International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 3 Mar. 2021, pp: 230-237 www.ijaem.net ISSN: 2395-5252

Diabetic Retinopathy Detection Using Retinal Images

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Submitted: 25-02-2021 Revised: 05-03-2021 Accepted: 10-03-2021

ABSTRACT - People with diabetes can have this disease. This is caused when sugar levels cause damage to blood vessels in the retina. These blood vessels can swell and leak. It is the most common reason of vision loss among people with diabetes and the leading cause of vision loss and blindness among working-age people. Here we have proposed a system where with the use of extracted retinal blood vessels, eye disease can be detected. At first retinal blood vessels from images are being extracted. Then noise and environmental interference from image are removed using filtering methods. Local entropy thresholding for segmentation of image has been adopted in this system. User will input retina image into system. System applies filtering techniques. Image pre-processing procedures are applied to get accurate and clear result. All unwanted objects from image are removed. System will apply algorithm to extract retinal blood vessels. Finally diabetic retinopathy is detected.

Keywords–Diabetes, retina, blindness, filtering, retinal images, retinal blood vessels, diabetic retinopathy, proliferative, non-proliferative

I. INTRODUCTION

The whole world is still concerned and tries to give maximum efforts to the screening methods to cure the dangerous eye ailment defect like Diabetic Retinopathy. Anyways, many difficulties arise while trying to implement these kind of methods in the process of identifying the defect with much accuracy and precision. Diabetic retinopathy (DR) is a defect with an increasing prevalence and the main reason of blindness among working-age people. It is a complication of diabetes which mainly affects the eye. It is caused by damage to the blood vessels in the tissue at the back of retina. The risk of severe vision loss can be significantly minimised by timely diagnosis and treatment. This defect is a condition caused due to extreme severity of diabetes mellitus. The severity of this defect is based on the glycemic control levels and the duration of diabetes in the person.

Systematic screening for DR has been recognised as a cost-effective way to save health services resources. Automatic retinal image analysis is appearing as an important screening tool for early DR detection, which can reduce the workload related to manual grading as well as save diagnosis costs and time. Many research efforts in the last years have been done for developing automatic tools to help in the detection and evaluation of DR lesions.

The damaged blood vessels are proven to be highly harmful as it leads to blindness cases in adults. In the earlier stages of DR, some symptoms are floaters, difficulty in identifying colours and sometimes complete colour and vision loss. Now, the two advanced types of DR are identified as Proliferative Diabetic Retinopathy and Non Proliferative Diabetic Retinopathy. And the only way to cure these would be early diagnosis and detection of the defect.

Screening for DR and monitoring disease succession, especially in the early asymptomatic stages, is effective for preventing visual loss and reducing costs for health systems. Most screening programs use non-mydriatic digital colour fundus cameras to acquire colour photographs of the retina. These photographs are then examined for the presence of lesions indicative of DR, including micro-aneurysms (MAs), haemorrhages (HEMs), exudates (EXs), and cotton wool spots (CWSs). In any DR screening program, about two-third of patients have no diabetic retinopathy defect. The implementation of automated image analysis to digital fundus images may reduce the workload and costs by minimizing the number of photographs that need to be manually graded.

In this proposed system, a DR detection technique has been developed, where the fundus image has been obtained from patient's retina. Here, a CNN based system has been utilized for analyzing the fundus image that are captured via Peek retina attached on smartphone camera lens. This proposed work aims at segmenting the fundus image into Exudates, Micro aneurysm, Optical Disk and hemorrhage and examine whether the retinal condition is in Proliferative /Non-proliferative DR stage.

II. LITERATURE SURVEY

Diabetic Retinopathy Detection Using Matlab - Hamood Ali Hamood Al shamaly, Sumesh E P, Vidhyalavanya R, Jayakumari C – This paper provides an MATLAB based analysis and classification of the fundus into Exudates, Micro aneurysm, Optical Disk and haemorrhage. It also examine the proliferative and non-proliferative stages of DR. For the purpose, morphological operations such as erosion and dilation were also done. This proposed mechanism observed 98% accuracy in the detection DR within a period of 39 seconds.

