International Journal of Scientific Research in Computer Science, Engineering and Information Technology
ISSN : 2456-3307 (www.ijsrcseit.com)
doi : https://doi.org/10.32628/CSEIT206483

Detection of Diabetic Retinopathy by Retinal Screening using Image Processing Techniques

Shaziya Banu S[1], Ravindra S[2]

[1]PG Scholar, Department of Computer Science and Engineering, J.N.N College of Engineering, Shivamogga, Karnataka, India

[2]Associate Professor,Department of Computer Science and Engineering, J.N.N College of Engineering, Shivamogga, Karnataka, India

Article Info
Volume 6, Issue 4
Page Number: 447-457
Publication Issue :
July-August-2020

Article History
Accepted : 10 Aug 2020
Published : 16 Aug 2020

ABSTRACT

Diabetic Retinopathy (DR) is a related malady with diabetes and primary driver of sightlessness in diabetic patients. Epidemiological overview categorizes DR among four significant reasons for sight impedance. DR is a microvascular entanglement in which meager retinal veins may blast, bringing about vision misfortune. In this condition veins in retina swells and may blast in severe extreme condition. Operative medication is timely discovery by steady screenings that is by emphasizing the determination of retinal images using appropriate image processing techniques such as, Preprocessing of retinal image, image segmentation using sobel edge detector, local features extraction like mean, standard deviation, variance, Entropy, histogram values and so on. For classification of retina, system uses K-Nearest Neighbor (KNN) classifier. By adopting this approach, The classification of normal and abnormal images of retina is easy and will reduce the number of reviews for the ophthalmologists. Developing a method to automate functionality of retinal examination helps doctor to identify patient's condition on disease. So that they can medicate the disease accordingly.

Keywords : Diabetic Retinopathy, Diabetes Mellitus, Preprocessing, Microaneurysm, Opticidisc, Exudates.

I. INTRODUCTION

The natural eye responds to brightness and has numerous details. Poles and Cones cells in retina permit light to fall on it, which results in the vision of eye and also in the differentiation of colors.

Diabetes is the most highly seen ailments faced by individuals all over globe. Prevalence of diabetes is estimated to 2.8% in 2000 and may rise to 4.4% by 2030 as the survey given by World Health Organization. The components adding to the expanded pace of diabetes are increasing weight, physical in movement and maturing populace. In whole world increment of diabetes among all age bunches is subsequently prompting upgrade odds of difficulties related to diabetes.

Patient with type I diabetes holding for long period may surge to 99% of occurrence of DR. where as type II patient may surge to 60%. Patient should ensure continuous testing so as to forestall vision misfortune. If neglected, patient may loose his vision because the disease is symptomless and irrecoverable in later severe stage. The number of Doctors or eye specialists who perform the quality assured regular screening of this disease is limited across the world.

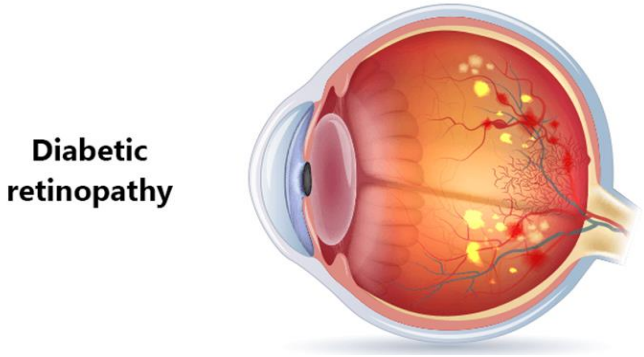

Figure 1: Image of Diabetic retinopathy.

In DR, various abnormalities such as signs like Micro aneurysm, Exudates, cotton wool spots, lesions are seen. DR is asymptomatic illness and its initial and solid location is a functioning exploration zone. Many exploration assemblies and academia are working on this automated Diabetic Retinopathy detectors which minimizes the cost and time of screening system, so as to help the ophthalmologists across the world [3]. Figure 1 shows the general structure of Diabetic Retinopathy.

