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Detection of Exudates and Classification of Retina Images using Random Forest Classifier

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Abstract— ***A disorder named Diabetic Retinopathy (DR) causes alterations in structure of the blood vessels in the retina due to raised glucose level in blood. This is a reason of blindness and vision defects in diabetic patient. Retinal image study is very significant as a non-intrusive diagnosis technique in modern ophthalmology. The existence of exudates within the macular region is a most important warning sign of diabetic retinopathy (DR) disorder. This permits detection of DR with a high sensitivity. Hence, detection of exudates is a key task, in which image processing methods play a major role.***

Here a system to examine the fundus images for the detection of hard exudates by using wavelet transform and random forest classifier is proposed. This is going to use image analysis technique for the automatic recognition of retinal components and pathologies like exudates from the parameters like vessel ratio, ratio of exudates area to the total area(cup to disc ratio) of the images are distributed into different groups normal, abnormal.

Exudates are spotted by using their high grey level deviation. Also, their contours are resolved by using morphological reconstruction techniques. Also, the detection of the optic disc is likewise important for this approach. Detection of optic disc is done with the help of morphological filtering techniques. We have aim to obtain a accuracy greater than 92.8%.

Index Terms— **Image processing, diabetic retinopathy (DR), exudates, morphological reconstruction techniques, optic disc.**

I. INTRODUCTION

Diabetic Retinopathy is a retinal disorder that is related with diabetes. It has been identified as a major and common reason of blindness among adults or age group of working people. Diabetic Retinopathy (DR) is a disorder which leads to variations of the capillaries, blood vessels in the retina due to elevated glucose level in blood, and then blindness and vision defects arise. Hard exudates are related with diabetic retinopathy and also are one of the most familiar clinical indications of retinopathy. The key to anticipation for vision loss due to DR is early detection and treatment of diabetic retinopathy.

Presence of hard exudates is a signal of diabetic retinopathy. For early detection of exudates image processing methods are used which gives location, size or level of abnormal parameters. Automated methods of detecting exudates in digital retinal images are derived from such image processing techniques which would be exceptionally useful for society. The screening of diabetic patients can potentially decrease the hazard of blindness in these patients by 50%. An early detection enables laser PRP treatment, vitrectomy and laser photoagulation for different severity levels for anticipation or delay visual loss which may be used for hopeful improvement in diabetic control. Current methods used in detection and estimation of diabetic retinopathy are manual, expensive, time consuming and necessitate trained ophthalmologists. Here the method for automatic detection of exudates in order to detect and suggest the treatment for the diabetic retinopathy at an early phase is presented.

Automatic detection of DR is a three step process 1.image preprocessing, 2.feature extraction, 3.severity classification. In all international journals these steps are used. In some international journals techniques analyzed are using colour normalization, local contrast enhancement, image enhancement using Wavelet Transform, morphological reconstruction methods in pre processing step. The colour retinal images are segmented using, Recursive Region Growing Segmentation (RRGS) algorithm, Fuzzy C-Means (FCM) clustering, K means clustering. Then the segmented regions are sorted into two disjoint classes i.e. exudates and non-exudates, by using neural network. Different classifiers used for this purpose are Bayesian statistical classifier to classify each pixel into lesion or non-lesion classes, detection of exudates using grey level variation, an image classifier based on Support Vector Machine (SVM), Random Forest

Classifier. The feature or parameter set used for working out the neural network contains size, colour, average intensity, edge sharpness and standard deviation of intensity.

Normal structural components of retina are blood vessels, optic disc and macula and the characteristic features showing diabetic retinopathy are hemorrhages, microaneurysms and exudates.

A system to examine the fundus images for the detection of hard exudates using wavelet transform and random forest classifier is proposed here. This is going to use image analysis method for the automatic recognition of retinal elements and pathologies like exudates from the parameters like ratio of optic disc area to the total area(cup to disc ratio), vessel ratio of the images are sorted into two disjoint groups normal, abnormal.

II. LITRATURE REVIEW

In 2002, Walter et al. "A Contribution of Image Processing to the Diagnosis of Diabetic Retinopathy- Detection of Exudates in Colour Fundus Images of the Human Retina", IEEE Transactions on Medical Imaging, vol. 21 [1] proposed new algorithm for detection of exudates. Exudates are found using grey level variation and means of morphological reconstruction techniques.

