

Analyzing the Severity of the Diabetic Retinopathy and Its Preventive Measures by Maintaining Database Using Gui In Matlab

Anil Kumar Neelapala, Mehar Niranjana Pakki

Abstract: Diabetic-related eye disease is a major cause of blindness in the world. It is a complication of diabetes which can also affect various parts of the body. When the small blood vessels have a high level of glucose in the retina, the vision will be blurred and can cause blindness eventually, which is known as diabetic retinopathy. Regular screening is essential to detect the early stages of diabetic retinopathy for timely treatment and to avoid further deterioration of vision. This project aims to detect the presence of abnormalities in the retina such as the structure of blood vessels, micro aneurysms and exudates using image processing techniques by automating the detection of Diabetic retinopathy (DR). This Process is achieved by the fundus images using morphological processing techniques to extract features such as blood vessels, micro aneurysms and exudates and then we calculate the area of each extracted feature. Depending on the area of each feature we classify the severity of the disease. Then finally by knowing the severity of the disease corresponding treatment measures can be analyzed. In addition to this, well established database have been developed regarding the disease analysis of patients which is implemented using GUI in MATLAB. It will surely help to reduce the risk and increase efficiency for ophthalmologists.

Keywords: Diabetic Retinopathy, Exudates, Fundus Camera, Micro-aneurysms, Morphological Operations, Segmentation.

I. INTRODUCTION

Diabetic retinopathy (DR) is one of the complications resulted from prolonged diabetic condition usually after ten to fifteen years of having diabetes. In the case of DR, the high glucose level or hyperglycemia causes damage to the tiny blood vessels inside the retina. These tiny blood vessels will leak blood and fluid on the retina, forming features such as micro aneurysms, hemorrhages, hard exudates, cotton wool spots, or venous loops U.R.Acharya (2007) et al [1].

DR affects about 60% of patients having diabetes for 15 years or more and a percentage of these are at risk of developing blindness discussed in [2]. Despite these intimidating statistics, research indicates that at least 90% of these new cases could be reduced if there was proper and vigilant treatment and monitoring of the eyes [3]. Laser photocoagulation is an example of surgical method that can reduce the risk of blindness in people who have proliferative

retinopathy [4]. However, it is of vital importance for diabetic patients to have regular eye checkups. Current examination methods use to detect and grade retinopathy include ophthalmoscope (indirect and direct) James L. Kinyoun et al [5], photography (fundus images) and fluorescein angiography. The objective of this project is to implement an automated detection of diabetic retinopathy (DR) using digital fundus images. By using MATLAB to extract and detect the features such as blood vessels, micro-aneurysms and exudates which will determine classifications: normal or abnormal (DR) eye. An early detection of diabetic retinopathy enables medication or laser therapy to be performed to prevent or delay visual loss.

II. ALGORITHM DESIGN

The automated disease identification system is not a single process. This system consists of various modules the success rate of each and every step is highly important to ensure the overall high accurate outputs. The rest of the work is organized as follows (a) Read the input image from Fundus camera, (b) Image Pre-Processing, (c) Anatomical Structure Extraction, (d) Feature Extraction, (e) Disease Severity, (f) Corresponding Treatment and (g) Maintaining Database and GUI. All these techniques are explained in the following sections.