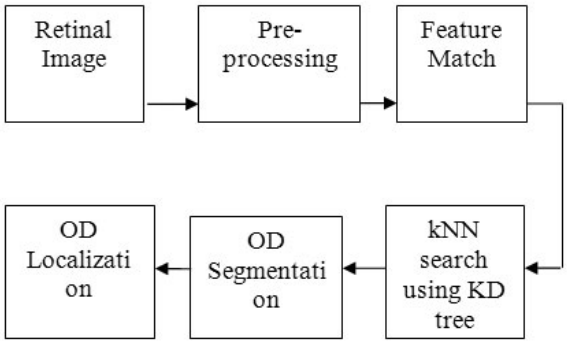

Figure 2: Block diagram of screening system of Diabetic retinopathy

The automatic exploration of retina would spare additional work and may support the eye examiners. In this work, Accentuation on programmed discovery of Diabetic Retinopathy utilizing retina is processed in like manner utilizing explicit procedures, for example, Sobel edge detector, histogram Threshold and classification using KNN algorithm. General screening system is shown in Figure 2.

Types of Diabetic Retinopathy:

- ✓ I phase is called minor non severe DR. It consists of minimum of one micro aneurysm.
- ✓ II phase is called Moderate non severe DR. Situation of few blocked veins in retina.
- ✓ III phase is Pre-proliferative DR. In this stage, more number of blocked blood vessels is seen; as a result retina will not receive adequate blood flow in order to replace the abnormal blood vessels in retina.
- ✓ IV phase is Proliferative DR. It is final phase; abnormal vessels will grow in retina. Blood may drip and cause vision damage and sightlessness.

II. LITERATURE SURVEY

S P Meshram et al. (2013) in [4] suggests Vision quality is retarded because of damage in retinal blood vessel. DR will not show any indications in the initial stage but may gradually lead to vision loss if it is not noticed early. DR can develop in all type of diabetic patients. This disease may affect to maximum number of diabetic patient who have disease for long time. If person has diabetes for longer period, then the probabilities of attainment DR is higher. Physical recognition of vessels is tough because vessel of retina is of less distinct and is composite. The image segmentation mainly uses the difference among veins and neighboring background of image.

According to Meshram et al. (2013) " A new method for blood vessel detection and extraction in digital

retinal images using Contrast Limited Adaptive Histogram Equalization (CLAHE), a regional contrast enhancement scheme". It increases distinction in vessels and circumstantial retina. That is improved to proper contrast pixel of the background of the image. Work uses GOLD STANDARD database.it achieves sensitivity of 65.65% and specificity of 98.97%.

Changira Sinthanayothin et al. (2003) in [5] describes, global ophthalmologists are dared by the speedy growth in occurrence of diabetes. DR is the complication of diabetes and it can be from minor visual damage to loss of sight. Frequent analysis of DR is an expensive and vigorous process. Several studies have been adopted for automated image analysis in order to resolve this complication. On the whole, 1,231 publications were recognized by PubMed, Cochrane Library. 3 examination plans were passed out to recognize the major search. 4 levels of selection were recognized and 7 studies valid for insertion. The automated screening system was established to identify the status of retina. Result with sensitivity of 80.21% and specificity 70.66% was obtained. Seven studies were included in which high sensitivities ranging from 80–95.2% is obtained. Reasons for false positive for 142 images are due to incorrect classified images caused by the artifacts near the vessels and exudates which misclassified the optic disc.

R.Radha et al. (2013) in [6] suggests a technique for the examination of retina by effective recognition of exudates. It also helps in classification of retina into normal or abnormal. The distinction of retina is improved by curve let transform. Therefore the morphology operators are applied to improve image to identify the retinal edges. The clustering method is adopted for exudate discovery of eye. Blood vessel and exudates are effectively detected. The dataset involves 110 images with test and trained extract the required features. These are collected from an eye clinic. In order to train the system with collected retinal images, the method make use of PNN algorithm. The retina is classified for normal or abnormal. It also analyzes the retinal image performance. The accuracy is around 98% in the exudate detection of the retina. In an automatic screening system, precise recognition of OD in color retina is an important job. OD is used as location for determining distances to find the macula. In color fundus image, optic disc is seen as bright spot with oval shape along with the vessels coming out of it. The optic nerves and vessels appear over OD into retina. That spot is also called blind spot. Optic disc size varies from one patient to another. Its diameter is among 80 to 100 pixels for normal retina.

Accurate classification is possible in this method, in which retina is classified either normal or abnormal. The feature extracted is trained by PNN successfully and K means clustering method is also adopted. Thin blood vessels are neglected in this threshold method. The segmentation and enhancement steps used in the quantitative performance method need to be improved.

