

# CLASSIFICATION OF DIABETES RETINA IMAGES USING BLOOD VESSEL AREA

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## ABSTRACT

*Retina images are obtained from the fundus camera and graded by skilled professionals. However there is considerable shortage of expert observers has encouraged computer assisted monitoring. Evaluation of blood vessels network plays an important task in a variety of medical diagnosis. Manifestations of numerous vascular disorders, such as diabetic retinopathy, depend on detection of the blood vessels network. In this work the fundus RGB image is used for obtaining the traces of blood vessels and areas of blood vessels are used for detection of Diabetic Retinopathy (DR). The algorithm developed uses morphological operation to extract blood vessels. Mainly two steps are used: firstly enhancement operation is applied to original retina image to remove noise and increase contrast of retinal blood vessels. Secondly morphology operations are used to take out blood vessels. Experiments are conducted on publicly available DIARETDB1 database. Experimental results obtained by using gray-scale images have been presented.*

## KEYWORDS

*Blood Vessels, Fundus Images, Morphological operations.*

## 1.INTRODUCTION

Diabetes has turn out to be one of the quickly increasing diseases worldwide. Diabetic Retinopathy is outcome of long standing hyper glycaemia, in which retinal lesions developed that could direct to blindness. Commonly excepted rigorous guidelines for the evaluation of biometric authentication methods for face recognition have enabled the fast progress in the field and similar can be likely in the medical image processing related to diabetic retinopathy detection.

Enhance in blood sugar levels linked with diabetes is the known reason of Diabetic Retinopathy (DR). Progressive degenerative syndrome of the retina has an asymptomatic phase that can start long before the beginning of recognized diabetes. Diabetic retinopathy is divided into various stages. The initial signs of DR are micro aneurysms, minute hemorrhages, cotton wool spots, and exudates that result from abnormal permeability and nonperfusion of capillaries. These early signs are known as Nonproliferative Diabetic Retinopathy (NPDR). There may even be prior indications of diabetic retinopathy. Fluid leaking from the retinal capillaries indicates a additional progression of the disease, this may lead to vision Threatening Diabetic Retinopathy if the leakage is situated in the area of most sensitive vision and is known as Nonproliferative Diabetic Retinopathy (NPDR). Proliferative Diabetic Retinopathy (PDR) develops from occluded capillaries that direct to retinal ischemia and formation of new vessels on the exterior of the retina either near the optic disc or in the retinal border. It is important noting here in advance that certain lesions representing DR, such as the number of microaneurysms and dot hemorrhages, have been established to correlate with disease severity and likely development of the disease, such lesions

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have a reasonably well defined appearance and signify useful targets for programmed image detection, and the detection of them provides useful information. It is also important that DR is a treatable disease all through disease development commencing from the preclinical stage, if detected early and treated then significant saving in cost and reduction in the progression of vision loss is possible. As the disease is treatable, detection and monitoring of the disease via fundus photography is beneficial and more efficient detection and monitoring saves costs. It would seem that automated image detection of diabetic retinopathy is an engineering solution to a increasing need.

The rest of the paper is organized as follows, Section 1 contains introduction. Section 2 provides related work done. Section 3 describes details about proposed methodology. In section 4, experimental results are discussed. Finally section 5 concludes the work.

## **2. RELATED WORK**

In 2007, Al-Rawi and Karajeh [1] presented a Genetic algorithm using matched filter optimization for computerized detection of blood vessels. Genetic algorithms and matched filters were used to notice the fine changes in vascular structure so as to break up blood vessels from remaining information of retina image.

In 2007, Grisam et al. [2] presented a new algorithm for the assessment of tortuosity in vessel, recognized in digital fundus images. It is based on partitioning every vessel in part of constant-sign curvature and then combining collectively each of evaluation of such segments.

In 2008 Aliaa et al. [3] introduced Optic disc (OD) detection for developing computerized screening systems for diabetic retinopathy. The OD detection algorithm was based on matching the usual directional pattern of the retinal blood vessels. Hence, a simple matched filter is projected to roughly match the direction of the vessels at the OD vicinity of retina image.

In 2010, Xu and Luo [4] presented a technique that uses adaptive local thresholding to produce a binary image, and then extract bulky connected components as large vessels. The residual fragments in binary image including some slight vessel segments were classified by support vector machine.

In 2010, Faust et al. [5] presented algorithms for an automated recognition of diabetic retinopathy by means of Digital Fundus images; retina images affected diabetes and normal are classified using characteristics such as blood vessel area, exudates, hemorrhage microaneurysms and texture extracted from retina image and supplied to the classifier.

In 2011, Vijayamadheswaran et al. [6] presented detection of diabetic retinopathy using radial basis function. The algorithm uses features obtained from the retina images captured through fundus camera. Contextual Clustering (CC) segmentation technique is used for classification of retina images.

