A Literature Survey On Defect Detection Mechanisms in Retina

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Abstract

Diabetic Retinopathy is the most common cause of blindness and vision loss to the human eye. Micrianeurysms should be considered as one of the major symptom of early blindness, for this, the detection of microaneurysms should be done well in advance. Several methods have been proposed not only to detect microaneurysms but also to detect haemorrhages, exudates etc. which should be considered as another major symptoms. The existing techniques has drawback that need to be focused. The survey presents very recent research on severity classification of microaneurysms and recommends neuro fuzzy could be applied to get a better performance.

1. Introduction

The detection of Diabetic Retinopathy is necessary for the early treatment. Mostly the diabetic patients are suffering from many of the diseases that are found in the retina of the human eye. Microaneurysms, exudates, haemorrhages, drusen, cotton wool spot are the major symptoms of blindness. All the above symptoms have to be detected well in advance. Automatic detection of the above mentioned symptoms like microaneurysms detection through cross-sectional scanning, haemorrhages detection through splat feature classification, Retinopathy Online Challenge for the detection of microaneurysms and exudates detection through the comparative analysis have already been proposed. But the detection and the severity classification of microaneurysms should be able to done with a new technique called the neurofuzzy which is a combination of both neural network and the fuzzy logic.

2. Splat Feature Classification for Haemorrhage Detection in Retina

Splat feature classification method was mainly introduced for the detection of retinal haemorrhages in the fundus image. In this, the colour images are partitioned into non-overlapping segments covering the entire image. A set of features should be selected based on the filter approach and the wrapper approach. The filter approach is fast accessing individual features separately. The wrapper approach access different combination of features.

Filter Approach:

In filter approach, the pixels that are having the same intensity are grouped as the training set. The training set is again classified as training subset and the testing subset. The test is applied to each pixel of the two groups and the values are sorted in an ascending order to determine their measure of effectiveness.

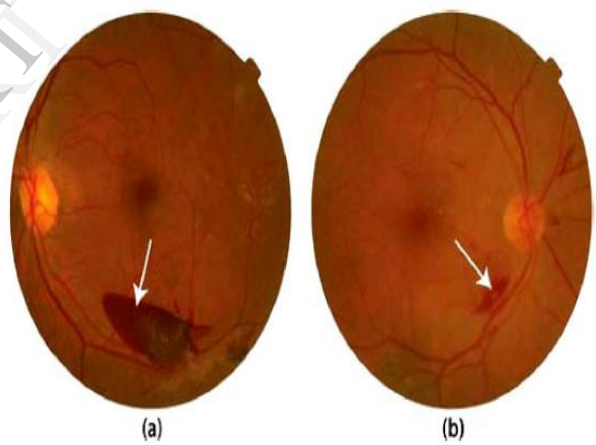

Fig.1 Retinal haemorrhages with different shapes and appearences[Ref [1]]

Wrapper Approach:

In wrapper approach, the irrelevant features or that are not very effective are removed. It selects different combinations of relevant features. Some of the relevant features are sent to the Sequential Forward Feature Selection that select the feature subset that covers the maximum area under Receiver Operating Characteristics (ROC).

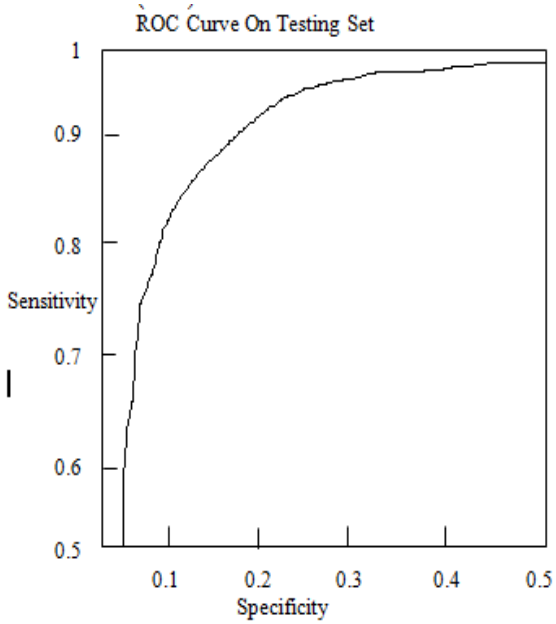

Fig.2 Splat based ROC curve [1]

Drawbacks: Many of the harmorrhages are connected with the retinal blood vessels, so during the detection of these haemorrhages may produce some of the false-positive rates. Another approach is to mask out all the blood vessels using one of the segmentation method. But some of the segmentation method may also mask out some of the large haemorrhages.