Thomas Walter et al. (2002) in [7] suggest a procedure in discovery of exudates along with OD. Core reason for DR is the existence of exudates in macula of retina. This work allows detection with higher sensitivity. Therefore, exudate detection is a significant work in the diagnosis. Exudates are identified by its high grey level difference of filtering reconstruction techniques. The process of OD detection is also an important work. OD detection is done by applying watershed transformation and morphological filtering technique. The procedure has been verified on collected database and the result with 92.8% sensitivity and a 92.4% of predictive value is obtained. Robustness is also evaluated according to the changing parameters.

Zahira et al. (2015) in [8] recommend early detection is best treatment to control the severity of the DR disease. Regular screening of retinal images is

adopted. The abnormalities in the retina seen in diabetic patients often named as Diabetic Retinopathy or DR. Latest advanced technologies involving various extracted features are used with image processing methods and these are applied in the automatic diagnosis of the disease. The standard datasets such as DRIVE and STARE are used and they are available over internet. The algorithms and techniques used would help doctors to diagnose different illnesses in patients. Cumulative distribution function for a given probability density function is to performed, which becomes complicated and time consuming. The extraction of required features and the severity of DR using image processing are adopted in order to get better result.

Kheng et al. (2001) in [9] describes, in the world, Diabetic associated eye disease is the reason of blindness. Early detection of DR is the best effective treatment. This includes a huge sum of samples of retina. The image processing methods are combined along with the data processing methods for analysis of eye linked diabetic complications. Experimental results detect abnormalities in retina. Mainly, abnormal OD to cup ratio, occurrence of abnormal exudates and convoluted vessels.

Jerusha et al. (2018) in [10] describes that diabetes is the most common hereditary disease which is prevalent in the world. The objective is to use convolution neural networks and deep learning method to develop a robust procedure for the automatic diagnosis system. Neural Network is usually a computer which is given a human neural system. As in a biological neural system it receives an input and produces a respond based on the input. Basically in Image processing using neural networks, the computer is trained based on certain inputs. The computer learns these inputs in a minimal level so that computer which has been trained is turned as a neural network. It works according to the designed purpose by detecting and conveying the information. It overcomes the drawbacks of earlier research by using a simple and efficient algorithm using deep learning and Back Propagation methods. In this prototype, an innovative evaluation on five stages of diabetic retinopathy and achieved an overall accuracy of 97%.

Carson Lam et al (2018) in [11] suggests Diabetic retinopathy is a principal reason of impaired vision in mid-age adults. This paper, Exhibits the usage of convolutional neural networks or CNN on fundus colored retina for the identification of diabetic retinopathy. This work achieves the performance metrics with 95% sensitivity. The system is built to grade the stages of DR according to presence of pathologies in retina. According to Carson Lam et al. (2018) "CNN convolves an input image with a defined weight matrix to extract specific image features without losing spatial arrangement information". Various designs are adopted to define better accomplishing CNN algorithm which achieves the considerable performance levels. Then multiple class models are built to enhance sensitivities in early stage. Data preprocessing and data augmentation methods are applied to increase accuracy of the system. It also improves the dataset efficiency.

According to **Muhammad Hamdi Mahmood et al. (2018) in** [12]. Vital information is extracted from retina and they are applied using image processing. This helps in advancement of medical imaging, which increases the scope of biomedical engineering platform by applying the use of robust technology. Many methods are adopted to examine the retinal image in order to study the geometric features namely, branching coefficients and its angles, vessel diameter and torque, and so on. These quantitative retinal features are used to analyze the abnormalities in the retina, which may result in other eye related serious diseases also. This tool can also be utilized for huge number of analysis system. This system is applied on quantitative retinal features by using

image processing methods. This shows that examination of fundus image is one of the utmost significant areas in biomedical engineering.

Bhavin et al. (2019) in [13] discusses the Micro aneurysms (MAs) detection from color retina. OD is identified by blob method is applied on retina. Box in which OD region present is extracted. It is a web application so that, it can be accessed from anywhere in the world. Thus transportation cost and time consumption for detection of such diseases decreases gradually. The system works under real time scenario. The accuracy rate is 95% for OD and 56% for MAs.