Symptom Analysis of Diabetic Retinopathy by Micro-Aneurysm Detection - Tajbia Karim, Md. SalehinRiad, RehnumaKabir – This proposed work utilized MATLAB Neural Network Pattern Recognition (NPRTOOL)) with misclassification rate as 43.7% which is a huge improvement compared to SVM classifier and Naïve-Bayes method which exhibit misclassification rate of 46.6% and 49.6%. It is found to have 61.6% sensitivity, whereas SVM classifier method provided 5.8% and Naïve-Bayes had 54.8% of sensitivity. On the other hand, SVM classifier and Naïve-Bayes method provide 42.85% and 44% specificity respectively. Also sensitivity rate of the proposed method is 61.6%. 26.3% accuracy is achieved which is greater than SVM classifier and Naïve-Bayes method having 53.3% and 50.4% accuracy. Based on sensitivity and accuracy, the proposed method provides satisfactory results.

Automatic Diabetic Retinopathy Detection Using Digital Image Processing - Kranthi Kumar Palavalasa and BhavaniSambaturu – In this approach, the exudates are detected using the combination of back ground subtraction of fundus image, exudate candidate extraction and other anatomy detection. Compared to the rest of the state of art segmentation techniques the proposed method can identify the hard exudates present in the fundus images with easy and acceptable sensitivity and accuracy. An improvement in the performance could be achieved by using the machine learning based approach with selection of proper features for the exudates.

Diabetic Retinopathy Detection by Extracting Area and Number of Micro-aneurysm from Colour Fundus Image - Shailesh Kumar and Basant Kumar - This method presented an improved scheme for the detection of diabetic retinopathy by accurate determination of number and area of micro-aneurysm. The achieved value of sensitivity and specificity shows that the proposed diagnostic system is better for non-proliferative diabetic retinopathy detection.

Automated detection of diabetic retinopathy using Support Vector Machine - Enrique V. Carrera, AndresGonzalez and Ricardo Carrera – Some of the efficient algorithms for the detection of blood vessels,

microaneurysms, the optic-disc, and hard exudates has been proposed. The proposed features show a great potential for DR detection and classification. SVM can detect DR with a sensibility of almost 95%, with an average accuracy of 85%. SVM consistently shows better results that other machine learning algorithms.

Diabetic Retinal Fundus Images: Preprocessing and Feature Extraction for Early Detection of Diabetic Retinopathy - Dilip Singh Sisodia, Shruti Nair and PoojaKhobragade **-** In this method, pre-processing and feature extraction of the diabetic retinal fundus image was done for the detection of diabetic retinopathy using machine learning techniques. The pre-processing techniques such as green channel extraction, histogram equalization and resizing were performed using DIP toolbox of MATLAB. The images were divided into two characteristic datasets, one was a normal stimulus, and the other was diabetic affected retinal images. The total 14 biologically different features are extracted from normal and diabetic retinal fundus image data sets. Out of the total extracted features, seven most characteristic features are used for comparison and ranking these features is very simple and fundamental in the process of identifying a normal and a diabetic fundus image.

Detection of retinal blood vessels and reduction of false micro-aneurysms for diagnosis of diabetic retinopathy - Rahul Chauhan, Anita Uniyal and V.P Dubey – This system focusses on micro-aneurysms detection using Gabor filter with thresholding factor which show better performance only when Gabor filter is used. At different values of sigma we get different results .Changing the parametric value and analysing the result. Selection of sigma involves a trade-off. Larger values are more robust to noise but more likely to create spurious rings and smaller values in the resultant image.

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Automated Detection of Neovascularization for Proliferative Diabetic Retinopathy Screening - Sohini Roychowdhury1, Dara D. Koozekanani2 , and Keshab K. Parhi - In this system, optimal feature sets for classification of major vessel segments in the Optic disk region and minor vessel segments has been identified. It is observed that for NVD classification, vessel structural features as well as intensity-based features from morphologically enhanced fundus images are more discriminating to detect DR.

Comparative study of imaging transforms on diabetic retinopathy images - Rakshitha T R, DeepashreeDevaraj, Prasanna Kumar S.C. - In this study, three enhancement techniques has been analysed and the comparison of all the three techniques has been computed by using PSNR. The transformation techniques used are as follows: Wavelet Transform, Curvelet Transform and Contourlet Transform. The main problem in wavelet is, with the missing data while reconstructing the image and those data cannot be regained. In case of curvelet transform, the image is improved and it helps to amplify the noisy images but it loses its geometric shape and information and later it is very difficult to identify the edges and the noises in the image. These are the drawbacks faced in these two transforms. Hence the Contourlet Transform is introduced to overcome the drawbacks of these two transforms and this technique gives the better performance when compared to the other two transforms.

