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Automatic Detection of Bright Lesion by Dynamic Shape Features in Color Fundus Images

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Abstract: In the modern world, Diabetic Retinopathy (DR) has become one of the most severe complication prevalent among diabetic patients and it can lead to impairment of vision and even blindness. Due to increasing amounts of suger in the body, the walls of blood vessels become damaged and because of this Microaneurysms, Hemorrhages, Hard Exudates, Cotton wool spots are starts to developing at various phases of retinopathy and it is called as Diabetic Retinopathy.This project is a novel method for automatic detection of bright lesions in color fundus images. First, it begins with a pre-processing stage for resizing, contrast enhancement and denoising. Second, all regional minima with sufficient contrast are segmented. Third, from segmented regions all the dynamic shape features are extracted. Finally, a Random Forest classifies the images into normal and abnormal images. This approach gives classification accuracy of 91%.

Keywords — Computer aided diagnostic, Diabetic retinopathy, Dynamic shape features, Fundus Images, Image database, Random Forest Classifier.

I. INTRODUCTION

DIABETIC retinopathy (DR) is a complication of diabetes that can lead to impairment of vision and even blindness .It is the most common cause of blindness in the working-age population. The damage caused to the tiny blood vessels in the retina of the human eye, is known as Diabetic Retinopathy. Due to increasing amounts of glucose circulating through the body, the walls of blood vessels become damaged and because of this Microaneurysms, Hemorrhages, Hard Exudates, Cotton wool spots are starts to developing at various phases of retinopathy. The earliest symptoms of Retinopathy are the Micro aneurysms, which occur due to dilatations of the blood capillaries and they appear as dark red spots on the retina. Hemorrhages occur when the microaneurysms burst. Bright-yellow colored Lesions such as hard exudates occur as a result of fluid leaking into the retinal surface from the capillaries or from Microaneurysms. Another bright colored lesions, called the soft Exudates or cotton wool spots occur occlusions of the nerve fibre layer.

One out of three diabetic person presents signs of DR and one out of ten suffers from its most severe and vision-threatening forms. DR can be managed using available treatments, which are effective if diagnosed early. Since DR is asymptomatic until late in the disease process, regular eye fundus examination is necessary to monitor any changes in the retina.

By considering the limited number of ophthalmologists and increasing population, there is an urgent need for automation in the screening process in order to cover the large diabetic population while reducing the clinical burden on retina specialists.

In this paper, a novel method is proposed to detect Bright lesions (hard exudates, cotton wool spots) that does not require prior vessel segmentation. Fundus image are used for diagnosis of Diabetic Retinopathy. Lesions are detected using Dynamic Shape Features such as Relative Area, Elongation, Eccentricity, Circularity, Rectangularity and Solidity. After image pre-processing, candidate regions are identified. Features are then extracted and used to classify each image. The various lesions associated with diabetic retinopathy are as shown in the figure below[1]

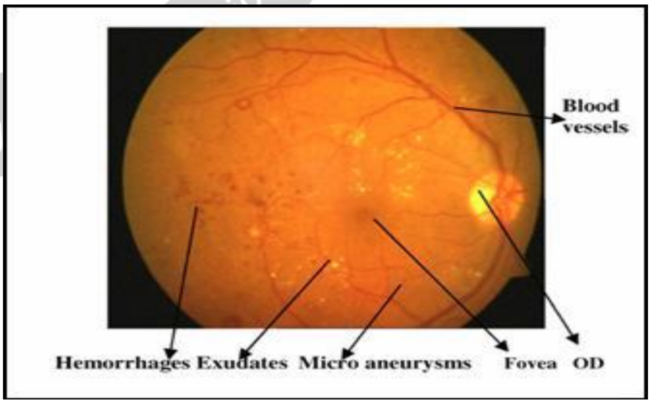

Fig.1 Retinal Lesions associated with Diabetic Retinopathy

II. SYSTEM MODEL

In this section methodology for the proposed work- Automatic detection of Bright Lesion by using Dynamic Shape Features in color fundus images is presented. Figure 1 shows the block diagram of proposed work- Automatic