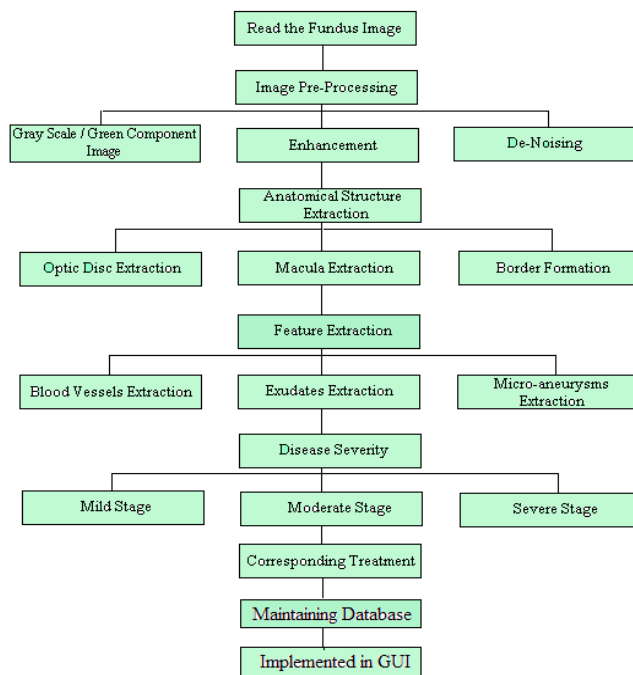


Fig.1 Algorithm processing steps

Revised Manuscript Received on 30 August 2012.

* Correspondence Author

Neelapala Anil Kumar, Department of Electronics & Communication Engineering, Vignana's Institute of Information Technology, Visakhapatnam, India.

Mehar Niranjana Pakki, Department of Electronics & Communication Engineering, Vignana's Institute of Information Technology, Visakhapatnam, India.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open access article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

III. IMAGE PRE-PROCESSING

The preliminary step in automated retinal pathology diagnosis is image preprocessing. This includes various techniques such as contrast enhancement, gray/green component, image de-noising etc. Initially we convert the RGB image into gray color image/green channel image Salvatelli A. (2007) et al [6] to further process the image. Then Image enhancement techniques are designed to improve the quality of an image as perceived by human being. Adaptive Histogram equalization is a constant enhancement technique which provides a sophisticated method for modifying the dynamic range and contrast of an image by altering that image such that its intensity histogram has a desired shape Andrea Anzalone (2008) et al [7]. The median filter is a non linear digital filter technique often used to remove noise from images or other signals. We use “*bwareaopen*” also to remove the small area of pixels considered to be noise after applying morphological operations.

IV. ANATOMICAL STRUCTURE EXTRACTION

The second step is the feature extraction technique in which suitable feature set is extracted from the enhanced retinal images. The feature extraction techniques for retinal images are broadly divided into two classes. The first category is the direct method in which the textural features are extracted from the pre-processed. The second category is the indirect method in which various anatomical structures are initially segmented from the preprocessed images and then features are extracted from these anatomical structures. These anatomical structures include macula, border formation and the optical disk.

We extract the anatomical structures like optical disk and macula using morphological opening function Daniel Welfer (2010), Cemal Kose (2008) et al [8, 9]. And using two border detection techniques for effective extraction, we extract the image border by applying morphological dilate and erode then subtracting dilate with erode image.

V. FEATURE EXTRACTION

The third step is to extract the features to detect the required features such as exudates, micro-aneurysms and blood vessels. In this process we use morphological

operations such as dilate, erode, opening and closing Dietrich Paulus (2005), Ana Maria Mendonca (2006) et al [10, 11]. After applying these operations we convert image into binary image then using logical operations ‘AND’ and ‘OR’, filters like ‘colfilt’ and segmentation we segment the exudates, micro-aneurysms and blood vessels Jagadish Nayak, Akara Sopharak (2008) et al [12, 13].

After extracting the features, by using loops we will calculate the area of each feature to know the severity of the disease.

VI. DISEASE SEVERITY





The next step is to know the severity of the disease which will be calculated depending on the area calculated from the above step. Depending on the severity we will categorize the disease into three categories such as Mild, Moderate and Severe by using ANOVA test [14].

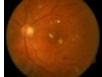







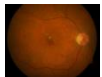







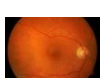











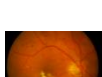



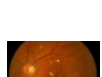



And in the final stage depending on the severity of the disease we will give the corresponding treatment to the patient. The treatments for the diabetic retinopathy are Vitrectomy, Scatter laser treatment, Focal laser treatment and Laser photocoagulation, treatments depending upon severity are gathered from Visakhapatnam government eye hospital.