III. EXISTING SYSTEM

Most screening programs use digital color fundus camera to acquire color photographs of the retina. These photographs are then examined manually, for the presence of lesions in the retinal area. This method was very time consuming and it requires specialized persons for examining the photographs and find whether the person is infected or not. So then the application of automated image analysis came into picture, which tends to reduce the workload and costs by minimizing the number of photos that needs to be manually examined.

Generally these are systems that are proposed for detecting the Diabetic retinopathy defect using the retinal images that are provides as input to the system. And there are separate systems that are used to detect DR based on different characteristics like exudates, micro-aneurysm, optical disk and hemorrhage. Our idea is to develop a system that also detects DR and examine the stage of the disorder whether it is in Proliferative or Non-proliferative stage.

IV. PROPOSED SYSTEM

We have proposed a classificationtool which will be helpful in identifying the disorder with maximum accuracy. The system applies filtering techniques and detects the diabetic retinopathy defect. Based on the severity of the defect, it is identified whether it's in proliferative or non-proliferative stage and displays the results to the users.

For image classification process, we have used Convolutional Neural Network and implemented VGG16 model. The images are processed followed by check constraints for over-fitting and under-fitting processes. Then image segmentation takes place, which helps in the accurate detection of the important characteristics such as exudates, micro-aneurysms, hemorrhages and optic disk.

A. Flow Chart

The flowchart shows the graphical representation of the sequence of functions involved in the proposed system. Firstly the fundus images are given as input to the system which will go through pre-processing stages and then detect the morphological features present in images. Finally based on the extracted features, the disease is classified and result is obtained.

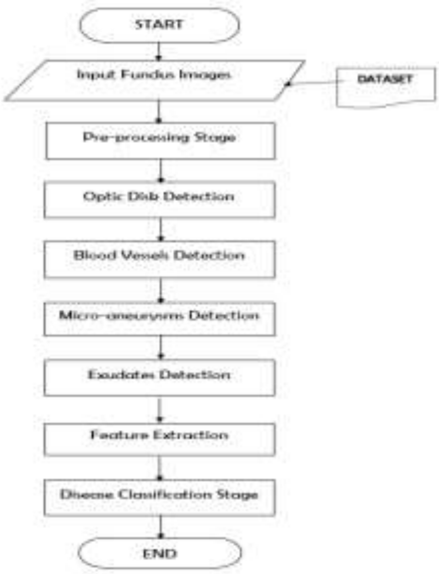

Fig 1: Flow Chart

B. Use Case Diagram

Use case diagrams identify the functionalities provides by the use cases, the actors who interact with the system and the association between the actors and the functionalities. The Use Cases in this system are:

- Uploading the Retinal fundus images to the system.
- Viewing the lesions caused in the patient's retinal area.
- Viewing the stage and severity of the disorder caused in the patient's retinal area.
- Viewing the type of the disorder based on the distinct features.

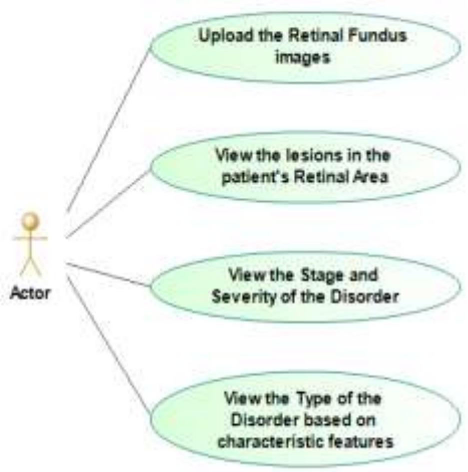

Fig 2: Use Case Diagram

C. Sequence Diagram

The sequence of the executions within the system are in the following order:

- At the initial module, the input images undergo acquisition process where the various vision based tasks processes and normalises the image.
- Next the pre-processing has to be done in order to attain perfect resolution of the input image. This can be obtained by resizing the input image.
- Then an automated unsupervised blood vessel segmentation based methodology has been utilized to enhance the features of the image. By removal of anatomical components, we can get a clear image. It then detects the pathological features and displays the result to the user.

