Optic Disc Boundary Detection for Diabetic Retinopathy

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ABSTRACT

Micro aneurysm and Exudates are the key indicators of Diabetic Retinopathy that can potentially cause retinal damage. The early detection of exudates and its grading are important to prevent further cause of retinal damage. Detecting the optic disc in the retinal image is the necessary step in the detection of the diabetic retinopathy because optic disc has the characteristics of exudates. In this paper we are detecting the optic disc using Active Contour Model, and then we quantify whether the optic disc detected for the above method is accurate. Many algorithms have been proposed and evaluated for the detection of the optic disc. But most of them depend on the fact that optic disc is the brightest part among all the components of retina. The aim of this work is performing accurate detection of optic disc and verifies whether the detected Optic Disc is really an Optic Disc using SVM classifier.

Keywords: Active Contour Model, Database, Diabetic Retinopathy, Optic Disc.

1. INTRODUCTION

Diabetic Retinopathy is damage to the retina that occurs with long term diabetes. According to World Health Organization (WHO) more than 75 percent of patients who are affected by diabetes for more than 20 years will develop some form of DR. The Diabetic patients may not experience major symptoms at initial stage until the disease has progressed to a severe stage Therefore the early detection and the regular screening are necessary to treat Diabetic Retinopathy. Different Screening programs for Diabetic Retinopathy and automation of severity grading of exudates would have number of benefits.

However, an important prerequisite for automated Diabetic Retinopathy is the accurate location of the main anatomical features in the image, notably the optic disc (OD).

The optic disc (OD), which has the characteristics of exudates, is considered as one of the main features of a retinal fundus image. And it is the brightest feature of the normal fundus, which has approximately a vertically slightly oval (elliptical) shape. The OD appears as a bright yellowish or white region. The OD is considered the exit region of the blood vessels and the optic nerves from the retina. Identifying and removing the OD improves the detection of exudates regions. Hence optic disc plays an important role in developing automated diagnosis. The process of automatically detecting and localizing the OD aims to correctly detect the centroid and boundary of OD.

2. METHODOLOGY

A. Active Contour Model

Active Contour Model describes an object boundary or some other salient image features as a parametric curve. Active Contour Model was introduced by kass et in 1987s. ACM are used to draw the contour of the optic disc more precisely. In computer vision, contour models describe the boundaries of shapes, in an image. The problem of finding the object boundary is for minimization of the energy problem, Active contour models commonly known as snakes, have been widely used for object localisation, shape recovery, and visual tracking due to their natural handling of shape variation. For instance, starting with a curve around the object to be detected, the curve moves toward its interior normal under some constraints from the image, and has to stop on the boundary of the object. Hence the Snakes, are nothing but a framework in computer vision used for delineating an object outline from a possibly noisy 2D image, in particularly these are designed to solve problems where the approximate shape of the boundary is known. The performance of ACM

highly depends on the given initial contour. Geometric active contours are also called as conformal active contours because they provide impressive performance in the segmentation of optic discs.

The objective of the active contour model is to perform the task of Image Segmentation. Active Contour Model has been used in various fields like medical imaging, motion tracking, stereo matching and Shape recognition.
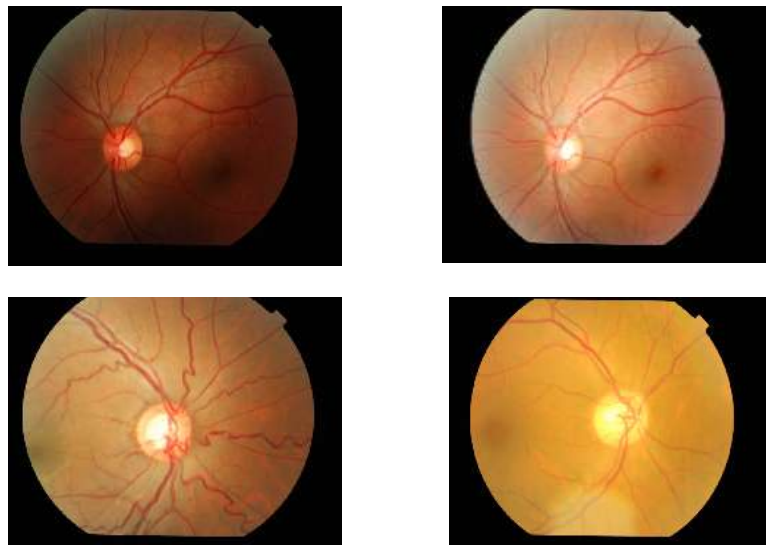
3. IMPLEMENTATION

A. Dataset

We have used well known and publicly available databases Stare Database, Diaret db11 and Vasan Eye Care Images for our study. Table 1 summarizes the details of the total number of images in each dataset.

