International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 05 | May 2022 www.irjet.net p-ISSN: 2395-0072

FEATURE EXTRACTION FROM RETINAL FUNDUS IMAGES

A. ARUL AFRIN MARY[1], I. MUTHUMANI[2], V. SELVAKUMAR[3]

[1]Student, Dept. of ECE, GCE, Tirunelveli, Tamil Nadu, India
[2]Professor, Dept. of ECE, GCE, Tirunelveli, Tamil Nadu, India
[3]Assistant Professor, Dept. of ECE, GCE, Tirunelveli, Tamil Nadu, India

---

Abstract - *COVID-19 pandemic has brought around changes in human life and work habits due to lockdown and has resulted in an increase in the frequency of numerous conditions like Diabetes. One such side effect of Diabetes is Diabetic Retinopathy. The proposed method aims to detect the optic disc, blood vessels and exudates in the retinal fundus images. Optic disc is detected using Histogram Normalization technique. Blood vessels are detected using Kirsch's template and Morphological Operations. Exudates appear as small white dots on the retinal fundus images which are detected using Morphological Operations. Retinal fundus images for testing were collected from the standard diabetic retinopathy database DIARETDB0 and DIARETDB1. From the results, it is found that the area of the extracted optic disc, blood vessels and exudates are more accurate than the state-of-the-art methods.*

Key Words: **Fundus Images, Optic Disc, Blood Vessels, Exudates, Morphological Operations.**

1. INTRODUCTION

Human eye is a sense receptor that reacts to light and permits vision with the assistance of the photoreceptor cells (rod and cone cells) present in it. Rod cell is helpful for vision during night time or in dim light and this vision is named as scotopic vision. Cone cells facilitate vision during daytime or in bright light and this vision is termed as photopic vision. Internal surface of the eye is the fundus which incorporates macula, retina, optic disc and fovea and can be examined by ophthalmoscope and/or fundus photography. Optic disc also known as optic nerve head is the point where the optic nerve connects to the brain. Optic disc is additionally referred to as blind spot since it doesn't embody any photoreceptor cells. Common eye disorders are cataract, night blindness, glaucoma, Diabetic Retinopathy.

Cataracts may occur either due to an eye injury or excessive exposure to actinic radiations. Nyctalopia also called night-blindness is a condition where the affected person is unable to see during night time or in dim light. It may also occur due to the deficiency of Vitamin-A. Glaucoma is a group of eye conditions which damages the optic nerve caused by an abnormally high pressure within the eye.

Insulin secreted by the duct gland helps glucose from food get into the cells to be used for energy. Diabetes is a disease that occurs when the blood glucose is just too high which could cause many other diseases. One such disease is Diabetic Retinopathy. Diabetic Retinopathy (DR) is a medical condition which damages the eye's retina due to diabetes which is a leading cause of blindness in several developed countries. Diabetic retinopathy has no early warning signs. Diabetic Retinopathy affected fundus images can be characterized by the presence of either exudates (or) microaneurysms (or) hemorrhages (or) all looking on the severity of the disease.

The first stage known as non-proliferative diabetic retinopathy (NPDR) in which the affected person has no symptoms and can be detected by fundus examination either by direct opthalmoscope or indirect ophthalmoscope by a trained oculist or optometrist.

The second stage known as proliferative diabetic retinopathy (PDR) in which abnormal new blood vessels (neovascularization) are formed at the back of the eye. Upon rupturing, these blood vessels leak fluid which causes deposition of lipids within the eye. These deposits are termed as exudates which are the primary clinical signs of DR, and they appear as small white dots on the retinal fundus images. These exudates are classified into two sorts as:

- Hard exudates – They're deep yellow and don't have a precise margin.
- Soft exudates – They don't have a definite boundary and are also known as cotton wool spots.

The number of exudates is employed to point the severity of the disease. Hard and soft exudates are conjointly known as bright lesions.

