EARLY DETECTION OF DIABETIC RETINOPATHY FROM FUNDUS IMAGES OF HUMAN RETINA

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Abstract

Diabetic retinopathy is one of the leading disabling chronic diseases, and one of the leading causes of preventable blindness in the world. Early diagnosis of diabetic retinopathy enables timely treatment and in order to achieve it a major effort will have to be invested into screening programs and especially into automated screening programs. Here, we present a simple and direct approach to the detection of microaneurysms from fundus images. Algorithms were categorized into image preprocessing and then, the segmentation of diabetic retinopathy pathologies.

Index Terms: Diabetic retinopathy, fundus images, microaneurysms.

I. INTRODUCTION

Medical imaging has revolutionized the medicine by providing cost-efficient health care and effective diagnosis in all major disease areas. Medical imaging allows scientists and physicians to understand potential life-saving information using less invasive techniques. In medical imaging the quality of the image acquisition and the image interpretation determines the accuracy of diagnosis. Computers have a huge impact on the acquisition of medical images. They perform multi-pronged functions like controlling imaging hardware, performing reconstruction, post-processing of the image data and storing the scans. In contrast, the role of computers in the interpretation of medical images has so far been limited. Interpretation remains an almost exclusively human domain. Recent years have witnessed pioneering work in the area of medical imaging.

Applications that can interpret an image are being developed, which in turn can aid a physician in detecting possible subtle abnormalities. The computer indicates places in the image that require extra attention from the physician because they could be abnormal. These technology is called CAD (Computer Aided Diagnosis). Studies on CAD systems show that CAD can be helpful to improve diagnostic accuracy of physicians and lighten the burden of increasing workload. The most established CAD applications in medical fields are the use of automated systems in mammography, chest computed tomography and radiography. This thesis describes components of an automatic system that can aid in the detection of diabetic retinopathy. Diabetic retinopathy is an eye disease and a general complication of diabetes that causes vision loss, if left undiagnosed at the initial stage.

II. BACKGROUND

There are many methods in the published literature for the detection of microaneurysms in the retinal images. Currently, there is an increasing interest for establishing automatic systems that screens a huge number of people for vision threatening diseases like diabetic retinopathy and to provide an automated detection of the disease. Image processing is now becoming very practical and a useful tool for diabetic retinopathy screening. Digital imaging offers a high quality permanent record of the fundus images, which can be used by ophthalmologists for the monitoring of

progression or response to the therapy. Digital images have the potential to be processed by automated analysis systems. Fundus image analysis is a complicated task, because of the variability of the fundus images in terms of color/gray levels, the morphology of the anatomical structures of the retina and the existence of certain features in different patients that may lead to a wrong interpretation. In the literature, numerous examples of the application of digital imaging techniques used in identification of diabetic retinopathy can be found. There have been few research investigations to identify retinal components such as blood vessels, optic disk, fovea and retinal lesions including microaneurysms, hemorrhages, and exudates in the literature[1-6]. Retinal blood vessel segmentation: Several studies were carried out on the segmentation of blood vessels in general, however only a small number of them were associated to retinal blood vessels. In order to review the methods proposed to segment vessels in retinal images, seven classes of methods have been considered: matched filters, vessel tracking, morphological processing[3], region growing, multiscale, supervised and adaptive thresholding approaches.

III. METHODOLOGY

A. Green Channel Extraction

In the green channel of color images, MAs appear as dark patterns, small, isolated and of circular shape[3]. The green channel is the most contrasted one, that the red channel is saturated and that the blue channel does not contain any information. Green light is less absorbed by the fundus layers than the blue part of the spectrum, but more than red light, which penetrates deeper into the layers of the inner eye and which is mainly reflected in the choroid. The red light is less absorbed by the pigments of the inner eye, and it dominates the reflected spectrum. This is the reason why the color fundus images appear reddish. Because of the lower absorption coefficients for red light, structures containing pigments are less contrasted than it is the case for green light. This does not mean that there cannot be any useful information in the red and blue channel. It just means that blood containing elements (as MA or vessels) in the retinal layer are best represented and have highest contrast in the green channel.

B. Histogram Matching

Histogram matching is a process of matching the histogram of a given image to that of a reference image. Here, there are fundus images with varying dark and bright regions. The proposed algorithm mainly works on empirical values which have been obtained from the assumption that all the test images will have similar histograms. So, as a reference image, im0221.ppm from the dataset available at STARE is used, whose histogram is matched.

C. Adaptive Histogram Equalization

Adaptive histogram equalization (AHE) [4] is an image processing technique used to improve contrast in images. It differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast of an image and bringing out more detail.

