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Detection of Microaneurysm in diabetic retinopathy using fundus image

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Abstract : Diabetic retinopathy (DR) is a serious diabetic complication and Microaneurysm (MA) is the earliest lesion in diabetic retinopathy, so early MA detection plays a critical role in diabetic retinopathy diagnosis. In this paper, number of MA has been determined. Initially, pre-processing techniques like green channel extraction, histogram equalization and morphological process have been used. For detection of micro aneurysms, contrast limited adaptive histogram equalization (CLAHE), morphological process, averaging filtering have been used. Classification of DR has been done by linear Support vector machine (SVM). The sensitivity and specificity of DR detection system are observed as 96% and 92% respectively. Finally, we demonstrated extensive experiment results on DiaretDB1 database for the effectiveness of the proposed algorithm.

Index Terms - Microaneurysm detection, diabetic retinopathy, CLAHE, Neural Network.

I. INTRODUCTION

Each Diabetic retinopathy (DR) is a widely spread eye disease and a majority of the people suffering from diabetes mellitus will eventually develop DR. In the early stage of disease, due to the symptoms are not very salient, those patients who have the DR often cannot pay attention to the changes in their vision. However, with disease develops, sufferers may lose their eyesight. Therefore, annual screening of patients for possible DR is recommended. Digital color fundus photography allows acquisition of fundus images in a noninvasive manner which is a prerequisite for large scale screening.

There are several different components in retinal images (Fig.1), such as blood vessels, the fovea, the macula, and the optic disc (OD). In clinical, ophthalmologists classify DR into two major phases namely Non-proliferative DR (NPDR) and proliferative DR (PDR). NPDR can be regarded as the initial phase of DR. During the NPDR, several lesions such as red lesions (micro aneurysms and hemorrhages, see Fig.1) caused by blood leakage, yellowish or bright spots (hard and soft exudates, see Fig.1) in case of fat or protein leakage. The second phase of DR is the PDR, because of the blood vessels cannot obtain the enough oxygen causing blood vessels to grow in different regions of the retina image to maintain the adequate oxygen. Among the lesions, micro aneurysms as one of the earliest lesions appear in diabetic retinopathy, which are dark-red round dot filled bulges in the artery walls and their diameters always range from 10µ *m* to 100µ *m* . Retinal micro aneurysms are focal dilatations of retinal capillaries, 10 to 100 microns in diameter, and appear as red dots. They are usually seen at the posterior pole, especially temporal to the fovea. They may apparently disappear whilst new lesions appear at the edge of areas of widening capillary non-perfusion. Micro aneurysms are the first ophthalmoscopically detectable change in diabetic retinopathy. However, the variations in shape, size and illumination of fundus images play important roles in detection of MA, which make the detection of MA becoming more challenging. Therefore, MA detection is importance for automatic retinopathy detection. Within this study, we pay attention to automatic MA detection.

Numerous approaches have been proposed for microaneurysm detection using retinal color fundus images. They can be divided into three categories, mathematical morphology, supervised classification and template matching. Among mathematical morphology, top-hat transformation operation based on liner structuring elements at a range of varying inclinations is widely used to remove elongated elements (i.e. the vessels) from unconnected circular objects, such as the MAs. However, when the size of MA is much smaller than the length of the structuring elements, the vessel can hardly be removed. In this case, some supervised learning-based methods have been proposed for MA detection such as *k*-nearest neighbor, artificial neural network (ANN), logistic regression classification. Whereas, pixel level classification methods need a reference standard which is mainly from medical experts manually labeling at each image pixel. So with the increase of numbers of fundus images, these approaches will become infeasible. At the same time, a series of template matching methods are used to enhance the lesion shape such as Gaussian filters, or some special-purpose filters, which have been widely used for MAs detection. However, how to design a suitable template to match the MAs is a key problem.

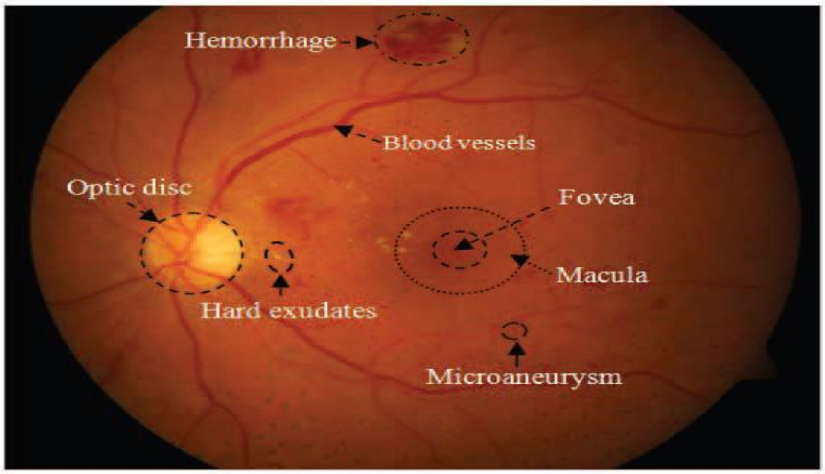

Fig.1 A retinal image with different types of lesions and main anatomical features.

