RETINAL IMAGE SEGMENTATION ANALYSIS TO DETECT GLAUCOMA AND EXUDATE USING SVM CLASSIFIER

Subhasree.D[1] | Suganthi.B[2] | Kannan.R[3]

[1](PG Scholar, Dept of ECE, RVS College of Engg And Technology, Coimbatore, India, subhasree01.ece@gmail.com)
[2](Associate Professor, Dept of ECE, RVS College of Engg and Technology, Coimbatore, India, suganth.b@gmail.com)
[3](Assistant Professor, Dept of ECE, RVS College of Engg and Technology, Coimbatore, India, kannanvlsi@gmail.com)

Abstract— *In this paper the diabetic retinopathy is analysed from an image using exudate and glaucoma secretion in the retina. An Edge analyzing from the scanned image to change the value in the image intensity usually associated with a discontinuity in either the image intensity. Edge detection is a problem of fundamental importance in object extraction as it reduces image data and detects the object which is required. Edges identify object boundaries and are detected through changes in grey level above a particular threshold. A Diabetic retinopathy is a very recent method of finding the level of acid secretion in the eye while the persons are having diabetics in their body. The edge detection is mainly applicable in case of data transmission; in that case the detected edge data reduce the amount of data to be transmitted. The experimental results show that our method achieves 91% in sensitivity and 92% in positive prediction value (PPV), which both outperforms the state of the art methods significantly.*

Keywords— Retinopathy; Diabetics; Android; SVM Classifier; Digital Image Processing

1. INTRODUCTION

In the early stages of Diabetic Retinopathy (DR) there are no symptoms and hence it is not possible to detect the disease without examination. Exudates are one of the main signs for the presence of DR, which occurs due to leakage of fats and proteins as yellow masses in various sizes. If the exudates are not diagnosed earlier, it may lead to complete blindness by the accumulation of exudates in the fundus oculi. Frequent screening procedure is necessary to detect early condition of DR. A major limitation faced by the clinicians is screening a large number of images, which is very expensive and also open to human error. In order to solve this problem a Computer Aided Diagnosis (CAD) is necessary to identify the stages of DR. The aim of this work is to develop CAD system to differentiate the abnormal images from the normal fundus images and also grade the abnormal images as mild moderate and severe.

2. METHODOLOGY

In order to monitor the affected level of DR condition a grading classification algorithm is necessary. A set of standard graded fundus images are collected from ophthalmologist which are graded according to the level of retinopathy condition. It spans into four classes no DR condition or normal, mild DR, moderate DR and severe DR. The ability to detect abnormalities in fundus images due to DR leads to the formulation of a system which can generate diagnosis without human interventions. The automatic screening system is trained to classify the fundus images similar to the classified image as that of ophthalmologist. In a real time environment there are many aspects which affects the grading of the image and results in error output. For this reason a pre-processing step is performed for correct diagnosis. The pre-processing step comprises of green channel extraction, image enhancement by adjusting the contrast value, vessel central light reflex removal, background homogenization and vessel enhancement for vessel segmentation. The second step is to apply entropy filter followed by removal of the optic disc and blood vessels in order to segment exudate. The texture features of Grey Level Co-occurrence Matrix (GLCM) are extracted from the segmented image. The classifiers like Support Vector Machine (SVM), multilayer network Scaled Conjugate Gradient – Back Propagation Network (SCG-BPN) and Generalized Regression Network (GRN), Probabilistic Neural Network (PNN), Radial Basis Network (RBF) are tested. It is found that SVM classifier is more accurate and exhibit high performance. The classifier classifies the fundus images as normal, mild, moderate and severe. The images and the severity of DR are transferred to the physician by mail which can be viewed in his mobile phone.

