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ROC Curve analysis for automatic detection of Microaneurysms in the retinal fundus image

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Abstract : Diabetic Retinopathy (DR) is the leading cause of blindness and its diagnosis is very important to protect the vision. DR diagnosis depends on the detection of retinal lesions such as Microanerysms, Hemorrhages, Hard Exudates, Soft Exudates and Neovascularization present in retina images acquired by a fundus camera. In this paper, proposed a method for the detection of retina lesions consists of preprocessing, extraction of candidate region, formation of feature vector and classification. A Total of 24 features are proposed in this paper which contain shape, color, gray and texture based properties of lesions for SVM, kNN and ELM classifier to distinguish MAs and non-MAs. The proposed framework is evaluated using 259 retinal images collected from publicly available database: DIARETDBO, DIARETB1 and DRIVE database. The experimental results reveals the effectiveness of the proposed method and it reduce the workload of ophthalmologist and helpful to diagnose DR clinically.
Keywords : Medical Image processing, Diabetic Retinopathy, NPDR lesions, Blood Vessel Segmentation, Features, Classification.

Introduction:

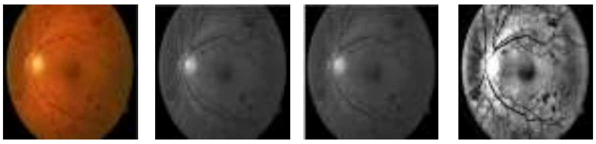
DR affects the blood vessels present in the human retina; it will become the main source for vision impairment [1]. Blurred vision, floaters, flashes and sudden loss of vision are the symptoms of DR [2]. DR is one of the reasons behind blindness in between the age group of 20 and 60 years. [3]. DR detection is very crucial and its severity is determined by their number of lesions present in the fundus image. DR can be classified into two stages such as Non-Proliferative DR (NPDR) and Proliferative DR (PDR). NPDR or background DR occurs when the blood vessels are damaged inside the retina and causes leakage of fluid on retina surface. There are different signs of retinopathy present in NPDR are Microanerysms (MAs), Hemorrhages (H), Hard Exudates (HE), Soft Exudates or Cotton Wool Spots (CWS) and Neovascularization (NV) (Frank, 1995) [4].

MAs are the earliest visible sign of DR and it is red in color and has a range from 10μm to 100 μm with sharp margins. It is considered as an earliest stage of DR and remains in the development of diseases [5]. The ophthalmologists have to diagnose the patient and determine the presence of DR, but it's difficult to screen the large number of images. In recent year, Computer Aided Diagnostic (CAD) system is introduced for screening the fundus image. CAD system is useful to diagnose number of disease present in the eye; it also differentiates the affected and non-affected retina images. This will reduce the ophthalmologist workload and this method was very time consuming. [6].

This paper describes a system for detection of MAs lesions present in retina image. The method consists of following steps such aspreprocessing, blood vessel segmentation, candidate region extraction, feature vector formation and classification. In candidate region stage, extract all possible candidate regions present in the retina image. A totally 23 features are generated using four different types of features are shape, color, gray level, texture features. The formed feature vectors are given to the classifier of SVM, kNN and ELM to classify the MAs or non-MAs in the retina image.

Methodology:

In the proposed system green channel of the fundus image is used as input for further processing. The green channel image provides better background contrast while red channel is saturated and blue channel is dark. Sometimes, the retina images are poor contrast and noise images. It is difficult to visible MAs in the presence of poor contrast. In order to reduce these drawbacks Extended Median filter [7] is applied to green channel of the retina image to remove the noise from the images is illustrated in Fig. 1c The background contrast is not enough in the fundus image, so enhancement method of contrast limited adaptive histogram equalization (CLAHE) method is applied to denoised retina image. It will make the features of the retina images are more visible [8]is shown in Fig. 1d.



a b c d

Fig. 1Preprocesing and retina enhancement.

a b c d

Fig.2 Gabor Filter Bank

a b c

d e f

Fig. 3 Blood vessel segmentation. aInput images of DIARETDBO. b DIARETB1. C Drive dataset. d,e and f output images of three dataset

The Gabor filter is applied to contrast enhanced image for lesions enhancement with four different orientations such as 45^0,90^0, 135^0 and 180^0 is shown in Fig. 2. This different orientation is suitable for MAs detection in the retina image. The Gabor filter is represent

$$G(x,y,\xi_x,\xi_y,\sigma_x,\sigma_y,\theta) = \frac{1}{\sqrt{\pi\sigma_x\sigma_y}} e^{-\frac{1}{2}\left[\left(\frac{g_1}{\sigma_x}\right)^2+\left(\frac{g_2}{\sigma_y}\right)^2\right]} e^{i(\xi_x x+\xi_y y)} \qquad (1)$$

Where ξ_x, ξ_y represents the spatial frequencies of the Gabor are filter, σ_x and σ_y standard deviation, θ gives the orientation of the Gabor filter, $g_1 = xcos\theta + ysin\theta$ and $g_2 = -xsin\theta + ycos\theta$.

