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New Approach of MA Detection & Grading Using Different Classifiers

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***Abstract*—**Diabetic retinopathy (DR) is the most frequent cause of cases of blindness among adults aged 20–74 years. Since the presence of microaneurysms (MAs) is usually the first sign of DR and occurs due to damage in the retina as a result of long term illness of diabetic mellitus. Early microaneurysm detection can help reduce the incidence of blindness and Microaneurysm detection is the first step in automated screening of diabetic retinopathy.Since micro aneurysm detection is decisive in diabetic retinopathy (DR) grading. Grading performance of computer aided DR screening system highly depends on MA detection. In this paper we propose a MA detector that provides remarkable results from both aspect.

***Keywords*—** Diabetic retinopathy (DR) grading; ensembles based systems; micro aneurysm (MA) detection.

I. INTRODUCTION

Diabetes is disease that affect blood vessels thought the body especially on kidneys & eyes. Along with diabetes, high blood sugar level in long periods can affect small vessels in the retina. Diabetic retinopathy (DR) is complicated eye dieses which is cause blindness for human being. MA is early sign of DR. so detection of MA is essential in an efficient screening process. MA is nothing but small circular spot on the surface of retina. MA is near thin vessel but they cannot actually lies on the vessels. DR can be prevented by earlier detection of MA & slows down progression of MA. Therefore regular eye checkup & timely treatment is needed. But due to the higher medical cost makes regular checkup costly. To fill this gap development of low cost & versatile MA detection technique is needed. We additionally add the ma detector & DR Grading which give remarkable result.

II. HUMAN EYE & DIBETIES

Anatomy of Human Eye

The anatomy of the human eye consists of different cellular structures which are responsible to maintain proper functioning of our vision system. Light entering the eye passes through the anterior and posterior regions before it is processed in the visual cortex. The anterior region which consists of cornea, iris, pupil, and lens mainly serves as a pre-processing step to control the amount of entering light and converges it on the retina. The posterior region contains retina which is a multi-layered sensory tissue made of millions of photo-receptors to capture incoming light. The central area within retina is called the macula which consists of the central fovea, rich in cones, and a peripheral area, rich in rods. Cones are highly color sensitive photo-receptors and are mainly responsible for day vision. On the other hand rods are highly sensitive to contrast variations and active during night vision or dark light condition.

Dibetic Retinopathy

These dieses originate from diabetic mellitus. It causes progressive damage to the retina. The light sensitive lining at back of eye. It is serious complication of diabetes. DR damages to the tiny blood vessels that nourishes to the retina. They leak blood & other fluid that cause swelling of retinal tissue & clouding of vision. Sometime patients can only differentiate between dark & light part of the image. It affects to the both eyes. Difference in vision of normal and DR affected person:

(a) Normal Vision. (b) Vision with Diabetic Retinopathy.
Fig. 1(a-b). Normal human vision vs. vision affected by diabetic retinopathy.

III. PRESENT THEORIES

Morphological Approach

Morphological processing is the most common method for the detection of lesions like micro aneurysm. Akara Sopharak et al. [1] proposed a morphology based method for the detection of MA. Feature Extraction helps in extracting the essential features that distinguish MA pixels from the non-MA pixels.18 such features like pixels intensity value of shade corrected image, pixel's hue, Perimeter, Area Circularity, Eccentricity were obtained. Then, Fine Segmentation using naïve

S. N. Patil and Komal hajare, "New approach of MA detection & grading using different classifiers," *International Journal of Scientific and Technical Advancements*, Volume 2, Issue 1, pp. 25-28, 2016.

Fractal Analysis

Rukmini et al. [3] proposed a method which comprises of two stages .The first stage comprises of image pre-processing and fractal Analysis. Various features were extracted like area, perimeter, diameter, circularity, aspect ratio. Receiver operating Characteristics curve was obtained, which displays the relationship between the sensitivity and specificity. Publicly available diabetic retinopathy database DIARETDB1 was chosen which consists of 89 color fundus images. The Sensitivity and the specificity was 89.5% and 82.1% respectively.

HSV Method and Eccentricity Technique

Preeyaporn et al. [4] proposed a method using the combination of HSV method, area identification and eccentricity technique. HSV color model is the method which mainly considers Hue, Saturation, value. The shape of the pixels can be divided based on the eccentricity ranging from 0-1.The eccentricity of MAs range from 0.3-0.89.If the eccentricity is less than 0.3,it is considered as a noise and if it is greater than 0.89,it is considered as a vein. The Accuracy was 93%.

