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RED Lesion Recognition in Diabetic Retinopathy using Image Processing

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Abstract

The number of people with diabetes is about 400 million in 2015. The global prevalence of diabetes among adults over 15 years of age has risen from 4.6 % in 1990 to 8.0% in 2015.Diabetes, often referred by doctors as diabetes mellitus that describes as a group of metabolic diseases in which the person has high blood glucose (blood sugar), either because insulin production is insufficient, or because the body's cells do not respond properly to insulin, or both. In this paper, a novel approach for the detection of both microneurysms and hemorrhages in fundus images. It has 4 sections: 1.Image Acquisition 2.Segmentation 3.Feature Extraction 4.Classification. The features represent the evolution of the shape during image flooding and allow to distinguish between lesions and vessel segments. On the Messidor database, when detecting images with diabetic retinopathy, the proposed method takes 131.611as execution time.

Keywords: Computer Aided Diagnostic, Diabetic Retinopathy, Fundus Imaging, Dynamic Shape Features, Random Forest

I. INTRODUCTION

Diabetic Retinopathy (DR) is also known as diabetic eye disease that will affect retina. It can eventually cause blindness. The severity of DR ranges from non-proliferative and pre-proliferative to more severely proliferative DR, in which the abnormal growth of new vessels occurs. Total or partial vision loss can occur through a vitreous hemorrhage or retinal detachment, and central vision loss can occur through retinal vessel leakage and subsequent macular edema. The prevalence of DR increases with prolonged duration of diabetes In studies including people with both type 1 diabetes and type 2 diabetes, after 30 years of diabetes, most patients had some form of DR, and over half proliferative DR, people with type 1 diabetes and taking insulin had the highest prevalence of DR, and people with type 2 diabetes diagnosed after age 30 had the lowest prevalence of DR. Diabetic retinopathy also recently was seen in approximately 10% of people with insulin resistance (prediabetes) and was associated with the presence of hypertension and a higher body mass index. Other studies of DR will show associations with younger age of onset, tobacco use, insulin treatment, abnormal blood lipid levels, pregnancy, renal disease, elevated homocysteine levels, and a diet high in fat.The earliest histological marker of DR is the loss of pericytes. Pericytes are elongated contractile cells that wrap around endothelial cells of small vessels and assist in providing maintenance of capillary tone, capillary growth, and protection against ROS damage. Therefore, the loss of pericytes with DR would interfere with capillary constriction that produce chronically dilated vessels, new capillary generation, and processes that protect vessels against continuous exposure to noxious molecules (i.e., normal homeostasis). Other microvascular changes that occur with DR include capillary basement membrane thickening increased permeability of endothelial cells, and formation of microaneurysms which means weakening of vessel walls that results in the projection of a balloon like sac shown in Fig. 1

Fig. 1: Micro aneurysms in diabetic retinopathy.

The most significant factor in the development and progression of DR in people with diabetes appears to be poor blood sugar control. Under hyperglycemic conditions, which are frequently seen in people with diabetes, impairment of retinal blood flow, increased inflammatory cell adhesion to retinal blood vessels, and capillary blockage can result in hypoxia and damage to the retina. Fig 2 tells about people with diabetic eye.

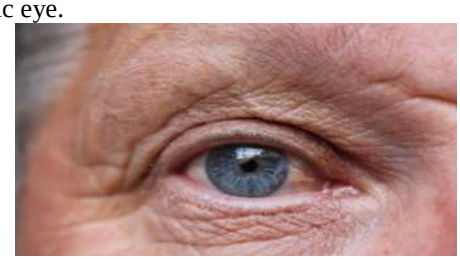

Fig. 2: People with diabetic eye.

As proposed by J. Ding and and T.Y. Wong [2] with increasing global prevalence of diabetes, diabetic retinopathy (DR) is set to be the principle cause of vision impairment in many countries. DR affects a third of people with diabetes and the prevalence increases with duration of diabetes, hyperglycemia, and hypertension-the major risk factors for the onset and progression of DR. There are increase in data on the epidemiology of diabetic macular edema (DME), an advanced difficulty of DR, which suggest DME may affect up to 8 % of people with diabetes. The risk factors for DME are largely similar to DR, but dyslipidemia appears to play a more significant role. Early detection of DR and DME through screening programs and appropriate referral for therapy is important to preserve vision in individuals with diabetes. Cree .M, Olson .J, McHardy .K, Sharp .P, and Forrester .J [1] proposed a fully automated digital image processing system, which provides an objective and repeatable way to quantify micro aneurysms in digitized fluorescein angiograms, has been developed. The automated computer processing includes registration of same-eye retinal images for serial studies, cutting of regions-of-interest centered on the fovea, the detection of micro aneurysms and the comparison of serial images for micro aneurysm turnover. The micro aneurysm detector was trained against a database of 68 images of patients with diabetes containing 394 true micro aneurysms, as identified by an ophthalmologist. The micro aneurysm detector achieved 82% sensitivity with 2.0 false-positives per image. An independent test set, comprising 20 images containing 297 true micro aneurysms, was used to compare the micro aneurysm detector with clinicians. The micro aneurysm detector achieved a sensitivity of 82% for 5.7 false-positives per image, whereas the clinician receiver-operator-characteristic (ROC) curve gives 3.2 false-positives per image at a sensitivity of 82%. It is concluded that the computer system can reliably detect micro aneurysms.

