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Detection of Blood vessels in Retinal images for diagnosis of Diabetics

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Abstract— **Early detection of blood-vessels in an retinal image and determining diameter of vessels is important for analysis and dealing of different diseases including glaucoma, hypertension and diabetic retinopathy (DR). To detect the blood-vessels in a retinal fundus images, we proposed a method consisting of four main steps. The first step is pre-processing. Initially, the contrasts of the blood vessels are not clear in the original retinal images. To improve the appearance of blood vessels we are using several image enhancement techniques. In the second step we are using various filters to improve the blood-vessels appearance in the retinal images. The third step is, feature extraction where we are extracting Grey Level Co-occurrence Matrix (GLCM) and Discrete Wavelet transform (DWT) features formed a feature vector. Finally we are applying Support Vector Machine (SVM) classifier which classifies the diseases based on the features. With the two publically available databases DRIVE and CHASE_DB1 databases we are comparing and analyzing the performance of proposed method which measures the specificity, sensitivity and accuracy.**

Keywords— Detection of Blood Vessel , Median filter, Gaussian filter, Adaptive thresholding, GLCM and DWT features, SVM classifier.

I. Introduction

A. Motivation

For analyzing the retinal fundus image, automatic detection of vessels from the retinal image background content is most common criteria which is more important in the retina image analysis task. This is a complex task mainly because of vessel variation in terms of diameter and width. Some complexity is by reason of inferior quality of fundus images which contain noise in the background and also alteration in contrast levels. The diameter, length and width of the vessels vary to indicate a variety of ophthalmologic diseases. By using automated retinal image analysis system provides a framework where ophthalmologists can manage retinal images, analyze the retinal image and it can be stored to assess the condition of the patients. In this work we are using color retinal images of the patient which is captured by fundus camera (ophthalmoscope). A new technique has been implemented to detect blood vessels and determining the related diseases. The diabetic patients will suffer from vision loss which indicates a severe condition of diabetic retinopathy. It should be detected as early as possible to diagnose the disease and which leads to a successful treatment.

The objective of proposed work is to construct a effective system which reduces the time and cost of poor people who are from rural areas. For the supporting clinicians it is very helpful to understand the procedures and methods. And also we can analyze the retinal image important features for diabetic retinopathy by using image processing techniques.

B. Related Work

In [1] discussed about detection of vessels in the retina and diseases condition of retina. For detection of blood vessels, RGB image is used to get the outline of vessels in the retina. This algorithm has worked on modules such as pre-processing, segmentation and feature extraction. In [2] proposed a method for analysis of retinal images for diabetic patients based on SVM. In this task, an effort has been made to make use of neural network for analysis in the medical field. In [3] presented a multi-concavity modeling approach for classifying both unhealthy and healthy retinas concurrently. In [4] described about blood vessel segmentation and optic disc in present in the retinal images using Expectation-Maximization **(EM)** algorithm. The morphology together with the optic disk and blood vessels is actually crucial warning intended for diseases similar toward hypertension, glaucoma and also diabetic retinopathy. They applied new method using graph cut technique to extract the vessels in a retina vascular tree. In [5] explained an algorithm by using wavelet for segmentation of blood vessels for diabetic retinopathy patients. This method enhances the blood vessels by using Gabor wavelet as a result of their capacity to increase directional structure and Euclidean distance technique for accurate vessel segmentation. In [6] illustrated a technique for high resolution retina blood vessel segmentation. In [7] depicted a method for retinal vessel segmentation by using unsupervised method with combined filters. In [8] demonstrated a technique for retinal vessel segmentation makes use of the Supervised

Classification and 2-D Gabor Wavelet. In [9] described a method for detection of blood vessels using images of retina to overcome the variations in terms of contrast of large and thin vessels. The paper is organized in three main sections: Proposed method, Results and discussion, Conclusion and future work. In 2nd section presented a methodology that is implemented to obtain the results as tabulated. The architecture of the proposed method is discussed and finally, the algorithm. In 3rd section describes the different databases that are used for performance measurement and results obtained from the proposed system. Finally section 4th summarizes the results in proposed method.

II. Proposed System

In this architecture, as shown in Fig. 1 initially we are reading the input image from the databases. Databases are publically available for retinal images analysis some of themare are DRIVE, STARE, and CHASE_DB1. By using these databases we are reading image from one of the dataset. After acquiring an image we are resizing it for our convenient. After resizing an input image we are extracting green channel from the RGB image. RGB image containing three primary components such as Blue channel (B), Red channel (R) and Green channel (G).

