Automated Detection of Red Lesion Using Dynamic Shape Features

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ABSTRACT

Complication of diabetes is a stage in which the retina gets damaged by the leakage of blood from vessels to the retina. This complication is commonly termed as Diabetic Retinopathy (DR). Its higher impacts may prove the way for impairment of vision and ultimately to blindness. By the manual and technological inspection of fundus images, certain features such as Microaneurysms, Hemorrhages, Exudates and cotton wool spots can be used for its identification. Dynamic Shape Features being a main contribution is a new set of shape features on which the precise segmentaion for the classification of segments is not necessary. During image flooding, the required shapes evoluation occure by these feature points and difference between lesions and vessel segments. By using Random Forest Classifier the differentiation between the lesions and non-lesions can be performed. With the use of six databases, this method is validated per lesion and per image. Due to the variability in image resolution, quality and acquisition system this proves to be robust. By the simulation analysis it is proved that in terms of accuracy, precision, sensitivity and specificity, the proposed work is better than the previous work.

Key Words: Diabetic Retinopathy (DR), Retina, Fundus Image, Screening, Microaneurysms, Hemorrhages, Dynamic Shape Features (DSF).

1.Introduction

Diabetic Retinopathy (DR) is also known as diabetic eye disease,that will affect retina.It can be caused by blindness in working age population [1]. This diabetic retinopathy can be diagnosed by the treatments that are present in early stages loss of vision and blindness. In a retina can be analysed by fundus images and identifies lesions such as Microaneurysms (MA) and Hemorrhages (HE).Here MA are circular in shape and limited in size. To differentiate MA from blood vessels are elongated structure of red lesions in the primary symptoms of DR [2]. The HE are present in severe case of the disease with bleeding into the deep layer of the retina.

The HE can be classified based on their shape features as flame shaped HE and dot blot HE. Both the MA and HE have to be considered in DR screening that does not require prior vessel segments and background noise. Automation can be achieved at testing a group of two levels: first level is detecting case with DR and second level is grading these cases [3]. In order to detect the red lesios for the manual DR screening technique is inefficient. The color and contrast of the digitized fundus images were enhanced according to an automated procedure involving full color stretching separately for each color channel. The lesions were outlined with a manually controlled screen marker. Red fundus lesions were defined as any fundus lesion visibly recognizable as being MA or HE or any of the two. No other types of red lesions were accepted. Hemorrhages were defined as comprising round or irregularly shaped, sharply or diffusely outlined, deep red areas of the color fundus of venous blood or darker. Microaneurysms were defined as small swelling or tiny aneurysm in the side of blood vessel to round lesions with a well defined edge [4].

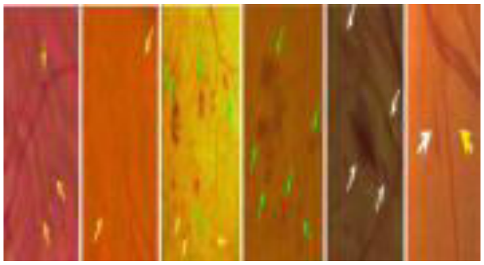


Figure 1: Fundus images with red lesions.

DR detection system are evaluated on the overall presence of DR in the patient, not the number of microaneurysms in a single image. The color and saturation of microaneurysms vary according to the oxygenation of the blood vessel, from bright red to deep red. Then the research development of computer aided screening and grading expect automatic telemedicine system for DR.

The candidate regions are correspondent to color and shape features are classified depends greatly on the accuracy of segmentation. In this general idea behind this approach lies on blood leaking from the vessels depending on the lesion is MA and HE. The retinal images of DR patients consist of both lesions and blood vessels that can be detecting the diseases related to bloodvessels are observed [5]. The performance of detection can be compared to human system and computer aided system using different database but not only one technique may pre-processing and candidate extraction which can be combined for DR. Exudates can be both the cotton wool spot/soft exudates and hard exudates[6]. The automatic detection of red lesions in color fundus images with DR can be detected morphological operation. Non-proliferative diabetic retinopathy commonly knows as background retinopathy is an early stage of diabetic retinopathy. The leaking fluid causes the retina to swell or to from deposits called exudates.

2.PROPOSED METHOD

The color fundus image with binary mask of region of interest is taken as a input. The output is the probability color map for red lesion detection in circular area surrounded by a black background.

