

Red Lesions Identification of Retina for Diabetic Patients



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Abstract: The automatic identification of retinal lesions in fundus images is crucial. In this paper, the approach used for identification of microaneurysms and hemorrhages in fundus images is appropriate. By using this technique, the features of changing shape for the identification of red lesions in the fundus images are effective in which segmentation is not necessary. While image flooding, shape features are evolved and characterized between red lesions and vessel segments.

Keywords: Diabetic Retinopathy, hemorrhages, microaneurism, Red lesions, retina

I. INTRODUCTION

The disorder of diabetes is diabetic retinopathy, which disturbs the range of view and may cause to blindness. The initial state of Diabetic retinopathy is asymptomatic which is challenging for examination, because of that regular examination of eye of diabetic patients is required. The increase in population increases the possibilities of diabetes and Diabetic retinopathy as it is very common disease in Diabetic patients. The identification of retinal lesions automation helps to diminish the burden on ophthalmologist.

Based on the number and shape of red lesions, severity level can be quickly identified and immediate treatment can be given if essential. Red lesions comprise microaneurism (MA) and hemorrhages (HE). The blood leakage forms a dark circular spot which is known as Microaneurism. The leakage of blood in the layers of retina as well as in the layers of nerve fiber leads to form HEs which are prolonged and non-uniform in shape.

II. METHODOLOGY

The figure 1 shows the flow diagram of the method used in this paper. In this proposed system, there are six steps to detect microaneurysms and hemorrhages from fundus image. The first step is to preprocess the input image of retina. The retina of input image which is in circular shape having a dark area is the region of interest.

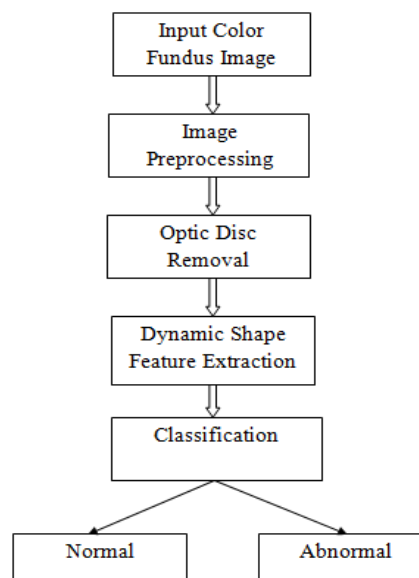


Fig. 1. Block diagram of proposed method

A. Image Preprocessing

As the non-uniformity of retina illumination is the main problem where in the low contrast area lesions are not visible properly. Preprocessing is the important step. There are following steps included in the Preprocessing.

- **Illumination Equalization:** The equation for improving the Illumination of input image:

$$I_{ie} = I + \mu - I * h_{M1} \tag{1}$$

Where the original input image, I is the average

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intensity, M_3 is the mean filter applied to input image.

- **Denosing:** This step is used to remove the noise from input image.
- **Adaptive Contrast Equalization:** The smoothness of background is proportional to the region having less standard deviation. This step helps to obtain Image details. By using this equation Contrast equalization is carried out:

$$I_{ce} = I_{dn} + \frac{1}{I_{std}}(I_{dn} * (1 - h_{M3})) \quad (2)$$

B. Optic disk removal

Removal of optic disk is mandatory step, because it may detect as a lesion. For removing optic disk entropy based approach is used. This approach consists of matched filter convolution in which multi scaling with ring shape is used.



Fig. 2. Preprocessing of Input Image

C. Dynamic Shape Features

The differentiation of actual red lesions and noisy vessels is important and we can achieve this by finding shape features. The dynamic regional minima is used to find the intensity threshold for detecting each candidate while image flooding. We are considering following extracted features to find the shape.