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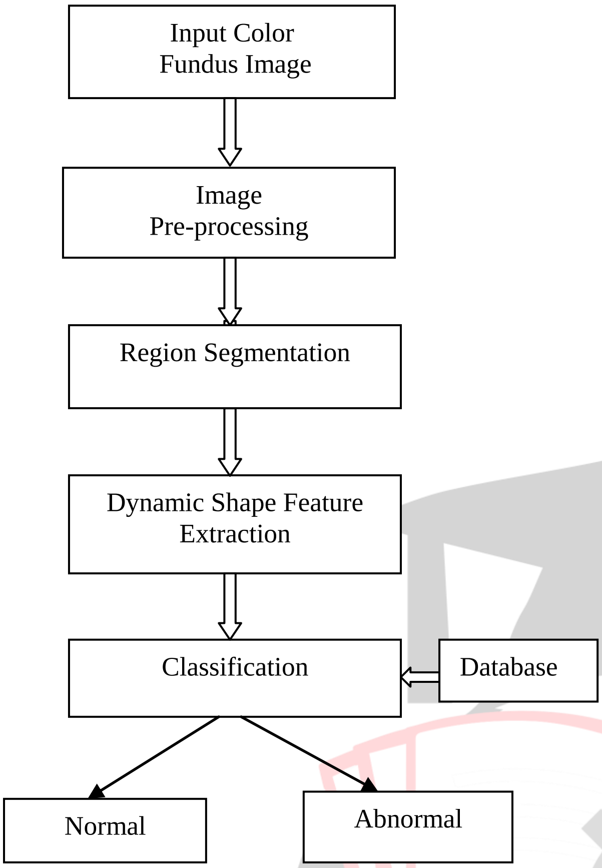

Fig.2 Overview of proposed system.

A. Image Acquisition

The first step in fundus digital image analysis is image capture. The digital retinal images were collected from publically available database. This database consist of normal and abnormal images.

B. Pre-processing

The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhance some image features important for further processing. Following steps are used for pre-processing the input color fundus image.[2]

1.Image Resizing

The captured retina images are in RGB colour space. In the pre-processing step, the input image is first resized into the size of 300 x 300 pixels. All images in database having different size, therefore we are doing image resizing to convert all image to fixed size.

2.Grey Scale Conversion

The resized image is then converted into a gray scale image which has the grey level intensity ranging from 0 to 255

3. Contrast Enhancement

The aim of contrast enhancement is to improve the contrast of an image. There are various method of contrast - enhancement techniques but I am using adaptive histogram equalisation technique. Adaptive Histogram Equalizer splits the image into small rectangular areas called tiles and enhances the contrast of these areas by adjusting their local histograms. This method is also called as Contrast Limited Adaptive Histogram Equalization(CLAHE).

4. Denoising

It is the process of removing the noise from image. Here I am using Wiener filter to remove noise from the image. It removes the additive noise and inverts the blurring simultaneously. It reduces the overall mean square error in image.

C. Image Segmentation

To find lesions, all regional minima are identified. A regional minimum is defined as a group of connected pixels with same intensity, such that all its adjacent pixels have strictly higher intensities. Only minima with a contrast superior to a threshold 0.1 are retained. After that area opening is done to remove small objects from binary image and small holes get filled.

D. Feature extraction

Segmented region include lesions and vessel segments. A region classification step is required to discriminate between lesions and non lesions. A new set of features is thus proposed in this subsection.