VII. MAINTAINING DATABASE

After doing all the Necessary operations the disease severity and corresponding treatment, of all patients and along with patient details are Saved and maintained in the database [15,16,17]. The following table shows the patients details, in that we maintain patient’s name, and for uniqueness we used patient’s phone number. Then as an input we give the patients input image for processing, after processing we get patient’s corresponding segmented images of blood vessels, micro-aneurysms and exudates. Then in the processing of image we calculate area of all the extracted features also. Then by depending on that area we should notify the severity of the disease and corresponding treatment details to the patient. All the patient’s disease severity and treatment details for 10 patients are shown in the following table 1.

Table I: The table shows all the patient details, patient’s disease severity and corresponding treatment.

S.No	Patient Name	Patient Phone Number	Patient Input Image	Blood Vessels	Exudate	Micro-aneurysms	Disease Severity	Corresponding Treatment
1.	Ganesh	7396069927					Mild	Laser PRP Treatment

2.	Srinu	8885384318					Moderate	Vitrectomy
3.	Mahesh	9700370745					Severe	Laser Photocoagulation
4.	Lalitha	9985536700					Moderate	Vitrectomy
5.	Surya	9908026375					Severe	Laser Photocoagulation
6.	Rahim	9908026375					Mild	Laser PRP Treatment
7.	John	8483864467					Severe	Laser Photocoagulation
8.	Williams	7726798340					Moderate	Vitrectomy
9.	Rohit	9848693260					Severe	Laser Photocoagulation
10.	Chan Lee	9497921875					Moderate	Vitrectomy

VIII. IMPLEMENTING IN GUI

All the details are implemented in GUI in MATLAB[18] for all patients. While implementing in GUI first we create a Main GUI which consists of some important push buttons like Add Patient, Patient Database, Search Patient, Delete Patient, Clean Database, Main Page and Exit. When we click on any button then corresponding GUI will be called from Main GUI except Exit push button. If we click on Exit Push button the dialogue box open whether to exit or not. The Main GUI is shown in the following figure 2.

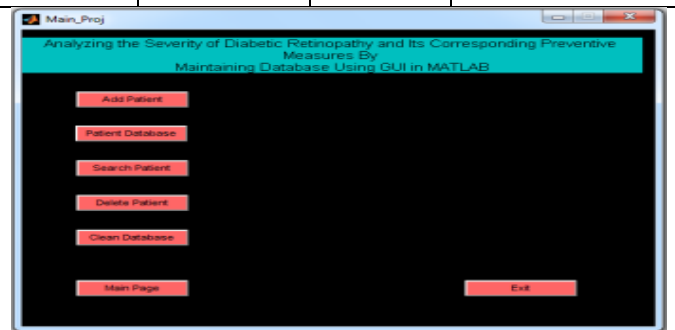


Figure (1) Main Page GUI to add patient details, analyzing the disease severity, searching, deleting and cleaning patient details

Fig.2 GUI for Main Page to add patient details, analyzing the disease severity, searching, deleting and cleaning patient details

When we click on the Add Patient push button in the main page GUI then immediately Add Patient GUI will be called. In this Add patient GUI we two main push buttons one for entering patients details like patient's name, patient's phone number and read the patient's image. Then another push button to analyze the disease, extraction of the features, calculating area, to know disease severity and to indicate corresponding treatment. All these information will be displayed in the text fields. And patient's input image, extracted features like exudates, blood vessels and micro-aneurysms are shown in figures. Along with the above said push buttons we have three additional buttons to return to the Main GUI, to clean the text fields and axis and Exit button. After we enter and analyze one patient, we can add another patient and like that we can add and analyze any number of patients. Then if we want to return to the Main GUI we can click on the Main page push button then immediately this GUI calls Main Page GUI. Otherwise we can directly exit from this GUI by clicking on Exit push button. This GUI is shown in the following figure3.

