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An Improved Approach for the Classification of Exudates from Fundus Image

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Abstract— **Diabetes is a condition of increase in the blood sugar level higher than the normal range. Prolong case of diabetes damages the small blood vessels which are present in the retina resulting in diabetic retinopathy (DR). DR progresses with time without any noticeable symptoms until the vision loss has occurred. Patients with diabetes are more likely to develop eye problems such as cataracts and glaucoma, but the disease affecting the retina is the main threat to vision. DR can be treated if it is diagnosed early. The fundus image of healthy and defective eyes with lesions is obtained from the Diaretdb1 database which is initially preprocessed followed by feature extraction and morphological segmentation. It is followed by the detection and classification of exudates using BPN neural network. MATLAB is used as a simulation tool in this work.**

Index Terms— **Diabetic retinopathy, Exudates, Image enhancement, Neural Network classifier, Segmentation.**

I. Introduction

DR is a complication of diabetes that can lead to impairment of vision and even blindness. It is the most common cause of blindness in the working-age population. [1] According to WHO report in 2016, the number of people having diabetes has nearly doubled since 1980, rising from 4.7% to 8.5%. Ophthalmic imaging modalities are increasingly important in screening, diagnosis, and monitoring of Diabetic Retinopathy. Retinal photography serves as a useful screening method for diabetic retinopathy, especially when access to ophthalmologists is difficult [2]. Diabetes of all types can lead to complications in many parts of the body and can increase the overall risk of dying prematurely. Possible complications include heart attack, stroke, kidney failure, leg amputation, vision loss and nerve damage. In pregnancy, poorly controlled diabetes increases the risk of fetal death and other complications, but the disease affecting the retina is the main threat to vision. DR can be managed using available treatments, which are effective if diagnosed early.

There are two types of diabetic retinopathy: Non-proliferative Diabetic Retinopathy (NPDR) and Proliferative Diabetic retinopathy (PDR). NPDR is the most primitive stage of Diabetic Retinopathy. During this condition, a small amount of blood and other extra fluid leak into the eye due to damaged blood vessels in the retina. Due to closing of the blood vessels in the retina, PDR occurs inhibiting enough blood flow. In an attempt to supply blood to the area where the original vessels are closed, the retina responds by growing new blood vessels [3][4].

The paper is structured as follows. Pre processing technique is discussed in Section II. Section III is about the classification method used to extract the lesion. Different types of classifications are dealt in Section IV. The simulation results and discussions are enumerated in Section V and the paper ends with a conclusion in Section VI.

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II PRE PROCESSING

The image obtained from the database undergoes various preprocessing steps. The aim of preprocessing is an improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing. The original colour image is resized to 512*512 gray scale image. Fig 1 shows the flowchart of the proposed model.

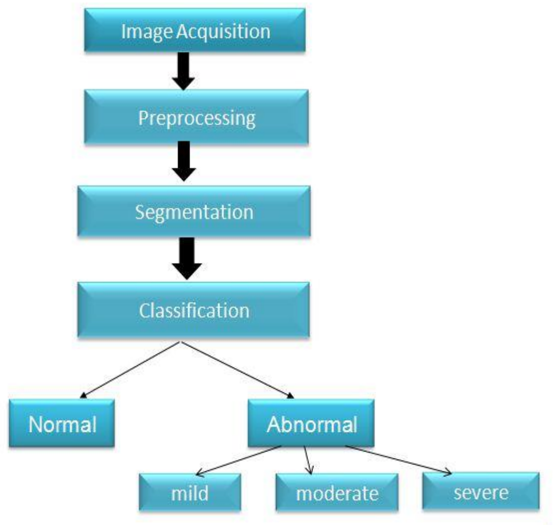

Fig.1 Flow chart of the model

In order to prepare the fundus images for lesion extraction, Green-plane images of the original RGB color image was taken. Lesions have the highest contrast with the background in the green color plane than the red and blue color planes [5]. Pre-processing will remove the errors incurred during the acquisition of the image as well as it reduces the effect of brightness. Bilateral filter is an edge-preserving and noise-reducing, smoothing filter. The intensity value at each pixel in an image is replaced by a weighted average of intensity values from nearby pixels. Bilateral filtering is effective when used particularly on medical images which are corrupted by additive white Gaussian noise with different values of variances.

Enhancement of the region affected by micro aneurysms and exudates is done by Adaptive Histogram Equalization (AHE). AHE technique is used to improve the contrast in the images and it is used to redistribute the lightness values of the image. This improves the local contrast and enhances the edges in each region of an image, so that the blood vessels and lesions are clearly seen from the background images. Fig.2 shows the input fundus image which is preprocessed and Fig.3 is the image that is obtained after applying Adaptive Histogram Equalization.