II. IMAGE ACQUISITION

Image acquisition can be broadly defined as the action of retrieving image from some basis. The successive steps are

- Gray scale image
- Denoising
- Contrast Enhancement

A. Gray Scale Image

Gray scale or gray scale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. The intensity of a pixel is expressed within a given range between a minimum and a maximum. This range is represented in an abstract way as a range from 0 (total absence, black) and 1 (total presence, white), with any fractional values in between.

B. Denoising

Noise is any undesirable signal. at each pixel in an image we have a neighborhood around that particular point, evaluate the values of all the pixels in the neighborhood according to the steps and then replace the original pixel's value with one based on the analysis performed on the pixels in the neighborhood. The neighborhood, moves successively over every pixel in the image, repeating the process. A median filter does a very good job at reducing the noise in image.

C. Contrast Enhancement

Contrast is an important factor in any subjective evaluation of image quality. Firstly, HE transforms the histogram of the input image into a uniform histogram by distributing the entire range of gray levels uniformly over the histogram of an image, with a mean value that is in the middle of gray level range. Secondly, histogram equalization performs the enhancement based on the global content of the image. The following figure shows the output of Image acquisition

Fig. 3: (a) Original (Color Image) (b) Grayscale Image, (c) Denoising, (d) Contrast Enhancement

III. SEGMENTATION

Image segmentation is the process of partition the input image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation which used to find objects and margins (lines, curves, etc.) in an images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. There are two steps involved in segmentation of medical image in digital image processing. They are

- Morphological Operation
- Thresholding Method

In this paper morphological operations are used in post processing mainly as a filter. Its fundamental operations are Boundary pixels and low frequency pixels are eliminated from image. Then difference image was generated. There are two operations performed in morphological process. They are 1. Erosion 2. Dilation.

- Erosion: It was originally defined for binary images, later being extended to gray scale images, and subsequently to complete lattices.
- Dilation: The dilation is applied to binary images, but it can work on grayscale images also. The basic effect of the operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels.
- Thresholding Method: Thresholding the simplest method of image segmentation. Set a threshold value over gray scale image, binary images can be created. After, Thresholding is employed to segment red lesions in retinal images. Thresholding makes it possible to highlight pixels in an image. Thresholding can be applied to gray scale images or color images. Figure 4 shows segmentation output.

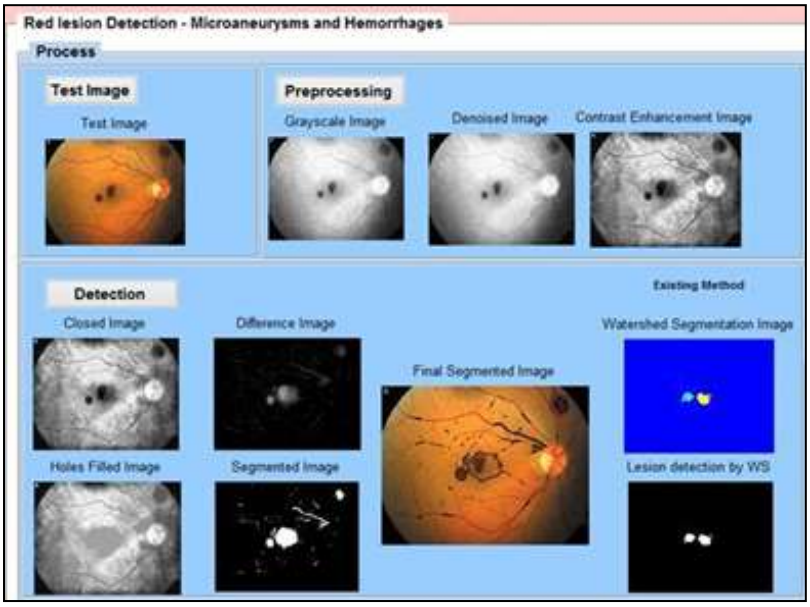

Fig. 4: Segmentation

IV. FEATURE EXTRACTION

Our major contribution is a new set of shape features that do not require precise segmentation of the candidates. We consider every regional minimum as a candidate. Since the boundaries of the minima do not necessarily correspond to the edges of the structures of interest, we propose to extract shape features through the process of morphological image flooding. The DSF together with color features are extracted for each candidate. The difference with a vessel segment is that the layers evolve more anisotropic ally in the latter case, following the vessel's orientation, and, at some intensity threshold, start merging with other vessel segments. This novel set of features, called Dynamic Shape Features (DSF).

A shape can be described by different aspects. The shape parameters are gravity, Inertia, variance, energy, Eccentricity, Circularity ratio, Rectangularity, Solidity, Euler number, Profiles, Hole area ratio, Convexity, Area, Perimeter, Length. DSF calculation which is done based on the inbuilt MATLAB function. The values are shown in Figure 5.