In a topographic representation of segmented image (Ip) each candidate (a regional minimum) corresponds to a water source, noted R_j. A morphological flooding, inspired from the watershed algorithm is applied to Ip starting from the lowest water source and ending when Ip's mean intensity is reached. At each flooding level i, pixels that are adjacent to a water source R_j and lower than the flooding level i are added to the catchment basin of Rj , noted $C_i^{R_j}$. When two basins merge, they start to share the same pixels and thus the same attributes[4].Table.1 shows all the dynamic shape features of lesion.[3]

AREA	1.6	MEAN GRADIENT MAGNITUDE	518.9641
ASPECT RATIO	0.8	MEAN	104.8667
PERIMETER	15.639	STANDARD DEVIATION	6.881557
ECCENTRICITY	0.84642	STAT. CONTRAST	14.29167
MAJOR AXIS LENGTH	6.98380	STAT. ENERGY	0.295139
MINOR AXIS LENGTH	3.71895	STAT. HOMOGENEITY	0.744792
PERIMETER^2/ Area	15.2861	ENTROPY	0.996792
EQUIVDIAMETER	4.51351	WAVE_ENTROPY	0.997772
SHAPE FACTOR	0.82206	WAVE_ENERGY	759414
ORIENTATION	38.3298	WAVE_HOMOGENEITY	1120.796
CONVEX HULL	14	WAVE_CORRELATION	1389.575
CONVEX AREA	19	WAVE_CONTRAST	16135
EULER NUMBER	1		

Table.1 Dynamic Shape Features

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F. Classification

To distinguish between lesions and non-lesions a Random Forest (RF) classifier is used. This powerful approach has been widely used over the last few years, due to its numerous advantages. It is convenient for non-linear classification with high-dimensional and noisy data. It is robust against outliers and over-fitting. After performing all processing on an image we are able to classify image whether it is infected or not infected it is done by Random Forest classifier[4].

III. RESULTS

Fig 3.shows original image. Original image is patient's eye image that is to be diagnosed. This image is processed

Fig.3 Original Image

Fig 4.describe resized image. All images in database are not having same size so to convert them in fixed size we have to resize image.

Fig.4 Resized Image

Fig.5 shows the grey scale image, which has the grey level intensity ranging from 0 to 255

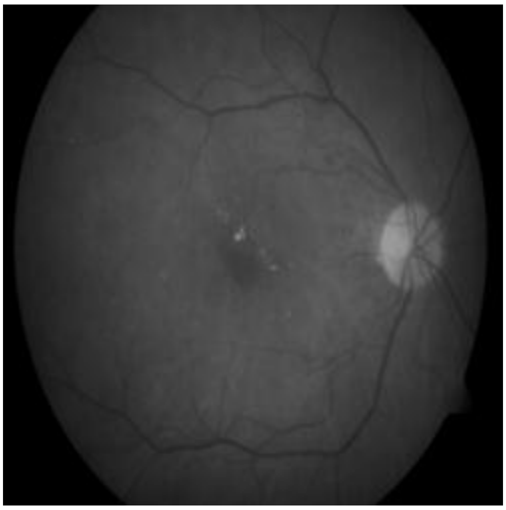

Fig.5 Grey Scale Image

Fig.6 shows contrast enhanced image which is enhanced version of the grey scale image. Here Adaptive Histogram Equalization technique is used to improve the contrast of the image.

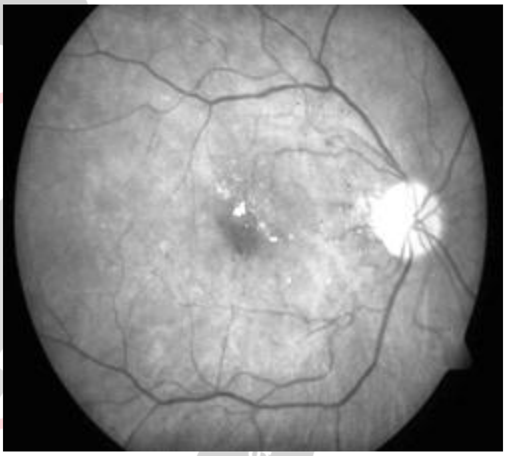

Fig.6 Contrast Enhanced Image

Fig7.describes wiener filtered image. Generally filtering technique is used to remove noise present in image.