In 2014, T.Akila et al. "Detection and Classification of Hard Exudates in Human Retinal Fundus Images Using Clustering and Random Forest Methods", International Journal of Emerging Technology and Advanced Engineering [2] used K-means and fuzzy C-means clustering. In this classification is done by using random forest method.

In 2008, Akara Sopharak et al. "Automatic Detection of Diabetic Retinopathy Exudates from Non-dialated Retinal images using Mathematical Morphology Methods", Computerized Medical Imaging and Graphics, pp720-727, August 2008 [3] used wavelet transform, morphological operations for feature extraction and segmentation.

In 2002, C. Sinthanayothin et al, "Automated Detection of Diabetic Retinopathy on Digital Fundus Image", International Journal of Diabetic Medicine, vol. 19 [5] reported the result of an automated detection of diabetic retinopathy on digital fundus image. In this Recursive Region Growing Segmentation (RRGS) algorithm is used for the exudates detection.

In 2000, H. Wang et al. "An Effective Approach to Detect Lesions in Color Retinal Images", Proc. IEEE Conf. on Computer Vision and Pattern Recognition, vol. 2 [6] used colour features on Bayesian statistical classifier. Bayesian classifier classifies each pixel into lesion or non-lesion classes.

In 2011, Hussain F. Jafar et al. "Automated Detection and Grading of Hard Exudates From Retinal Fundus Image ", 19th European Signal Processing Conference [10] used image preprocessing techniques median filtering & gaussian filtering for smoothing and contrast limited adaptive histogram equalization(CLAHE) for contrast enhancement. Fovera localization is carried out by using geometrical relationship of optic disc and blood vessels. Detection of exudates is done by Adaptive thresholding and classified using rule based classifier based on features. Lastly, grading of HE is done.

In 2003, A. Osareh et al, "Automated Identification of Diabetic Retinal Exudates in Digital Colour Images", British Journal of Ophthalmology, vol. 87 [4], 2005, A. Osareh et al, "Automatic recognition of exudative maculopathy using fuzzy c-means clustering and neural networks", Proc. Medical Image Understanding Analysis [7], 2002, A. Osareh et al. "Comparative Exudate Classification using Support Vector Machines and Neural Networks", Proc. 5th International Conf. on Medical Image Computing and Computer-Assisted Intervention [8] used colour normalization, local contrast enhancement in preprocessing step. The segmentation of colour retinal images is done by using Fuzzy C-Means(FCM) clustering and segmented regions are distinguished as exudates and non exudates.

In 2007, Akara Sopharak et al. "Automated Exudate Detection from Diabetic Retinopathy Retinal Image using Fuzzy C-means and Morphological Methods", International Conference of Advances in Computer Science and Technology [12] used segmentation for exudates detection, coarse segmentation using FCM and fine segmentation using morphological reconstruction.

In 2012, Anil Kumar Neelapala et al. "Analyzing Severity of the Diabetic Retinopathy and it's Preventive Measures by maintaining Database in using Gui in MATLAB " International Jouranal of Recent Technology and Engineering [11] described 5 steps- Preprocessing with contrast enhancement and denoising, segmentation of preprocessed image, feature extraction using morphological operation, severity classification using ANOVA test, maintain database in Gui MATLAB.

In 2005, X. Zhang et al. "Top-down and bottom-up strategies in lesion detection of background diabetic retinopathy", Proc. IEEE Computer Society Conf. on Computer Vision and Pattern Recognition (CVPR) [9] used Improved FCM (IFCM) to segment candidate bright lesion areas. Then a hierarchical Support Vector Machines (SVM) classification structure is applied to classify bright, non-lesion areas.

In 2014, Madhura Jagannath Paranjpe et al. "Review of Methods for Diabetic Retinopathy Detection and Severity Classification", International Journal of Research in Technology and Engineering, March 2014 [13] used seven steps for classification and feature extraction.1.Preprocessing, 2.detection and segmentation of optic disc, 3.detection fovea, 4.segmentation of retinal blood vessels, 5.feature extraction,6.classification, performance of classifier.

