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Enhancement and Feature Extraction of Fundus Images

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Abstract:- Diabetes is increasing at a faster rate. Due to diabetes various diseases are caused. Diabetic retinopathy is one of the major complications caused due to diabetes that affects the retina of a eye. Using fundus image analysis Diabetic Retinopathy can be detected for which feature extraction algorithms are implemented on the fundus images. Earlier the process of detecting diabetic retinopathy based on abnormal features like exudates and hemorrhages was time consuming. Latest technological advances help in automatic detection of diabetic retinopathy. Objective of the project is feature detection of fundus images. In the study, a blob detection methodology is proposed for detecting the features such as macula, exudates and hemorrhages.

Keywords:- *Diabetic retinopathy, fundus images, feature detection, macula, exudates, hemorrhages.*

I. INTRODUCTION

Diabetic Retinopathy is a diabetes complication that affects retina; it is caused by damaging of blood vessels due to light sensitive tissue at the back of the eye (retina). Initially diabetic retinopathy may cause no or mild vision problem eventually it causes blindness. In India there is a shortage of around 121K eye doctors and 46% of patients suffer vision loss before diagnosis. Constant check-up and screening for detection and diagnosis of diabetes related disease like Diabetic Retinopathy is very important. Our project aims at studying and analysing the fundus images using software that works on the concept of image processing algorithms on fundus images. This project involves fundus image analysis with different types of processing techniques for pre-processing, feature extraction and classification. The high functioning cameras are used. But due to several reasons such as human errors like inappropriate placing of eye onto the camera or environmental errors like illumination, the images are improper. Hence it is difficult to analyse them. Enhancement and segmentation of these images using OPENCV software will be done. Figure 1 shows the fundus image and its features.

Various IEEE papers on feature extraction of fundus image are available which use different algorithms. IEEE paper on "Detection and classification of diabetic retinopathy using retinal images" revealed that the proposed method of classification based on area and perimeter of blood vessels and hemorrhages produce motivating results. Sensitivity of 80.21% and specificity of 70.66% is obtained. Preprocessing is done using adaptive, local, and contrast enhancement techniques. They adopted a neural network based classification.

Another paper on "Detection of diabetic retinopathy and maculopathy in eye fundus images using fuzzy image processing. Fuzzy based image processing algorithm is used. The system can be enhanced by implementing different other combinations of preprocessing techniques including those based on fuzzy approaches. Employing fuzzy image processing can help produce a more reliable screening system. In addition, it helps achieve the overall aim of the screening, which is to detect earlier the sight threatening diseases and to ensure a timely treatment in order to prevent vision loss.

A paper on "Exploring clinically relevant image retrieval for diabetic retinopathy" uses algorithm based on feature extractors for distinguishing DR lesions. The algorithm is 87.61% accurate.

"Segmentation of blood vessels for detection of PDR" concludes that the algorithm used is 95.02% accurate. Neovascularization is a sign of PDR and its detection is very important for diagnosis of diabetic retinopathy.

The main idea proposed in "Feature extraction for early detection of diabetic retinopathy" paper is detecting exudates using green channels. The paper represents the methods for detection of blood vessels, exudates and optical disk. Accuracy of 92% is obtained.