TABLE1: COMPARISON OF DIFFERENT METHODS

Author	Method	Accuracy	Sensitivity	Specificity
Meshram[2]	Blood vessels detection	70%	Not reported	Not reported
Changira[3]	Optic disc,blood vessel	Not reported	80.21%	70.66%
Jerusha [8]	Evaluation of 5 stages of DR	97%	Not reported	Not reported
Carson [9]	Classification of 5 stages of DR	74.5%	95%	Not reported
Bhavin [11]	Optic disc	95%	Not reported	Not reported
	Microaneurysms	56%		

III. PROPOSED METHODOLOGY

Proposed System

- DR is one of the difficulties of diabetes and this occurs due to change vessels of the retina.
- The severity in disease varies along the phase of disease.
- In this process, the algorithm for auto recognition of OD on retina by using Edge detection is used.
- In the pre-processing stage of detection, functions such as resizing of given image, noise removal of the image and gray conversion is performed.
- Edge detector like sobel is smeared to find edge region. Feature extraction based on local features technique is implemented.
- In the final step, the retinal abnormalities are considered and they are classified as either normal or abnormal retina. This process of classification mainly uses KNN algorithm (K-Nearest neighbor).

Pros:

- The projected procedure is not as much of reliant on training data.
- It necessitates fewer segmentation time.
- It accomplishes reliable vessel segmentation accurateness.
- This presents minor incorrect vessel pixels in vessel segmentation.
- The projected method is desirable in recognition of retinal images with considerably huge amount of red lesions.

SYSTEM ARCHITECTURE

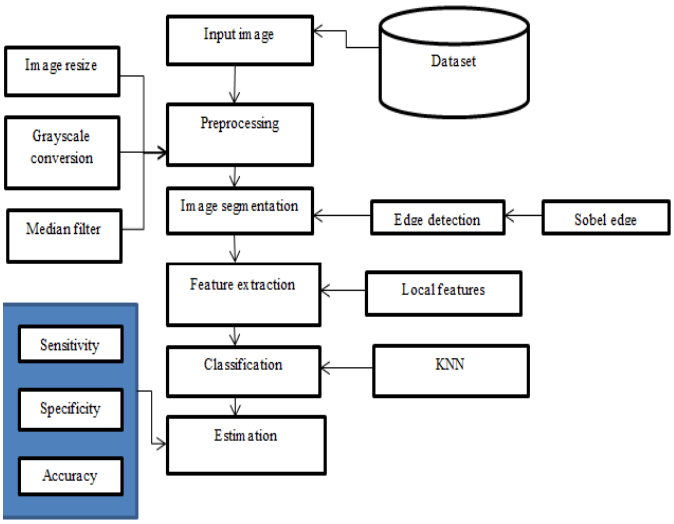

Figure 3: Proposed system

MODULE DESCRIPTION

➢ IMAGE ACQUISITION AND INPUT IMAGE:

a) Image acquisition stage is the first stage of screening.

b) The digitization and storage of an image in database is performed.

c) Load the database with fundus retina using applicable functions.

d) If image quality is not adequate even after enhancement then result will not be acceptable.

➢ Preprocessing stage:

Image from database is preprocessed as follows:

a) Image is resized into smaller image which helps in concentrating on required area. That is called Region of Interest (ROI). Image resizing is performed to 256 * 256 axes.

b) Resized color image is transformed to grayscale.

c) Image smoothening is performed by applying median filters to reduce noise and misrepresentations in image.

Image Resize:

i. In scaling of vector image, various geometrical changes are performed on it but without loosing quality.

ii. In scaling of raster image, less number of pixels in image is interchanged so as to get the better quality.

Gray conversion:

a) The Grey scale image only holds the high intensity information in every pixel.

b) Image is made of black and white pixels which explicitly show gray color that varies from weak intensity black to strong intensity white.

Median Filter:

a) When this filter is applied on image, it minimizes the noise to give better quality image.

b) This process is used in preprocessing phase so as to enhance the result.

➢ SEGMENTATION

Segmentation is the practice of separating an image to fixed number of constituents. In this system, optic disc and vessels of the retina must be separated in order to find the abnormality of eye.

- **Vessel Discovery:**

Vessels are the branching structures through which blood flows. That may be curved or straight in structure. Diameter of the vessels may be about 125 μm [14]. They widen and will go through curly path as referred by Argade (2015).