In 2013, Snehal P.Savarkar et al. "Review of Methods for Diabetic Retinopathy Detection and Severity Classification", September 2013 [14] used preprocessing on region of interest (ROI) by convolution with Gaussian mask of variance 1.0.Classification is done by using Naive Bayes classifier.

In 2013, Sidra Rashid et al. "Computerized Exudates Detection in Fundus Images using Statistical Feature based Fuzzy C mean Clustering", September 2013[15] implemented image aquisation followed by green channel extraction i.e RGB to grey conversion.In preprocessing BPDFHE is used for histogram equalization and CLAHE for decorrelation streaching.

III. METHODOLOGY

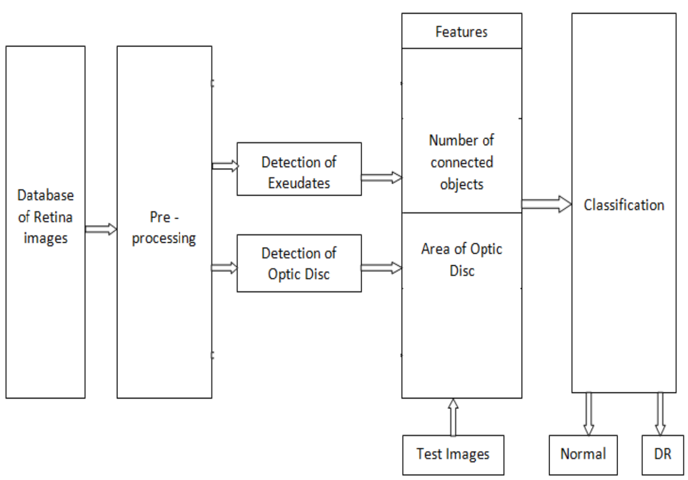


Fig 1.Block Diagram

A. Outline

We proposed a system for automatic detection of hard exudates with wavelet transform and random forest classifier. The availability of the digital retinal images taken by a fundus camera, then scanned by 965 NIKON CoolScan V LS-50 ED Slide Scanner and stored in a JPEG image format (.jpg) files with lowest compression rates are required for the proposed system. Here, detection of the optic disc is a vital task. It is crucial for detection of exudates, because the optic disc has analogous attribute in terms of color, brightness and contrast.These will be helpful characteristics for the detection of exudates.

There are three major steps for detection of exudates and hence to classify the image of retina is affected by DR disorder or not.

1. **Preprocessing ,**
2. **Feature extraction,**
3. **Severity classification.**

B. Working

1. Preprocessing

In preprocessing we are using

- ***Image enhancement :***

Here the retinal colour fundus image from the database is first resized. Resize is done for convenience for further processing. This resized image is then converted in the grayscale image. Grayscale image is used for its high contrast [1]. Contrast enhancement of this image is done which becomes more convenient for exudates detection. Median filter is used for smoothing.

Discrete wavelet transform is used for image enhancement by removing noise and compression. Here 3 stage Daubachies wavelet transform is used.

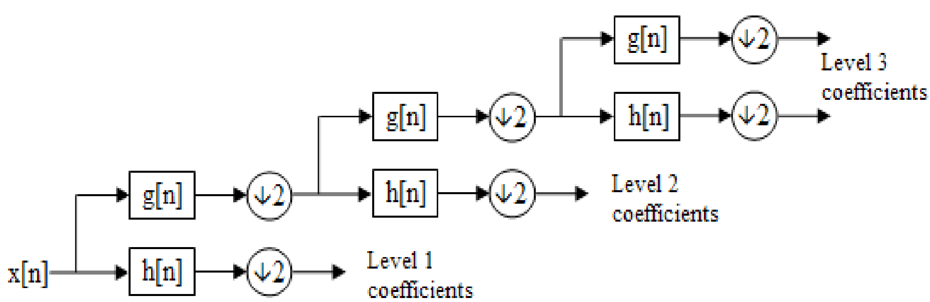


Fig 2. 3-stage DWT

- ***Properties of Daubachies wavelet transform***
  - Finite number of filter parameters / fast implementations
  - High compressibility
  - Sensitive recognition
  - Similar forward / backward filter parameters
  - Fast and exact reconstruction

Here energy feature of grayscale image is extracted. This is shown in histogram fig 4.