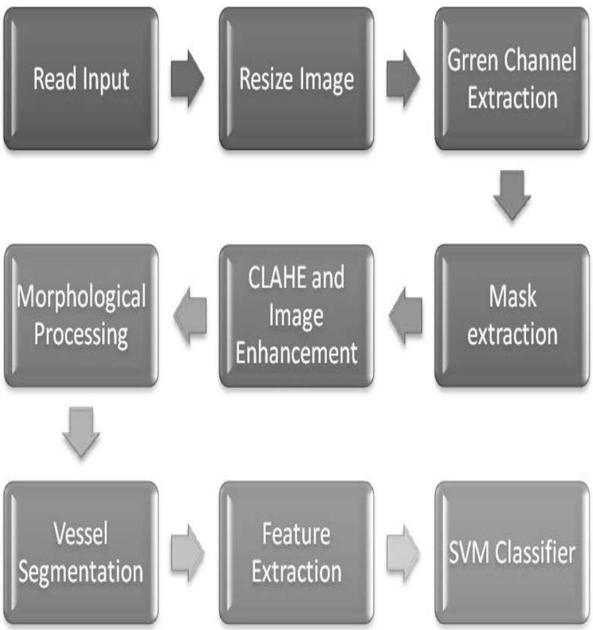

Fig. 1. System Architecture

The green channel gives high sensitivity to the blood vessels. Hence this channel is considered for the segmentation and detection of retinal blood vessels in the retinal image. To detach the images from the background we are extracting the mask to make image to be on its particular place or to put it in another background. We are removing the background noise and highlighting only the foreground objects those are blood vessels and exudates. Further, we are using contrast-limited adaptive histogram equalization (CLAHE) to increase the contrast between the vessels. It is also an option of using histogram equalization. Histogram equalization performs action over the entire image but adaptive histogram equalization works on small areas present in the image. The small parts or areas are called as tiles. We are improving each tiles present in an image. After completion of equalization, to connect the tiles which are neighbor we are using adaptive histogram equalization which leads to bilinear interpolation eliminates false boundaries.

In morphological operations we are performing Dilation to enlarge foreground and shrinking the background to highlight only the interested regions. Segmentation is performed to change the image representation which gives more meaning and easy. After segmenting an image next step is to apply feature extraction technique which is key part to classify the diseases by having different features like GLCM and DWT. Creating a feature vector leads to classification. It gives interesting areas in an image in the form of feature vector. Then we are applying SVM classifier which classifies the disease based on features.

A. Algorithm

Proposed technique is containing some of the following footstep as shown in algorithm 1.

Algorithm 1:

Step1: Reading the RGB image from the database

Step 2: Resizing an image

Step 3: Convert the RGB image into Gray Scale image

Step 4: From the Gray Scale image extracting red, green and blue component. Red and blue histograms the extracted images tend to be more noise. So extract green channel which exhibits more contrast.

Step 5: Apply adaptive histogram equalization to increase the contrast of an image

Step 6: Perform mask extraction to the contrast improved image

Step 7: Apply CLAHE and image enhancement techniques to enhance the image

Step 8: Dilating the unwanted portion of an image

Step 9: Convert the gray scale image into binary image

Step 10: For vessel detection, apply first and second level segmentation and enhancement filters to the image that removes the background and highlight only the foreground vessel

Step11: Sort the components which are not connected to central area.

Step 12: Perform feature extraction to create a feature vector to the vessel detected image.

Step 13: Apply SVM classifier to make decision or classification

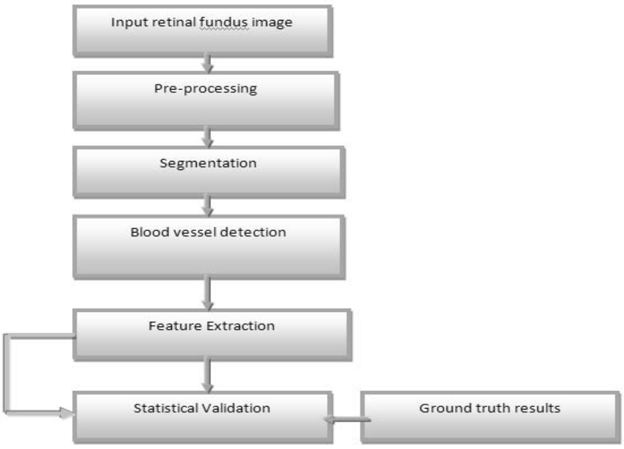

Fig. 2. Flow chart of the proposed technique

III. Result and Discussions

To compare the performance of the proposed methodology we used three different databases which are publically available. The performance also compared with a ground truth findings.

A. Image Databases

The image databases are required to evaluate the performance of the proposed methodology. Some of the images are collected from the hospitals related to the diabetic retinopathy as well as normal fundus images. The databases are,

- DRIVE database
- CHASE_DB1 database

1) DRIVE database

In DRIVE database which is digital retinal images for vessel extraction which holds 40 colored retinal images, 33 images does not show any symptoms of diabetic retinopathy and 7 indicates the symptoms of mild diabetic retinopathy.