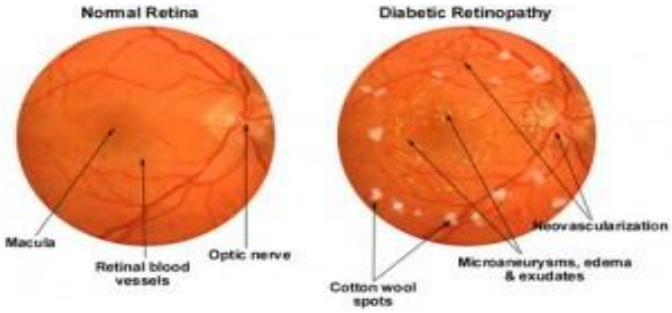

Fig -1: Normal Fundus Image vs. DR affected Fundus Image

Microaneurysm is an eye condition in which tiny red dots encircled by yellow rings are found within the eye as a result of vascular leakage. Retinal hemorrhage refers to abnormal bleeding within the delicate blood vessels of the retina whose symptoms range from the undetectable to severe vision issues. Vision problems are often temporary, but in some instances, they'll be permanent. Microaneurysms and hemorrhages are jointly known as red lesions.

2. PROPOSED METHODOLOGY

The detection of optic disc, blood vessels and exudates is a major problem in the automatic processing of retinal images. The segmentation of exudates is essential in differentiating the normal eye from the DR affected eye. In this work fundus image of the retina is used. MATLAB is used for implementing the process.

2.1 Dataset

The retinal fundus images for testing were taken from the standard publicly available Diabetic Retinopathy database DIARETDB0 and DIARETDB1.

2.2 Preprocessing

Preprocessing includes resizing of the retinal fundus images and choosing the appropriate color component from the RGB image.

The retinal fundus images collected for testing were of different resolutions. In order to maintain a uniform resolution, all the images collected were resized to 512x512 pixels. The resized retinal fundus images were in RGB colour space. The contents in the blue colour channel of the image are of low contrast whereas the red colour channel of the image is noisy. The optic disc, blood vessels and exudates has good contrast in the green colour channel of the image. Hence the green channel is chosen for the analysis of the retinal fundus images.

2.3 Image Enhancement

CLAHE (Contrast-Limited Adaptive Histogram Equalization) algorithm is applied for noise reduction by increasing the contrast and filtering of the image. Histogram equalization is used for enhancing the contrast of the image. It removes the background for the resulted image by converting the background to white color (every pixel outside the white board changed to white color).

2.4 Exudates Detection

The proposed technique for the detection of exudates in the retinal fundus images is implemented using morphological top- and bottom-hat filtering operations.

The flow diagram for exudates extraction in the retinal fundus images is shown in fig. 2

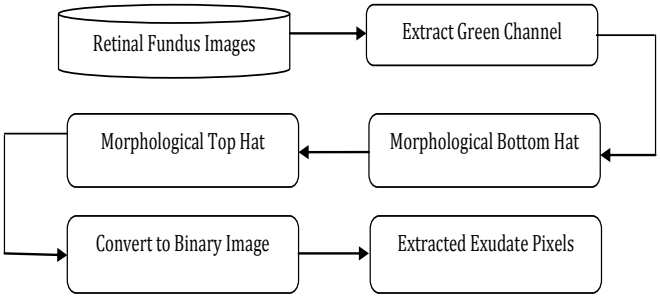

Fig -2: Flow Diagram for Exudates Extraction

The exudates from the retinal fundus images are detected by applying the morphological bottom-hat filtering on the extracted green channel of the fundus image with a disc shaped structuring element. Bottom-hat filtering subtracts the original image from the morphologically closed image. Then morphological top-hat filtering is applied on the extracted green channel of the fundus image with a disc shaped structuring element. Top-hat filtering subtracts the morphologically opened image from the original image. Then the bottom-hat filtered image is subtracted from the top-hat filtered image. Then a binary image is obtained by converting the resultant image with a threshold value i.e., the pixels with luminance value greater than the threshold value are replaced by value 1 (white) and the remaining pixels are replaced by a value 0 (black). The white pixels correspond to the exudates pixels in the original image.