The extracted region from Gabor filter contains false lesion regions in their blood vessels pixels. So have to remove that false lesion region for further processing. The accurate segmentation of blood vessel is carried out through threshold techniques. After vessel enhancement, thresholding techniques are applied to generate binary mask for blood vessel segmentation. It is very difficult to find optimal threshold value for blood vessel segmentation because blood vessels have high response at center and low on edges and far thin vessels. So, different threshold are applied for blood vessel segmented processes. Fig. 3 shows the result of blood vessel segmentation of respective datasets DIARETDBO, DIARETB1 and DRIVE database.

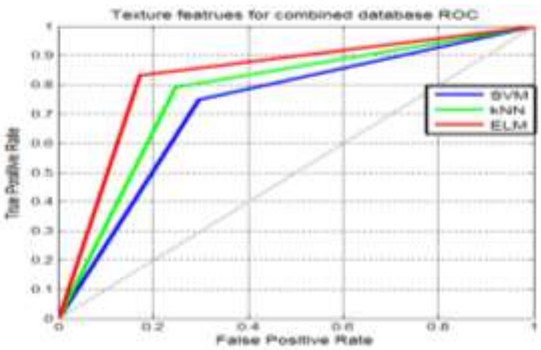


Fig. 4 ***The ROC curve of the shape based features***

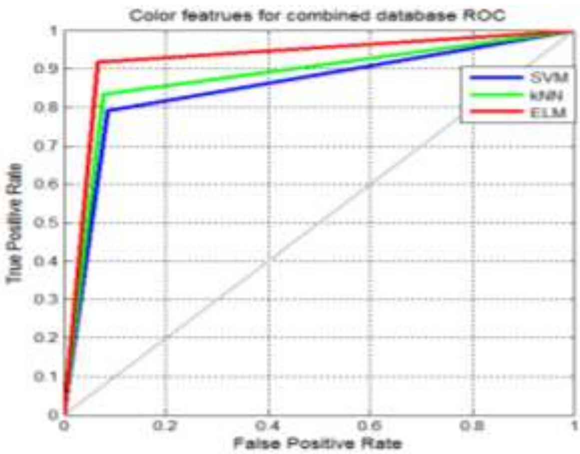


Fig. 5*The ROC curve of the Color based features*

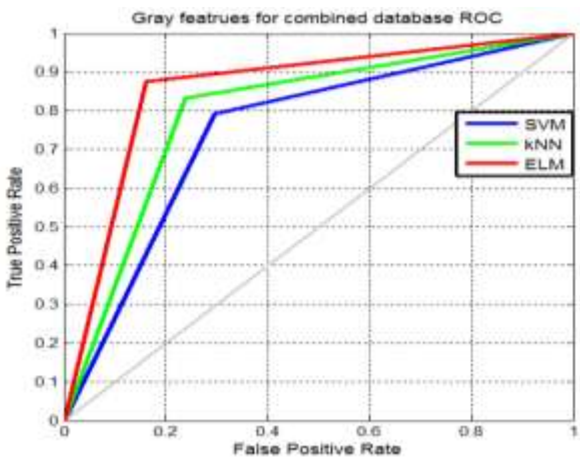


Fig. 6*The ROC curve of the Gray Level based features*

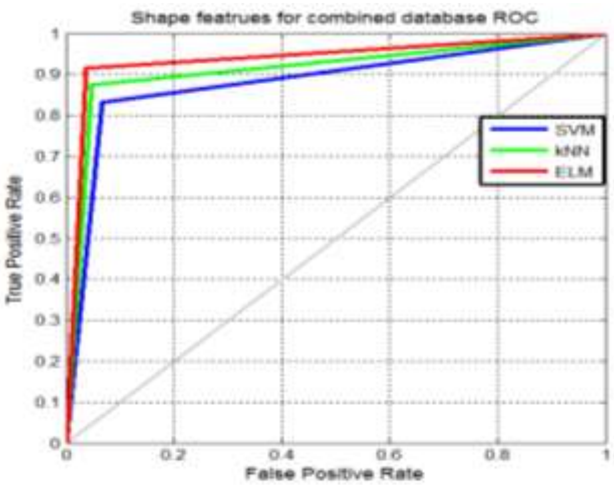


Fig. 7The ROC curve of the Texture based features

Fig. 4-7 illustrates the ROC curve for the combined dataset of DIARETDBO, DIARETB1 and DRIVE database contains overall 259 retina images of which 48 images are not affected by any sign of DR where remaining 211 images are affected by DR signs. For training purpose, we used 130 images and for testing purpose we used 129 images where 24 images are non-MA and 105 images are affected by MAs. In this paper, the Receiver Operating Characteristics (ROC) is used to evaluate the performance of the proposed system. A ROC curve is a plot between the true positive rate and false positive rate detection per image. An optimal threshold is used for the ROC curve, if any increase in sensitivity then decreases is obtained by FPR.

$$TPR(Sensitivity) = \frac{TP}{TP+FN} \quad (2)$$

$$FPR(1 - specificity) = \frac{FP}{TN+FP} \quad (3)$$

Where TP denotes the true positive, MA pixels are correctly detected, FN denotes the false negative, a number of MA pixels are not detected and FP denotes the false positive, number of non-MA is detected wrongly as MA. In this paper, four types of features such as shape, color, gray and texture based features are used to classify the MA region in the retina image. Three types of classifiers such as SVM, kNN and ELM classifier is selected for classification are evaluated on the given combined database to compare the performance based on individual features. The performance of the ELM classifier with shape based features provides better performance than other approaches. The color based features provides second better performance compared to gray and texture based features. The shape and colorbased features used to distinguish the MAs and non-MAs region because lesionsare different in size and color where MAs are small round in size and red in