In this proposed method can be classified as six databases.The first step involves calibrating a single image resolution to be adapted. Second step involves preprocessing of the input image will be illuminated by giving a flat regular surface which can be more collectively called as smoothing and normalization. The third step involves automatically detected in the optic disc which to be discard relative area from red lesion detection. The fourth step involves identifying the people with corresponding lesions that are identified in the image preprocessing phase based on their intensity and contrast. The fifth step involves the dynamic shape features with color features are extracted in each candidate. The final step involves the people gets affects with diabetic retinopathy are classified according to their actual probability of being red lesions[7].

2.1. Spatial Calibration

This method refers to the process of various image resolution of the pixels of an acquired image to real features in the images. Here the image is neither increased nor decreased. Then the images are not resized in the region of interest. Instead the diameter of the circular area surrounded by the black background to the region of interest is taken with the removal of dark input variation i. The diabetic retinopathy screening is obtained with a field of view at 45 degree, where the diameter D is used to set different filter sizes.

There are three parameters that are considered in this method they are;

- d1 is the average radius of the optical disc
- d2 is the size of the smallest microaneurysms
- d3 is the size of the largest hemorrhages

2.2. Image Processing

The lighting of the retina is non-uniform which often leadings to local luminosity and contract variation. The RGB to Grayscale conversion is done to increase the dynamic range of the images are variable. The red channel is brighter than a wider range of gray-level values. Then the red channel is less contrast between bright lesions and the background noise. Hence, mixing the intensity of both green and red channel information of the same fundus image is used for detecting the red lesions. To acquire the histogram matching is used in which the histogram of the green channel component of the image is modified with the histogram of the red channel component of the same retinal image to be obtain a new image having both the red and green channels.

2.3 Illumination equalization

To overcome the reduction of an image brightness or saturation we use the illumination equalization method. A large mean filter (hM1) of diameter (d1) is applied on each color component of the original input image. Then the equalized method poor color can be overcome.Then the intensity of the original image μ is also added by the color range is given as,

$$I_{ie}=I+\mu-I*hM1$$

2.4 Denoising

In this method a small mean filter (hM2) of diameter (d2) is applied to each channel in the produced image I_{ie} in order to reduce the noise that results from the steps which does not involve the smoothing of red lesions. Then the noise can be removed by the lesions.

2.5 Adaptive Contrast Equalization

The contrast continuous slow movement from one place to another place is approximated by using a local standard deviation which is used to compute each pixel in the neighbourhood which is of diameter (d) for different color channel (IAd) places which have low standard deviation indirectly denote that they are areas which have less contrast or smooth background to improve the low contrast areas.

$$I_{ce}=I_{dn}+1/I_{std}(Idn*(1-hM3))$$

2.6 Color Normalization

In this step is necessary to obtain image with the standard color range for normalized image.

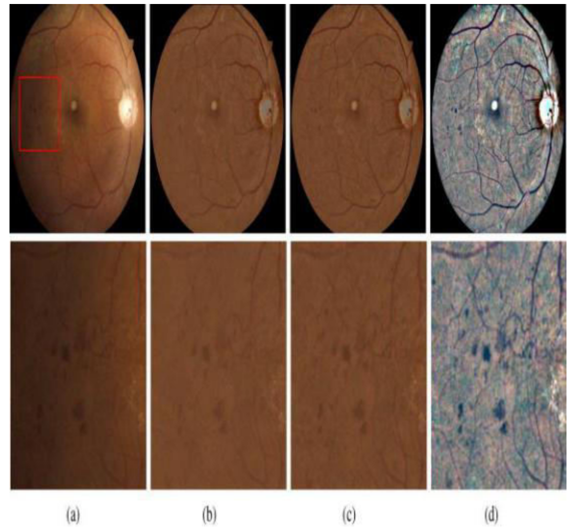


Figure 2: Image preprocessing steps

3. Optic Disc Removal

The optic disc removal is a significant phase where the false positive in the red lesions detection need to be removed. In the preprocessed image we apply an entropy based technique to locate the straight forward process of the center optic disc [8]. Usually the whole optic disc is present in the region where there is high intensity is brighter than the surrounding area where the vessels have maximum directional entropy.

The matched filter that minimized the convolution are selected by the optic disc radius and center position. The green channel of the color fundus image is extracted with the binary image will applying a high threshold value. After that find the removal of segment with maximum area on the binary image which will corresponding to optic disc.