II. LITERATURE SURVEY

In the paper presented by Kranthi Kumar, Palavalasa and Bhavani Sambaturu, a system has been introduced which uses a new system to descry hard exudates with high delicacy with respect to lesion level.They originally detected the possible seeker exudate lesions by using the aft ground deduction methodology in the present system. Following the posterior way, in the last stage of the algorithm they removed the false exudate lesion findings using thede-correlation stretch grounded system. Likewise they tested algorithm on intimately available DiaretDB database, which contains the ground verity for all images [1].

In the paper presented by Niladri Sekhar Dattaa, Himadri Sekhar Dutta, Mallika De, and Saurajeet Mondal, they proposed a system using position grounded discrepancy improvement process which is popularly known as Differ Limited Adaptive Histogram Equalization (CLAHE) for the discovery of retinal changes in DR images.
Their proposed algorithm divides the retinal images into a number of small on-overlapping contextual penstocks. Likewise, following CLAHE at each pipe independently, median filtering of DR images is carried out in order to smooth the background noise. Results of their proposed algorithm showed a considerable enhancement in the improvement of DR image quality. The outgrowth generated by them for average perceptivity and particularity of this Diabetes Webbing System revealed as 82.64 and 99.98 independently [2].

In the paper presented by Usman M. Akram, Shoab A. Khan, they proposed a computer aided system for the early detection of DR. They presented algorithms for retinal image preprocessing, blood vessel enhancement, segmentation, optic disk localization and detection which eventually lead to detection of different DR lesions using proposed hybrid fuzzy classifier.They tested developed methods on four different publicly available databases. After which they compared presented methods with recently published methods and the results show that presented methods outperform all others[3].

In the paper presented by ShitalN. Firke and Ranjan Bala Jain, it presents a complication neural network approach to detecting diabetic retinopathy. The use of intimately accessible Apatos Blindness Discovery database to train a complication neural network was done, where the image is reused at an early stage, primarily involving image resizing, pixel rescaling, and marker encoder. After that, an image is given to the complication neural network model, to decide whether the case has diabetic retinopathy or not. About 3789 color retinal images are used in trials to train the proposed model and about 948 images are collected to test its effectiveness in bracket [4].

In the paper presented by Anam Tariq,M. Usman Akram, Arslan Shaukat and ShoabA. Khan, they developed a system that excerpts the macula from digital retinal image using the vascular structure and optical slice position. It creates a double chart for possible exudate regions using sludge banks and formulates a detailed point vector for all regions. The system uses a Gaussian Mixture Model- grounded classifier to the retinal image in different stages of maculopathy by using the macula coordinates and exudate point set. The results attained from their system have been compared with other styles in the literature in terms of perceptivity, particularity, positive prophetic value and delicacy [5].

In the paper presented by Gehad Hassan, Nashwa El-Bendary, Aboul Ella Hassanien, Ali Fahmy, AbullahM.Shoeb and Vaclav Snasel, they presented blood vessel segmentation approach, which can be used in computer grounded retinal image analysis to prize the retinal image vessels. They used the Mathematical morphology and K- means clustering to member the vessels. To enhance the blood vessels and suppress the background information, they perform a smoothing operation on the retinal [6].

In the paper presented by Jayant Yadav, Manish Sharma and Vikas Saxena, they approached the idea issue by using computer vision to not only descry this complaint, but also automating this procedure using a neural network to give results of numerous cases within a short time frame. DR discovery is being done by detecting two major corridor of it, videlicet, Exudates and FleckHemorrhages.They designed the overall armature of the design in following ways 1. Rooting Optic Disk 2. Rooting Blood Vessels 3. Discovery of Exudates 4. Discovery of Fleck hemorrhages [7].

In the paper presented by Karkhanis Apurva Anant, Tushar Ghorpade and Vimla Jethani, the proposed fashion uses image processing, data mining, texture and sea features which are uprooted for discovery. The results are attained for image of

standard database DIARETDB1 and estimated using parameters of perceptivity, particularity and delicacy. The final outgrowth generated by them yields a high delicacy of 97.75 which can help to descry and help diabetes [8].