- **Vessel Enhancement:**

a) Image enhancement techniques are:

i. Spatial domain methods, it operates upon pixels.

ii. Frequency domain methods, it operates by Fourier transform.

b) When image quality is improved and used in the early stages of image processing, then this quantitative information can be utilized to find various associated techniques.

- **Optic disc segmentation:**

Optic disc is yellow like boundary with high intensity. Eyecup is present in the center of the disc. [14] It appears in the temporal position of retina and covers about 40% region in optic disc. The size, shape and position may vary from person to person (Argade et al. 2015).

OD originates from the perimeter. [14] The arteries and veins also arise from same region. Size of OD varies according to person but diameter may lie

between 40 - 60 pixels of 640 * 480 images (Argade et al. 2015).A multidimensional vector space is created with green intensity boundary. It is shown in Figure 4.

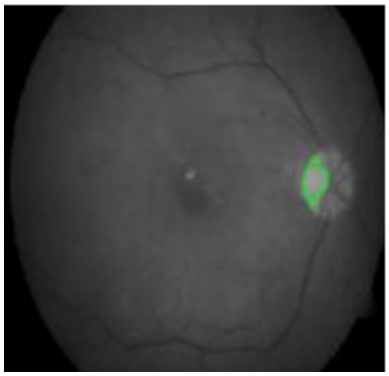

Figure 4 : Segmented OD with green channel boundary

Sobel Edge Extraction:

[14] An edge is a limit between two locales. An edge indicator discovers locales in a picture where the dim levels are changing rapidly to be an irregular impact, and some search for alters in a particular course. Sobel extraction is an extremely well known edge recognition procedure in detecting slope variety in a picture due to its minimal effort and usability (Argade et al. 2015).

Algorithm for Sobel Edge Detector

Input: An Example Image

Output: Identified edges

Step 1: Examine given Image.

Step 2: Put on G_x, G_y gradients to testing image.

Step 3: Put on Sobel edge detector on gradient.

Step 4: Covering control of the G_x, G_y independently on testing image.

Step 5: Outcomes are united to obtain gradient magnitude

$$|G|=\sqrt{(Gx^2 + Gy^2)} \text{ or } |G|=|G_x|+|G_y|$$

Step 6: Output gradient.

- **FEATURE EXTRACTION**

Local features such as mean, standard deviation, variance, entropy, histogram values along with other features are estimated for test images and trained images. These are available from the Kaggle database [1].

- **CLASSIFICATION**

KNN Classifier (K Nearest Neighbor) :

- After local feature extraction, the retina must be classified. For that purpose, KNN classifier is used.
- It is one of the efficient classifier which produces effective results.
- KNN classifier is used for classification of retina as normal or abnormal. Algorithm of classifier is mentioned as follows.

Algorithm of KNN classifier

Input: local extracted features.

Output: classify as Normal or Abnormal.

Step 1: First step is to load data of training and test datasets.

Step 2: K may be integer, group or can be Boolean value. That K value has to be choosing which is near to data points. In this system K is group. That is either normal or abnormal.

Step 3: Do the following, aimed at every test data,

i. By using Euclidean distance, compute distance between test data and every row of training data.

ii. Based on the distance value, the values are sorted in increasing order.

iii. K row which is present in top is selected from obtained array.

iv. Based on common available class of row, the required particular class is assigned.

Step 4: End.

PERFORMANCE ESTIMATIONS:

Sensitivity and specificity are the statistical measurements which are used for the calculation of performance metrics. They are used for classification function in statistics.

a) Sensitivity: It is nothing but, true positive count. It estimates the section of positives that are rightly recognized. That is, the measurement of sickening persons rightly recognized with disease.
b) Specificity: It is nothing but, true negative count. It estimates the section of negatives that are rightly recognized. That is, the measurement of healthy persons rightly recognized without disease.
c) Accuracy: Accuracy is prediction of test values of both the sensitivity and specificity.

IV. EXPERIMENTAL RESULTS

Data base Description:

a) The DATABASE 1 used is Kaggle dataset.
   Kaggle dataset consists of huge number of high resolution retina which has been obtained in various circumstances [1]. It includes sample 30 retinal images, training data values and there associated local features. For example few samples are taken.
b) The DATABASE 2 used is DR HAGIS
   [2] DR HAGIS dataset is one of the standard dataset. From This dataset, around 40 samples of retina are taken for this work.(Sven Holm et al. 2017).

