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Optic Disc and Blood Vessels Screening in Diabetes Mellitus using Otsu's Method

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Optic Disc and Blood Vessels Screening in Diabetes Mellitus using Otsu's Method

Ms. Jyoti Patil ^α & Dr. S.R. Chaudhari ^ο

Abstract Diabetes Mellitus (DM) has type-1 & type 2. So in diabetes type-2 is very severe disease which creates complications and effect on various part of body. Most sensitive part of body is Eye which is affected by DM responsible in progression of Diabetic Retinopathy (DR). DR is a slowly effects on eye & come to focus when the changes on the retina have progressed to a level at which treatment turns complicate, so an early diagnosis and referral to an ophthalmologist or optometrist for the management of this disease can prevent 98% of severe visual loss. The aim of this work is to automatically identify Diabetic Retinopathy (DR), and Background Retinopathy using fundus images. Our results show a classification accuracy of 92%, with sensitivity and specificity of 95%.

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I. INTRODUCTION

The Diabetes Mellitus (DM) is nothing but it is a set of chronic and degenerative disorders that involves alterations in the metabolism of carbohydrates, lipids, and proteins, as a consequence of a decreasing in the production of the hormone insulin for the β cells from the pancreas, and a resistance to the hormone's action in the different tissues [1]. One of the most serious complications of the DM is the DR [2], which is the main cause of worldwide blindness in the economically active population, because it affects people between 20 to 74 years old [3, 4]. Two types of clinical DR exist: Non-Proliferative Diabetic Retinopathy (NPDR), also called Background Retinopathy and Proliferative.

Diabetic Retinopathy (DR), this work aims to detect the optic disc (OD) and the blood vessels; these are very important & sensitive part from anatomy of eye. Also, the optic disc and the exudates are the bright area of the image. Detection of optic disc and the blood vessels can help the ophthalmologists to detect the diseases earlier and faster. With help of using mathematical morphology methods such as closing, filling, morphological reconstruction and Otsu algorithm Optic disc and the blood vessels can be detected and eliminated.

Main cause of Diabetic Retinopathy is increase in high sugar level in the small blood vessels in retina. This increase in glucose level attacks on tiny blood vassals and optic disk in eye causes increase in ocular

pressure in eye. Due to increase in pressure vassals may leak, or swelling may be observed in severe stage of retinopathy.

We in this research work using the screening method of diabetic retinopathy which can reduce the risk of blindness by 50% [1]-[2]. Therefore, early detection could reduce the severity of the disease and treating the disease more efficiently. It is very important to detect the optic disc so that after optic disk detection we can identify the other fundus features. The optic disc looks like as the elliptical shape in the eye fundus image. Its size varies from human eye to eye, between one-tenth and one-fifth of the image [3]. In color image, it appears as the bright yellowish region as the exudates. The optic disc is the normal feature of the image but the exudates are the abnormal case. Detection the optic disc can be used to reduce the false positive in the detection of the exudates [4] [5].

A number of methods for optic disc detection and blood vessels detection have been published. Osareh et al. [6] located the optic disc center by means of template matching and extracted its boundary using a snake initialized on a morphologically enhanced region of the optic disc. Lowell et al. [7] also localized the OD by means of template matching as well as also selected a deformable contour model for its segmentation. Another deformable model-based approach was presented in [8]. Another template-matching approach for OD segmentation is the Hausdorff-based template matching presented by Lalonde et al. [9]. Initially, they determined a set of OD candidate regions by means of multi resolution processing through pyramidal decomposition. For each OD region candidate, they calculated a simple confidence value representing the ratio between the mean intensity inside the candidate region and inside its neighborhood. As final step, using the Hausdorff distance between the edge map regions and circular templates with different radii, they decided the OD among all the candidates. There are some methods for blood vessels detection in retinal fundus images such as region growing technique [10], morphological and thresholding techniques [11], neural network based approaches [12], statistical classification based methods [13-14] and hierarchical methods [12].

We introduce different algorithms. Our work has explain about two methods of the optic disc detection and blood vessels detection like Otsu's thresholding method based on mathematical morphology on the

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fundus images because it requires lower computing time. In second of filtering we have removed a Noise of grayscale image & then applied adaptive Averaging filter by estimating the local mean and variance around area of detection in which we can detect each pixel. The detail of pre -processing steps and detection of optic disk are described below.

