DETECTION OF MIRCOANEURYSMS IN DIABETIC RETINOPATHY USING IMAGE PROCESSING AND PYTHON

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Abstract - *Diabetic retinopathy (DR) is one of the most common reasons for blindness in the working-age population of the world. Diabetic Retinopathy is an eye disease, which occurs with long-standing untreated diabetes. Progression to vision impairment can be slowed down or stopped if DR is detected on time; In detection or screening of DR, automatic methods can play an important role. A microaneurysm is a tiny aneurysm, or swelling, in the side of a blood vessel.*

People with diabetes, microaneurysms are sometimes found in the retina of the eye. These miniature aneurysms can rupture and leak blood, hence the purpose of our project is to detect the microaneurysms which is the initial stage of Diabetic retinopathy so that we could prevent blindness. We have accordingly designed our algorithm to detect microaneurysms and tested it on a publicly available DiaretDB1 database, which contains the ground truth for all images. For the detection of Micro aneurysms we will be following the given steps, image acquisition, green channel and CLAHE, sequential filtering , blood vessel detection, BV extraction from the image, thresholding and after the micro aneurysms will be detected.

Key Words: Diabetic Retinopathy, Microaneurysm, Hemorrhages, exudates.

1. INTRODUCTION

Health and medical services in rural areas are unsubstantial compared to urban areas due to inadequate tools or medical application that can be installed in rural areas. Diabetes is the disease which is of great concern as according American Diabetes Association, the global prevalence of diabetes was estimated to be 2.8% in 2000 whereas it is estimated to be 4.4% in 2030[1]. In India alone, 70 million people suffer from diabetes mellitus, and this number is projected to increase in the future[2]. Diabetic retinopathy is a condition when high blood sugar levels cause damages to the blood vessels in the retina which in turn result in loss of vision. The disease is related to diabetic retinopathy-Microaneurysms, Exudates, Hemorrhages and Glaucoma. Microaneurysms is an initial stage of diabetes when the blood vessels start swelling and leaking blood. Microaneurysms are small circular structures with a size ranging from 10u-135u which is very complicated and laborious to detect with the human eye[3,4,5]. MA's are the only lesions present at the earliest stage of the disease and continue to be present at the later stages. Early detection of DR is dependent upon the accurate identification of microaneurysms. This project demonstrates the development of GUI application by inputting color fundus image and using image processing getting the MA's and Exudates detected output for immediate diagnosis. Through this model, it will be easier to diagnose a patient suffering from MA's or Exudates.

2. LITERATURE REVIEW

[1] proposed ensemble-based framework to detect microaneurysm. They provide a framework to select the best combination of MA candidate extractors.

In [3] uses the watershed transform to catch MA and non-MA candidates in their catchment basin region.

Keerthi Ram et al. [5] detect MA based on clutter by comparing the probability of occurrence of target.

In [6] Seoud et al. used a set of dynamic shape features for MA detection. Their method does not require precise segmentation of the candidates for detection.

Niemeijer et al. [7] proposed a red lesion candidate detection system based on pixel classification. They used both the morphological method as well as a pixel classification technique to detect MAs.

Adal et al. [8] proposed a method based on finding blobs like regions from an image to automatic selection of MA. Wu et al. [9] used 27 characteristic features which contain local features and profile features, extracted for the KNN classifier to distinguish true MAs from spurious candidates.[16]

In [10] Walter et al. also detect MA, based on automatic classification technique[16].