D. Bottom-hat transform

Here, closing-top hat transform [3] or bottom hat transform is used. This transform or operation enhances the valley regions or the dark points. Our requirement is to darken the dark regions. It is given by

$$Y = X - (X \ominus B)$$

Where, X is the reference image, B is the structuring element and Y is the resultant contrasted detail. This is then added to the original image, to increase the contrast

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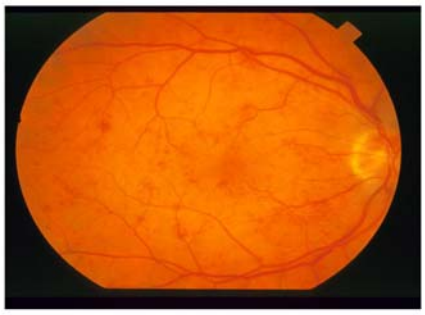

Fig. 1. Original Image

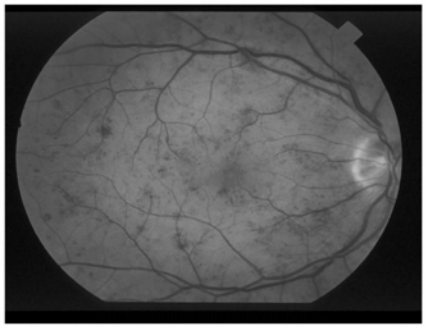

Fig. 2. Green Channel of the Original Image

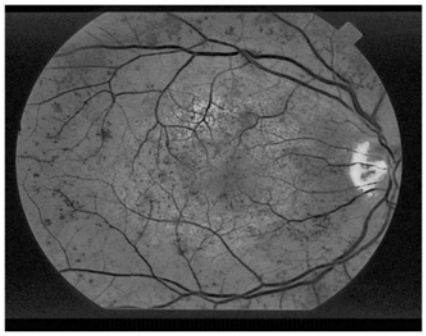

Fig. 3. Contrast Enhanced image

E. The proposed method

Here, we consider the image locally, by using windowing technique. Two windows are used, both of different sizes. The first is the outer windows of sizes 11, 9, 7 & 5. And for each of these outer windows, the smaller windows will be of sizes, 11 - {9, 7, 5, 3}, 9 - {7, 5, 3}, 7 - {5, 3}, 5 - {3}. The smaller window is present, exactly at the centre of the larger window. The inner (smaller) window is used to detect regions enclosed by the outer (larger) window that have dark regions in the centre. The outer window and the inner window are then used together to check for presence of blood vessels.

- Initially, the mean of the pixel values in the inner window is taken. Next, the mean if the pixels in the outer window, excluding the inner window is taken.
- In the initial screening, the difference between these 2 means is taken and if it is greater than a threshold value, the corresponding points are passed on to next test clause. Here most of the unwanted portions will be excluded.
- In the next test clause, the region in the outer window, excluding the inner window is checked for no. of pixels with values greater than the mean pixel value.
- If the value is at least 75% of the total no. of pixels in the window, then the region in the window is considered as a microaneurysm.

The figure Fig. 4, 5 & 6 shows the algorithm working on a microaneurysm and a blood vessel. For the microaneurysm, the no. of highlighted pixel is more than 75%, while for the blood vessel, it is not.

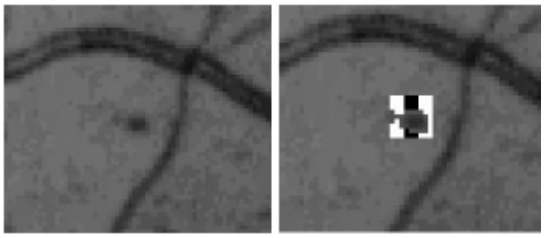

Fig. 4. Second screening process on a microaneurysm.

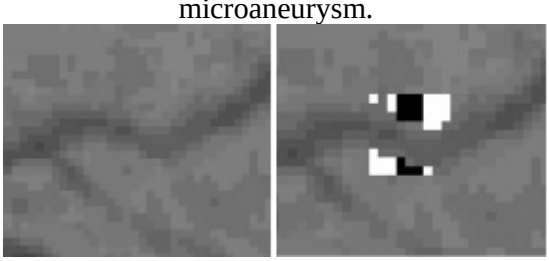

Fig. 5. Second screening process on a blood vessel.

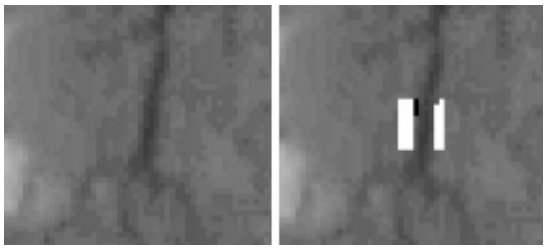

Fig. 6. Second screening process on another blood vessel.

This screening process eliminates most of the unnecessary features that passed the initial stage. The figure below shows the current state of the output.

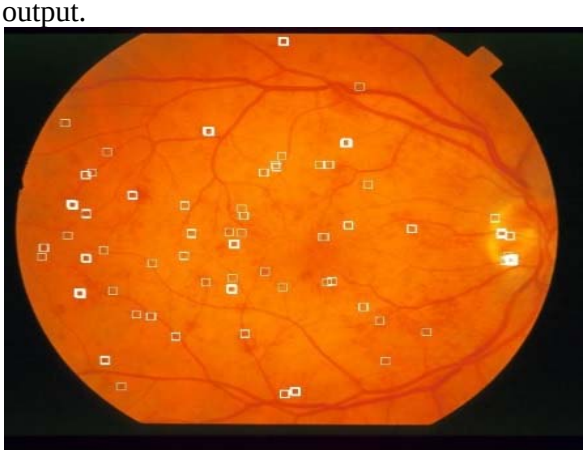

Fig. 7. Output Image

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