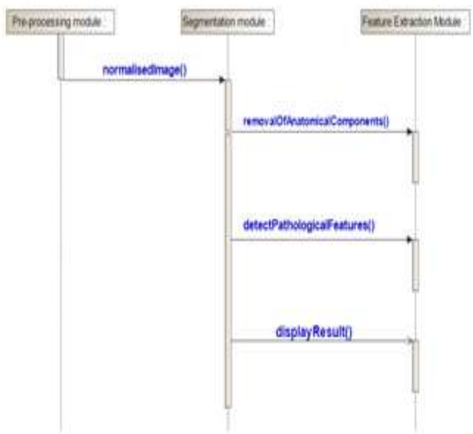

Fig 3: Sequence Diagram

D. State Diagram

The below state chart diagram describes the flow of control from one state to another state (event) in the flow of the events from the creation of an object to its termination.

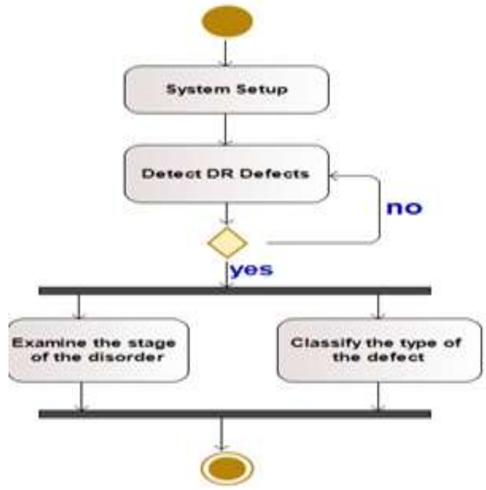

Fig 4:State Diagram

V. WORKING PRINCIPLE

The given block diagram shows the pictorial representation of the working principle of this tool. The system comprises of four different modules namely acquisition module, segmentation module, feature extraction module and classification module.

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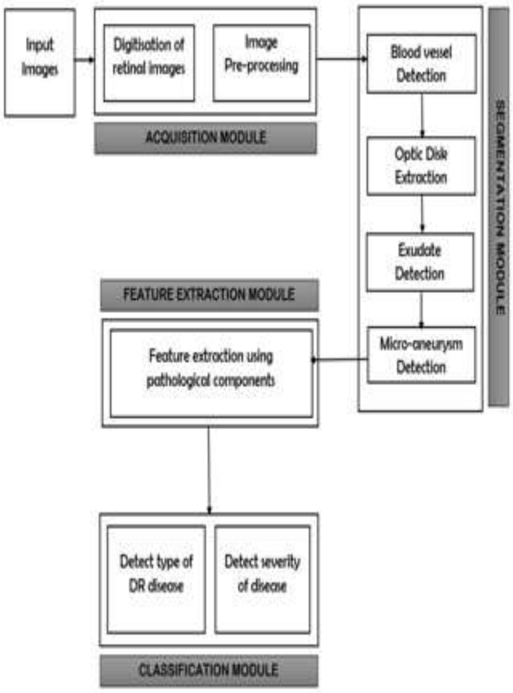

Fig 5: Block Diagram

At the initial module, that is the Acquisition module, the input images are digitized and pre-processed to attain perfect resolution. Then these images are stored for undergoing the further processes.

In the next module, that is the Segmentation module, segmentation process takes place in order to detect and differentiate based on the important classifying characteristics such as micro-aneurysm, exudates, hemorrhages and optic disks. These morphological characteristics are helpful in segmenting the images using an unsupervised blood vessel segmentation methodology. Also in some exceptional cases, some morphological operations such as Dilation (process of adding pixels to the image; makes the object to be more visible) and Erosion (remove pixels from the object boundaries) are done to get much better accurate results.

In the Feature Extraction module, the important features are extracted using the pathological components and then it is classified into the types and severity of the defect whether it's in Proliferative or Non-Proliferative Diabetic Retinopathy stage. After all these stages, the end result is shown to the user.

VI. EXPERIMENTAL SETUP

In this experiment, Python IDE version 3.9 or higher should be installed and executable. High package libraries such as Keras, Tensorflow, Matplotlib and Scikit should be installed in a runnable interface. Also the CNN network VGG16 model should be installed which is used for feature extraction. The input images are stored in a working directory file and set ready for training procedure.

VII. RESULTS

As a result, our system can able to fetch the images from the database and predict the result, whether the person is affected with Diabetic Retinopathy or not.

