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Detection of MA and HA in Diabetic Retinopathy

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***Abstract*—As diabetic retinopathy is a progressive disease, the longer a patient has untreated diabetes, the higher is the chance of progress towards the blindness. For this reason, early detection as well as periodic screening of Diabetic Retinopathy potentially helps in reducing the progression of disease and in preventing the subsequent loss of visual capability. An automated diagnosis system provides the grading of severity level of diabetic retinopathy which is based on detecting and analyzing the early clinical signs associated with disease, such as microaneurysms (MA) and hemorrhages (HA). Given system extracts some retinal features such as optic disc, fovea and retinal tissue for easier segmentation of dark spot lesion in fundus image and then it is followed by the classification of correctly segmented spots into MA and HA. Based on the number and location of MAs and Has, the system quantifies the severity level of DR.**

Keywords— Diabetic Retinopathy, Microaneurysms, Hemorrhages.

I. INTRODUCTION

Diabetic Retinopathy has become a serious threat in our society, where the number of patients with DR is considerably increasing as a result of the increasing number of people affected by diabetes mellitus. As Diabetic Retinopathy is a progressive disease, the longer a patient has untreated diabetes, the higher his chance of progress towards blindness. Hence the screening of the retina of the diabetic patient must be done very often, which includes obtaining and analyzing a sequence of fundus images and observing the early changes in blood vessel patterns and also the presence of the dark spots, such as microaneurysms (MAs) and hemorrhages (HAs). It is known that there exists a positive correlation between the number and location of MAs and HAs and the severity and progression of Diabetic Retinopathy. There are two approaches for the detection of MAs and HMAs. First, the semi automated approach applies SHCS algorithm which is followed by thresholding to detect true MAs and HMAs and second the automated approach applies AHCS algorithm followed by feature extraction and SVM classification. [1] Automated segmentation of the vasculature in retinal images can be done by classifying each image pixel as vessel or nonvessel, based on the pixel's feature vector. [2] Automatically detection of red lesions (RLs), like hemorrhages (HEs) and microaneurysms (MAs) can be done based on their properties by extracting a set of features from image regions [3] The detection of the presence and characteristics of lesions near the center of the retina (the fovea) is focused [4]. It is possible to solve problems caused by lighting variations or high-frequency noise by choosing the working sub bands. [5].To improve automated hemorrhage detection method to help diagnose diabetic retinopathy, new method for preprocessing and false positive elimination is proposed. The brightness of the fundus image was changed by the nonlinear curve with brightness values of the hue saturation value (HSV) space. [6] Automatic detection of red lesions is important for mass screening of DR. A simple and effective method for the detection of red lesions in digital fundus images has been proposed. [7]

II. PROPOSED MODEL

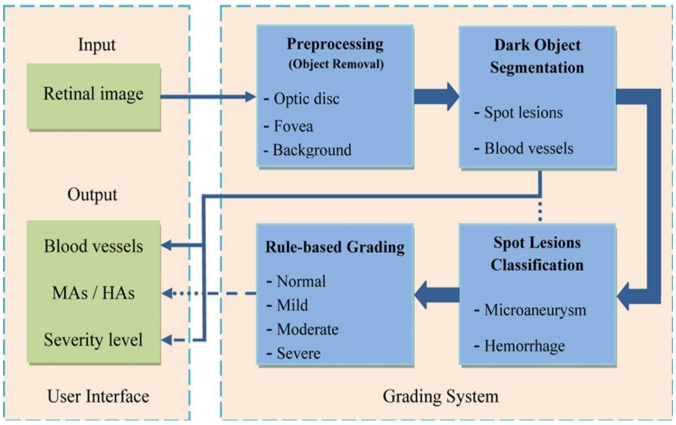

Fig.1. block diagram

A. Input

Input to the developed system is the colour image of human retina. Database of 98 low resolution colour images are compressed by JPEG image. The main components of human eye retina are optic disc, fovea, tissue and blood vessels. Removing these components will help in avoiding the errors as much as possible.

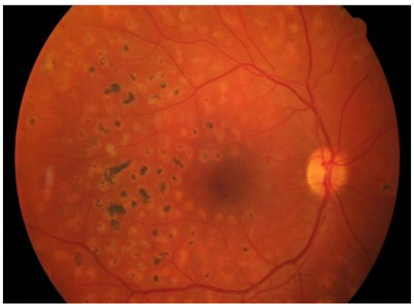

Fig.2. Input image

B. Preprocessing

Green channel extraction

Color test images, are divided into two sets based on size. The algorithm thus starts with resizing all input images to 600×800 pixels. Amongst the color image components (i.e. red, green, and blue), green-channel provides maximum local

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contrast among the image pixel values. As MAs and HAs are clearly distinct from the other retinal features, the green-channel IG is first extracted from the RGB image. The total number of levels possible for a color image is about 16 million (224) levels, the green image contain only 256 levels. Thus, such conversion will decrease the computational time, as well as the storage space.