- **Area:** Area can be calculated by considering all catchment basin pixels and dividing it by pixels count of ROI.
- **Eccentricity:** We can calculate eccentricity with the help of following equation.

$$\sqrt{L^2 - W^2}/L^2 \quad (3)$$

- **Elongation:** It is calculated as shown in below equation.

$$E = 1 - \frac{W}{L} \quad (4)$$

- **Circularity:** For circularity formula is as follows.

$$C = \frac{\text{Area of catchment basin}}{(\text{Perimeter})^2} \quad (5)$$

- **Solidity:** Solidity is nothing but the ratio of area of catchment basic ($B_i^{S_j}$) to its convex area. In this flooding level i , candidate S_j and catchment basin B_i notations are used.
- **Edge features:** Edges are the important parameter to classify various objects from the image which

give the idea of where the brightness changes are present in the image. It is calculated as follows.

$$f(x) = \frac{I_r - I_l}{2} \left(\text{erf} \left(\frac{x}{\sqrt{2}\sigma} \right) + 1 \right) + I_l \quad (6)$$

Where $I_l = I_r = \lim_{x \rightarrow \infty} f(x)$, σ is the scale parameter, $f(x)$ is the input image.

- **Wavelet features:** To find frequency and particular location of every object present in the region of interest wavelet features are used. It can be calculated with the help of DWT (Discrete Wavelet Transform) which is evaluated by giving input signal to low pass filter and using impulse response g of it and convolution these two signals is carried out.

$$y[n] = (x * g)[n] = \sum_{k=-\infty}^{\infty} x[k]g[n-k] \quad (7)$$

The frequency resolution is calculated with the help of above equation and high pass filter. By using these features we will be able to find the shape and size of the lesions very easily. Wavelet features are calculated as shown in following equation.

$$Wf(a, b) = \langle f, \psi_{a,b} \rangle = \int_{-\infty}^{\infty} \psi_{a,b}(t)f(t)dt \quad (8)$$

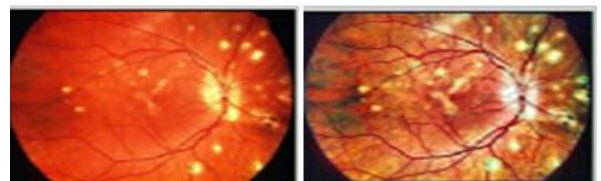
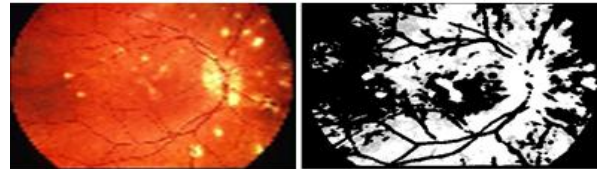


Fig. 3. View of input images at various stages of preprocessing

- **Classification:** After feature extraction, next step is classification. In this we can distinguish the image taken as a input is either lesion detected or lesion free. We have used KNN classifier for the classification of images with lesions or without lesions. In this classification method the value of K nearest neighbor is used and according to that class is assigned. The value of K is the positive integer. Ex: If K=1, then the object is classified to the single nearest neighbor class.

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Where x is the label of class y . and $r \sim p_r$, $r=1,2$ (and probability distribution).

$$R_R(C_n^{wnn}) - R_R(C^{Bays}) = (B_1s_n^2 + B_2t_n^2)\{1 + o(1)\} \quad (9)$$

Where, $\sum_{i=1}^n w_{ni} = 1$, B_1 and B_2 are constants, and

$$s_n^2 = \sum_{i=1}^n w_{ni} \quad \text{and}$$

$$t_n = n^{-2/d} \sum_{i=1}^n w_{ni} \{i^{1+\frac{2}{d}} - (i-1)^{1+\frac{2}{d}}\}$$

Also weights are assigned as follows, by using the Euclidean distance.

$$DT(a, b) = \|a - b\| = \{(a - b)(a + b)\}^{1/2} \quad (10)$$

III. EXPERIMENTAL RESULTS

For experimentation, the standard database of input images of eye of diabetic patients is used. In order to get rid of noise in the image as well as to obtain more clear illumination of image, preprocessing of an input images are done with the help of large and small mean filters. Also, for the sharpness of the image region contrast equalization is carried out with the help of standard deviation. The standard colour image depends on the colour normalization and lesions which are emerged as a noise in the image is removed. Then the extraction of the candidates from the output images is carried with the help of dynamic transformation. The feature extraction is carried out by using dynamic shape features. The KNN classifier helps to detect images having lesions by using classification technique.