2.5 Blood Vessels Detection

The proposed technique for the detection of blood vessels in the retinal fundus images is implemented using Kirsch's templates.

The flow diagram for blood vessel extraction in retinal fundus images is shown in fig. 3

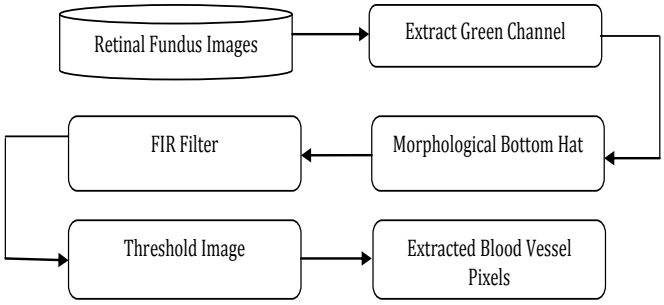

Fig -3: Flow Diagram for Blood Vessels Extraction

The blood vessels in the retinal fundus images were detected by applying a 2-dimensional digital finite impulse response (FIR) on the bottom-hat transformed

image and the Kirsch's template co - efficients. Then a threshold is applied on the 2-D FIR filtered image to extract the pixels of the blood vessels from the filtered image. The pixels greater than the threshold value correspond to the blood vessel pixels.

2.6 Optic Disc Detection

The proposed technique for the detection of optic disc in the retinal fundus images is implemented using histogram conversion and normalization of histogram.

The flow diagram for optic disc extraction in retinal fundus images is shown in fig. 4

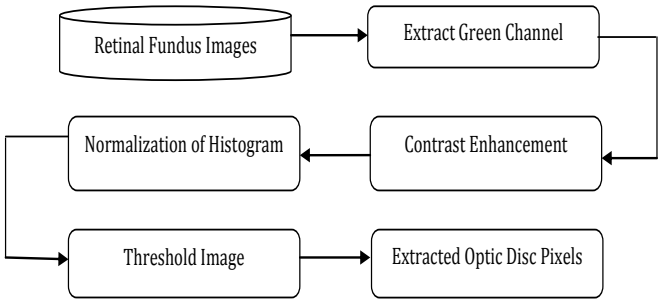

Fig -4: Flow Diagram for Optic Disc Extraction

In image processing, normalization is a process used for changing the range of intensity values of the pixels in the image. It is also called histogram stretching or contrast stretching. Histogram normalization enhances the fine details within an image. Then a threshold is applied on the normalized histogram to find the pixels of the optic disc from the normalized histogram. The pixels greater than the threshold value correspond to the optic disc pixels.

3. RESULT

3.1 Retinal Fundus Image

Fundus Image consists of RGB Channel which has unique feature.

Fig -5: Normal Retinal Fundus Image

Fig -6: DR affected Retinal Fundus Image

3.2 Detected Optic Disc

Fig. 7, 8 shows the detected optic edges disc in normal and DR affected fundus images.

Fig -7: Detected Optic Disc in a Normal Retinal Fundus Image

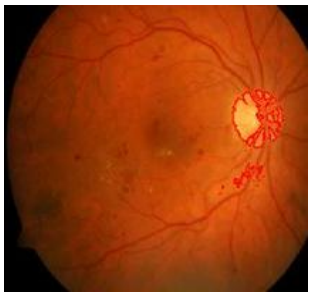

Fig -8: Detected Optic Disc in a DR affected Retinal Fundus Image

3.3 Detected Blood Vessels

Fig. 9, 10 shows the detected blood vessels in normal and DR affected fundus images.

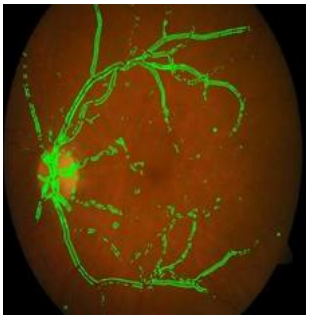

Fig -9: Detected Blood Vessels in a Normal Retinal Fundus Image

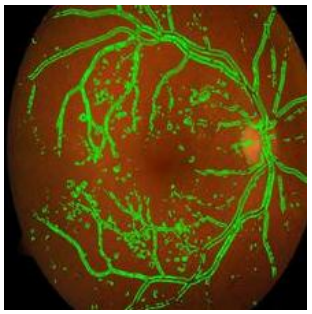

Fig -10: Detected Blood Vessels in a DR affected Retinal Fundus Image

3.4 Detected Exudates

Fig. 11, 12 shows the detected exudates in normal and DR affected fundus images.