color. So, this property is obtained from shape and color based features and helpful to differentiate the lesion in the retina image. The kNN classifier provides better result comparable to SVM classifier because of small data set with discriminative features. If the size of the dataset increased with discriminative features SVM provides better result compared to kNN classification method. ELM provides better performance with shorter learning time compared to kNN and SVM. ELM is simpler for parameter tuning compared to SVM. The good classification accuracy is given by ELM classifier compared to kNN and SVM. In terms of execution time, ELM classifier takes several seconds for processing each candidate lesions on Core i-7 (3.4-GHz PC) with 4 GB RAM. SVM obtain higher computation time of 18.052s compared to kNN of 7.433s and ELM of 7.312s.

Conclusion*:*

In this paper automatic detection of MAs in the fundus images was proposed. First, preprocessing method was applied to enhance the retina image for better extraction of candidate lesions and feature vectors. A totally 23 features are used which contain shape, color, gray and texture based features of candidate regions. Three types of classifier such as SVM, kNN and ELM are compared to find the suitable classifier for given selected features for MAs detection in the retina image. The results of ELM classifier with shape based features shows better performance of MAs detection in the combined dataset. This method will be used for diabetic retinopathy screening system.

References

1. Klein, R, Klein, B. E., Moss, K. S. E.:'Visual impairment in diabetes', Ophthalmology., 1994, 91, pp.1–9.
2. Effective Health Care.: 'Complications of Diabetes: Screening for Retinopathy and Management of Foot Ulcers', Royal Society of Medicine Press 1999, 5 (4): 0965-0288
3. Walter, T., Massin, P., Erginay, A.: 'Automatic detection of microaneurysms in color fundus images', Med. Image Anal., 2007, 11 (6), 555–566.
4. Zhang, B., Wu, X., You, J., et al., 'Detection of microaneurysms using multi-scale correlation coefficients', Pattern Recogn., 2010, 43 (6), pp.2237–2248
5. Antal, B., Hajdu, A.: 'Improving microaneurysm detection using an optimally selected subset of candidate extractors and preprocessing methods,' Pattern Recogn, 2012a, 45 (1), pp. 264–270.
6. Pereira, C., Veiga, D., Mahdjoub, J.: 'Using a multi-agent system approach for microaneurysm detection in fundus images', Artif. Intell. Med., 2014, 60 (3), pp. 179–188.
7. Subbuthai, P., Muruganand, S.: 'Restoration of retina images using extended median filter algorithm', 2nd International Conference on Signal Processing and Integrated Networks (SPIN)., 2015, pp. 131-138.
8. Antal, B., Hajdu, A.: 'An ensemble-based system for microaneurysm detection and diabetic retinopathy grading', IEEE Trans. Biomed Eng.,2012b,59 (6), pp. 1720–1726

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