A. Automatic Screening System – A Review

In the past, various exudate segmentation methods have been proposed. Alireza Osareh et al [8] proposed a computational intelligence based approach for detection of exudates in DR images. The pre-processing steps involved in this approach are color normalization and contrast enhancement. The pre-processed images are segmented using Fuzzy C Means clustering. A set of initial features that are extracted to classify the segmented regions into exudates and non-exudates are color, size, edge strength and texture. Genetic based algorithm is used to rank and identify a subset of features for better classification results. A multilayer neural network classifier is used for classification. The images were collected from Bristol Eye hospital for testing the algorithm. Doaa Youssef et al [9] proposed a fast and accurate method for early detection of exudates in fundus photographs. For noise reduction median filter is used and the contrast enhancement is done using top hat transform. The optic disc is extracted using Hough transform. Since this method is based on contour detection, snakes algorithm is used. The blood vessel is detected using morphological operations. The blood vessels and optic disc are eliminated from the edge detected image, to obtain an initial estimate of the exudates. Morphological reconstruction algorithm is used to get the final estimate of exudates. The images were collected from the NILES, Cairo University, Egypt and from STARE database.

After contrast enhancement, the binary image is obtained by thresholding and the morphological operations are used to remove the blood vessels and optic disc. Watershed transform is applied to convert the image to RGB. Zhang proposed [20] a robust exudate segmentation method from color retinal images for mass screening of DR.

This method comprises of pre-processing, exudate candidate detection, classification and individual risk evaluation. Pre-processing is done to remove bright structures including reflections, and bright regions along the borders of field of view. The candidates are extracted using a novel two scale exudate candidate's segmentation method. Large exudate candidates are obtained from the pre-processed image using a mean filter followed by a reconstruction. Small exudate candidates are directly computed from the green channel of the original image by means of morphological top-hat transform. The features are extracted from the candidates and random forest method is used to perform classification.

1) Proposed Method for Classification of DR

In the proposed method, pre-processing step enhances the quality of the image. Further to improve the contrast between exudate and non-exudate regions, shade correction is performed. The second stage involves segmentation of exudates from the green channel image after removal of blood vessels and optic disc. The GLCM features are extracted from the segmented region. Using the extracted feature five classifiers SVM, SCG-BPN, GRN, PNN, and RBF are trained and tested for obtaining the best classifier.

B. Image Pre-Processing

The green band is largely used for identification of exudates, since it gives more information than red and blue bands. The green channel image is filtered by applying a morphological opening as structuring element in order to remove vessel central light reflex, since it may contribute to false detection of exudates. Background homogenization is done using arithmetic mean kernel which smoothens the intensity values uniformly.

C. Exudate & Glaucoma Detection

The exudates are segmented by removing blood vessels and optic disc from the green channel image extracted from the fundus image. The steps for exudate detection are as follows. 1) Step 1: Blood vessel segmentation

Blood vessels are prone to cause bright lesion like appearance during the segmentation of exudates. Hence it is removed in order to reduce false positive and to improve the accuracy of exudate segmentation. Fuzzy C-Means (FCM) clustering algorithm is used to segment the blood vessel since it can retain more information of the dataset.

2) Step 2: Optical disc segmentation

The segmentation of optic disc is crucial since it is circular in shape with high contrast and is similar to exudates. The optic disc is removed using a circular mask.

3) Step 3: Exudate & Glaucoma segmentation

An entropy filtering is performed on the pre-processed image clearly segments blood vessels, optic disc and exudates. For detecting the exudates, the blood vessels segmented in step 1 and the optic disc obtained in step 2 are subtracted from the filtered image.

3. FEATURE EXTRACTION

The extraction of features is essential in order to extract the desired information and discard the undesired information. The textural feature utilizes the contents of the GLCM to provide the measure of variation in intensity at the pixel of interest. The features are extracted by pairwise spatial co-occurrences of pixels separated by some angle and distance which are tabulated using the GLCM. The GLCM consist of an NxN matrix, where N is the number of grey levels in the image. The Four GLCM features that are selected as the feature set are correlation, cluster shade, dissimilarity and entropy.

Cluster shade [17] is a measure of the skewness of the matrix or lack of symmetry. When the value of cluster shade is higher, the image is not symmetric with respect to the texture value.

Dissimilarity [18] is a measure that defines the variation of grey level pairs in an image. It is computed as in (4)

$$\text{Dissimilarity} = \sum_{i,j} |i - j| p(i, j) \qquad (4)$$

It is expected that these two measures behave in the same way for the same texture because they calculate the same parameter with different weights. Contrast will always be slightly higher than the dissimilarity value. Dissimilarity ranges from [0, 1] and obtain maximum when the grey level of the reference and neighbour pixel is at the extremes of the possible grey levels in the texture sample.