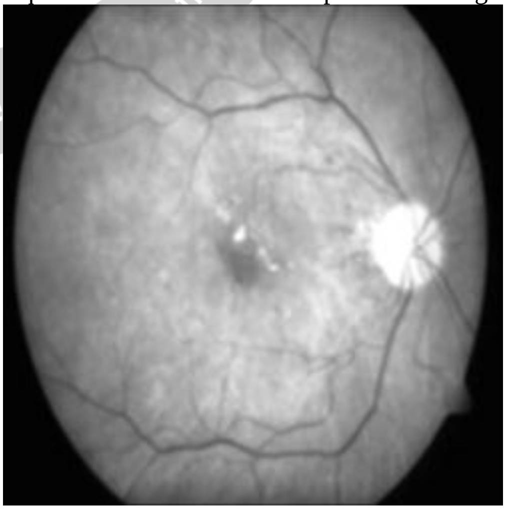

Fig 7.Denoised Image

Fig 8.describe ROI segmented image .Image Segmentation is the process of partitioning digital image into multiple

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segments. Image segmentation is used to locate object and boundaries in an image.

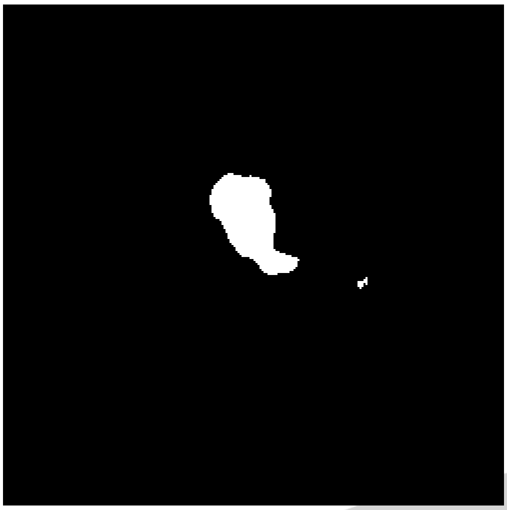

Fig.8 Segmented Image

Fig 9.descibes classification result. After performing all processing on an image we are able to classify image whether it is infected or not infected it is done by Random Forest Classifier

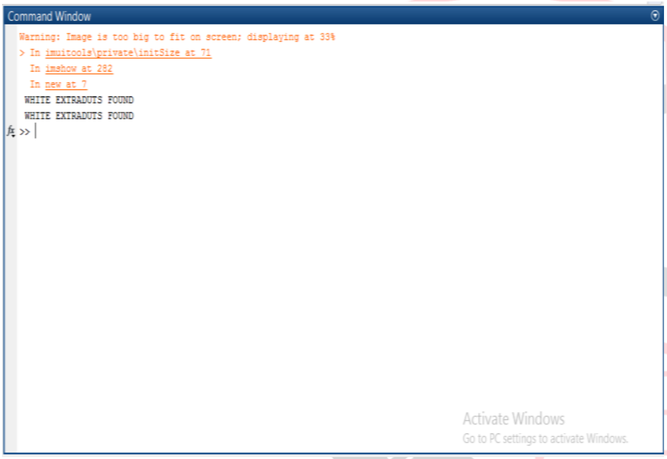

Fig.9 Output of classification in Command Window

The classification accuracy has been calculated as the total number of normal and abnormal images identified correctly to the total number of images used for training. In the proposed system total 89 images are trained. The percentage of accuracy achieved by Random Forest method is given in the table.2. The total classification accuracy is 91%. This accuracy is calculated using publically available database.

Table.2 Classification Accuracy of public Database

Number of Features	Classification Accuracy
25	91%

IV. CONCLUSION

A novel Bright Lesion detection method is based on a new set of shape features i.e. Dynamic Shape Features is evaluated on publically available database. Dynamic Shape Features have proven to be robust features, highly capable of discriminating between lesions and vessel segments. The result demonstrates the strong performance of the proposed method in detecting Bright Lesion in fundus images. This approach gives classification accuracy of 91%.

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