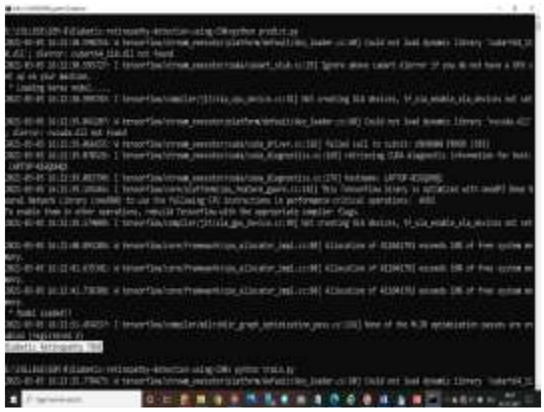

Fig 6: Project output

In the above Figure, the Keras model VGG16 is loaded and it shows the result as the fetched image is true for the label Diabetic Retinopathy. The below screenshots will elaborate the process of model training and testing process.

Fig 7: VGG16 model loaded

We have classified the datasets as three files, training, testing and valid for easy classification. The two labels provided for classification are dr and nodr. Image Data Generator

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is the chosen pre-processing function with softmax activation function. The images are loaded into the VGG16 Keras model which then undergoes through Maxpooling and Convulution functions.

Fig 8: VGG16 model – test labels

Fig 9: VGG16 model - parameters

Basically the images fed into the system are three dimensional figures. For attaining more clarity and resolution, an extra dimension is added. Hence the column output shape consists of four values. The images are trained one by one based on different layers of maxpooling and convolution. The system keeps on eliminating the unwanted features such as tissues and blood vessels, in the dense layer and finally extracts the morphological features for classification.

Fig 10: Features extracted in dense layer

There are five Epoch (number of iterations of the entire training dataset the machine learning algorithm has completed) in this process. Starting with epoch 1, it is trained in a duration of 29s with an accuracy of 0.5250. At the end of Epoch, that is epoch 5, the duration taken to train the datasets is 22s with an accuracy of 0.5750.

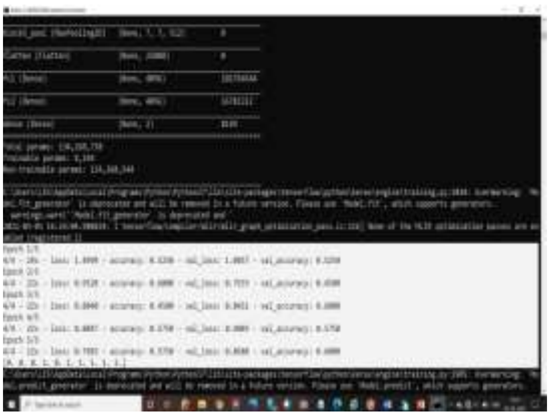

Fig 11: Epoch loss and accuracy

Fig 12: Confusion Matrix

VIII. CONCLUSION

The Diabetic Retinopathy is regarded as a very threatening optic disorder, which if left undiagnosed, leads to permanent blindness. Hence the only effective method, to cure this defect, would be timely monitoring of the retinal area. This defect could be very well cured, if treated at its early stages.

Manual screening, would be a disadvantage, because the identification of retinal lesions is really challenging for the ophthalmologists. Hence with the use of an automated system for the detection of Diabetic retinopathy, we can detect the disease in an efficient manner. Generally, there are automated systems that are proposed for detecting the retinal defects. But it detects the disease through some characteristics they are exudates or micro-aneurysms.

Our projectis an analysis of a model to identify the severity of Diabetic Retinopathy from Fundus Photographs. Our method performed well in comparison to other methods.It is a fact that the better and accurate the diagnosis, the more exact will be the treatment plan. So diagnostic measures should aim towards accuracy for an effective treatment regimen. In our study we were able to establish a good accuracy in the diagnosis results.

Our proposed system detects the disease through all the four main characteristic features i.e. haemorrhages, exudates, micro-aneurysm and optic disk. It also classifies the defect based on its severity and type as Proliferative and Non-Proliferative Diabetic Retinopathy. Also, our system classifies the defect with good precision and accuracy.

IX. FUTURE WORKS

In future we would like to improve the accuracy of the system in detecting the Diabetic Retinopathy defect so that the results are more accurate and clear.Also,we would like to make the whole toolaccessible as a web or mobile application so that it provides a much more user friendly and integrated platform.

ACKNOWLEDGEMENT

The authors are deeply grateful to The Honourable Principal and Faculties of Sri Ramakrishna Institute of Technology, Coimbatore for providing the necessary support, guidance and facilities for the preparation of this paper.

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International Journal of Advances in Engineering and Management
ISSN: 2395-5252

IJAEM

Volume: 03 Issue: 03 DOI: 10.35629/5252

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