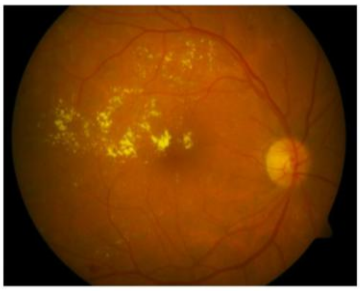

Fig. 2 Original image

Fig.3 Adaptive Histogram Equalized Image

Optic Disc (OD) segmentation: The removal of the OD is necessary because both micro aneurysms and optic disc appear as brighter regions in the fundus image. For the elimination of the optic disc, Cup-to-Disc ratio (CDR) is calculated. If it is more than 0.3, [6] it corresponds to optic disc. Removing the optic disc is important in order that it is not misinterpreted as exudates. Otherwise, it will result in false prediction.

II. SEGMENTATION

The segmentation process is to simplify the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate the objects and boundaries in the images. Precisely processing of assigning a label to every pixel in an image is carried out such that pixels with the same label which share certain characteristics are grouped together [7]. Morphological process is used since it follows the goal of eliminating all defects and maintaining structure of image. Morphological operations focus more on binary images, but these techniques can also be applied to grayscale images [8]. Morphological techniques verify the image with a small template called structuring element. The structuring element size used in this work is 4, as discussed in literature [9].

This structuring element is applied to all possible locations of the input image and generates the same size output. In this technique, the output image pixel values are based on similar pixels of input image with the neighbors. There are various structuring elements like diamond shaped, square shaped, cross shaped etc. In this method, circular shape is used, since microaneurysms and exudates are circular in shape. Exudates are nothing but accumulations of lipid and protein in the retina. Typically, they are bright, reflective, white or cream-colored lesions seen on the retina [10].

In the proposed method, morphological closing and opening technique is used. Closing of an image is done which consists of dilation followed by erosion with the same structuring element. It is then followed by opening of an image in which erosion is followed by dilation, using the same structuring element. The close operations are further done on the image obtained from the previous step so that the removal of the blood vessels becomes complete. It is performed in order to get the actual size of the hemorrhages. Fig.4 is the obtained image after segmentation process which detects the lesion. Erosion causes the objects to shrink or become thin in size. It erodes away the boundaries of the foreground which results in areas of those pixels shrink in size and holes of those areas become larger [11] Dilation causes the objects to grow in size. It causes a gradual increase in the boundaries of foreground pixels. The structuring element determines how much the image is to be dilated. The diameter size of OD is 0.3 cup to disk ratio (CDR) as found from the literature [12]. If the diameter size is less than the CDR, it is considered as lesions and is extracted from the image. Fig.4 shows the final output of the image after close and open process. Fig.5 shows the removal of optic disk to avoid false prediction.

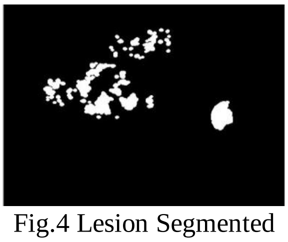

Fig.4 Lesion Segmented

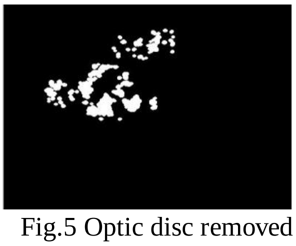

Fig.5 Optic disc removed

IV. CLASSIFICATION

There are many different types of classifiers which are used for finding the stages of diabetics. SVM classifier is used for the detection of exudates and micro aneurysm. Image extraction of exudates is done by counting the number of pixels, which are used for classifying their stages of growth [13]. Random Forest (RF) classifier is also used to perform the classification of the exudates. This method yields good results in general applications. When it is used for medical images after a certain threshold, increasing the number of the trees will not bring any improvement, but can reduce the variance of the result [14]. To overcome this entire problem, in the proposed method, Artificial Neural Network(ANN) with feed forward network and Back Propagation algorithm is used for the classification of fundus image that were obtained from the DIARETDB1 database [15]. Which contains both healthy and unhealthy images.Thus, the segmented images were give as an input to the BPN to classify the exudates present in the image. MATLAB version 14.a is used as a simulation tool in the work. In this work, the number of hidden layers used is 5. Size, shape and intensity are used as input parameters. The ANN can learn arbitrary boundary while random forest or decision tree can only detect boundary like rectangle. RF can do only simple selections, while ANN can perform more complicated selections by proper training. It takes more time that the RF classifier, but once trained, they can give accurate results than other classifiers.