Local Rotational Cross-section Profile Analysis

Istvan et al. proposed detection of microaneurysm though local rotational cross-section profile analysis. The inverted green channel of the fundus image was acquired, since MAs, Haemorrhages and vasculature appear as bright structures. It was tested on 60 retinal images. This method has achieved a higher sensitivity at lower false positive rates i.e., 1/8 and ¼ FPs/image. Table I show the Evaluation and the comparison Results for MA Detection.

IV. PREPROCESSING METHODS

The pre-processing method is been selected so that from the noisy images is been removed so that the MA detection is done easily.

Walter-Klein Contrast Enhancement

This method is used to improve the contrast by using the gray level transformation.

(1) Assigning the walter preprocessing operation in the variable [wali].

(2) Computing the mean of the intensity values of original image (i) and assigning into the variable (mu).

(3) Assign constant(r)=2

(4) to (7) Finding the smallest and the largest elements in the array and assigning it into the minimum and maximum intensity levels of the original and enhanced image.

(8) Returns a n-dimensional array with the same elements as the original image (i) but reshaped to size(i).

(9) to (18) implementing the formula given in basepaper. μ is the mean value of the original grayscale image.

(20) Performing the reshape operation for the f_im and assign it into the variable (wali).

(21) to (22) finally displayed the walter Klein contrast enhanced image.

Contrast Limited Adaptive Histogram Equalization

It increases the clarity of the salient part of the image making it visible and clear.

(1) Assign the CLAHE operation into the variable [hhi].

(2) Performing the adaptive histogram equalization to the original image. (used to enhance the contrast of the image)

(3) to (4) displaying the CLAHE image

Vessel Removal and Extrapolation

This makes the image more clear to detect the MA.

(1) Assign the vessel removal operation into the variable [B].

(2) performing the inpainting algorithm for coversion of image to double precision type.

(3) to (4) Displaying the vessel removed image.

Illumination Equalization

Eliminate the uneven illuminations of the fundus image

(1) Assign the illum equalis operation into the variable (f)

(2) Assigning the desired intensity value.

(3) Converting the elements of orignal img (i) into uint8 and then compute the mean of the intensity values and then assign into the variable [inn] inn – local avg intensity.

(4) Subtract the local int. value from the desired int. value.

(5) New pixel intensity value (by using the formula)

(6) to (7) displaying the ill.equlzd image.

No Pre-processing

Without doing the pre-processing method directly the candidate extraction method is been done.

V. CANDIDATE EXTRACTION

Candidate extraction is the process that is to spot the characteristics of the MA image obtained after the pre-processing method. For future enhancement of the system, the new candidate extractors methods can be used.

Walter et al

This method used is to find small dark patterns on the green channel by using grayscale diameter closing.

Spencer et al

The retinal image extracts a vascular map and top-hat transformation is done .The final image obtained is then bilinear zed

Circular-Hough Transformation

This technique is used for extraction of circular objects from the image.

Zhang et al

This method is used to constructs maximal correlation response for the input image. The methods like vessel detection is done to reduce the number of candidates and to determine the size of the image.

Lazar et al

Cross-sectional profiles of pixel wise is used to construct multidirectional height map and this map set the height values

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that describes the distinction of the pixel that is used in the surrounding image.

VI. Ensemble Creation

In this section, we describe our ensemble creation approach. In our framework, an ensemble *E* is a set of *(*preprocessing method, candidate extractor) or shortly *(*PP, CE) pairs. The meaning of a *(*preprocessing method, candidate extractor) pair is that first we apply the preprocessing method to the input image and then we apply the candidate extractor to this result. That is, such a pair will extract a set of candidates *HE* from the original image. If an ensemble *E* contains more *(*preprocessing method, candidate extractor) pairs, their outputs are fused in the following way:

Take 10 training images (already disease affected images). Then we present the selected preprocessing methods, which we consider to be applied before executing MA candidate extraction. There may be around 5 methods present in Preprocessing. Candidate extraction is present next to preprocessing. Similar to preprocessing there are 5 techniques or methods present in Candidate extractors.