2. Feature Extraction

2.1 Segmentation for Exudate detection

There are numerous methods for exudates detection. Recursive region growing, grey level variation, colour normalization etc. are some of them. [15]Image segmentation is a process of partitioning image pixels on the basis of one or more selected image features and in this case the preferred segmentation feature is colour. The aim is to split pixels that have distinct colours into distinct regions and simultaneously, spatially connected and similar colour group pixels into the same region. Here coarse segmentation done by using FCM clustering which evaluates Gaussian smoothed histogram and fine segmentation using morphological operators.

FCM clustering is algorithm is overlapping algorithm. Each pixel may occure in two or more clusters. The features with more similarity in image are grouped into same cluster.

2.2 Morphological Techniques

As stated in [1], in the green channel exudates appear most contrasted. In [1] it is stated that the algorithm can be divided into two parts. First, we find candidate regions. These regions have possibility to contain exudates. Then, we apply morphological techniques in order to find the exact contours.

Finding the Candidate Regions*:* Regions which contain exudates are characterized by a high contrast and a high grey level. The problem with this is if we use the local contrast to determine regions that contain exudates, is that bright regions between dark vessels are also characterized by a high local contrast. So, we first remove the vessels by a closing. Hence, RGB to grayscale conversion is done in preprocessing.

Image segmentation is used for partitioning an image into regions. The hard exudates candidate regions have to be classified later. Segmentation will be get done by using the properties of histogram of the preprocessed image. The aim of segmentation is to simplify the representation of an image and provide significant information which is easy to evaluate. [3]

3. Severity classification

Random forest (RF) classifier consists of number of signal predictors trees. Each tree is guided over randomly and independently chosen samples from training data. This classifier depends on individual trees and correlation between them. Its accuracy is 92.94%. Here aim is to increase accuracy of RF classifier.
[3]The following steps describe how the random forest:
1. From the original image draw ntree samples.
2. Select a random subspace of ntrial features
3. Detect the best split at each node.
3. Detect the threshold and feature.
4. Continue process until the maximum depth (mdepth) is reached or there only remains a few numbers of samples in a node that cannot be further split forms a leaf.