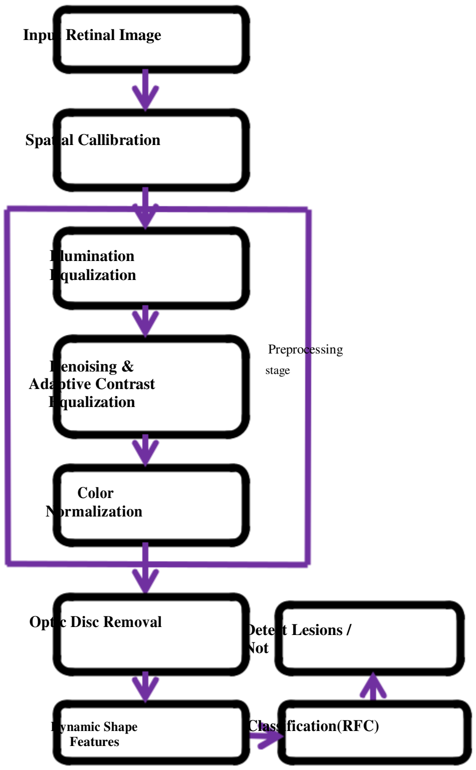


Figure 3: Block Diagram

4. Candidate Extraction

The blood vessels and lesions which are dark possess high contrast in the green channel. The red channel and the blue channel are used in the latter part for the extraction of certain colour features.Especially in the green channel Microaneurysms and hemorrhages appear as shapes which contain local minimal intensity of the region. In this technique the minimalregions are rated to their appropriate local contrast. The regions which are noisy usually have low contrast and lesions present [9]. The extract and pre-processed image which is denoted as Gp.

The main advantage of this method is that the out coming contrast measurement does not depend upon the size and shape of the regional minimum. Contrast and illumination equalization are very important because if these steps are not applied the global contrast and intensity thresholding will be difficult to calculate independent of the size and shape of regional minimum. Then finally selected to minimum intensity lower than mean intensity to be extracted by the region.

5. Dyanimic Shape Features

In the diabetic retinopathy affected patients several regions correspond to non-lesion region such as segments and remaining noise in the retinal background of false positive and true lesions. It is need to vessels of the flooding level in the topographic representation at each flooding levels for each person affected with diabetic retinopathy and catchment basins degenerate red lesions computed to six shape basins B_i^{sj} is given as;

- Relative area(Rarea):number of pixels in B_i^{sj}divided by total number of pixels in the region of interest.
- Elongation (Elong): 1-W/L where W is the width and L is the length of the bounding box of present in B_i^{sj} along the major axis.
- Eccentricity (Ecc): $((L^2-W^2)/L^2)^2$with W and L the width and length of the bounding box present in B_i^{sj} along the major axis.
- Circularity(Circ):ratio of the area over the B_i^{sj} squared perimeter and multiplied by 4π.
- Rectangularity(Rect):ratio of the area B_i^{sj} over the bounding box along the major axis.
- Solidity(Sol):ratio of the areaB_i^{sj} over the area of its convex hull.

6. Classification

To differentiate between lesions and non-lesions we can use a Random forest classifier (RF). The classification process is done over the segmented images.This classification is the most powerful technique in the computer vision over the recent years, since it has number of advantages this technique can be applied to high dimensional and noisy data [10]. RF classifier is applied over the segmented images and classification is done.

3.EXPERIMENTAL SETUP

To check evaluate the performance of the proposed method we use 6 different databases which helps us to evaluatein the technique with respect to image resolution in field of view (fov) and image compression technique.

A.Per-Lesion Evaluation:

To detect the red lesion we need to performed the free response receiver operating characteristic (FROC) analysis. This is a process where the perlesion sensitivity and the average number of false positives per image (FPI) are calculated for different threshold probabilities. The sensitivity are taken at 7 specific points in a FROC. The evaluation of the testing dataset provides aFROC curve. It provides manual segmentations of both MA and HE are built from training images. False positive detection occurring in most images without DR and corresponding to tiny vessel segments located in between nerve fiber layer. These local minima are surrounded by high intensity region and DSFs do not allow the classification to discriminate these red lesions and vessel segments.

B.Per Image Evaluation:

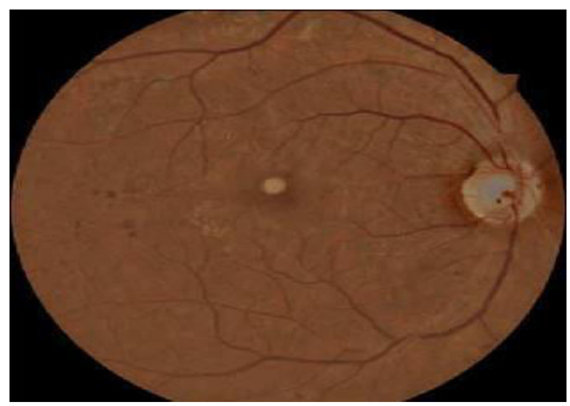
There must be at least one lesion in the retina to indicate the presence of diabetic retinopathy. If no such lesions are present then the retina is a healthy one. Therefore the people with red lesions have the high probability of having Diabetic retinopathy. It takes atleast one lesion in an image for the retina to be detected as DR. The performance of red lesion detection being the threshold can be considered as a lesion. Then only the image with DR that was missed to the edge of ROI and directly connected to a large vessel.