II. OTSU'S METHOD OF THRESHOLDING

We have removed a Noise of grayscale image & then applied adaptive Averaging filter to detect Optic

Frequency:

$$\omega = \sum_{i=0}^T P(i) \quad P(i) = n_i / N$$

Mean:

$$\mu = \sum_{i=0}^T iP(i) / \omega$$

N: total pixel number, ni: number of pixels in level i Analysis of variance (variance=standard deviation-2) Total variance.

$$\sigma_i^2 = \sum_{i=0}^T (i - \mu)^2 P(i)$$

Between-classes variance (δb2): The variation of the mean values for each class from the overall intensity mean of all pixels:

$$\delta b2 = \omega_0 (\mu_0 - \mu_t)^2 + \omega_1 (\mu_1 - \mu_t)^2,$$

Substituting $\mu_t = \omega_0 \mu_0 + \omega_1 \mu_1$, we get:

$$\delta b2 = \omega_0 \omega_1 (\mu_1 - \mu_0)^2$$

$\omega_0, \omega_1, \mu_0, \mu_1$ stands for the frequencies and mean values of two classes, respectively. The criterion function involves between-classes variance to the total variance is defined as:

All possible thresholds are evaluated in this way, and the one that maximizes η is chosen as the optimal threshold.

III. ALGORITHM FOR OTSU'S METHOD

- Step 1: Convert the RGB values in Grayscale values
- Step 2: Use a 2-D Laplacian of the Gaussian
- Step 3: Convolve the image with output from kernel
- Step 4: Subtract the image with a constant value to reduce noise.
- Step 5: Noise removal by adaptive wiener filtering by estimating the local mean and variance around each pixel.
- Step 6: Apply Averaging filter to remove noise of the image in two dimensions & to detect Optic Disk & Blood Vessels.
- Step 7: Compute a global threshold to convert an intensity image to a binary image. By normalized intensity value that lies in the range [0, 1].

Disk & Blood Vessels; by estimating the local mean and variance around each pixel, then selected damage nerve fibers & optic disk using otsu's Method. Otsu's thresholding method is based on selecting the lowest point between two classes (peaks). Frequency and Mean value:

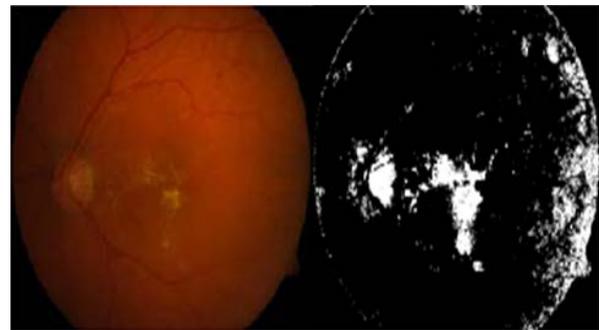


Fig. 1 : (a)Original diabetic Infected image, (b)clearly Shows damaged optic disk.after application of ostu's method

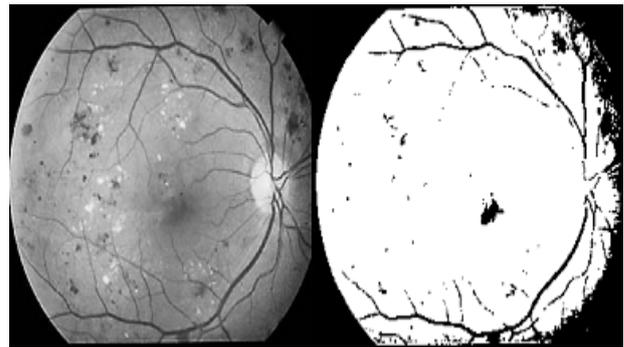


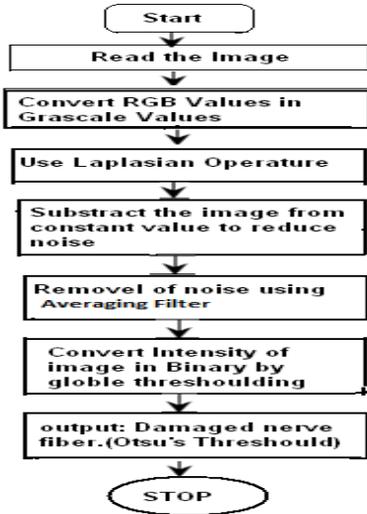
Fig. 2 : Shows Damaged Nerve fibers with damaged optic disk by application of Otsu's method

IV. BLOOD VESSELS DETECTION AND ELIMINATION

Blood vessels are the normal features of the retinal images. So the blood vessels detection and elimination is also important. The general flow chart of the blood vessels detection is shown in Fig.7. To detect the blood vessels, first the input image is converted into grayscale image due to strengthen the appearance of the blood vessels. Then Laplacian operator is applied.

Then the median filtering and the CLAHE techniques are used for reducing noise and image enhancement purposes. Then, the closing and the filling operators are used to close the same intensity values and fill the holes in the vessels.