3. Texture less Macula Swelling Detection in Retina

Macula swelling detection with multiple retinal fundus image uses uncaliberated multiple view fundus images to analyze the swelling of macula. The technique should be divided into three parts: a pre-processing technique that enhances the dark microstructures of the macula. Secondly, all the available views are registered and thirdly, a naive height map reconstruction technique was applied.

Pre-processing:

The input image should be resized and an equal contrast is applied to all the areas of the image. It detects all the microstructures of the macula.

Registration:

In registration, the Speeded Up Robust Features(SURF) generate an 64-D vector for a given point and it selects all the points whose Speeded Up robust Feature quality is greater than 0.0001 and it keep track of all the points that are showing a distance larger than 0.7.

Naive Height Map Reconstruction:

The 64-D vector for the points obtained will be in a random for the areas where there is no texture. But the area having a texture, the noise will be distributed. So the naive height map should be determined with the help of mathematical formula.

$$im^{nhm} = \frac{1}{(n-1)} \sum_{i=1}^{n-1} im_i^{dmap}$$

Eqn.1 Naive Height Map reconstruction [2]

Where, n is the number of images

im_i^{dmap} is the magnitude of each vector

Drawbacks: Here the images are captured with the nonmydriatic digital fundus camera are the versatile tools for the diagnosis of various retinal diseases, but it cannot reliably detect depth, which is a key indicator of the early phase of the disease.

4. Retinal Nerve Fiber Layer Defect Detection in Retina

A computerized scheme for the detection of glaucoma which is a disease caused due to defect in the retinal nerve fiber layer was proposed.

Blood Vessel Removal:

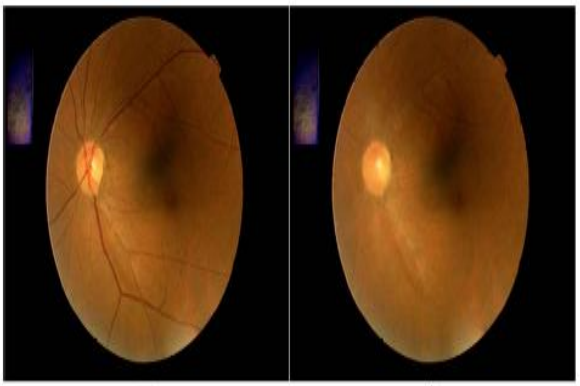

Fig.3 (a) Original fundus image (b) Blood vessel erased image

In blood vessel removal, the pixels of the blood vessels should be interpolated with other pixels for creating blood vessel erased images.

Polar Transformation and Enhancement:

The polar transformation and the enhancement process will make the curved retinal nerve fiber into a relatively straight nerve fiber and the enhancement of the retinal nerve fiber should be done with a Gabor function. This Gabor function is the multiplication of the Gaussian function and the cosine function.

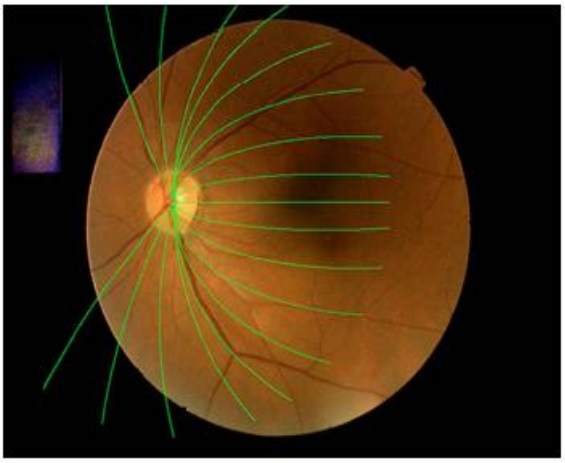

Fig.4 Straight nerve fiber [3]

Feature Determination:

From the determined features the retinal nerve fiber layer defect should be determined by the two classifiers namely, Linear Discriminant Analysis and the Artificial Neural Network. The results of the detection method was evaluated by the Receiver Operating Characteristics(ROC).