In the paper presented by Xianglong Zeng, Haiquan Chen, Yuan Luo and Wenbin Ye,a computer- backed opinion system grounded on deep literacy algorithms is proposed to automatedly diagnose the referable diabetic retinopathy (RDR) by classifying color retinal fundus photos into two grades. In this work, a new convolutional neural network model with Siamese-suchlike armature is trained with transfer literacy fashion. The proposed model accepts binocular fundus images as inputs and learns their correlation to help make prognostications. To further corroborate the effectiveness of the binocular design, a binocular model for five- class DR discovery is also trained and estimated on a 10 confirmation set [9].

III. BLOCK DIAGRAM

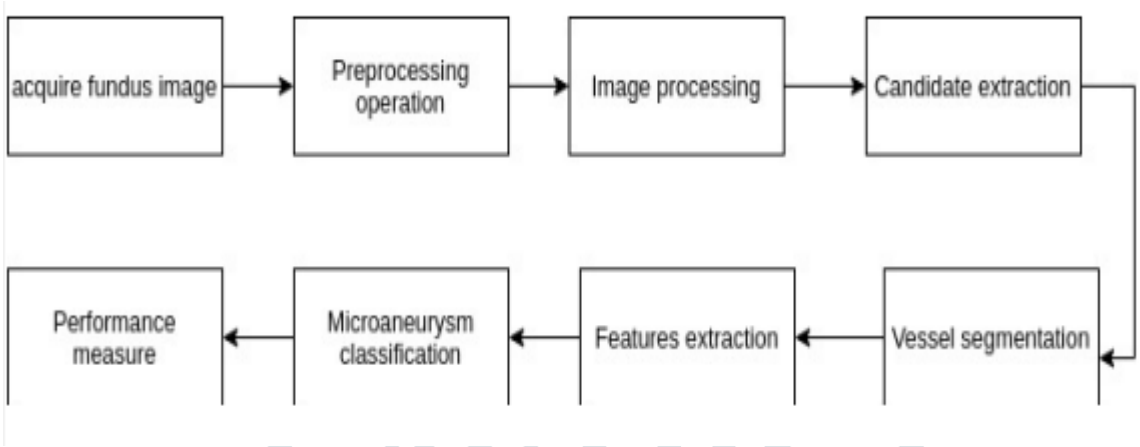

Figure 1. Proposed Block Diagram

Algorithm:
Input: RGB fundus image.
Output: Binary image with microaneurysms and 4 feature values representing area occupied by microaneurysms in 4 quadrants.

Step 1: Pre processing:

i. Normalize the image with relation to size.
ii. Extract green channel of the RGB image.
iii. Apply adaptive histogram equalization thrice, to enhance the image.

Step 2: Segmentation:

i. Apply canny edge detector to find the edges of blood vessels and pathologies.
ii. The candidate microaneurysms are selected by filling them supported on their shape and size.

Step 3: Morphological operation:
Morphological opening with large ball shaped structuring element of size 11 is used to eliminate blood vessels.

Step 4: Boundary of optic disc:
It is marked using an active contour method and is eliminated by converting the pixels inside the boundary to back ground.

Step 5: Area Calculation:
The resultant image is split into four quadrants and also the area occupied by microaneurysms in each quadrant is calculated.