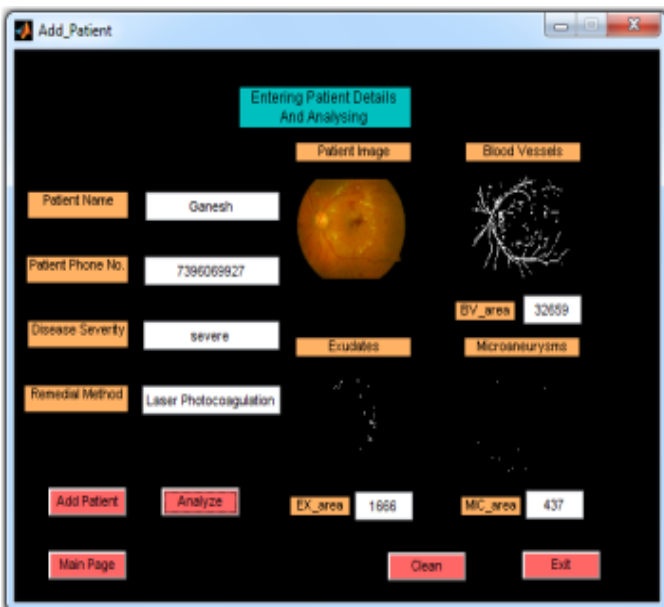


figure (2) Entering patient details and analyzing disease severity

Fig.3 GUI for entering patient details and analyzing disease severity

Then after entering patients details, analyzing disease and return to Main page GUI we have another button i.e., Patients Database if we click on this button then immediately the Main page GUI calls the Patients Database GUI. In this GUI we have three main push buttons to see the patients details, Next and Previous push buttons to see all the patients database. When we click on the Patient Database push button we get the first entered patient's details like patient name, patient phone number, disease severity and corresponding treatment. And if we click on the Next push button we get the details of next patient like that if we click on Previous push button we get previous patient details. As like before GUI we have another three push buttons to return to main page, to exit from this GUI and to clean the text fields, all of them works as in previous GUI which are explained in the above fig.3. This GUI is shown in the following figure 4.

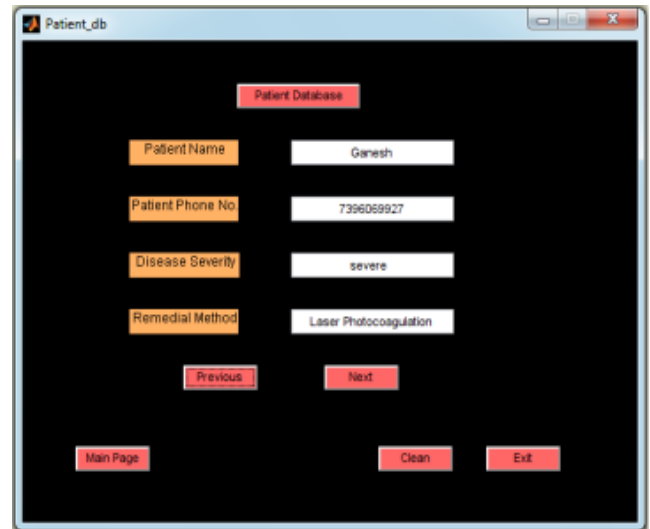


figure (3) Patient Database which contains all the patients details

Fig.4 Patient Database which contains all the patients details

After we see all the patients details and return to the main page GUI we have another push button i.e., Search Patient button. This is used to search the particular patient details whether the patient is there or not. In this GUI we have one important push button to search patient details i.e., Enter Patient Details when we click on this button a dialogue box will be open it asks for the patient name then immediately it asks the patient enrolled phone number because there may be the patient with same name so for uniqueness we ask for patient phone number also. Then if both name and phone numbers are matched with anyone of the patient who are present in the database the those patient's corresponding disease and treatment will be displayed on the text fields. If both name and phone number are not matched with any patient then a dialogue box will display 'NoPatient'. Like that we can search any number of patients. As like in the above GUI we have three common push buttons to return main page, to clean text fields and to exit. This GUI is shown in the following figure5.