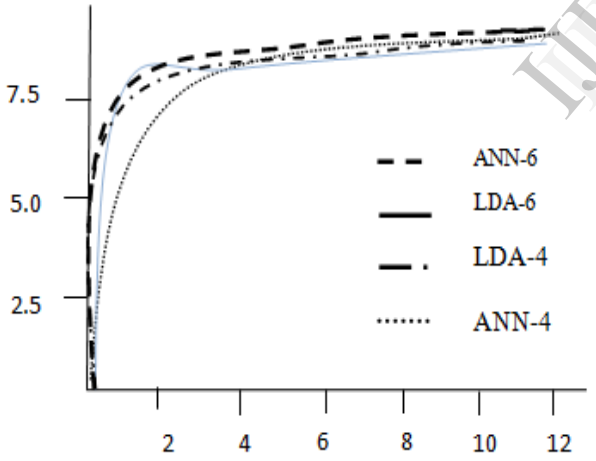

Fig.5 ROC curve for the retinal nerve fiber layer detection [3]

Drawbacks: Here the detection of optic disc is done manually for that a fully automated system is required and the determination of the exact center of optic disc could be difficult.

5. Optic Disc Boundary Detection in Retina

Circular Hough Transform method was used for detecting the optic disc boundary.

Circular Hough Transform:

The Circular Hough Transform method is used to transform a set of feature points in the image space into a set of accumulated votes in the parameter space. The circular Hough transform can be defined as

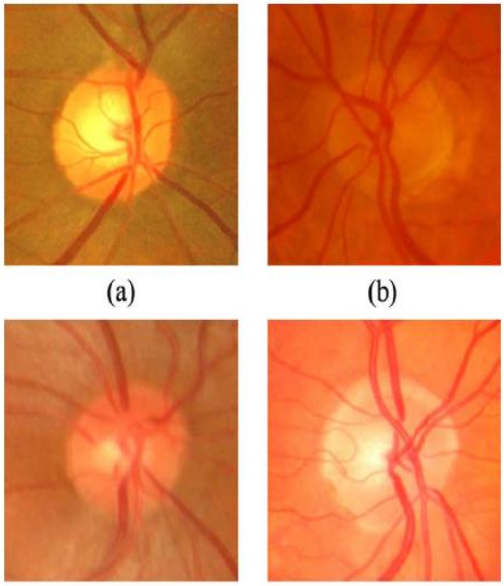

Fig.6 Examples of optic disc appearance [4]

$$(P_c,r) = CHT(I_{BM},r_{min},r_{max})$$

Eqn.2 Circular Hough Tranform[Ref[4]]

Where,$P_c=(i_c,j_c)$ and r are the center position and the radius that define the circular shape. The radius r is restricted to be between r_{min} and r_{max} which are one-tenth and one-fifth of the image that are divided by two.

Drawbacks: Since some of the optic disc is elliptical in shape, the Circular Hough Transformation method cannot be applied because it should be applied to detect the optic discs that are spherical in shape.

6. Automatic Detection Of Microaneurysms In Retina

Retinopathy Online Challenge:

A Retinopathy Online Challenge is a multilayer online competition for the detection of microaneurysms in retina. In the Retinopathy Online Challenge, a comparison of the results should be done from the results produced by five different methods produced by five different team of researches on the same set of data.