For example few samples are taken.

PERFORMANCE ANALYSIS

In the experiment, two databases with totally 70 images are taken for analysis. The system achieves better performance and better accuracy in sensitivity and specificity rate. For example few images are considered and their performance analysis values are shown in following tables.

PERFORMANCE GRAPH:

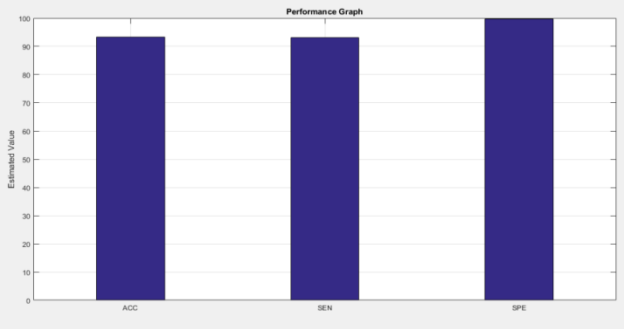

Figure 5: Performance graph of retinal image

The graph in Figure 5 shows the specificity of 99.7622%, sensitivity of 93.1034% and accuracy of 93.333%.

TABLE 2: PERFORMANCE OF DATASET_1

Img	Sensitivity	Specificity	Accuracy	Result
Img(1)	89.65%	99.6433%	90.0000%	Normal
Img(2)	89.6552%	99.6433%	90.0000%	Normal
Img(3)	89.6552%	99.6433%	90.0000%	Normal
Img(4)	93.1034%	99.7622%	93.3333%	Normal
Img(5)	89.6552%	99.6433%	90.0000%	Normal
Img(16)	89.6552%	99. 6433%	90.0000%	Abnormal
Img(17)	89.6552%	99. 6433%	90.0000%	Abnormal
Img(18)	89.6552%	99. 6433%	90.0000%	Abnormal
Img(19)	89.6552%	99. 6433%	90.0000%	Abnormal
Img(20)	93.1034%	99. 7622%	93.3333%	Abnormal

TABLE 3: PERFORMANCE OF DATASET_2

Img	Sensitivity	Specificity	Accuracy	Result
Img(1)	93.103448 %	99.7622%	93.3333 %	Normal
Img(2)	89.6552%	99.6433%	90.0000 %	Normal
Img(3)	93.103448 %	99.7622%	93.3333 %	Normal
Img(4)	89.6552%	99.643282 %	90.0000 %	Normal
Img(5)	93.103448 %	99.7622%	93.3333 %	Normal
Img(15)	89.6552%	99.6433%	90.0000 %	Abnormal
Img(16)	89.6552%	99.6433%	90.0000 %	Normal
Img(17)	93.103448 %	99.7622%	93.3333 %	Normal
Img(29)	93.103448 %	99.7622%	93.3333 %	Abnormal
Img(30)	93.103448 %	99.7622%	93.3333 %	Normal
Img(40)	93.103448 %	99.7622%	93.3333 %	Normal

By above values the specificity obtained is 99% and sensitivity obtained is 93%. Overall Accuracy obtained is 93%.

SNAPSHOTS:

CASE 1: Normal retina.

The first step is to load the images from the available dataset. The image is input into the system. Retina is inputted into system in Figure 6.