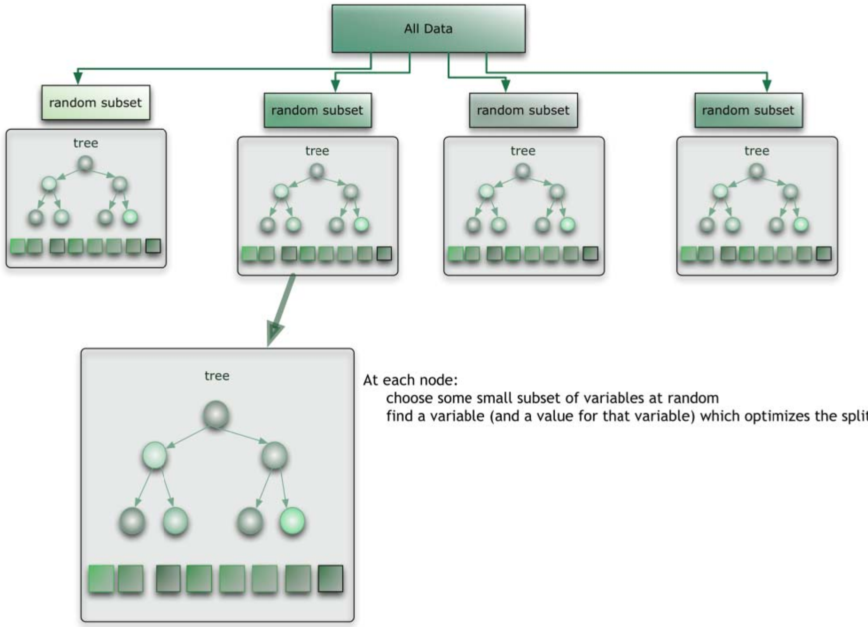


Fig 3.Random Forest Classifier

IV. RESULTS AND DISCUSSION

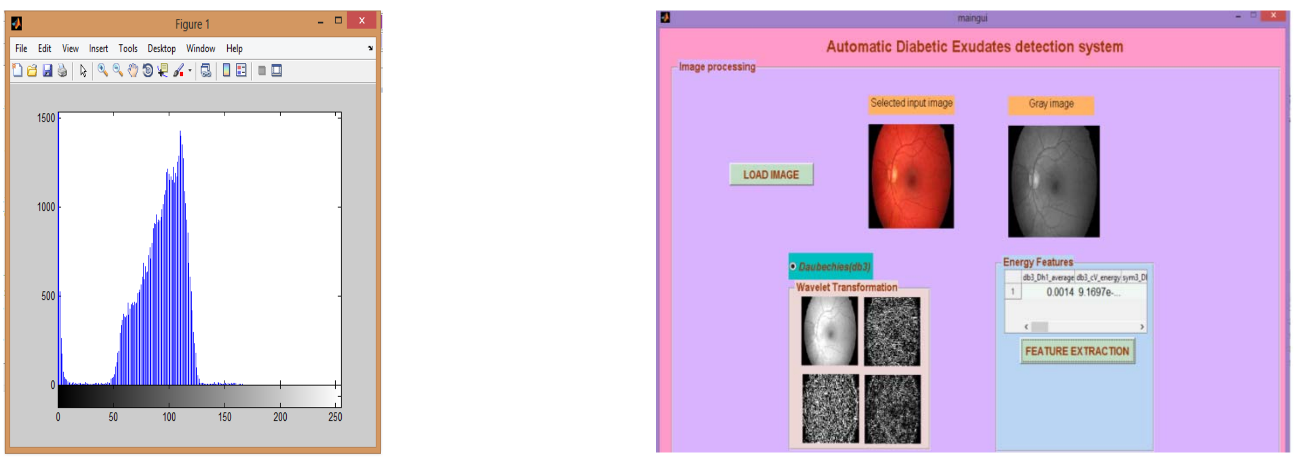


Fig 4. Preprocessing output

This system designed for exudates detection and image classification is tested by using a set of retinal fundus images DRIVE. DRIVE is a database of 60 images. Each image in this database contains basic information about the exudates.

This system is designed using MATLAB. Here we are using GUI in MATLAB. Figure 4 shows preprocessing output by taking an input from DRIVE database. It shows Daubachies Wavelet and also energy feature in histogram. Figure 5shows Feature extraction. In this we can see green channel image or grayscale image, optic disc and exudates detected by segmentation, morphologically reconstructed image. Figure 6 shows classification of an input image using random forest classifier.