3. PROPOSED SYSTEM

First we will take a fundus image of an eye. Then from the RGB component of an image we will extract the green channel because in green channel we get more contrast as compare to red and blue channel. Then to enhance the image we have performed contrast limited adaptive histogram equalization (Clahe) followed by sequential filtering to get the vessels and background together. To detect the vessels we have used contours. Then to get the background of an image we have removed the blood vessels to get MA candidates and noise.. By using thresholding on the basis of intensity we got many candidates For MA and then using area perimeter we have detected the MAs.
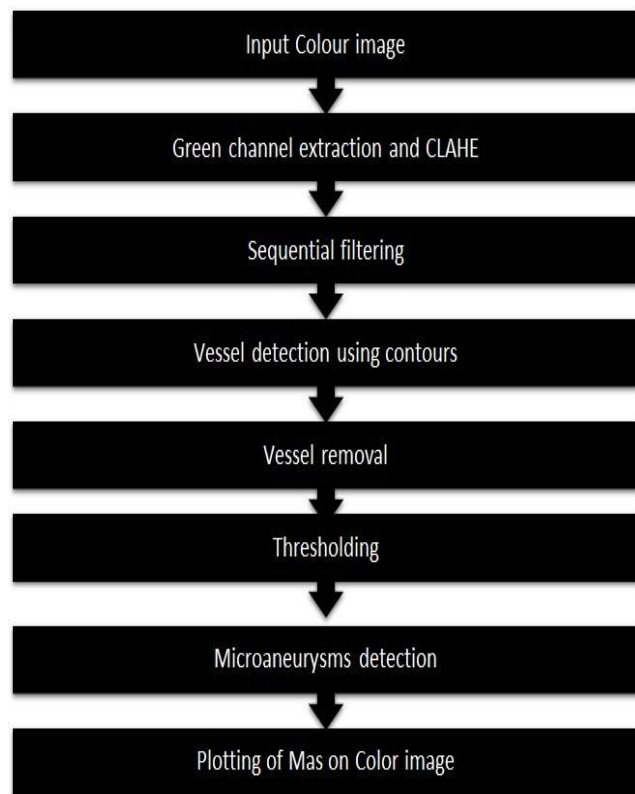

Fig.1 : Flow chart of the proposed system

3.1 Input Color Image

For the detection of diabetic retinopathy, we initially took an image of the patient's eye. This is a fundus image that has Micro aneurysms ,exudates and hemorrhages present in it. This colored image is then given as an input to our system. Fundus image is basically the rear image of the eye. It is the interior surface of the eye and consists of macula , fovea, and posterior pole , retina and optic disc. This colored image is then further given as an input for green channel extraction.
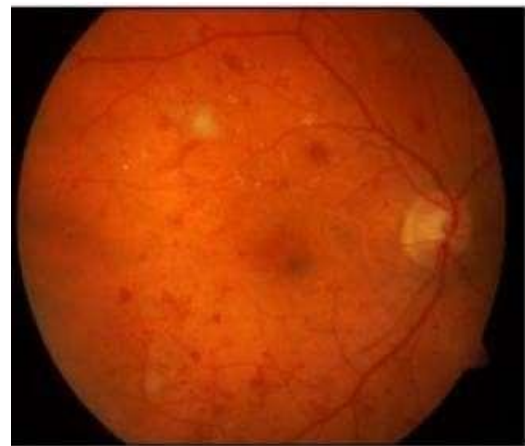

Fig.2: Input Color image

3.2. Green Channel Extraction and CLAHE

In preprocessing, the colored image is given as an input, the green channel of the image is extracted. The retinal images are usually low contrast images. Microaneurysms are clearly visible in the green channel due to high contrast.

Preprocessing is performed in order to enhance the contrast of the green channel. Green channel is alone extracted from this concatenated RGB and CLAHE (Contrast Limited Adaptive Histogram Equalization) is done on that in order to improve the contrast on tile level.

clahe=cv2.createCLAHE(cliplimit=2.0,titleGridSize=(8, 8))

cliplimit is set to 2 for the contrast enhancement for the grid of matrix(8,8).
Thus at the end of the preprocessing the images are equally illuminated and contrast is enhanced.
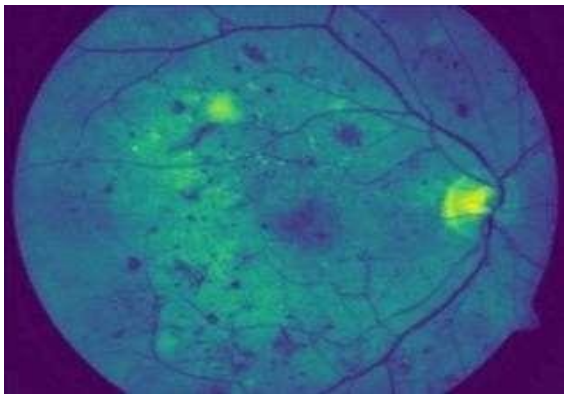
Fig.3: Green Channel; and CLAHE