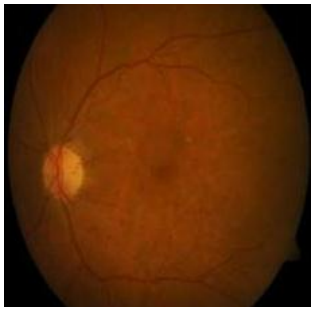

Fig -11: Detected Exudates in a Normal Retinal Fundus Image

Fig -12: Detected Exudates in a DR affected Retinal Fundus Image

From fig.11, it is observed that the normal retinal fundus images do not have any exudates. The yellow dots in the above figure (fig. 12) shows the detected exudates.

3.5 Area of the Detected Features

Fig. 13, 14 shows the area of the extracted features from the retinal fundus image.

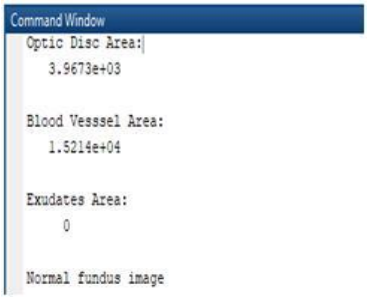

Fig -13: Area of the Extracted Features in a Normal Retinal Fundus Image

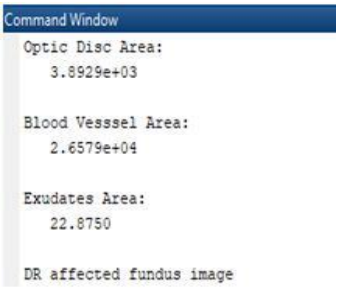

Fig -14: Area of the Extracted Features in a DR affected Retinal Fundus Image

4. CONCLUSION

In this work, features like optic disc, blood vessels and exudates in the human retinal fundus images were extracted. Retinal fundus images including both normal and Diabetic Retinopathy affected images were taken from the publicly available standard Diabetic Retinopathy Databases like DIARETDB0 and DIARETDB1 for testing. Optic Disc in the retinal fundus images were detected using the Histogram Normalization technique. Blood Vessels in the retinal fundus images were detected using Kirsch's templates and Morphological Operations. Exudates in the retinal fundus images were detected using the Morphological Operations. The area of the extracted features was also measured. The extraction of all the above three features and the area of these extracted features were performed using MATLAB R2018a. From the extracted exudates and its area, it was observed that the area of the exudates was zero in the normal retinal fundus images and greater than zero in the case of Diabetic Retinopathy affected retinal fundus images. From this observation, it is inferred that if the area of the exudates is greater than zero, then the corresponding retinal fundus image can be classified as a Diabetic Retinopathy affected retinal fundus image and if the area of the exudates is equal to zero, then the corresponding retinal fundus image can be classified as a normal retinal fundus image.

REFERENCES

[1] Meindert Niemeijer, Bram van Ginneken, Joes Staal, Maria S. A. Suttorp-Schulten, Michael D. Abramoff, "Automatic Detection of Red Lesions in Digital Color Fundus Photographs," IEEE Transactions on Medical Imaging, Vol. 24, No. 5, pp. 584-592, May 2005.

[2] Dongbo Zhang, Xiong Li, Xinyu Shang, Yao Yi, Yaonan Wang, "Robust Hemorrhage Detection in Diabetic Retinopathy Detection," pp. 209-213, 2011 IEEE.

[3] Balint Antal, Andras Hajdu, "An Ensemble-Based System for Microaneurysms Detection and Diabetic Retinopathy Grading," IEEE Transactions on Biomedical Engineering, Vol. 59, 6, pp. 1720-1726, June 2012.