Table 1: Database with Images

Database	Number of Images
Diaret Db11	90
Vasan Eye Care	266
Stare Database	101

Figure 1. Optic Disc images for Vasan Eye Care

B. Optic Disc Boundary Detection

The detection of accurate boundary of the optic disc is important for the detection and diagnosis of DR where the variation in the shape and size of the optic disc is used to detect and measure the severity of disease. Difficulty in finding the optic disc boundary is due to its highly variable appearance in retinal images. In contrast the automatic optic disc boundary is detected by using active contour based on geometric model.

Algorithm for Optic Disc Boundary Detection

1. Read image.
2. Extract green channel.
3. Enhance the image using adaptive histogram equalization.
4. Choose the highest intensity pixel in the image.
5. Perform recursive region growing.
6. Perform connected component analysis.
7. Find the centroid of region.
8. Initialize a circle of radius 50 pixels with the identified centroid.
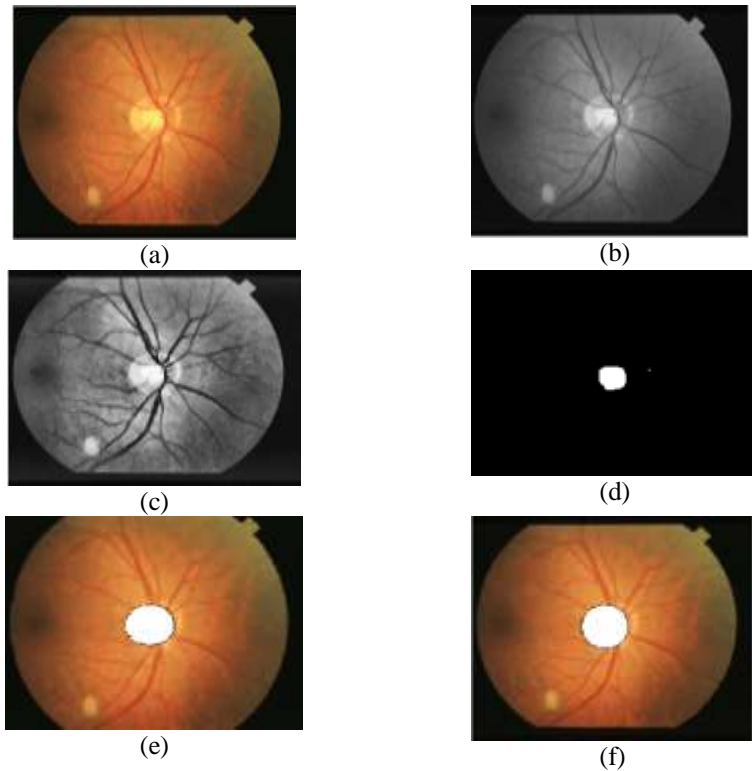9. Allow the ACM curve to evolve.

Figure 2. Boundary Detection of Optic disc (a) Input retinal Image (b) Green Channel Image (c) Image after Adapthisteq (d) Initial patch of OD after Recursive Region Growing (e) Initial curve placed around OD patch (f) Detected Optic Disc Image.

Table 2: Database with Accuracy

Database	Total Number of images used	Number of Images Optic disc detected correctly	Accuracy
Diaret Db11	65	52	80
Vasan Eye Care	91	88	96.7
Stare Database	64	38	60

C. Validation of Optic Disc Detection

Table 2 summarizes the result of optic disc detection for the database used for the study .In case of Diaret db11, 65 images used and in 52 images OD is detected correctly. Among 91 images from Vasan Eye Care, OD is detected correctly in 86. But in case of Stare Database we used 64 images and the total no of images detected correctly are 38. Since Stare Images have many images with wrongly identified Optic Disc, authors have used this database for further analysis using first order histogram images and SVM classifier.

