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RETINAL BLOOD VESSEL SEGMENTATION USING ROI DETECTION AND PCA CLASSIFICATION

B. SUJATHA and B. VANAJAKSHI

Department of CSE, GIET (A)
E-mail: birudusujatha@gmail.com
Department of CSE, SRk Engg. College
E-mail: vanaja2birudu@gmail.com

Abstract

Retinal blood vessel segmentation is an advanced technique being used for the detection of several eye diseases. This project proposes a strategy for the identification of diseases like diabetic retinopathy, glaucoma, mascular degeneration etc., through the discovery of exudates. Exudates is the lipoprotein that gets leaked out of the damaged blood vessels of a human eye. These exudates, damaged vessels are extremely difficult to be identified by visual inspection. An efficient image analysis program can be used to detect their presence effectively. In this project we have proposed one such method where the disease can be identified for its presence using the fundus image of an eye. The image is then pre-processed and it helps ophthalmologists in the detection of diabetic retinopathy disease using region of interest-based segmentation and a principal component analysis algorithm being implemented for the classification of disease.

I. Introduction

The fundamental idea of Image Processing is that most of the image processing algorithms leave some traces into the processed image, and hence the existence of these traces can be investigated in order to understand whether the image has undergone any kind of processing or not.

The proposed method comprises several basic image processing techniques namely noise removal, image illuminating, enhancement, region of interest-based segmentation and object classification. The method that has been proposed was tested on a set of retinal images. The algorithm based on the information of the blood vessels and the optic disks. It helps

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ophthalmologists for detection of diabetic retinopathy disease. In the retinal image, the abnormal features [1] are found to be crucial for classification. Using ophthalmoscopes, these features will be collected. The exudates [2] are used for the recognition of retinal fundus. Among several techniques, the thresholding methods are found to be prominent. Among all these methods, estimation of optic disk is a crucial stage. The Principal Components [3] are used for the identification segmentation. For this, the statistical approach will be followed by the existing methodologies. The components at lower order frequency are found to be prominent for describing the unique features.

II. Methodology

The methodology used for the detection of the abnormalities of the retinal image can be explained using different modules. Image acquisition and pre-processing are the primary methods followed to make the image noise free and better enhanced. In the later stages the segmentation is done using the Region of interest method for better identification of the exudates present in the retina and the segmented part is further classified for detection of anomalies in it. The segmentation technique being used is Region of interest where the part of the retina being affected can be identified uniquely. The equations being used for the segmentation of the image are as follows.

$$S(1) = \sum_{k} 1(X_k; Z) R_k(1),\ R_k(1) = \{\max\ [-\ \mathrm{Im} * F_k(1),\ ]\}^2 + \{\max\ [\mathrm{Im} * F_k(1),\ 0]\}^2 \tag{1}$$

$$\theta_k = \frac{S(l_k)}{\sum_{j=1}^{N} S(l_j)},\ z_k = (\theta_k,\ l_k,\ s_k)^T,\ k = 1, \ldots, N. \tag{2}$$

These features include mean intensity of the segmented area, blob intensity of the image, perimeter, orientation etc. The main goal of feature extraction is to extract a set of properties, which increases the recognition rate with the least number of elements and to generate similar feature set for different instances of the same symbol. The classification algorithm Principal Component Analysis will be implemented later for the identification of the anomalies. The equations that are used to derive the principal components are as follows.

(1) The matrix is as follows

$$X_{nXm} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \cdots & \cdots & \cdots & \\ x_{n1} & x_{n2} & & x_{nm} \end{bmatrix} = [x_1, x_2, \cdots, x_n]$$

(2) The mean feature vector is calculated as follows

$$\mu = \frac{1}{n} \sum_{i=1}^{\cdot\cdot} x_i (2)$$

(3) The deviation from average is calculated using the equation.

(4) The covariance matrix is calculated using the equation

In proposed system we are taking the original RGB fundus images as input, processing them for noise reduction, illumination and enhancement, then segmenting the image for the identification of the effected blood vessel using region of interest method. The region of interest method further consists of four different types region of growing, region of splitting, region of merging and region of split and merge out of which region of splitting is implemented. The method gives the area of image effected. An unsupervised machine learning algorithm i.e., Principal Component Analysis is used for classification of image and the result is obtained.

Region of interest method is used for the segmentation of the images. The region of interest further consists of region of growing, region of splitting, region of merging, region of split and merge.