[4] Sohini Roychowdhury, Dara D. Koozekanani, Keshab K. Parthi, "Screening Fundus Images for Diabetic Retinopathy," pp. 1641-1645, 2012 IEEE.

[5] M. Usman Akram, Shehzad Khalid, Shoab A. Khan, "Identification and classification of microaneurysms for early detection of diabetic retinopathy," ELSEVIER - Pattern Recognition 46 (2013), pp. 107-116.

[6] L. Giancardo, F. Meriaudeau, T. P. Karnowski, K.W. Tobin, E. Chaum, "Validation of Microaneurysm-based Diabetic Retinopathy Screening across Retinal Fundus Datasets," pp. 125-130, 2013 IEEE.

[7] Sundararaj Wifred Franklin, Samuelnadar Edwar Rajan, "Diagnosis of Diabetic Retinopathy by employing Image Processing Techniques to detect Exudates in retinal images," IET Image Process, 2014 Vol. 8, Iss. 10, pp. 601 – 609.

[8] R. S. Deshmukh, "Analysis of Diabetic Retinopathy by Automatic Detection of Exudates," International Journal of Electronics and Communication Engineering (IJECET), Vol. 5, Iss. 12, December (2014), pp. 266 – 275.

[9] ManojKumar S B, Manjunath R, Dr. H S Sheshadri, "Feature extraction from the Fundus Images for the diagnosis of diabetic retinopathy," International Conference on Emerging Research in Electronics, Computer Science and Technology, pp. 240-245, 2015 IEEE.

[10] Sudeshna Sil Kar, Santi P. Maity, "Automatic Detection of Retinal Lesions for Screening of Diabetic Retinopathy," IEEE Transactions on Biomedical Engineering, pp. 1-9, 2016 IEEE.

[11] Karan Bhatia, Shikar Arora, Ravi Tomar, "Diagnosis of Diabetic Retinopathy Using Machine Learning Classification Algorithm," 2016 2nd

International Conference on Next Generation Computing Technologies (NGCT-2016), pp. 347-351, 2016 IEEE.

[12] Sarni Suhaila Rahim, Vasile Palade, James Shuttleworth, Christiana Jayne, "Automatic screening and classification of diabetic retinopathy and maculopathy using fuzzy image processing," Brain Informatics (2016) 3: 249 – 267.

[13] Dilip Singh Sisodia, Shruti Nair, Pooja Khobragde, "Diabetic Retinal Fundus Images: Preprocessing and Feature Extraction For Early Detection of Diabetic Retinopathy," Biomedical and Pharmacology Journal, Vol. 10(2), pp. 615-626 (2017).

[14] Wei Zhou, Chendong Wu, Dali Chen, Zhenzhu Wang, Yugen Yi, Wenyou Du, "Automatic Microaneurysm Detection of Diabetic Retinopathy in Fundus Images," pp. 7453-7458, 2017 IEEE.

[15] Shuang Yu, Di Xiao, Yogesan Kanagasingam, "Exudate Detection for Diabetic Retinopathy with Convolutional Neural Networks," pp. 1744-1747, 2017 IEEE.

[16] Wei Zhou, Chengdong Wu, Xiaosheng Yu, "Computer Aided Diagnosis for Diabetic Retinopathy based on Fundus Image," Proceedings of the 37th Chinese Control Conference 2018, pp. 9214-9219.

[17] Zihao Wang, Ke-Jia Chen, Lingli Zhang, "A R-CNN Based Approach for Microaneurysm Detection in Retinal Fundus Images," – 2019.

[18] Muhammad Mateen, Junhao Wen, Nasrullah Nasrullah, Song Sun, Shaukat Hayat, "Exudate Detection for Diabetic Retinopathy using Pretrained Convolutional Neural Networks," Hindawi Complexity, Vol. 2020, pp. 1-11.

[19] DIARETDB0 and DIARETDB1 Database.

[20] Software Package, "MATLAB (2018a)".