3.3. Sequential Filtering

The output of green channel and CLAHE is then further given for the sequential filtering. Sequential filtering is one of the most fundamental operations of image processing and can greatly improve image quality and yield information that otherwise would have been missed. You should note that some filters are known for detecting or preserving edges, while others are typically used for smoothing or denoising. Filter performance is dependent both on the input image and on the parameters selected for filtering, such as kernel shape and size, iterations, and interpretation. Sometimes the best results may be obtained by applying two or more filters sequentially. For example, you may need to preserve edges while smoothing uniform yet noisy areas. In the Image Processing panel, you can simply add sequential filtering operations to create a composite filter. However, you should be careful to note your order of operations as some filters may be contradictory and may not always be simply applied sequentially. Hence we use sequential filtering for the images after the green channel extraction and CLAHE. This enhances the image and the noise is removed.
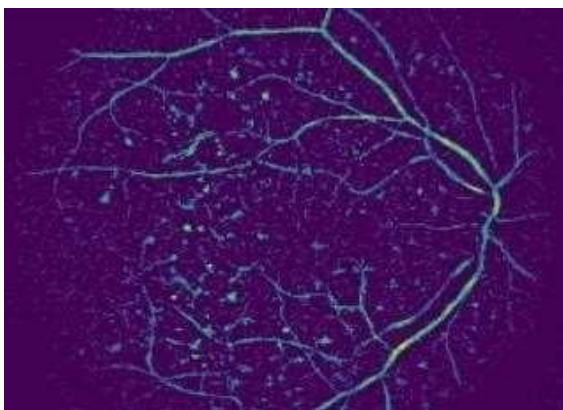

Fig.4- Sequential filtering

3.4. Vessel Detection

Because MA's are situated on capillaries and capillaries are not visible in color fundus images, they generally appear disconnected from the retinal vessel network. Considering the vessels may affect MA's detection, the blood vessels were before extracting MA candidates. By observing the fundus images, it found out that retinal vessels always appear as piecewise linear structures, while the MAs generally appear as small round spots. Through contour method small elements from the fundus image named MA's and noise by defining their size and shape were removed. The leftover part was the continuous part which is Blood Vessels which are further processed in the next stage for a better result of Microaneurysms.
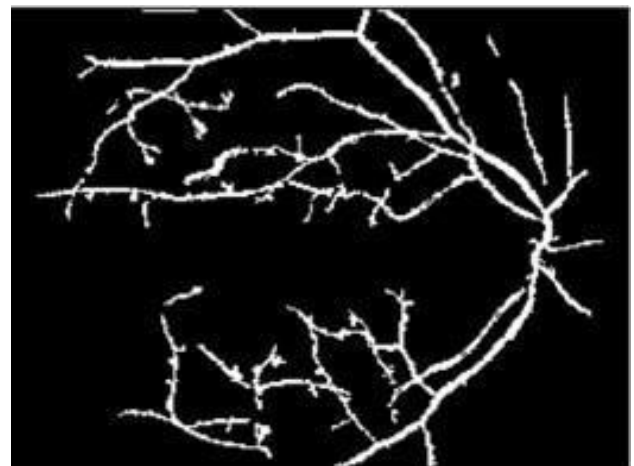

Fig.5-Vessel Detection

3.5. Blood Vessel Extraction

In this step, the blood vessels are subtracted from the sequential filtering output image, and the final image contains only the MA candidates and noise from which noise will be further removed in the further step. The Blood Vessel extraction from sequential filtering image is done by using the python command:

BV_removed=cv2.subtract(f5,blood_vessels)

Here cv2.subtract is the standard subtracting

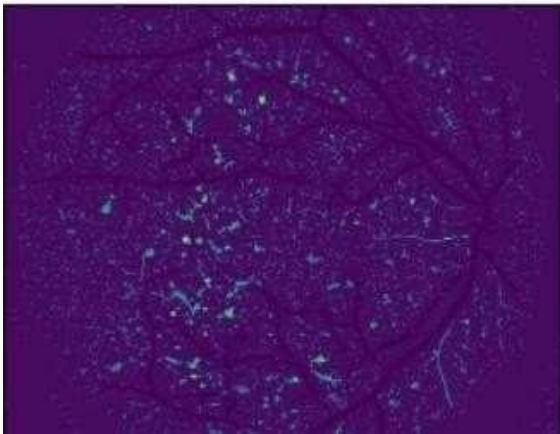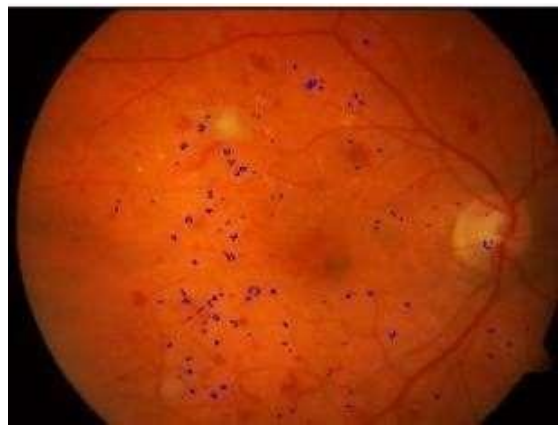**Fig. 6-** Blood Vessel Extraction