2) CHASE-DB1 database

This dataset contains retinal image upto 28 which are fundus images. Those images are collected from child heart program of totally 14 patients.

B. Performance Measures

Performance algorithm is a process of making evaluative judgment about algorithms. The four performance measurements are true positives (TP), false negatives (FN), true negatives (TN) and finally, false positives (FP). In turn to evaluate the performance of the proposed methodology with other high-tech algorithms, we are calculating the performance parameters those are specificity, accuracy and sensitivity.

1) Sensitivity

Sensitivity is the ability to exactly classifying the patients who are having diseases. Precisely, this can be written as follows:

$$\text{Sensitivity} = \frac{TP}{TP + FN}$$

= probability of test as positive

1) Specificity

Specificity is the ability to exactly classifying the patients who are not having any disease. Precisely, this can be written as follows:

$$\textit{Specificity} = \frac{TN}{TN + FP}$$

= probability of test as negative

2) Accuracy

Accuracy is a combination of both systematic and random errors. High accuracy requires high precision values. Precisely, this can be written as follows:

Accuracy = (TP + TN) / (TP + FP + FN + TN)

C. Experimental Results

In this work, extensive experimentations are performed on two publicly available retinal image databases, namely, DRIVE and CHASE. Fig. 3 shows overall result of the proposed method.

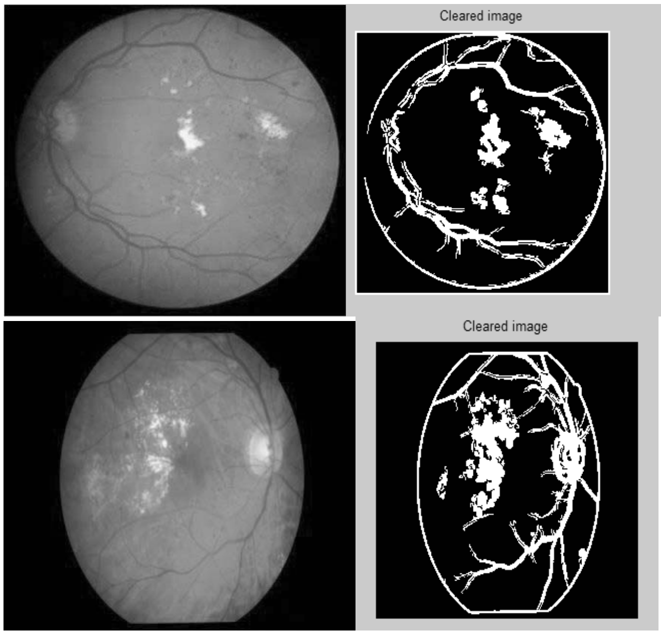

Fig. 3. Detection results: (a) Retinal images, (b) Result of proposed method.

As shown in Fig. 3 (a) initially, we are obtaining image from the database. Then we are applying image enhancement techniques and filters to obtain vessels and also exudates present in the retinal image as in Fig. 3 (b). The sensitivity and accuracy is more compared to the other researchers. Using the manual labeled set as a reference, Se, Sp and the accuracy obtained are (DRIVE: Se= 1.000, Sp=0.666 and Acc=0.923) and (CHASE_DB1: Se=1.000, Sp=0.000 and Acc=0.826). For on the DRIVE and CHASE_DB1 data set are better than many state-of-the-art supervised an and unsupervised algorithms are shown in Tables I

Table I: Performance measure

DRIVE DATABASE:

Method	Sensitivity	Specificity	Accuracy
Mendinca et al. [12]	0.734	0.976	0.946
Shabana et al. [4]	0.874	0.0364	0.950
Hempriya et al. [1]	0.874	0.900	N/A
Gao et al. [3]	0.88	0.25	0.940
Proposed method	**1.000**	**0.666**	**0.923**

CHASE_DB1 DATABASE:

Method	Sensitivity	Specificity	Accuracy
Fraz et al. [10]	0.722	0.971	0.945
Azzopardi [11]	0.7896	0.9485	0.928
Proposed method	**1.000**	**0.000**	**0.826**

IV. Conclusion

The proposed method for retinal blood-vessels detection is working effectively on all images of different databases considered for evaluation of results. GLCM and DWT features together are used as feature vector they play an important role in classification of images. The method tested on the databases DRIVE and CHASE_DB1. On both the databases it has given encouraging results and they comparable with earlier findings. The results obtained by this data sets are, (DRIVE: Se = 1.000, Acc=0.923; CHASE_DB1: Se = 1.000, Acc = 0.82) are better to many of the other methods. Compared to the approaches by other researchers, our algorithm for detection of blood vessels has the advantage that it is applicable to both unhealthy and healthy images.

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