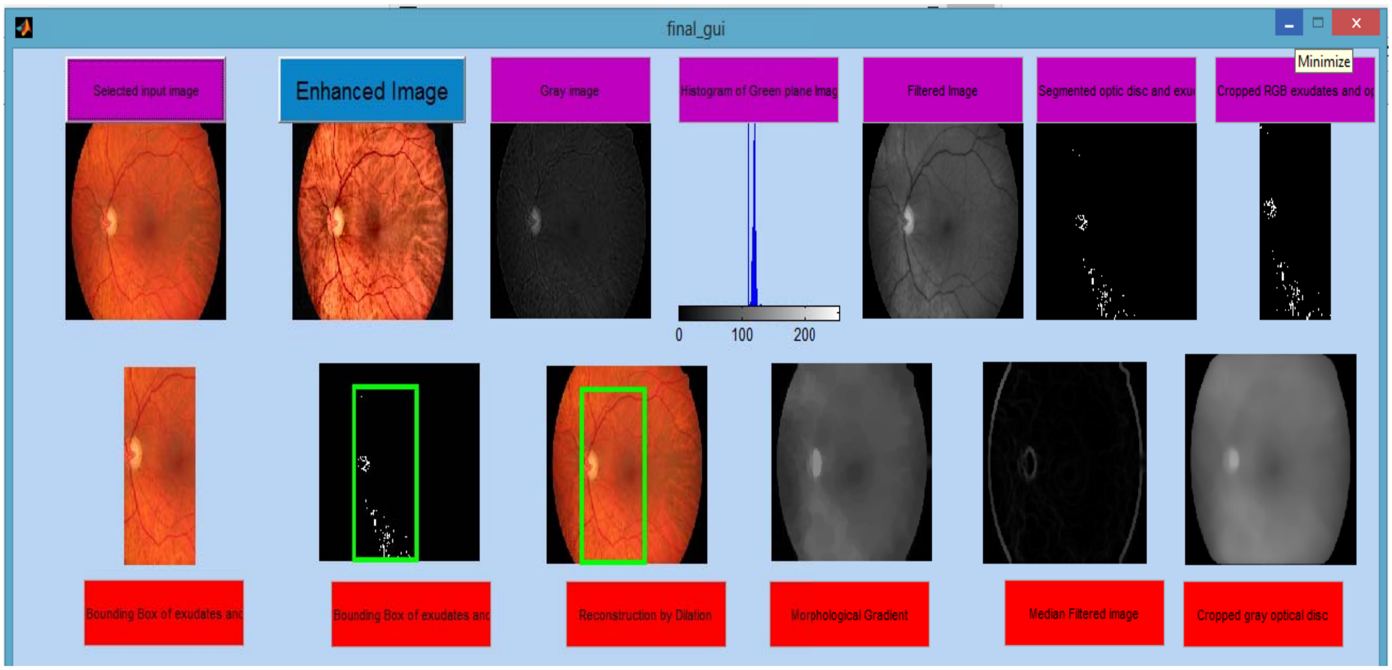


Fig 5.Feature Extraction

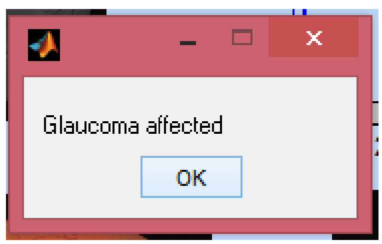
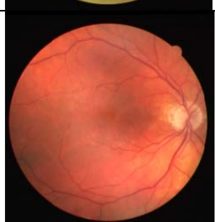
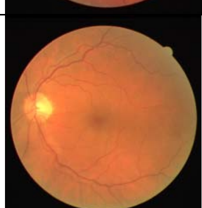
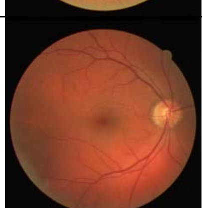
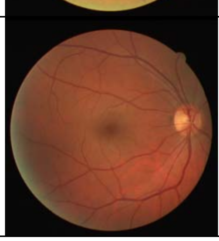


Fig 6.Classification of Input Image

Table 1 shows test images in DRIVE database. We find here disc area and cup area in terms of number of pixels present in optic disc and retina. Cup to disc ratio a parameter is used to get the result. If C:D<0.5 then normal and else abnormal. C= number of pixels in retina, D= number of pixels in optic disc

Image	Disc Area(in terms of No. of pixels)	Cup Area(in terms of No. of pixels)	Cup to Disc Ratio	Result
	20123	1586	0.078815	Normal

	2888	353	0.122230	Normal
	316	95	0.300633	Normal
	49	82	1.673469	Abnormal
	4484	1108	0.247101	Normal
	1008	407	0.403770	Normal
	1520	1497	0.984868	Abnormal
	26	82	3.153846	Abnormal
	13921	1505	0.108110	Normal

	658	989	1.503040	Abnormal
	328	851	2.594512	Abnormal
	3524	213	0.060443	Normal
	2006	586	0.292124	Normal
	1264	1159	0.916930	Abnormal
	1133	1332	1.175640	Abnormal
	3337	1252	0.375187	Abnormal

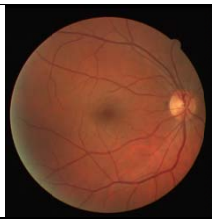
	3337	1252	0.375187	Abnormal

Table 1. disc area,cup area,cup to disc ratio and classification of DRIVE database images

V. CONCLUSION

The system implemented here is useful for the ophthalmologist to detect exudates and optic disc automatically and faster than algorithm implemented previously. Hence, with this system early detection of diabetic retinopathy is possible so that patient gets treatment within time and reduces risk of vision loss.

In this system area where exudates and optic disc are present in the coloured retinal fundus image is shown. This is useful for laser treatment in specific part/area of eye.