- The region of an image segmentation should be similar with respect to some characteristic (e.g. grey level or texture).
- The interior region should be simple and without many holes.
- Corresponding regions of a segmentation should have different values with respect to the properties on which they are uniform.
- The edges of each segment should be simple and must be spatially accurate

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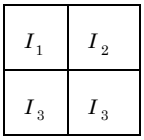
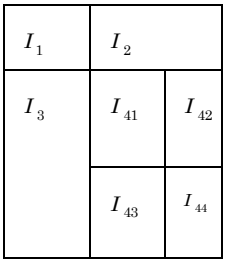
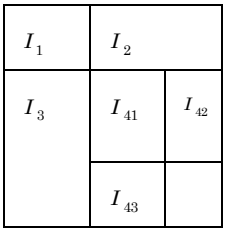
(a) Whole Image



(b) First Split



(c) Second Split



(d) Merge

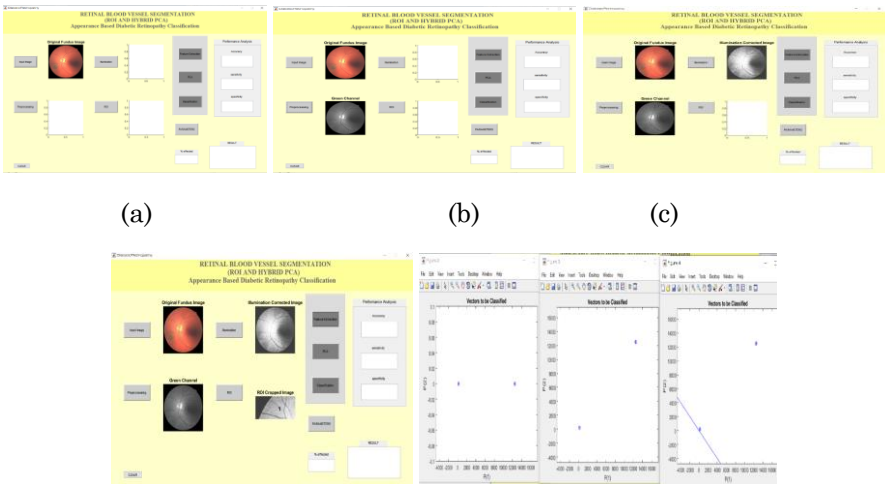
Figure 1. Region of Interest representation.

The steps used for the identification of the principal components are as follows:

- The mean feature vector is computed.
- The co-variance matrix is generated.
- Eigen vectors and eigen values of the co-variance matrix are computed.
- The high value eigen vectors are estimated.
- The principal components/low dimensional feature vectors are extracted.

III. Results and Discussions

The Figure 2(a) shows the image acquisition module in which the image that need to be tested are extracted from the folder on click of the input image button. The pre-processing module is shown in Figure 2(b). The Image illumination module is shown in Figure 2(c) and segmentation module is shown in Figure 2(d). The Principal Component analysis (PCA) result is shown in Figure 2(e).

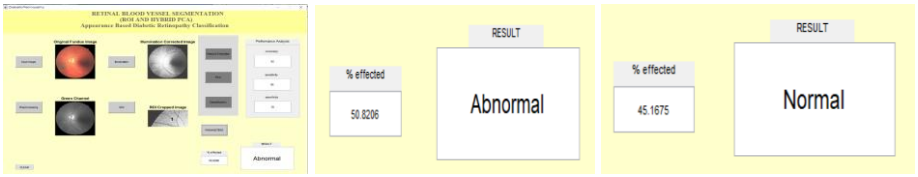


(a) (b) (c)

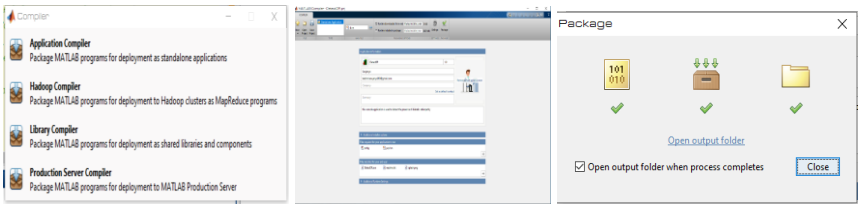
(d) (e)

Figure 2. Result of (a) Acquisition module (b) Pre-processing module (c) Illumination module (d Segmentation module (e) PCA.

The resultant image is shown in Figure 3(a). The result of abnormal eye is shown in Figure 3(b) and the result of normal eye is shown in Figure 3(c). The deploying applications are shown in Figure 3(d) and 3(e). The packaging application is shown in Figure 3(f).



(a) (b) (c)



(d) (e) (f)

Figure 3. Result of (a) Result of ROI (b) Result of Abnormal Eye (c) Result of Normal Eye (d) Deploying Application-I (e) Deploying Application – II (f) Packaging Application.

All the above figures depict the results how a fundus image can be analysed through various algorithms and diagnosed whether normal or abnormal and packaging as a console application which could be sharable.

Conclusions

The Principal Component Analysis Algorithm is employed to detect the actual diabetic retinopathy the classification was performed using the principal component analysis which identifies the disease with more accuracy compared to many other techniques. The result demonstrates that the proposed algorithm can be used for detection of diabetic retinopathy and Vessel diameter measurement in their day to day use. Also, it is verified that the performance of the proposed method is better than the existing method.

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