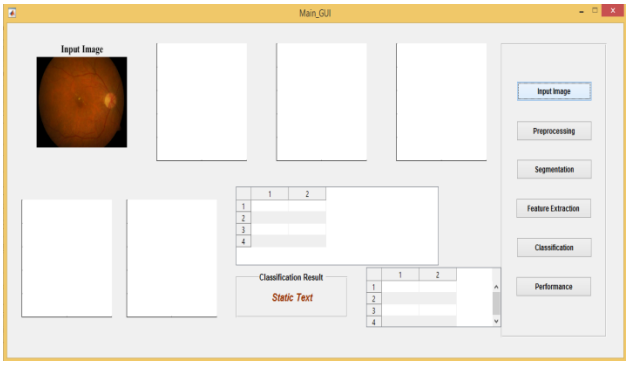

Figure 6: Input the images from the dataset

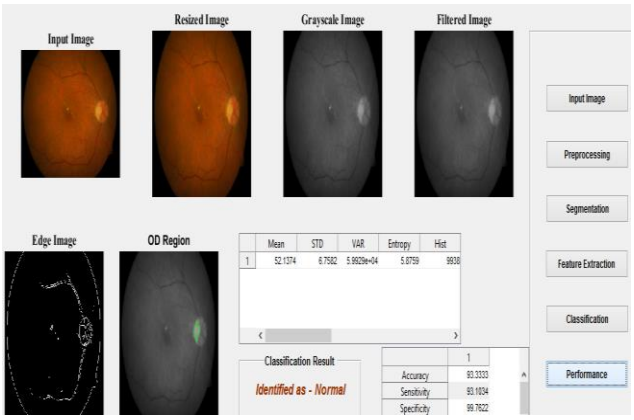

Figure 7: Image classified as normal

The result is normal retina. Performance metrics of image is tested with specificity of 99.7622%, sensitivity of 93.1034% and accuracy of 93.333%.

CASE 2: Abnormal retina

Randomly select another image from dataset and Input the image as shown in Figure 8

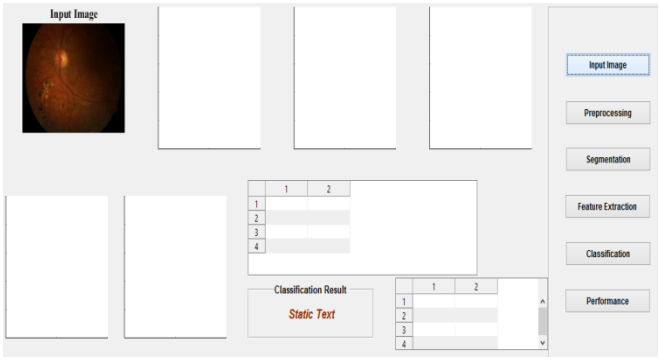

Figure 8: Input the selected image

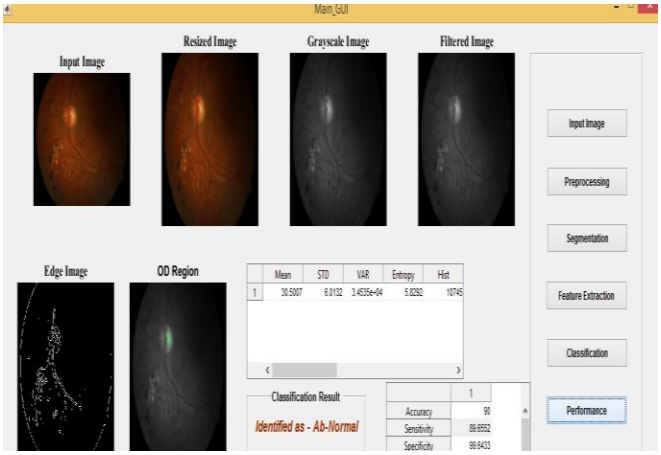

Figure 9: Image classified as abnormal

The above user interface includes all the process of screening system. The result is Abnormal Image and it is shown in Figure 9. Performance with specificity of 99.6433%, sensitivity of 89.6552% and accuracy of 90% is obtained.

V. CONCLUSION AND FUTURE SCOPE

This paper explores an approach of automatic recognition of DR in the fundus retina, which was taken from the standard datasets such as KOGGLE and DR HAGIS.

The ROI from the retinal images are extracted and better edge detection algorithm such as Sobel edge detector procedure is utilized to obtain OD region along with blood veins. Then the related local features are estimated and they are compared with the training set and target values of the system. The KNN algorithm is used for classification of normal and abnormal images. By this approach the detection becomes easy and the time taken for the detection is very less. So it proves an efficient way of retinal screening. In this disease, the most useful remedy is untimely discovery by symmetric screenings. This approach of automatic screening can benefit the eye specialists to effortlessly identify patient's condition in an exact manner.

In future enhancement,

- This work can be applied to real time live image for diagnosis. But it needs specialized fundus camera to capture the anterior position of the retina.so that related features of the retina such as optic disc, blood vessels, exudates, cotton wools and other features are recognized to identify the patient's disorder of diabetic retinopathy.
- An MRA is a test performed which helps the doctor to diagnose blood vessels of arteries and veins. As the region of diagnosis is larger than that of an eye, it needs better threshold techniques to extract the whole parts of the blood vessels on MRA data.
- If the region of diagnosis is restricted to ROI, Then this concept can be adopted to analyze the local features of MRA for each ROI.