V. RESULTS AND DISCUSSIONS

The images for this work are taken from DIARETDB1, a publicly available database. It contains both healthy and unhealthy images. Pre-processing of the images is followed by segmentation and classification of lesions.

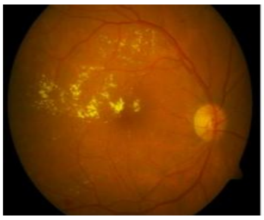

Fig.6 mild exudates

Performance of the classifier can be measured in terms of sensitivity, specificity and accuracy. The parameters used are True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN). These parameters are calculated by comparing the classifier outcome with the number of normal and abnormal images from the database.

Sensitivity = TP/(TP+TN)

Specificity = TN/(TN+FP)

The comparison between the existing method and the proposed method is depicted in Table.1 the same 50 images are used for comparison.

Table.1

Performance metrics	Existing method	Proposed method
Accuracy	89%	90%
Sensitivity	93.9%	89.9%
Specificity	50%	60%

VI CONCLUSION & FUTURE SCOPE

The proposed work is found to outperform the existing method. Genetic algorithm can be used with ANN to improve the accuracy of detection and classification of exudates.

REFERENCES

[1] Gabor Mark Somfai,Erika Tátrai"Automated classifiers for early detection and diagnosis of retinopathy in diabetic eyes," BMC Bioinformatics 2014, pp. 1-10, 2014.

[2] N. Cheung, P. Mitchell, and T. Y. Wong, "Diabetic retinopathy," Lancet, vol. 376, no. 9735, pp. 124–36, June 2010.

[3] Raju Sahebrao Maher, Dnyaneshwar S. Panchal, , Dr. Mukta Dhopeshwarkar," Automatic Identification of Various Stages of Diabetic Retinopathy Using Retinal Fundus Images" International Journal of Advanced Research in Computer Science and Software Engineering, Vol.5, Issue 9, September 2015.

[4] C. Sinthanayothin, J. F. Boyce, T. H. Williamson, H. L. Cook, E. Mensah, S. Lal and D. Usher,"Automated detection of diabetic retinopathy on digital fundus images," diabet.med pp.105-112 Feb 2002.

[5] MeindertNiemeijer, Bram van Ginneken"Retinopathy Online Challenge: Automatic Detection of Microaneurysms in Digital Colour Fundus Photographs," IEEE transactions on medical imaging, Vol. 29, no. 1, pp.185-195, January 2010.

[6] https://en.wikipedia.org/wiki/Cup-to-disc_ratio.

[7] M. Sridevi Maheswari, Adarsh Punnolil, "A Novel Approach for Retinal Lesion Detection In Diabetic Retinopathy Images," International Journal of Innovative Research in Science, Engineering and Technology, Vol. 3, Issue 3,pp.1109-1114 March 2014.

[8] Eswaran, C., Reza, A., Hati, S., "Extraction of the contours of optic disc and exudates based on marker-controlled watershed segmentation". International Conference on Computer Science and Information Technology, ICCSIT'08.IEEE, pp. 719–723.

[9] http://www.inviewmedical.pl/wp-content/uploads/2015/08/2014.07-Acta-Ophth-Bek-AO-in-diabetic-retinopathy.pdf

[10] Raju Maher, Sangramsing Kayte, Suvarnsing Bhable , Jaypalsing Kayte, "Automated Detection of Microaneurysm, Hard Exudates, and Cotton Wool Spots in Retinal fundus Images" IOSR Journal of Computer Engineering (IOSR-JCE) Vol.17, Issue 6, pp. Dec. 2015

[11] V.Saravanan, B.Venkatalakshmi,Vithiya Rajendran. "Automated Red Lesion Detection in Diabetic Retinopathy" Proceedings of 2013 IEEE Conference on Information and Communication Technologies. PP 236-239, June2013.

[12] PratapVikhe,Ms.Preeti Mistry "Automatic Detection of Diabetic Retinopathy Level Using SVM Technique,"International Journal of Innovation and Scientific Research,Vol. 11 pp. 171-180,Oct. 2014.

[13] X.Zhang, Guillaunethibauit, "Exudate detection in colour retinal images for mass screening of diabetic retinopathy," Medical Image Analysis, vol. 18, no. 7, pp. 1026–1043, May 2014.

[14] T Chandrakumar, R Kathirvel, "Classifying Diabetic Retinopathy using Deep Learning Architecture," International Journal of Engineering Research & Technology (IJERT) Vol. 5 Issue 06, pp. 19-24 June-2016.

[15] http://www.it.lut.fi/project/imageret/diaretdb1/

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