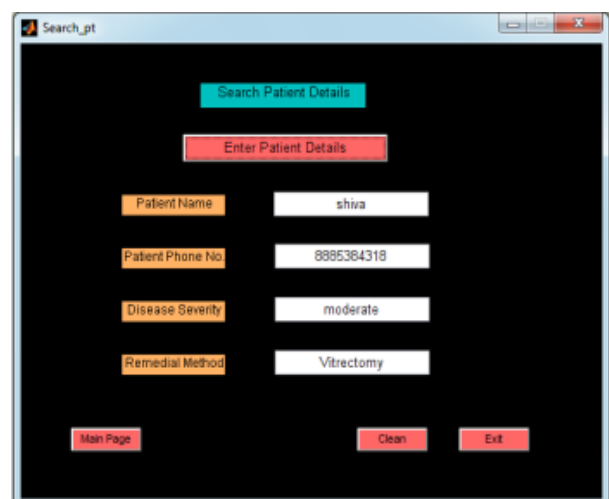


figure (4) searching patient details successfully

Fig.5 GUI to search patient details

In Main GUI we have another important push button i.e., Delete Patient button, which is used to delete the required or unwanted patients details. When we click on the Delete Patient push button then immediately Main GUI calls the Delete Patient GUI, in this GUI we have Delete Patient push button when we click on this button we get a dialogue box to enter the patient name to delete but along with patient name we ask for phone number also because same name patients may exist. After checking both the name and the phone number successfully it delete the patient if exists otherwise it shows the dialogue box that patient not there. In this GUI we have two additional push buttons to return to main page and to exit from this GUI directly. This GUI is shown in the following figure6.

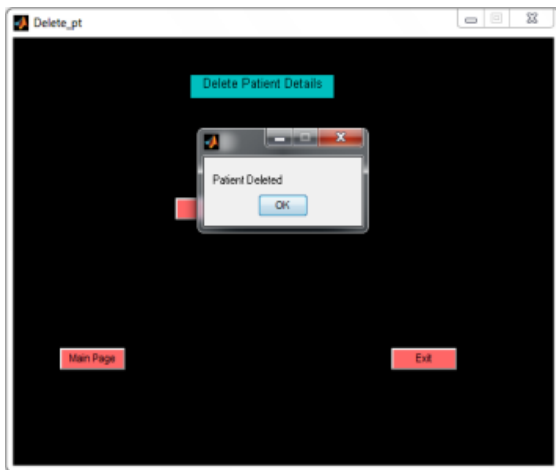


figure (5) Deleting patient details successfully

Fig.6 GUI to delete unwanted Patient details

And another push button is to delete all the patient’s details i.e. to clean all patients database in Main GUI. This push button is used to remove all the patients details when we click on this button and it asks for conformity whether to delete permanently or not then if we click on the yes button it will clean whole database. This GUI is shown in the following figure7.



figure (6) Cleaning patients database successfully

Fig.7 GUI to clean Database of all patients

IX. CONCLUSION

In summary, a medical system for the automatic diagnosis of the primary signs of Diabetic Retinopathy (DR) has been developed by maintaining the database which addresses the severity and preventive measures. The results demonstrated with the various samples of DR eye and this algorithm proven to be well suited in complement the screening of DR helping the ophthalmologists in their daily practice.

ACKNOWLEDGMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

I would like to express my special gratitude and thanks to T. JYOTHIRMAYI, M.SC (OPHTHAMOLOGIST), Visakhapatnam government hospital.