Entropy [19] shows the amount of information of the image that is needed for the image compression. Entropy measures the loss of information in a transmitted image as in equation (5).

$$\text{Entropy} = -\sum_{i,j} p(i, j) * \log(p(i, j)) \quad (5)$$

A completely random distribution would have very high entropy because it represents disorder. Solid tone image would have an entropy value of 0.

4. CLASSIFICATION

Classification helps to identify the classes with similar features. GLCM features such as correlation, cluster shade, dissimilarity, and entropy are extracted. Based on the features the classifier classifies the images as normal, mild, moderate and severe. The classifier is selected by testing different classifier performances. The classifiers Support Vector Machine (SVM), multilayer network Scaled Conjugate Gradient – Back Propagation Network (SCG-BPN) and Generalized Regression Network (GRN), Probabilistic Neural Network (PNN), Radial Basis Network (RBF) are tested and found SVM classifier is more accurate and have high performance.

A. Support Vector Machine

SVMs are efficient learning approaches for training classifiers based on several functions like polynomial functions, radial basis functions, neural networks etc. SVM is a linear classifier that maps the points into the space with separate categories such that they have wider space with a clear gap in between. A hyper-plane is chosen to classify the data [19]. The separating hyper-plane must satisfy the constraints.

$$y_i[(w.\ x_i) + b] \geq 1 - \xi_i,\ \xi_i \geq 0 \quad (6)$$

Where

w = the weight vector b = the bias

ξ_i=The slack variable

The SVM requires the parameters such as the kernel function and the regularization parameter C. In this work Radial Basis Function (RBF) kernel function is used.

B. Generalized Regression Network

It is a radial basis function that is often used functional approximation. The use of this network is especially due to its ability to the underlying function of the data with only few training data available. The probability density function used in GRN is the normal distribution. Each training sample Xj, is used as the mean of a normal distribution. The distance Di between the training sample and the point prediction is used as a measure of each training sample.

5. RESULT

In this paper we found the result with unit value of the severity ratio and the level of severity for the patient's treatment for exudate and glaucoma secretion to stop developing further.

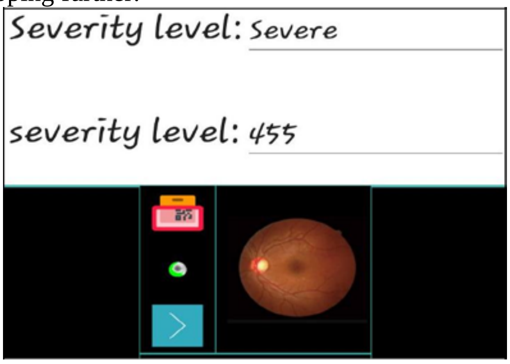

Fig. 1: Result

6. CONCLUSION

Early detection of DR can be effective in preventing blindness. The proposed approach is designed for the detection of exudates and glaucoma to diagnose DR. The entropy based segmentation method segments the exudates precisely and clearly. The SVM classifier gives better accuracy and performance compared to SCG-BPN, GRN, PNN, and RBF. This automated system can filter out the exudate images and thereby reduces the burden on ophthalmologist in classifying the exudate images manually. It further classifies the given input image as normal, mild DR, moderate DR and severe DR. This provides the patients to get treated according to their severity level. The results are also sent to the physician's e-mail which can be viewed by him in his desktop or mobile phone. This work mainly reduces the time consumption needed for the diagnosis of mass screening processes.