IV. RESULT

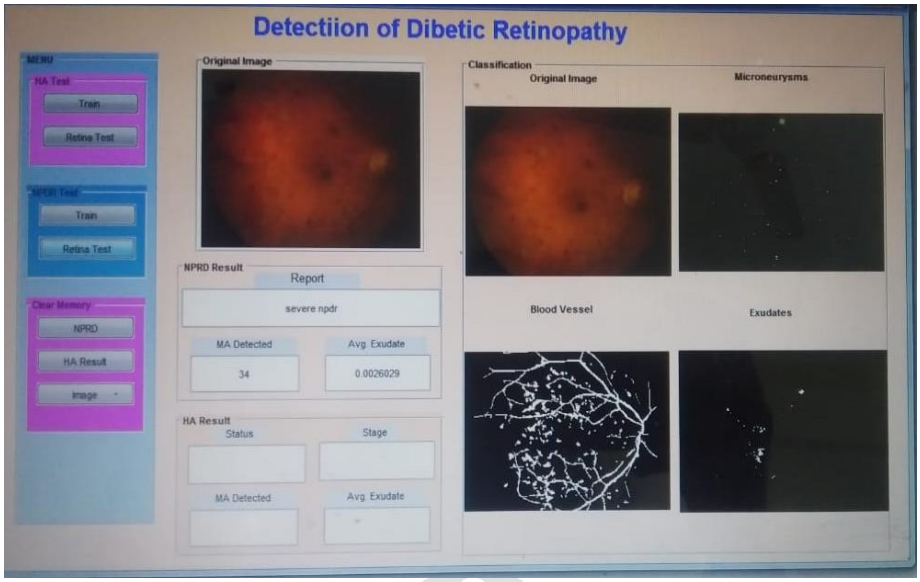

Fig 2. Proposed system

Fig 3. Performance Plot

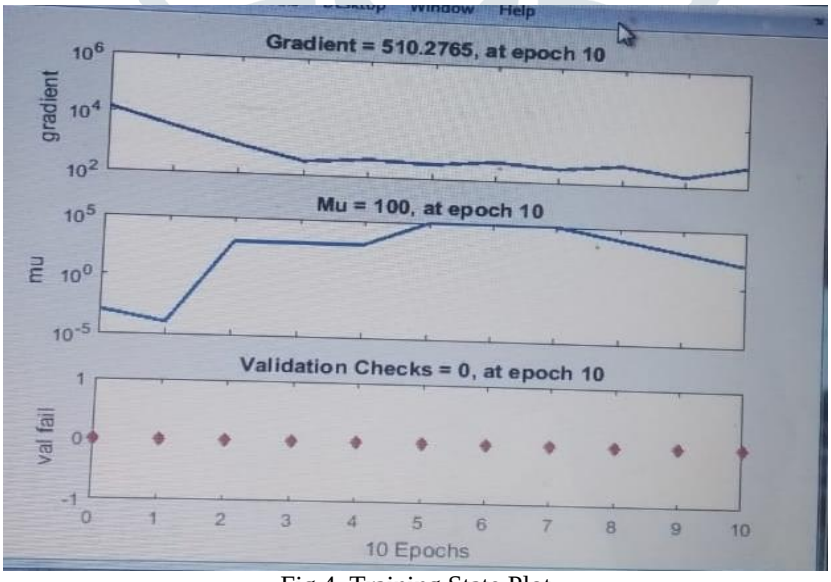

Fig 4. Training State Plot

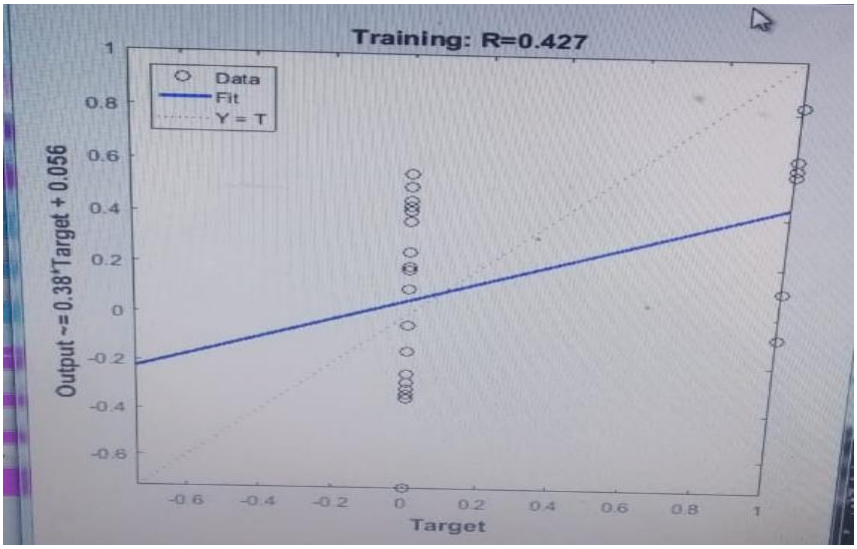

Fig 5. Regression Plot

V. CONCLUSION

An unique method for AMD and DR diagnosis was presented. It is based on an- analyzing texture discrimination capability ties in fundus images to differentiate healthy patients from AMD and DR images. In diabetic retinopathy (DR), retina blood vessels are broken owing to fluid discharge from these vessels. Completely different lesions, i.e., Exudes, hemorrhages, microaneurysms, and textures are used to observe the stage of DR. in this system, we use taken 76 images out of 82 images from our database for DR lesion detection are mentioned and evaluated. Image processing techniques mentioned in this paper will find the DR accurately. Hybrid methodology ought to be utilized in order to get higher end in terms of accuracy and potency for DR detection.

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