Fig. 4. Experimental results of normal image i.e. without lesion

The above figure is the resultant input image with no red lesions which indicates that it is not affected by diabetic retinopathy. The image having red lesions requires treatment which is affected by diabetes retinopathy.

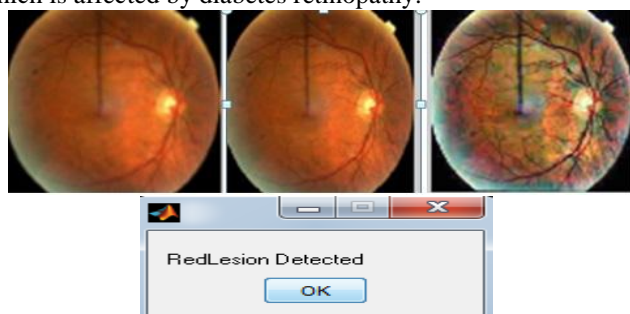


Fig. 5. Experimental results of input image of abnormalities i.e. with detected red lesions

The table below shows the values of the feature which includes area, eccentricity, solidity, edge features and wavelet features.

Table- I: Feature values of Diaretdb1 database

Sr. No.	Input Images	Area	Eccentricity	Solidity	Edge	Wavelet
1	diaretdb1-image001	22665	0.730277598	0.5237556	-1.06581E-14	175.932
2	diaretdb1-image002	8098	0.747754753	0.2727793	-3.4586E-16	61.8842
3	diaretdb1-image003	4128	0.691926599	0.2019471	-2.79187E-15	32.5392
4	diaretdb1-image004	4620	0.926093161	0.2391057	-1.11022E-15	34.6565
5	diaretdb1-image005	3036	0.854155362	0.170084	-2.32003E-16	23.2726

Table- II: Feature values for Erlangen database

Sr. No.	Area	Eccentricity	Solidity	Edge	Wavelet
1	23557	0.805376232	0.4700	0	178.7945
2	13302	0.83056885	0.2741	-1.06581E-14	102.4672
3	27230	0.762855411	0.5299	-7.10543E-15	206.2795
4	18554	0.735947549	0.3935	4.44089E-15	141.7090
5	20415	0.821262419	0.4336	1.77636E-15	155.3218

Table- III: Feature values of Messidor database

Sr. No.	Area	Eccentricity	Solidity	Edge	Wavelet
1	20232	0.777684927	0.7092974	1.36133E-15	146.1852
2	6483	0.906636238	0.2339167	-8.92564E-16	49.5279
3	6961	0.812655628	0.2457373	3.60113E-15	53.5818
4	20926	0.783790112	0.7398267	3.6673E-16	151.2516
5	21293	0.752112687	0.7539747	5.2573E-15	153.7296

The number of false images is obtained by removing every feature to measure the accuracy of every feature.

Table- IV: Comparison of different databases

Database	Diaretdb1 (89)	Erlangen (45)	Messidor (100)
Eccentricity	94.38%	88.88%	89%
Solidity	89.98%	93.35%	92%
Edge	95.50%	93.55%	93%
Wavelet	96.62%	94%	97.77%

Different databases having different feature values are shown in tables 1, 2, and 3 which indicate Diaretdb1, Erlangen, Messidor databases respectively.

Diaretdb1 database is having 89 images, Erlangen is of 45 images and Messidor is having total 1200 images out of that we have used 100 images.

The table 4 shows the accuracy of different features for different databases. It is calculated by doing multiple experiments. For increasing the accuracy two methods i.e. edge features and wavelets features are used. Sorting of images with lesions or without lesions edge feature is used. To locate the particular target at specific interval of time wavelet feature is used.

IV. CONCLUSION

In this paper the dynamic shape features like wavelet features and edge detection features are used in order to detect red cleared lesions. The details of red lesions are automatically detected for easy treatment and disease can easily be cured. The classification of noisy data in the input processed images can be obtained by using KNN classifier.

The future scope of the work is to obtain the detailed result of lesions in the retinal images.

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