Diabetic Retinopathy Detection from Human Retinal Images using Image Processing Techniques

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Abstract—Diabetic Retinopathy is an eye disease that affects retina and it will leads to Blindness. Early detection of DR is helpful to improve the screening of patient to prevent blindness. DR detection, poor quality retinal image makes more difficult the analysis for ophthalmologist. Automatic detection of blood vessels from retinal images is helpful to find the exudates. Soft and hard Exudates are identified by removing extracted retinal blood vessels and optic disc. The Retinal vessels are extracted using Curvelet Transform and Morphological reconstruction techniques. And also an optic disc is segmented by Circular Hough Transform.

Key words: Diabetic Retinopathy, Human Retinal Images

I. INTRODUCTION

One of the most important internal components in the eye is called the retina, covering all posterior compartments, on which all optic receptors are distributed. Disorders in the retina resulted from special diseases are diagnosed by special images from the retina, which are obtained by using optic imaging called Fundus. Applications of the retinal images are diagnosing the progress of some cardiovascular diseases, retinal image registration, diagnosing the region with no blood vessels (Macula), using such images in helping automatic laser surgery on eye, and using such images in biometric applications, etc. Now a days, there are a lot of diabetic patients suffered from diabetic retinopathy. And most of the patients got blindness due to severe DR.

Diabetic retinopathy is a consequence to people affected by diabetes mellitus when glucose level is not kept in control. It occurs as a result of an imbalance in the body’s insulin level. The signs of the disease are expressed in the retinal vasculature as well as in the vitreous humor (gel surrounding the retinal blood vessels). The signs occur the form of hemorrhages, exudates, cotton wool spots (CWS) and microaneurysms (MA). The presence of these abnormalities leads to NPDR. The disease progresses into a severe stage known as PDR characterized by the abnormal growth of blood vessels (neovascularization).

In biomedical application, automatic diagnosis of DR using fundus image could help ophthalmologists easier for detection of diabetic retinopathy severity level. Fig. 1 shows the typical example of color fundus image with different feature components marked on it. The bright circular region is called as optic disc (OD). It is the area from where thick blood vessels originated in the retina. The remaining bright lesions called as hard exudates and cotton wool spot. Hard exudates appear as a bright yellowish deposit. It is of variable size, irregular forms and appears anywhere in retinal surface.

II. PROPOSED SYSTEM

A. Preprocessing Of Retinal Image

In detecting abnormalities associated with fundus image, the images have to be pre-processed in order to correct uneven illumination problem, non-sufficient contrast between blood vessels, exudates and background pixels and presence of noise in the input fundus image. The intensity input image is converted into grey scale image initially. The green channel tends to be saturated and blue channel tends to be empty and the red channel tends to be saturated.
B. Blood Vessel and Optic Disc Extraction

1) Segmentation of Blood Vessels

Blood vessels are also an important feature of fundus images. In some cases, blood vessels appear darker in intensity level than average intensity of the healthy part retina so it is segmented as unhealthy part in region growing method. In such instances the elimination of blood vessels is necessary for proper segmentation of exudates results.

Since the curvelet transform is well adapted to represent the images containing edges, it is a good candidate for edge enhancement. Curvelet coefficients can be modified to enhance the edges in an image, which improves the image contrast. To this end, we introduced a nonlinear function to modify the representation coefficients in such a way that details of the small amplitude are enlarged at the expense of the larger ones and perform this uniformly over all scales. Definition of the function parameters based on some statistical features of curvelet coefficients of the input image is very beneficial to adapt the function better with every input image. Therefore, there is a need for a nonlinear function, such as \( y \), to multiply against the transform coefficients. Multiply each coefficient individually by the following function \( y \): \[
y(x) = \begin{cases} 
  k_1 \left( \frac{m}{|x|} \right)^p, & \text{if } |x| < ac \\
  k_2 \left( \frac{m}{|x|} \right)^p, & \text{if } ac \leq |x| < m \\
  k_3, & \text{if } |x| \geq m 
\end{cases}
\] (1)

where \( x \) is the curvelet coefficient, \( 0 < p < 1 \) determines the degree of nonlinearity; \( k_1, k_2 \) and \( k_3 \) are assigned weights to each function part to allow us to control the modification of coefficients with a higher severity and makes the modification more appropriate.