V. FLOWCHART FOR OTSU'S METHOD



a) Thresholding

The Otsu's thresholding technique is applied to the image to detect the desire area. Equations of Otsu algorithm is

$$\sigma^2_{\text{Between}}(T) = w_B(T)w_o(T)[\mu_B(T) - \mu_o(T)]^2$$

$$w_B(T) = \sum_{i=0}^{T-1} p(i) \quad , \quad \mu_B = \sum_{i=0}^{T-1} \left(\frac{ip(i)}{p(i)} \right)$$

$$w_o(T) = \sum_{i=T}^{L-1} p(i) \quad , \quad \mu_o = \sum_{i=T}^{L-1} \left(\frac{ip(i)}{p(i)} \right)$$

- $\sigma^2_{\text{Between}}(T)$ = Between-class variance
- w=weight, B=background of the image, o=object of image
- μ = combined mean,
- T = threshold value

The optic disc is the largest and brightest region of the image. The optic disc detection is useful because it can reduce the false positive detection of the exudates. Fig.5 shows the general flow chart of the optic disc detection.

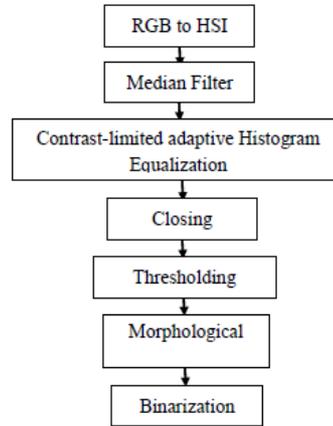


Fig. 5 : Flow Chart of disc Detection

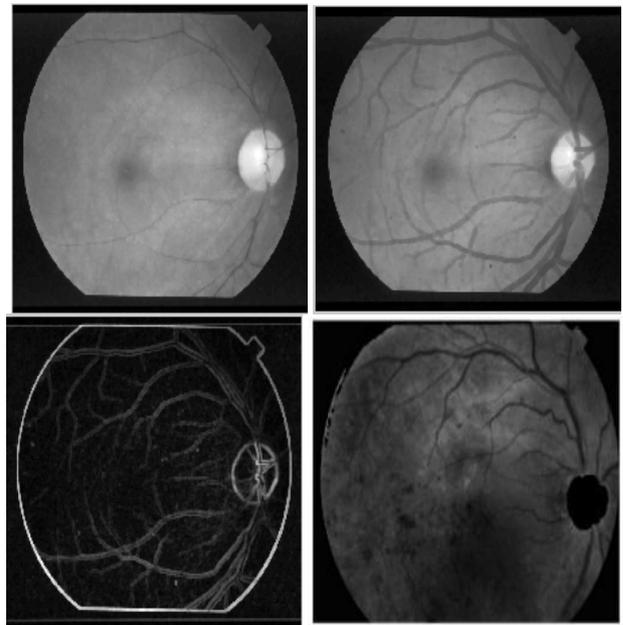


Fig. 6 : (a) Closing (b) Thresholding (c) Filling (e)(d) Reconstruction

b) Detected Optic disc

The closing (morphology) operator is useful in detection of vessels. While using closing operator it is important to select structuring element. The closing is a dilation followed by erosion that joins the very close objects together. Then, the result image is binaries by thresholding using Otsu algorithm [16]. The result image is shown in Fig.6 (b).The filling operator is applied to fill the holes in the image and the result image is shown in Fig.6 (c). The result image is reconstructed by using the morphology reconstruction and is shown in Fig.6 (d). To detect the optic disc region, the Otsu algorithm is applied on the difference between the original image and the reconstructed image. The optic disc detected area is shown in Fig.6 (e). The results of the optic disc detection are shown in Fig.6 (a), (b), (c), (d) and (e). Fig.6 (a) shows the result of the closing operator

VI. AVERAGING FILTER

It is necessary to remove grain noise from image of retina to get selected part of optic disk & vassals from a photograph. Each pixel gets set to the average of the pixels in its neighborhood. The result of the averaging filter is shown in Fig.5 (b).



Fig. 5 : (a) original Image

Fig. 5 : (b) Result of averaging filter

VII. RESULT & DISCUSSION

Otsu's method is used to detect damaged optic disk & damaged nerve fibers.

For which 1) we compute a mean value of colors with maximum intensity by applying a global threshold to convert an intensity image to a binary image. By normalized intensity value that lies in the range [0, 1].

2) We have removed a Noise of grayscale image & then applied adaptive wiener filtering & by median filter; by estimating the local mean and variance around each pixel. Thus as shown in figure (1 & 2) only selected damage nerve fibers & optic disk is observed.

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