Table 3: shows the first order histogram features that are extracted for OD validation

Histogram Features	Formula
Mean	Mean=sum(Prob.*G)
Variance	Variance=sum(Prob.*(Gray_vector-Mean).^2
Skewness	(Gray_Vector,Prob,Mean,Variance)
Kurtosis	(Gray_Vector,Prob,Mean,Variance)
Energy	Sum(Prob.*Prob)
Entropy	-Sum(Prob.*log Prob))

4.   EXPERIMENTAL RESULTS

We have tested the optic disc detection on the standard available databases. We have used two publicly available databases namely Stare Database, Diaret db11 and Vasan Eye Care Images. The Diaret db11 database, 65 images being used and   52   images the OD detected correctly. Among 91 images from Vasan Eye Care, OD is detected correctly in 86. But in case of Stare Database we used 64 images and the total no of images detected correctly are 38 .The accuracy for the each of the databases is also being illustrated from Table 2.

Ten Cross Validation for classifier
To test the performance of the classifier, we have used Ten cross-validation. In this procedure we will randomly sort the data, dividing it into K folds. Here the name itself informs that the common value of k is 10 so in this case we will divide the data in to ten parts. Then run the k rounds of cross validation. Here the authors have performed ten cross validation for three databases. The average accuracy obtained for Sensitivity and Specificity is shown in Fig3 and Fig4.
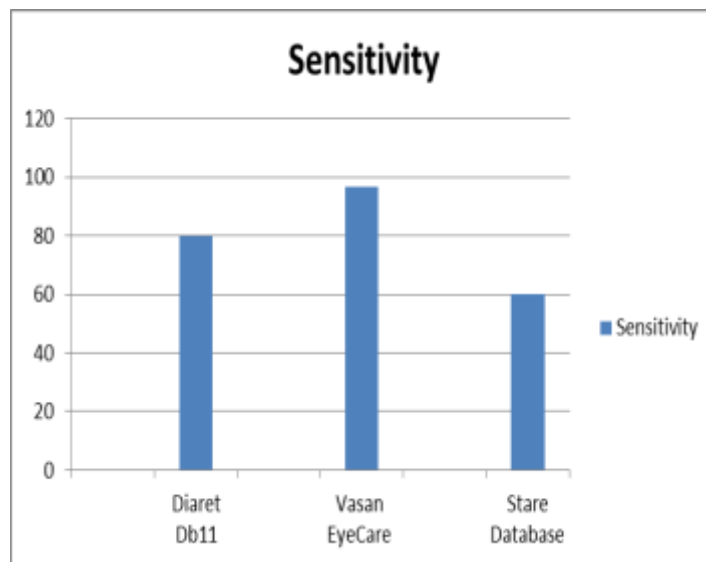

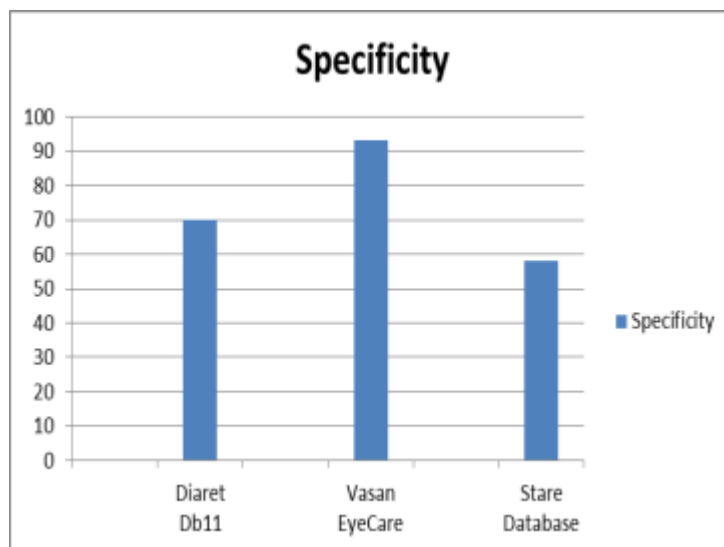**Figure 3. Database versus Sensitivity**

Figure 4. Database versus Specificity

5.   CONCLUSION

Active contour model is an efficient method for the automatic segmentation of the optic disc boundary in the retinal images. Retinal images of patients at different stages of retinopathy were being considered and in most of the cases the optic disc was located correctly. Based on the result obtained in optic disc boundary detection, it can be stated that geometric based implicit active contour models provide a better segmentation for images .The classifier used SVM also provides good out of sample generalization and they deliver unique solution by this they evaluate more relevant information in a convenient way.

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