REFERENCES

[1] Mariotti S. and Pascolini D: Visual Impairment, Vision Loss and Blindness 2010 global estimates, and VI and blindness causes. Global Data on Visual Impairments 2010, WHO (2010)
[2] Kande G. B., Subbaiah P. V., Savithri T. S.: Feature extraction in digital fundus images. In: Journal of Medical and Biological Engineering, vol. 29, No. 3, (2009).
[3] Jonas, J., Schneider, U., and Naumann, G. (1992). Count and density of human retinal photoreceptors. Graefe's Arch Clin Exp Ophthalmol, pages 230:505–510.
[4] Abramoff, M. D., Garvin, M. K., and Sonka, M. (2010a). Retinal imaging and image analysis. IEEE Reviews in Biomedical Engineering, 3:169–208.
[5] Walsh, A. C., Wildey, R., Lara, C., Ouyang, Y., and Sadda, S. R. (2010). Detection of fundus abnormalities using 3d-oct versus mydriatic color fundus imaging. In ARVO 2010.
[6] Niemeijer, M., Garvin, M., van Ginneken, B., Sonka, M., and Abramoff, M. (2008). Vessel segmentation in 3d spectral oct scans of the retina. In Proceedings of SPIE, volume 6914.
[7] P. Massin, A. Erginay, A. Gaudric, and E. scientifiques et médicales Elsevier. Rétinopathie diabétique. Ed. scientifiques et médicales Elsevier, 2000.
[8] Alireza Osareh, Bita Shadgar, and Richard Markham: A Computational Intelligence Based Approach for Detection of Exudates in Diabetic Retinopathy Images. IEEE Transactions on Information Technology in Biomedicine, Vol. 13, no. 4, pp. 535-545, (2009).
[9] Doaa Youssef, Nahed Solouma, Amr El-dib, Mai Mabrouk, and Abo-Bakr Youssef : New Feature-Based Detection of Blood Vessels and Exudates in Color Fundus Images . Image Processing Theory Tools and Applications (IPTA), 2010 2nd International Conference on 7-10, pp. 294 – 299, (July 2010).
[10] M Kowsigan, P Balasubramanie, An Improved Job Scheduling in Cloud Environment using Auto-Associative Memory Network, Vol 6, No 12, pp. 390-410, 2016.
[11] M Kowsigan, P Balasubramanie, Scheduling of Jobs In Cloud Environment Using Soft Computing Techniques, Vol 10, No 38, pp. 28640-38645, 2015.
[12] J.Rajeshkumar M.Kowsigan, Efficient Scheduling In Computational Grid with an Improved Ant Colony Algorithm, Vol 2, No 4, pp 317-321, 2011.
[13] M Kowsigan, S Kalicharan, P Karthik, A Manikandan, R Manikandan, An Enhanced Job Scheduling In Cloud Environment Using Probability Distribution, International Journal of Engineering and Technology, Vol 9, No 2, pp 1374-1381, 2017.
[14] M Kowsigan, A Christy Jebamalar, S Shobika, R Roshini, A Saravanan, Heart Disease Prediction By Analysing Various Parameters Using Fuzzy Logic, Vol 14, No 2, 159-163. 2017.
[15] A Jameer Basha, V Palanisamy, T Purusothaman, Fast multimodal biometric approach using dynamic fingerprint authentication and enhanced iris features, IEEE International Conference on Computational Intelligence and Computing Research, 2010.

[16] R Kanmani, A Jameer Basha, Performance Analysis of Wireless OCDMA Systems Using OOC, PC and EPC Codes, Asian Journal of Information Technology, Vol 15, No 12, pp. 2087-2093, 2016.

[17] Geetha K Rajesh kumar T, A Perspective Approach on Artificial Cognitive Computing and its Future Development, International Journal of Innovative Research in Computer and Communication Engineering, Vol 4, No 11, 2016.

[18] Rajesh kumar,T., Geetha,K., "An Artificial Technique Based Approach for Channel Selection and Classification of Electroencephalogram Signals", International Journal of Printing, Packaging & Allied Sciences, Vol. 5, No. 1, 2017.

[19] Rajesh kumar,T., Geetha,K., Satheesh,R.,Barkath Nisha,S., "MRI Brain Image Segmentation using Fuzzy C Means Cluster Algorithm for Tumor Area Measurement", International Journal of Engineering Technology Science and Research, Vol 4, No 9, 2017.

[20] Zhang.X, Thibault. G, Decenciere. E, Marcotegui. B, Lay.B, Danno. R, Cazuguel. G, Quellec. G, Lamard.M, Massin.P, Chabouis. A, Victor.Z and Ergina. A: Exudate Detection in color Retinal Images for Mass Screening of Diabetic Retinopathy. Medical Image Analysis Volume 18, Issue 7, pp. 1026-1043, (Oct 2014).