VI. REFERENCES

[1] Kaggle.com. Diabetic Retinopathy Detection | Kaggle. [online] Available at: https://www.kaggle.com/c/diabetic-retinopathy-detection.

[2] Sven Holm, Greg Russell, Vincent Nourrit, Niall McLoughlin, "DR HAGIS—a fundus image database for the automatic extraction of retinal surface vessels from diabetic patients," J. Med. Imag. 4(1) 014503 (9 February 2017) https://doi.org/10.1117/1.JMI.4.1.014503

[3] Jesse Vislisel And Thomas Oetting, Diabetic Retinopathy: From One Medical Student To Another, September 1,2010. Available at: http://webeye.ophth.uiowa.edu/eyeforum/tutorials/Diabetic-Retinopathy-Med-Students/Diabetic-Retinopathy-medical-students.pdf

[4] Meshram, S. and Pawar, M.,"Extraction of Retinal Blood Vessels from Diabetic

Retinopathy Imagery Using Contrast Limited Adaptive Histogram Equalization". *International Journal on Advanced Computer Theory and Engineering (IJACTE)*, 2(3), pp.143-146. 2013.

[5] Changira Sinthanayothin, ViravudKongbunkiat, Suthee Phoojaruenchanachai, Apichart Singalavanija, -"Automated Screening System for Diabetic Retinopathy". Proceedings of 3rd International Symposium on Image and Signal Processing and Analysis,2003.

[6] R.Radha and Bijee Lakshman," Retinal image analysis using morphological process and iclustering technique". Signal and Image Processing : An International Journal (SIPIJ) Vol.4, No.6, December 2013.

[7] Thomas Walter*, Jean Claude Klein, Pascle Massin, Ali Erginary, -" 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.Oct 2002.

[8] Zahira AsifaTarannum, Srilatha, "Detection of Diabetic Retinopathy with Feature Extraction using Image Processing", 2Ece Department, Sri Sairam College Of Engineering,Volume -3, Issue-8 2015

[9] Kheng Guan GOH, Wynne HSU, Mong Li LEE, Huan Wang, -" ADRIS: an Automatic Diabetic Retinal Image Screening system", National University of Singapore,2001.

[10] Jerusha Lawrence1, Shiju C.Chacko2, Feba Sosa Abraham3, Sethu Rama Reddy "Automated Detection System For Diabetic Retinopathy"- 4 Electronic and Communication Department,Chennai,June 25, 2018.

[11] Carson Lam, MD1, Darvin Yi 1, Margaret Guo 2, Tony Lindsey, PhD1;AMIA Jt Summits TranslSci Proc. "Automated Detection of Diabetic Retinopathy using Deep Learning"-. 2018; 2018: 147–155.Published online 2018 May 18.

[12] Kuryati Kipli, Mohammed Enamul Hoque, Lik Thai Lim, Muhammad Hamdi Mahmood, Siti Kudnie Sahari, Rohana Sapawi, Nordiana Rajaee and Annie Joseph. "A Review on Extraction of Quantitative Retinal Microvascular Image Feature", Computational and Mathematical Methods in Medicine. Volume. 2018,Article ID 4019538.

[13] Bhavin Thakar,Suhel Patel,Vaishnavi Palod "Automatic Detection of Micro aneurysms in Diabetic Retinopathy using Python"-; 2nd International Conference on Advances in Science & Technology (ICAST-2019) K. J. Somaiya Institute of Engineering & Information Technology, University of Mumbai, Maharashtra, India,2019

[14] Ketki S. Argade ; Kshitija A. Deshmukh ; Madhura M. Narkhede ; Nayan N. Sonawane ; Sandeep Jore , "Automatic detection of diabetic retinopathy using image processing and data mining techniques"in Green Computing and Internet of Things (ICGCIoT), 2015 International Conference on 8-10 ,Oct. 2015, pp.1-6.

Cite this article as :

Shaziya Banu S, Ravindra S, "Detection of Diabetic Retinopathy by Retinal Screening using Image Processing Techniques", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 6 Issue 4, pp. 447-457, July-August 2020. Available at doi : https://doi.org/10.32628/CSEIT206483
Journal URL : http://ijsrcseit.com/CSEIT206483