REFERENCES

1. U R Acharya, C M Lim, E Y K Ng, C Chee and T Tamura. ‘Computer-based detection of diabetes retinopathy stages using digital fundus images’.
2. Singapore Association of the Visually Handicapped. http://www.savh.org.sg/info_cec_diseases.php.
3. What is Diabetic Retinopathy? <http://www.news-medical.net/health/What-is-Diabetic-Retinopathy.aspx>.
4. Diabetic Retinopathy. <http://www.hoptechno.com/book45.htm>.
5. James L. Kinyoun, Donald C. Martin, Wilfred Y. Fujimoto, Donna L. Leonetti. Ophthalmoscopy Versus Fundus Photographs for Detecting and Grading Diabetic Retinopathy.
6. Salvatelli A., Bizai G., Barbosa G.Drozdownicz and Delrieux (2007), ‘A comparative analysis of pre-processing techniques in colour retinal images’, Journal of Physics: Conference series 90.
7. Andrea Anzalone, Federico Bizzari, Mauro Parodi, Marco Storage (2008), ‘A modular supervised algorithm for vessel segmentation in red-free retinal images’, Computers in Biology and Medicine, Vol. 38, pp. 913-922.
8. Daniel Welfer, Jacob Schacanski, Cleyson M.K., Melissa M.D.P., Laura W.B.L., Diane Ruschel Marinho (2010), ‘Segmentation of the optic disc in color eye fundus images using an adaptive morphological approach’, Journal on Computers in Biology and Medicine”, Vol. 40, pp. 124-137.
9. Cemal Kose, Ugur Sevik, Okyay Gencalioglu (2008), ‘Automatic segmentation of age-related macular degeneration in retinal fundus images’, Computers in Biology and Medicine, Vol.38, pp. 611-619.
10. Dietrich Paulus and Serge Chastel and Tobias Feldmann (2005), ‘Vessel segmentation in retinal images’, Proceedings of SPIE, Vol. 5746, No.696.
11. Ana Maria Mendonca and Aurelio Campilho (2006), ‘Segmentation of Retinal Blood Vessels by Combining the Detection of centerlines and Morphological Reconstruction’, IEEE Transaction on Medical Imaging, Vol. 25, No. 9, pp. 1200-1213.
12. Jagadish Nayak, Subbanna Bhat (2008), ‘Automated identification of diabetic retinopathy stages using digital fundus images’, Journal of medical systems, Vol.32, pp. 107-115.
13. Akara Sopharak, Bunyarit Uyyanonvara, Sarah Barman, Thomas H.Williamson (2008), ‘Automatic detection of diabetic retinopathy exudates from non-dilated retinal images using mathematical morphology methods’, Computerized Medical Imaging and Graphics, Vol. 32, pp. 720-727.
14. ANOVA test for severity of disease. http://afni.nimh.nih.gov/pub/dist/HOWTO/howto/ht05_group/html/background_ANOVA.shtml
15. ‘Save’ function in matlab. <http://www.mathworks.in/help/techdoc/ref/save.html>
16. ‘Load’ function in matlab. <http://www.mathworks.in/help/techdoc/ref/load.html>
17. ‘strvcat’ function in matlab. <http://www.mathworks.in/help/techdoc/ref/strvcat.html>
18. Graphical User Interfaces (GUIs) Matlab, <http://www.mathworks.com>

AUTHOR PROFILE



Neelapala. Anil Kumar has Obtained B. Tech. in ECE Department from JNT University, Hyderabad and ME in Electronic Instrumentation (EI) from Andhra University, Visakhapatnam. He has Seven years of teaching experience, presently working at Vignan's Institute of Information Technology, Visakhapatnam, as Assistant Professor in Department of ECE. His Areas of interests are bio medical instrumentation and image processing.



Mehar Niranjana Pakki is pursuing his M. Tech degree in the Department of Electronics & Communications, Vignan's institute of Information and Technology, Duvvada. His Areas of interests are bio-medical and image processing.