It uses segmentation for exudates detection. Coarse segmentation used to remove optic disc after detection of exudates for classification. Fine segmentation uses morphological operations are used. In this closing and dilation operators are used.

Here, classification algorithm used is Random Forest classifier. This algorithm consists of signal predictor trees called as samples. In these trees, each tree is randomly and independently selected and split till maximum depth is reached. The performance of the classifier depends on individual trees correlation between them. Its accuracy is 92.94%.

REFERENCES

[1] Thomas Walter, Jean-Claude Klein, Pascale Massin, and Ali Erginay, “A Contribution of Image Processing to the Diagnosis of Diabetic Retinopathy—Detection of Exudates in Color Fundus Images of the Human Retina”, IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 21, NO. 10, OCTOBER 2002

[2] T.Akila, G. Kavitha, “Detection and Classification of Hard Exudates in Human Retinal Fundus Image using Clustering and Random Forest Method”, International Journal Of Emerging Technology and Advanced Engineering, pp 24-29, April 2014

[3] Akara Sopharak, Bunyarit Uyyanonvara, Sara Barman, Thomas H. Williamson, “Automatic Detection of Diabetic Retinopathy Exudates from Non-dialated Retinal images using Mathematical Morphology Methods”,Computerized Medical Imaging and Graphics, pp720-727, August 2008

[4] A. Osareh, M. Mirmehdi, B. Thomas, R. Markham, “Automated Identification of Diabetic Retinal Exudates in Digital Colour Images”,British Journal of Ophthalmology, vol. 87, no. 10, pp. 1220-1223, 2003

[5] C. Sinthanayothin, J. F. Boyce, T. H. Williamson, H. L. Cook,“Automated Detection of Diabetic Retinopathy on Digital Fundus Image”, International Journal of Diabetic Medicine, vol. 19, pp. 105-112, 2002

[6] H. Wang, W. Hsu, K. Goh, G. Lee, “An Effective Approach to Detect Lesions in Color Retinal Images”, Proc. IEEE Conf. on Computer Vision and Pattern Recognition, vol. 2, pp. 181-186, 2000

[7] A. Osareh, M. Mirmehdi, B. Thomas, and R. Markham, "Automatic recognition of exudative maculopathy using fuzzy c-means clustering and neural networks", Proc. Medical Image Understanding Analysis Conf., pp. 49 -52, July 2001

[8] A. Osareh, M. Mirmehdi, B. Thomas, and R. Markham, “Comparative Exudate Classification using Support Vector Machines and neural Networks”, Proc. 5th International Conf. on Medical Image Computingand Computer-Assisted Intervention, pp. 413-420, 2002
[9] X. Zhang and O. Chutatape, “Top-down and bottom-up strategies in lesion detection of background diabetic retinopathy”, Proc. IEEE Computer Society Conf. on Computer Vision and Pattern Recognition (CVPR), pp. 422-428, 2005
[10] Hussain F. Jaafar, Asoke K.Nandi, and Waleed Al-Nuaimy, “Automated Detection and Grading of Hard Exudates from Retinal Fundus Images”, 19th European signal Processing Conference, 2011
[11] Anil Kumar Neelapala and Mehar Niranjan Pakki, “Analysing the Severity of the Diabetic Retinopathy and its Preventive Measures by Maintaining Database using GUI in MATLAB”, International Journal of Recent Technology and Engineering 2012
[12] Akara Sopharak and Bunyarit Uyyanonvara, “Automated Exudates Detection from Diabetic Retinopathy Retinal Image using Fuzzy C means and Morphological Methods”, International Conf. on Advances in Computer Science and Technology, 2007
[13] Madhura Jagannath Paranjpe and M N Kakatkar, “Review of Methods for Diabetic Retinopathy Detection and Severity Classification”, International Journal of Research in Technology and Engineering, March 2014
[14] Snehal P.Savarkar, Namrata Kalkar and S.L.Tade, “Diabetic Retinopathy using image processing detection, classification and analysis”, International Journal of Advanced Computer Research, vol 3 Sept 2013
[15] Sidra Rashid and Shagufta , “Computerized Exudates Detection in Fundus Images using Statistical Feature based Fuzzy C mean Clustering”, International Journal of Computing and Digital systems, September 2013