In 2012, Joshi and Karule [7] discussed Retinal Blood Vessel Segmentation. The fundus RGB image was used for obtaining the traces of blood vessels. The algorithm generated uses morphological operation to smoothen the background, retaining veins.

In 2012, Selvathi et al. [8] presented computerized detection of diabetic Retinopathy for early diagnosis using feature extraction and support vector machines. The features considered are blood vessels, exudates & microaneurysms in training set and in test image.

In 2013, Badsha et al. [9] presented automated method to extract the retinal blood vessel. The proposed method comprises several basic image processing techniques, namely edge growth by standard template, noise removal, thresholding, morphological operation and entity classification. In 2013, Nidhal et al. [10] introduced blood vessel segmentation using mathematical morphology in fundus retinal images. The method uses RGB retina image and separates Green channel from RGB image which gives good details. Retinal images are normally noisy and non-uniform illumination. So contrast limited adaptive histogram equalization is used for contrast improvement. The Top-Hat transform is used for withdrawal of small details from given image. In 2013, Kavitha and kumar [11] presented edge detection for retinal image using Superimposing concept and Curvelet transform, which makes the edge recognition effectively. Back propagation algorithm is used for blood vessel detection which helps to find out the real retinal blood vessels from the image to generate the better result.

In 2013, Rashid and Shagufta [12] presented automated method to detect exudates from low contrast images of retinopathy patient's with non-dilated pupil using features based Fuzzy c-means clustering method with a combination of morphology techniques & pre-processing to improve the strength of blood vessels and optic disk detection.

In 2014, Jefrins and Sundari [13] presented Diabetic retinopathy, and also cardiovascular diseases like ophthalmic pathologies, hypertension. The work examined the blood vessels segmentation of two dimensional retinal images acquired from a fundus camera. Many of the techniques quoted above have been tested on large volumes of retinal images but accurate segmentation of blood vessel from retina image is still challenging issue.

### 3. PROPOSED METHODOLOGY

Accurate retinal blood vessel extraction is required for recognizing the changes in structure of blood vessels. The components of an automatic screening system for diabetes retina are shown in Fig.1. The proposed system is designed for retinal blood vessels segmentation and computation of blood vessel area for monitoring the changes in blood vessels due to diabetics.

- **RGB to Gray:** RGB retina image acquired through fundus camera is converted into a gray-scale image in order to make easy computations and decrease the size of data and computational time. All input image size is resized to 256x256 to consider uniform areas.
- **Contrast Enhancement:** Low contrast images could occur often due to many reasons, such as poor or non-uniform illumination condition, nonlinearity or small active range of the imaging sensor, i.e., illumination is distributed non-uniformly within the image. Therefore, it is needed to increase the contrast of these images to provide a better transform representation for succeeding image analysis steps. Contrast Limited Adaptive Histogram Equalization (CLAHE) technique is adopted to perform the contrast improvement
- **Image Segmentation:** The size and shape of the structuring element affects the number of pixels being added or removed from the object in the image. Closing operation is defined as dilation (Max filter) followed by erosion (Min filter). Dilation is an function that grows or

thickens things in a binary image. Dilation in gray scale enlarges brighter regions and closes small dark regions. The erosion is needed to shrink the dilated objects back to their original size and shape. The dark regions closed by dilation do not react to erosion. Thus, the vessels being thin dark segments laid out on a brighter background are closed by a closing operation. The image through smoothing filter is input for the edge detection technique. The results of edge detection is compared with the image passing before and after the smoothing filter and results are found better for the Canny's edge detection technique.

- **Thresholding and Background Exclusion:** The main purpose of this step is to remove background variations in illumination from an image so that the foreground objects may be more easily seen. This produces a binary image in which the value of each pixel is either 1 or 0

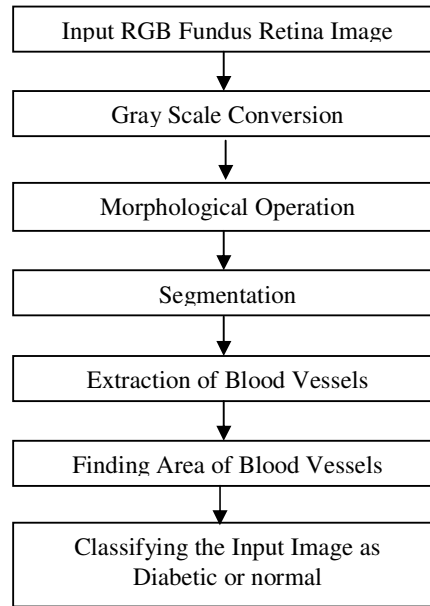


Fig.1. Block diagram for the Proposed Model

- **Morphological Closing:** Closing of set A by structuring element B is denoted by  $A \bullet B$  and is given by equation (1).

$$A \bullet B = (A \ominus B) \oplus B \quad (1)$$

In this step we apply morphological closing process with disk as structuring element. The size of the structure element square is chosen as 10 to turn characters and other small shapes with foreground to background color.