3.6. Thresholding

The final stage of this method is very crucial as there are high chances of noise insertion. Thresholding is the process of splitting an image into smaller segments, or junks, using at least one color or gray scale value to define their boundary. The advantage of obtaining a binary image is that it reduces the complexity of the data and simplifies the process of recognition and classification. In this section using FOR LOOP condition in python the image was analyzed pixel by pixel. The threshold value is set to 70 and the pixels having intensity greater than 70 will be kept as they are MA candidates and the low intensity pixels are considered as noise elements.

Fig.7 – Thresholding

3.7 Micro Aneurysm Detected Output

Based on the perimeter and area of a candidate we got we found the microaneurysms form the thresholding output image. The output is then clubbed with the input color image with the detected Micro Aneurysms. This is the final output of our system.

Fig.8 – Micro Aneurysms Detected Output

4.TECHNOLOGY USED

In this project, the software used is PYTHON of version **3.7.** This is the latest version of Python available at the moment. The python 3.7 series contains many new features and optimization.

PACKAGES USED:

● OPENCV

● NUMPY

● TKINTER

● PILLOW

● MATPLOTLIB

4.1. OPENCV

OpenCV is the most widely used python package for image processing. It includes features such as image resizing. Converting image into grayscale. Contrast enhancement. Various pre-processing and detection tasks can be performed using the OpenCV library package.
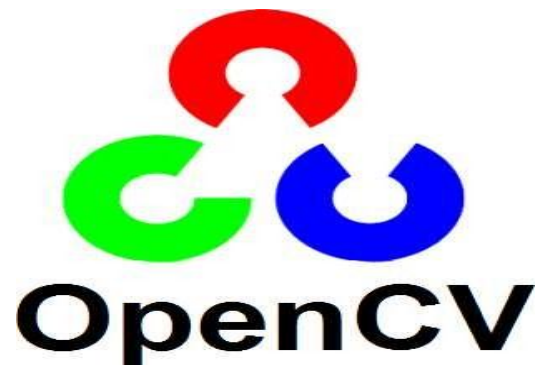

Fig.9- OpenCV

4.2 NUMPY

NumPy is used to read and write the image. It is also used to convert images into array matrices for performing computational operations. NumPy is the fundamental package for scientific computing with Python. It contains among other things:

- A powerful N-dimensional array object.
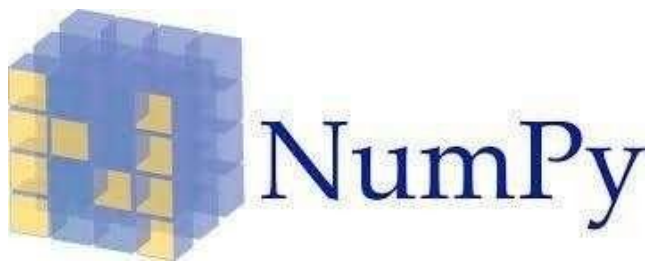- Useful linear algebra, Fourier transform, and random number capabilities

Fig.10 – NUMPY

4.2. TIKINTER

Python offers multiple options for developing GUI(Graphical User Interface).Out of all the GUI methods, tkinter is the most commonly used method. It is a standard Python interface to the Tk GUI toolkit with Python. Python with tkinter outputs the fastest and easiest way to create GUI applications. Tkinter(or TK) provides a set of dialogues, which can be used to display message boxes, showing warnings or errors, or widgets to select files and colors.

4.4 PILLOW

Pillow packages are used to get a file dialog- box to upload the color fundus image. So that further operation can be performed. It contains various other features of Image enhancement, Contrast level enhancement and many more.