Optic disc and fovea removal

Fovea appears as dark region and located at the center of the retina. Optic disc has high intensity, circular shape and constant size. This characteristic of optic disc indicates exact location in the image. Optic disc is located in the middle third of the image due to the position of the imaging device. For this reason, the proposed method for optic disc removal starts with focusing on the middle third of the green intensity image. Sometimes some dark objects also appear inside the optic disc which may be incorrectly considered as MA and HA. Such confusions can be easily avoided by removing optic disc. The optic disc can be removed by passing through different blocks.

The first block is Median filter. It is used to remove noise without blurring the sharp border edges. The second block is Top hat transformation which extracts minor elements and details from the given image. The contrast of the resulting image is then enhanced based on a morphological top-hat transform. The top-hat operation involves subtracting the result of performing a morphological opening on the input image from the image itself based on a given structuring element. It is followed by contrast stretching block. It enhances the image quality by improving the contrast in the image by stretching the range of intensity values.

Contrast stretching is used to obtain an image by expanding the range of intensity values of the contrast-enhanced image so that the full dynamic range of the image is covered. This process can be performed by specifying lower and upper limits that can be used for contrast stretching So that data is saturated at low and high intensities of image. Values of lower and upper limits used in the proposed algorithm specify the bottom 1% and the top 1% of all pixel values. The green intensity image is then converted to a binary image by using a threshold value. In order to detect the rough location of the optic disc both morphological opening and closing operations are utilized.

Background Removal

The background removal process eliminates the background variations in illumination from an image so that the foreground objects may be more easily analyzed, which will represent the brighter part in the image. The combination of top-hat and bottom-hat is used here for getting good prominence for the dark spot lesions with minimal effect on the background intensity levels. As top-hat operation involves subtracting the result of performing a morphological opening on a green intensity image from the image itself. On the other side, bottom-hat operation is performed by subtracting the green intensity image from the result of performing a morphological closing on the input image. The proposed algorithm enhances the contrast of the image.

In the next step, image background is removed using by subtracting the contrast-enhanced mage from the median-filtered image. Mathematically, the difference between two images median filtered image and contrast enhanced image, is generated by computing the difference between all pairs of corresponding pixels in median filtered image. As the resulting image is low contrasted, contrast stretching is then used by expanding the range of intensity values. So that the full dynamic range of the image is covered. In order to reduce the resulting noise in contrast stretched image, median filter is used once again.

C. Dark Spot Segmentation

Dark spot lesions such as MAs and HAs can be efficiently segmented using a sequence of stages that is H-Maxima transformation, thresholding and feature extraction.

H-Maxima transformation

In this stage, the resulting image from the pre-processing stage is processed by the h-maxima transform for reducing the number of intensity levels, which will be helpful in the subsequent stages. Let I be an intensity image; then the h-maxima transform is used for suppressing all maxima in the intensity image I whose values are less than a certain threshold.

Thresholding

In this stage, both MAs and HAs are segmented by thresholding the intensity image. Thresholding is one of the most commonly used methods in image segmentation, which produces a binary image in which the value of each pixel is either 1 (dark spot) or 0 (background).

D. Dark Spot Classification

Classification of the different spot lesions can be performed based on seven features, which are: size, shape, roughness, edge sharpness, brightness, color, and depth. Among the features above, MAs and HAs are similar with respect to five features, which are dull (roughness), insignificant edge (edge sharpness), dark (brightness), reddish (color), and superficial (depth). Hence the classification is mainly based on the remaining two features, i.e. size and shape. MA appears small and round in shape while HA appears larger and arbitrary in shape. Based on some threshold values for size an object can be judged as normal or mild or moderate or severe case.

Fig.3. Binary image which contains HAs

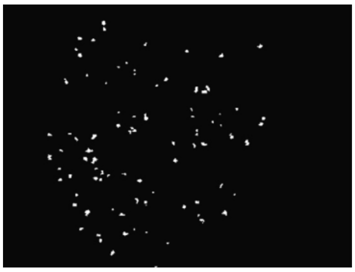

Fig.4. Binary images which contains MAs

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III. CONCLUSION

The main components of the human retina, i.e. the optic disc, fovea, and tissues can be extracted by using median filtering, morphological Top hat transformation, Contrast stretching, thresholding, morphological opening and closing for easier segmentation. Then, an efficient algorithm based on h-maxima transformation and multilevel thresholding will be employed for dark spot segmentation. The severity level can be determined and graded into four scales, i.e. normal, mild, moderate, or severe based on the number and location of MAs and HAs.

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