	Resolution(Height x width in pixels)	Coverage of retina	Number in training set	Number in testing set
Type I	768 x 576	45º	22	22
Type II	1058 x1061	45º	3	6
Type III	1389 x 1383	45º	25	22

Table 1 Different types of image in ROC dataset [5]

The above evaluation and comparison was done in a uniform manner. The result of the above method was submitted through a website after which some of the standardized software was used to determine the performance of each method.
But the overall method results shows that the detection of microaneurysms should be a challenging task for both the automatic method with the help of software and also for the human expert. Through these techniques, the data used for the retinopathy Online Challenge was difficult due to the presence of noise. Another issue is that the data was heterogeneous and was having different resolution and camera being used that leads to the greater variation in the image quality.

7. Blood Vessel Detection in Retina

The extreme condition of microaneurysms is the exudates. The microaneurysms should burst out and forms a yellow patch in the retina of the human eye is called the exudates. This exudate causes blindness to the human eye.

A comparative analysis for the automatic detection of exudates was done. In this, they have proposed some of the morphological techniques like pre-processing, vessel enhancement etc. for the automatic detection of exudates.

Pre-processing:

The captured input image should be resized and an equal contrast should be applied to the entire area of an image so that the pattern should have a better appearance in the image.

Vessel Enhancement:

For the vessel enhancement Gabor filters are used, because with the help of Gabor filters the background noise of the retinal image should be removed. The Gabor function uses a mathematical formula which should be defined as

$$g(x,y) = \exp[-\pi((x^2_p/\sigma_x)+(y^2_p/\sigma_y))\cos(2\pi f x_p)$$

where,

$x_p = x\cos\theta + y\sin\theta$

$y_p = -x\sin\theta + y\cos\theta$

Eqn.3 Gabor Function [6]

Θ is the orientation of the filter
'f' is the central frequency
Here, the performance of this method is evaluated based on both the sensitivity and the specificity at the pixel level.

Database	No of images	Sensitivity(%)	Specificity(%)
DRIVE	40	86.47+3.6,86.47-3.6	96+1.01,96-1.01

Table 2 Performance of blood vessel segmentation [6]

Method	Sensitivity Range(%)	Specificity Range(%)
Proposed Method	79-91	94-98
Hoover et al.2000	80-90	92-93

Table 3 Comparison of blood vessel segmentation on Hoover's database [6]

S.No	Application	Techniques
1	Hemorrhage detection	Splat Feature Selection Through Filter Approach And Wrapper Approach
2	Macula Swelling Dectection	Preprocessing,Registration And Naive Height Map Reconstruction
3	Retinal Nerve Fiber Layer Defect Detection	Blood Vessel Removal,Polar Transformation And Enhancement,Feature Determination
4	Optic Disc Boundary Detection	Circular Hough Transform
5	Automatic Detection Of Microaneurysms	Retinopathy Online Challenge
6	Blood Vessel Detection In Retina	Preprocessing,Vessel Enhancement

Table 4 Application Vs Techniques

8. Recommended Solution

The drawbacks of the previously mentioned techniques shoul be removed with the help of Neurofyzzy which is a combination of both the neural network and the fuzzy logic.

The neural network should be considered as a knowledge based system.It should process the information in a similar way like the human brain does.The network is composed of a large number of highly interconnected processing elements working in parallel to solve a specific problem.Neural network learn by example.Theycannot be programmed to perform a specific task.

During training,the network is trained to associate output with each of the input pattern.When the network is used,it identifies the input pattern and tries to output the associated output pattern.The first step in developing neural network is to create a database that contain the image.These images are converted into digital image by using any one of the scanning device.Half of the image should be taken from the databse to train the neural network and the remainder to test the performance.

In fuzzy technique,the rule have to be implemented for each and individual application and hence it is considered as a rule based system.But in neurofuzzy which is a combination of neural network and fuzzy logic,when we are training data the rules should be framed automatically.

9. Conclusion

Since this microaneurysms should be considered as one of the major symptom of blindness to the human eye and it is most commonly found in diabetic patients,the early detection of these microaneurysms should be very necessary inorder to avoid the early blindness.By the concept of Neurofuzzy, we should be able to produce a better performance from the existing techniques for thedetection of microaneurysms and also to determine its severity classification.

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