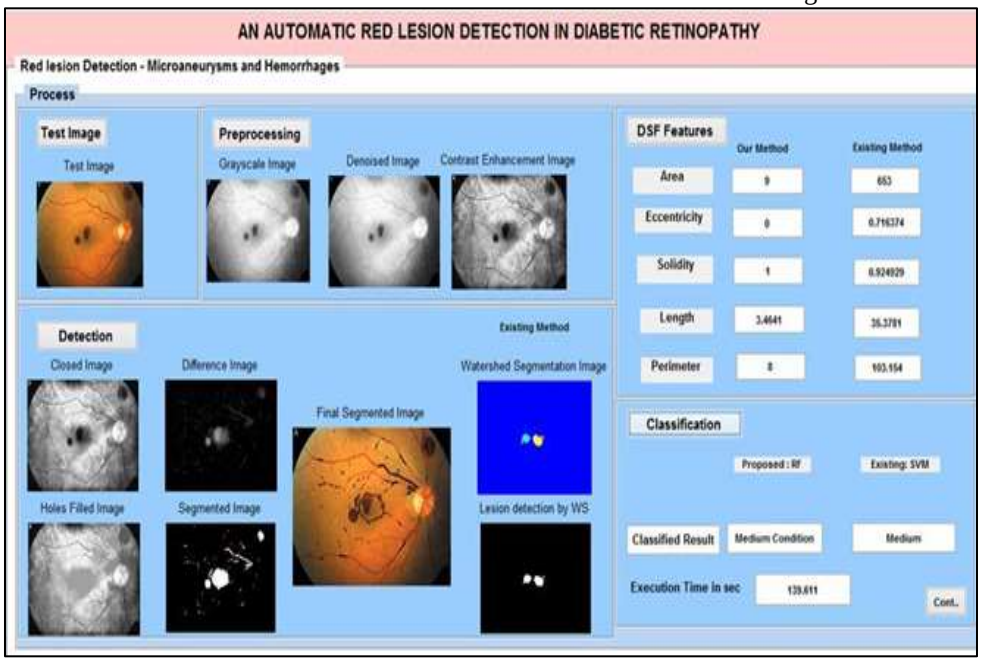

Fig. 5: Red Lesion Recognition

V. CLASSIFICATION

Classifies individual pixel based on this spectral information. The classification is done over segmented image using Random Forest (RF) Classifier. One of the foremost common ways or frameworks utilized by knowledge scientists at the rose knowledge science skilled follow clusters is Random Forests. The Random Forests formula is the simplest among classification algorithms able to classify giant amounts of information with accuracy. Random Forests are associate degree ensemble learning technique (also thought of as a kind of nearest neighbor predictor) for classification associate degreed regression that construct variety of call trees at coaching time and outputting the category that's the mode of the categories output by individual trees. Figure 6 shows classification result of proposed and existing work. The affected lesion will outputted as high, medium or low condition during classification part.

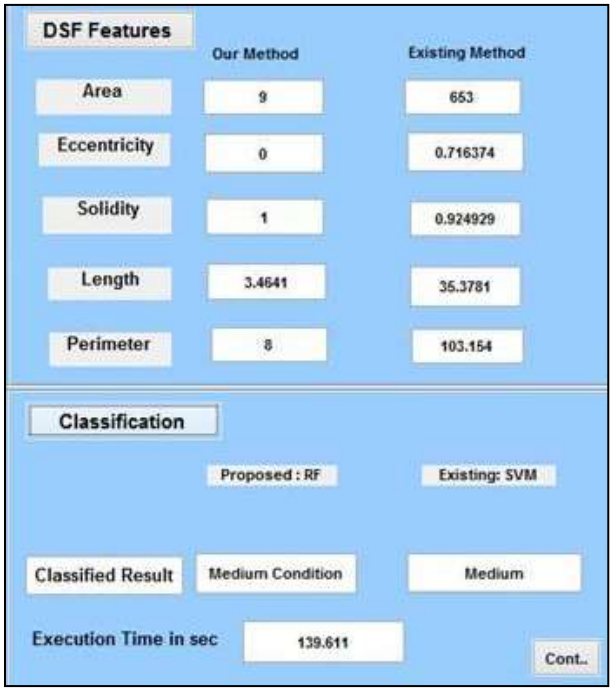

Fig. 6: Classification Result

VI. CONCLUSION

The Red lesion in retina is being recognized by using computer aided software MATLAB and it is being classified based on the amount of red lesions that is present in the retina. A novel red lesion recognition method based on a new set of shape features, the DSFs, was presented and evaluated. The results demonstrate the strong performance of the proposed method in detecting both MAs and HEs in fundus images of different resolution and quality and from different acquisition systems. The method outperforms many state-of-the-art approaches at both per-lesion and per-image levels. Dynamic Shape Features have proven to be robust features, highly capable of discriminating between lesions and vessel segments. The concept of DSFs could be exploited in other applications, particularly when the objects to be detected do not show clear boundaries and are difficult to segment precisely. Further work focusing on bright lesion and neo vessel recognized will complete the proposed system and allow automatic DR grading. Thus the result is being classified based on the random forest classifier.

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