For a single image, 25 combinations of results are available. Since there are 5 methods available in both preprocessing and candidate extraction, for each method in preprocessing 5 candidate extraction methods are processed. Likewise it repeated for 5 methods in preprocessing. So there are 25 methods proceeded for a single image. Then we should calculate the entropy for all 25 results. Then after calculating the entropy for the 25 methods, we can predict the best technique, considering whose entropy is highest. For ex., If 3rd method's entropy is highest means we determine that 3rd one is the best technique.

Likewise, we should calculate for a set of 10 training images. By following the procedure mentioned above we can determine best techniques for 10 images. For ex. the best techniques of 10 images are like this format mentioned below: [3 2 4 3 6 3 8 3 4 3] After analyzing the best techniques whose entropies are highest for 10 images, mentioned above, we can see that 3rd technique is repeated many times than other. So we can conclude that the 3rd technique is the best one.

VII. Implementation

It is proposed to develop new & effective detection technique of MA which use set of different algorithms for candidate extractors & pre-processing methods (pair). A set of MA candidates belongs to each such pair, extracted by the given candidate extraction algorithm on the images with the corresponding preprocessing method applied.

MA Detection

We describe our ensemble creation approach. In our framework, an ensemble *E* is a set of *(*preprocessing method, candidate extractor) or shortly (PP, CE) pairs. The meaning of a (preprocessing method, candidate extractor) pair is that first we apply the preprocessing method to the input image and then we apply the candidate extractor to this result. That is, such a pair will extract a set of candidates HE from the original image. After we find best ensemble we apply it on test image. If small red dot detected on retina than it is true positive or it is true negative. It also depends on Euclidian distance. Sometime MA like characters appear on retina image so we also get false positive and false negative.

DR Grading

The proposed framework increases sensitivity using Circular Hough transformation method. After performing the testing task, we have obtained the grading of Diabetic Retinopathy. For testing, input images were taken from the database, and the detection of Microaneurysm was marked as R0 (normal condition), R1 (mild), R2 (moderate), R3 (severe).

Grading	State of MA	No. of MA detected
R0	Normal	No MA detected
R1	Mild	1-5
R2	Moderate	5-15
R3	Severe	Above 15

VIII. Result

Our approach find whether eye is affected or not by DR we detect MA as well as we calculate parameter like sensitivity, specificity, accuracy. We also extract features like area, perimeter, eccentricity, major axis, minor axis. Figure shows the final gui for severe condition.

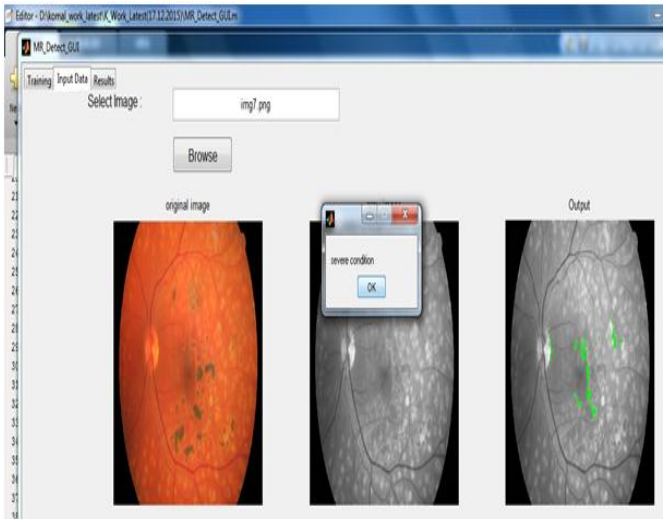

Table shows the calculate value for features and parameter we displayed only first some values.

Sensitivity	Specificity	Accuracy
0.80	0.99	0.96
0.30	1	0.80
0.80	1	0.96
0.82	0.99	0.91
0.80	0..84	0.87

We also extract some features like area, parameter as mention in below table.

S. N. Patil and Komal hajare, "New approach of MA detection & grading using different classifiers," *International Journal of Scientific and Technical Advancements*, Volume 2, Issue 1, pp. 25-28, 2016.

Area	Perimeter	Eccentricity	Major axis length	Minor axis length
5	8.2	0.7	4.3	2.6
6	6.8	0.4	3.2	2.9
2	2	0.8	2.3	1.1
5	9.6	0.5	3.7	3.2

IX. CONCLUSION

In this paper, we have proposed an ensemble-based MA detector that has proved its high efficiency in an open online challenge with its first position. Our novel framework relies on a set of PP, CE pairs. However, a proper screening system should contain other components, which is expected to increase the performance of this approach, as well.

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