Fig.11- PILLOW

4.5. MATPLOTLIB

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, Wxpython. Pyplot is a Matplotlib module which provides a MATLAB-like interface. Matplotlib is designed to be as usable as MATLAB, with the ability to use Python, and the advantage of being free and open-source.
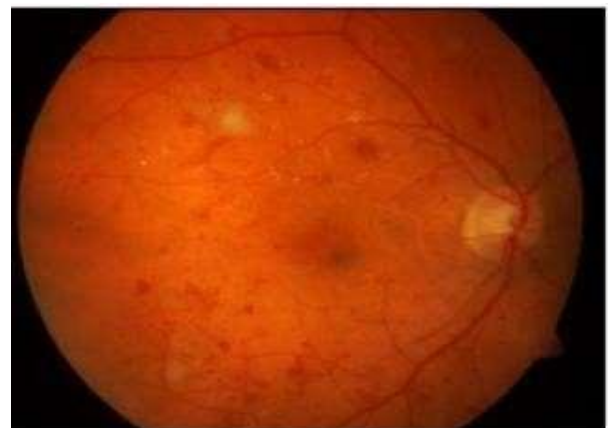

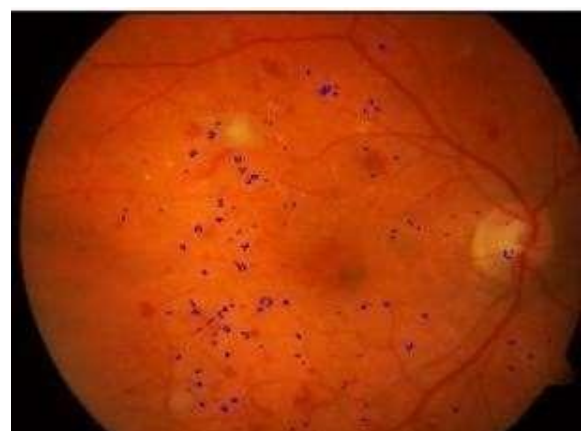**Fig.12-** MATPLOTLIB

5.RESULTS

Fig.13- Input Fundus image
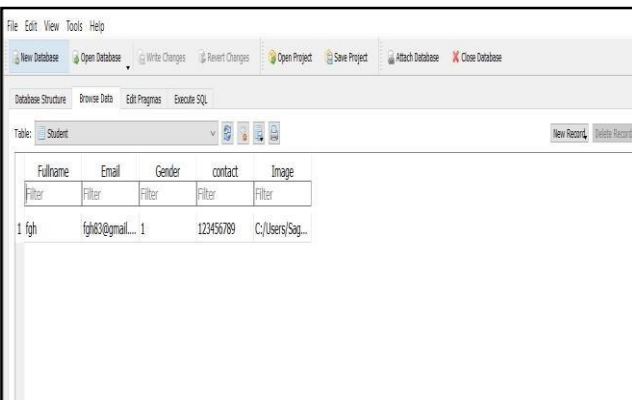

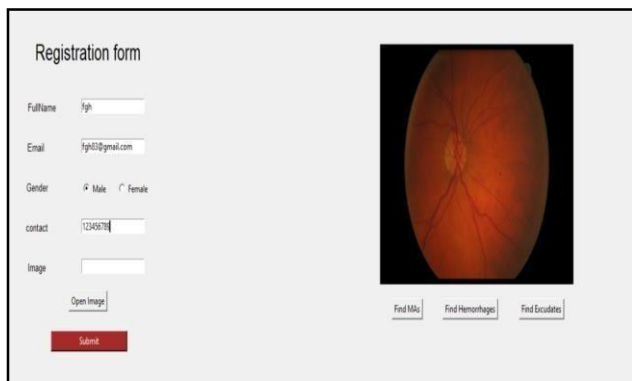**Fig14 –** Output Image with detected Micro Aneurysms

Fig.16- Database of the system

6.CONCLUSION AND FUTURE SCOPE

The proposed system presented in this work is capable of detecting the early signs of diabetic retinopathy such as micro aneurysms. Hence the method which uses green channel along with sequential filtering and thresholding for detection of microaneurysm. The system could also be extended to further detect other retinal diseases like glaucoma, age-related macular degeneration. Moreover, the proposed work has contributed only for the detection of Micro -aneurysm. Anatomical features like fovea or macula can be detected by considering the optic disc as the reference point. In future, the algorithm could however be developed for the detection of dark lesions such as hemorrhages in addition to micro aneurysms detection. This system will detect the micro aneurysms and prevent blindness in diabetic patients.

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