4.RESULTS AND DISCUSSION

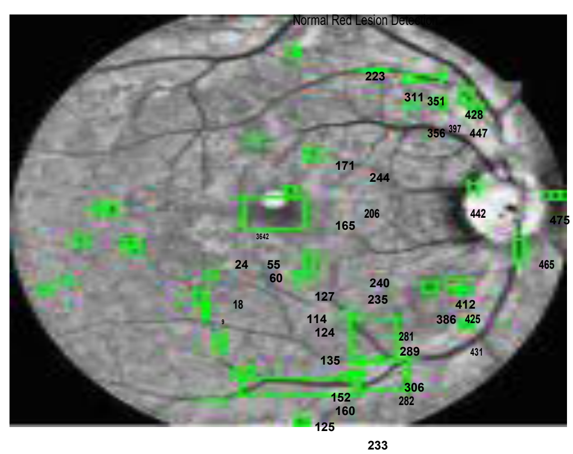
The simulation tool used is MATLAB R2013A implemented with Windows 8.1Pro and 1.80GHz Intel processor at 64 bit operating system. The simulated results for automatic detection in diabetic retinopathy are as follows. The test image which is any fundus image is given as input and is pre-processed via smoothing and normalization. During pre-processing the colour image is converted to greyscale image followed by denoising and equalization. Then the images are segmented image using morphological and thresholding method is used.

The DSF parameters such as area, eccentricity, solidity, major axis length and perimeter for the lesions segmented are calculated.The random forest always creates a confusion matrix which has true positive, false negative, false positive and true negative. Since it is a random forest classifier, the calculations are done for random images and based on the accuracy, sensitivity and specificity is calculated. The graph is plotted for the performance evaluation.Automated red lesion detection demonstrated a specificity of 71.4% and a resulting sensitivity of 96.7% in detecting DR, when applied at the tentative threshold setting for use in retinopathy screening.

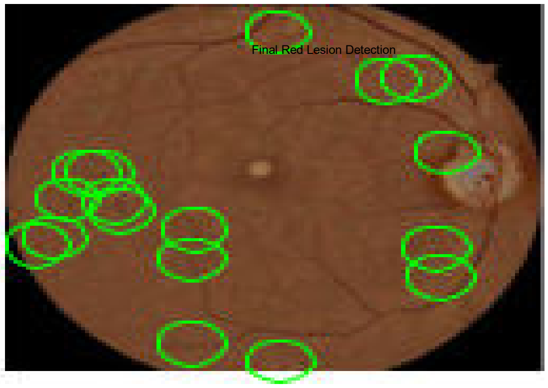
Original image



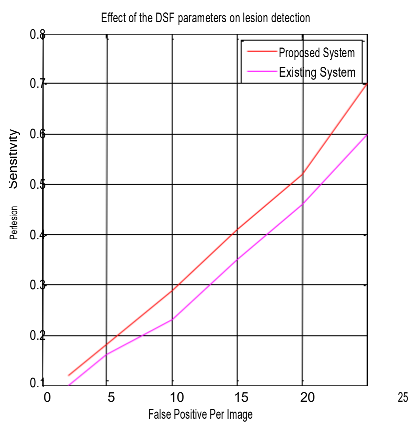
a)original image



b)normal red lesion detection



c) final red lesion detection



d) performance graph

5.CONCLUSION

Diabetic Retinopathy is caused by complications of eye disease which eventually lead to blindness. A novel red lesion detection method based on a new set of shape features, the DSFs was presented and evaluated on different databases. The strong performance of the proposed method in detecting both MAs and HEs in fundus images of different image resolution and image quality and from different acquisition systems. The DSFs have proven to be robust features and highly capable of discriminating between lesions and vessel segments. Then itsfocusing on bright lesion and neovessel detection will complete the proposed system and allow automatically detected in screening and DR grading. Automatic method for the detection of retinal structures such as blood vessels and optic disc in color fundus images are explained. The red lesions and hard exudates were also detected. However, the scope and direction to be included more instances of retinal images to construct a robust classifier for detecting different stages of DR to achieve higher accuracy. The efficiency of the correct classification can also be improved by extracting more number of features from the red lesion images.

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