In order to perform edge detection using morphological techniques, the multi structure elements are used. A simple method to eliminate these undesired objects present in the edge detected image is using morphological opening. Therefore, morphological opening by reconstruction in its first step eliminates bright features smaller than the SE. In the next step, it dilates iteratively to restore the contours of components that have not been completely removed by opening and it is performed by considering the original image as the reference.

In order to obtain a clear final result without presence of pixels that do not belong to vessel tree, we use length filtering with the aim of removing the small pixel blocks. Finally, using the connected component analysis (CCA) with four and eight neighbourhoods of the pixels, respectively, in two steps and by applying the adaptive filter on the created components locally, the frills in the image are removed and the extracted blood vessels are obtained. Finally these extracted blood vessels are removed from original retinal image.

2) Segmentation of Optic Disc

Optic disk is an important feature of fundus images. It is really significant to detect OD because of its similarity index in color, contrast and brightness to the exudates. In most of the cases it comes along with the exudates detection results. Thus there is need to mask it out. OD can also be employed to diagnose the Glaucoma. ODs have many distinctive properties like their circular geometric structure, blood vessel originating area, high intensity and such. In the literature many techniques are used to detect OD [4], [11], [12].

In this paper, a circular geometric structure of OD with bright intensity is used for the detection of the same. A closing operation performed on the green channel of an image using structuring element (we used disk structure of 6 pixels). Closing operation performs dilation followed by erosion. The formulation of dilation and erosion for grayscale images is shown in (3) and (4).

Dilation: \[
A \circ B = D(x, y) = \max \{A(x-i, y-j) + B(i, j)\}
\] (2)

Erosion: \[
A \bullet B = R(x, y) = \min \{D(x-i, y-j) + B(i, j)\}
\] (3)

where \( A(x, y) \) is input image, \( B(i, j) \) is the structuring element of size mxn, \( D \) is dilated image, \( R \) is the resultant image of closing operation and \( 0 \leq i \leq (m-1), 0 \leq j \leq (n-1) \).

Closing operation eliminates vessels originating from OD by brighter region. The canny edge detection technique is applied on resultant image which passes on the circular edges around OD. The Circular Hough Transform (CHT) is a feature extraction technique for detecting circles. It is a specialization of Hough Transform. By applying CHT on the canny edge detected image gives the approximate center and radius of OD which are used to locate OD in fundus image.

C. Thresholding

After the segmentation of retinal blood vessels and Optic disc, the thresholding technique is applied for the preprocessed image. The threshold \( \alpha_1 \) is chosen to separate brighter objects from background. It can be set to indicate the percentile of the histogram area defined by the estimated curve that represents class (yellow elements). Percentile indicates the percent of the total number of pixels there are in a certain range. This threshold represents an algorithm’s parameter. Fig. 2 (c) shows the result with \( \alpha_1=0.995 \).

![Fig. 2: (a) & (b) are Color retinal fundus images with exudates. (c) & (d) are after blood vessel removal. (e) & (f) exudates extraction after optic disc removal](image-url)
After thresholding, other yellow lesions, such as cotton wool spots, the OD and artifacts near the papillary region may be erroneously detected. Therefore, they must be removed from the final result. Thresholding the result at grey level $\alpha_2$, only the sharpest edges are obtained. This image is combined with the result of the thresholding stage using reconstruction by dilation operation to remove from the final result the elements with high intensity but blurred edges. Fig. 2(d) shows the final result of the detection of hard exudates. The thresholds $\alpha_1$ and $\alpha_2$ are selected as parameters of the proposed algorithm. If they are chosen too low, the sensitivity increases, while the number of false positives may also increase leading to a lower predictivity.

III. Conclusion
Detection of Diabetic Retinopathy plays an important role in the field of ophthalmology. If any abnormality falls over the macular region it effects the central vision and gradually it leads to blindness. In this proposed method For exudate detection, optical disc and blood vessels are extracted and removed for avoiding false problem to ophthalmologists. And finally by applying thresholding technique only the exudates are extracted from the retinal image. So earlier detection and diagnosis of Diabetic retinopathy help the patients from vision loss and also the severity of disease can be decreases. This work can be extended for diagnosis of other diseases as stroke, macula and fovea.

REFERENCES