- **Noise removal:** This step applies median filter to remove non-blood vessel part in the retina image. It keeps much of the blood vessel part as it is in the retina image (white) and converts remaining part of the retina into background black.

## 4. RESULTS AND DISCUSSION

The data base description, evaluation procedure and results are discussed in the following section.

#### 4.1 Database description

Proposed system uses a database of dedicatedly selected high quality medical images which are representatives of the problem and have been verified by experts. A database DIARETDB1 is used which consists of 89 color fundus images of which 84 contain diabetic signs and 5 are normal.

#### 4.2 Evaluation Procedure

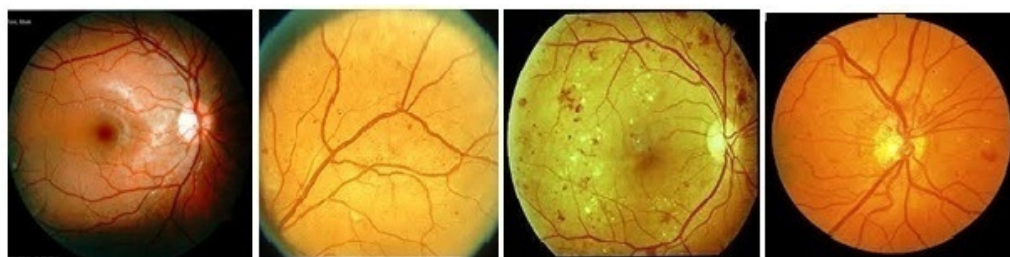
In medical analysis, the medical inputs patient's data is usually classified into two classes, that is the disease is found or not. The classification precision of diagnosis is assessed using sensitivity specificity measures. Sensitivity is the measure used to find percentage of correctly identified diabetic retina images from database and specificity pertains to percentage non-diabetic images detected from the database. These parameters are computed using equation (2) and (3) respectively.

$$\text{Sensitivity} = \frac{T_P}{T_P + F_N} \quad (2)$$

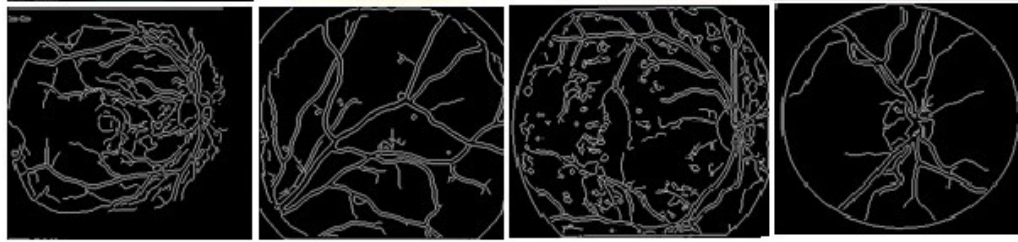
$$\text{Specificity} = \frac{T_N}{T_N + F_P} \quad (3)$$

Where  $T_P$  is number of abnormal images determined as abnormal,  $T_N$  is number of normal images found as normal,  $F_N$  is number of abnormal images found as normal and  $F_P$  is number of normal images found as abnormal.

Fig.2 (a) and (b) Shows some sample fundus retina images used for testing and their blood vessels extracted from corresponding input retina image. The test retina image which is to be classified as diabetic or non-diabetic is given as input and we get the blood vessels separated from other contents of retina image as shown in Fig.2. Further the areas of blood vessels are computed and based on computed values of blood vessel areas the retina images are classified as diabetic or non-diabetic. Total 89 Retina images are tested out of which 80 images are classified correctly and 9 images are classified incorrectly because of low quality input image.



(a) Input retina images used for testing



(b) Results of blood vessel extraction

Fig 2. Blood vessels extracted from input images

The Table 1 shows the results of classification of retina images of database DIARETDB1 in terms of sensitivity and specificity

Table 1. Classification results of retina images

Total Images in the database	Correctly classified Images	Incorrectly classified Images	% of sensitivity	% of specificity
89	80	9	90	90

## 5. CONCLUSION

The methods presented in the paper are based on morphological operations and tested for large number of images. The projected method for blood vessels detection based on mathematical morphological operation is simple and robust in representing the directional model of the retinal vessels surrounding the optic disk. The method developed here is simple and computationally efficient for retinal blood vessel segmentation, which gives good information about presence of diabetes and classification of retina images.

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