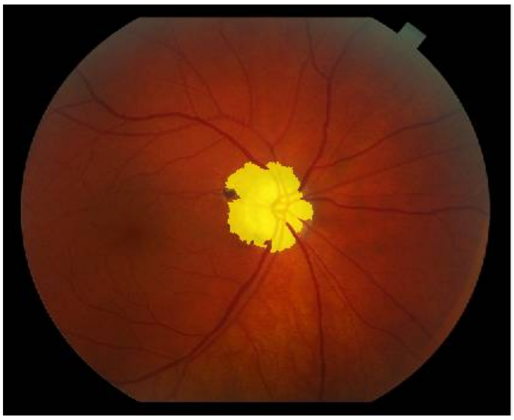

FIGURE 5(a). RESULT OF GRAPH CUT SEGMENTATION

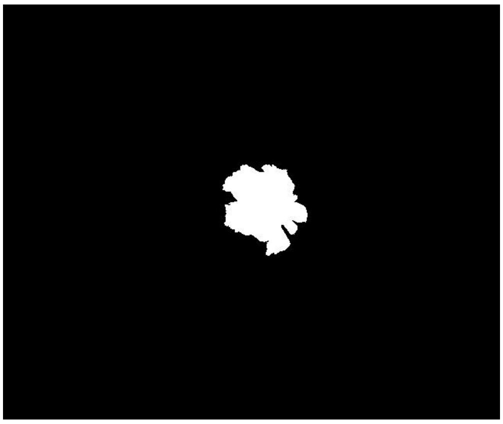

FIGURE 5(b). BINARY RESULT OF GRAPH CUT SEGMENTATION

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FIGURE 6(a). RESULT OF ACTIVE CONTOUR BASED SEGMENTATION

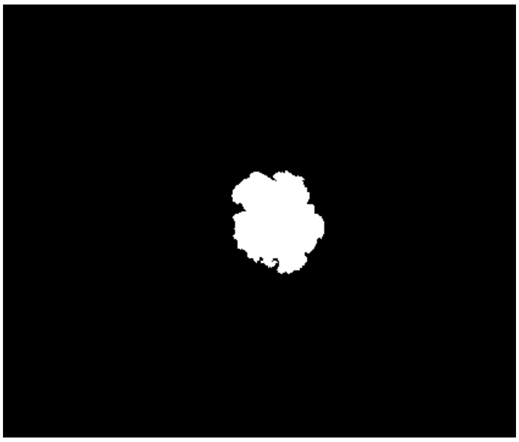

FIGURE 6(b).BINARY RESULT OF ACTIVE CONTOUR BASED SEGMENTATION.

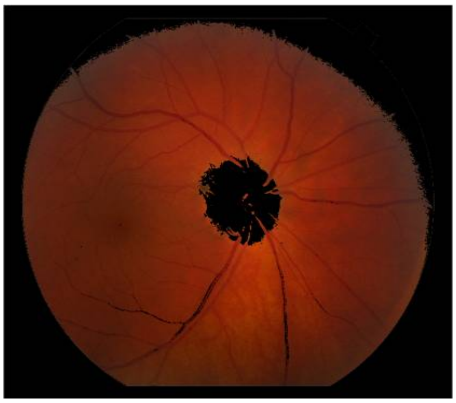

FIGURE 7(a).CLUSTER 1 OF K- MEANS SEGMENTATION

FIGURE 7(b).CLUSTER 2 OF K- MEANS SEGMENTATION

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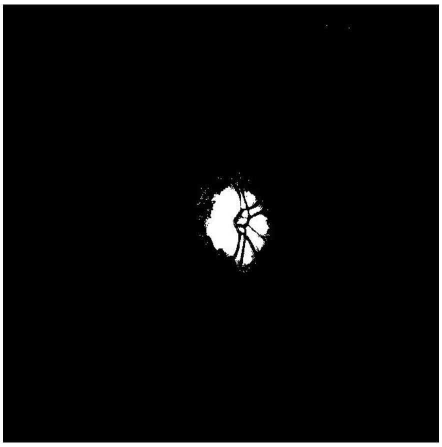

FIGURE 7(c). BINARY RESULT OFCLUSTER 2 OF K- MEANS SEGMENTATION

FIGURE 8. GROUND TRUTH MASK

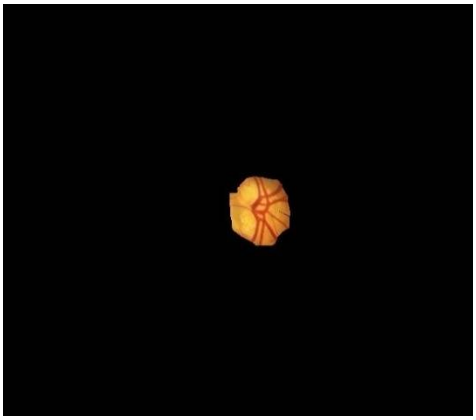

FIGURE 9. ROI

The above figures represent the ground truth mask of the optic disc is given in Figure. 8 and the corresponding ROI is given in Figure 9.

V. PERFORMANCE COMPARISON

Performance comparison is performed based on the Structural Similarity Index Measure (SSIM). It is a metric that gives a mesure how far two images are related to each other. Higher the SSIM value, better the quality of segmentation.

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From Table.I, it is observed that the graph cut segmentation algorithm performed better in comparison to the other 3 algorithms.

TABLE I
PERFORMANCE COMPARISON OF THE DIFFERENT SEGMENTATION TECHNIQUES

Technique	ROI	SSIM
Thresholding based segmentation	Red Channel	.9633
	Green Channel	.9711
	Blue Channel	.9523
Active contour based segmentation	Retinal Image	.9568
K-Means based segmentation	Optic Disc Cluster	.9761
Graph Cut based segmentation	Retinal Image	.9788

VI. CONCLUSION

In this work, optical disc of retinal images are segmented using 4 different segmentation techniques namely, Thresholding based segmentation, Active contour based segmentation, K-Means based segmentation, Graph Cut based segmentation. The experimental results shows that Graph Cut based segmentation performed better in comparison to the other three techniques. SSIM metric is used to estimate the efficiency of the segmentation results. The highest SSIM value of .9788 is obtained for Graph Cut based segmentation. Hence it is concluded that for optical disc segmentation in retinal images Graph Cut based segmentation can be used more reliably in comparison to the other 3 works.

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