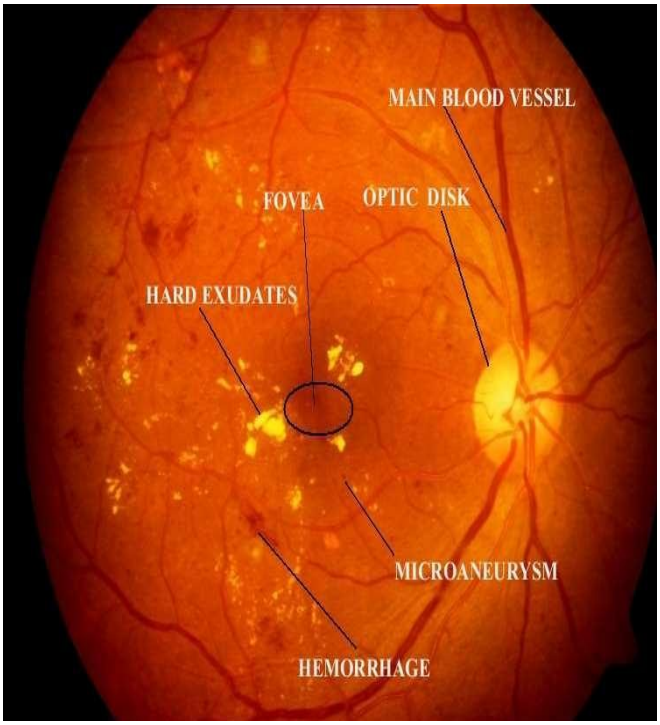

Fig 1:- Fundus Image

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II. PROPOSED METHOD

A. Flowchart : Figure 2 shows the flow of the project.

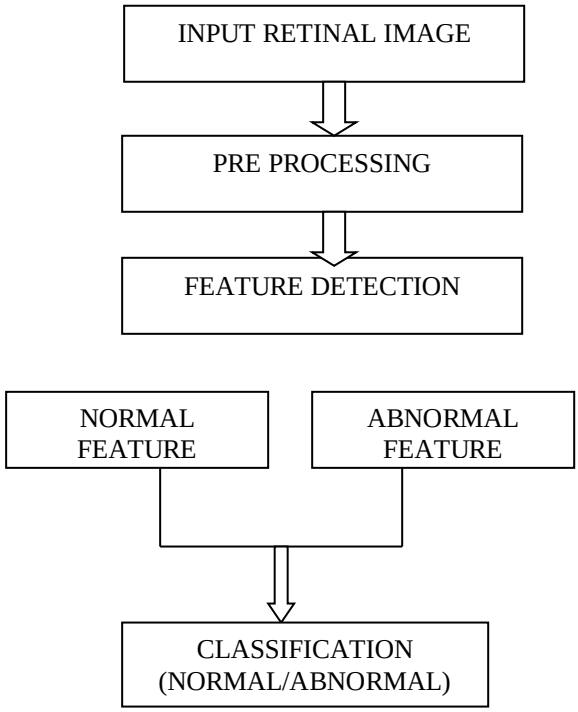

Fig 2:- Flowchart

B. Image pre processing

- *Color space conversion :* A colour space is a method by which we can specify, create and visualize color. HSV (Hue-saturation-value) is the most common cylindrical coordinate representation of points in an RGB color model. The HSV representation rearranges the geometry of RGB in an attempt to be more intuitive and perceptually relevant.
- *Noise removal:* Erosion (usually represented by ⊖) is one of two fundamental operations in morphological image processing from which all other morphological operations are based. It is originally defined for binary images, later being extended to grayscale images, and subsequently to complete lattices.
- *Smoothing:* Smoothing is often used to reduce noise within an image or to produce a less pixelated image. Most smoothing methods are based on low pass filters. Smoothing is also usually based on a single value representing the image, such as the average value of the image or the middle (median) value.
- *Thresholding:* Image thresholding is a simple, yet effective, way of partitioning an image into a foreground and background. This image analysis technique is a type
- of image segmentation that isolates objects by converting grayscale images into binary images.

C. Image analysis using blob detection:

➢ *Feature Extraction*

In study three features macula, exudates and hemorrhages are extracted on images using morphological operations and blob detection algorithm.

- *Macula detection:*

Macula is the normal feature of a retina. It is the functional center of the retina. It gives us the ability to see and provides the best color vision. As seen in fig.3 the retina image undergoes various preprocessing steps followed by a blob detection algorithm to detect macula. Initially a path is set to the image containing folder. The RGB is converted to HSV image. All the preprocessing steps mentioned in image preprocessing section are performed on the images. Opencv allows to perform these steps using simple commands like " img= img.Smooth Gaussian(3)", "img.Erode(1)" wherein the number in the parenthesis is the amount of times the pre processing step is performed on the image. After enhancement of the image next step is detecting the blobs for which a range of gray level is set in which object is to be detected. Contour analysis is performed on the enhanced image in which the blobs are detected and are simultaneously stored in a linked list. This list at the end of the analysis will help to determine the number of blobs detected and the area of the same. A rectangular box is drawn around the blob. based on the threshold values of the area the corresponding image severity is classified as "LOW" , "MEDIUM" or "HIGH".

- *Exudates detection:* Exudates are the yellow flecks made up of lipid residues of serous leakage from damaged capillaries. Same algorithm is used to detect exudates. Fig. 4 shows the exudate detection with all the pre processing steps. For detection of exudates the image is first converted to HSV and is enhanced. Noise is removed followed by smoothing and thresholding. After image enhancement blog detection is done. Here a rectangle is drawn around the area of the image which falls under a gray level range set for exudates detection.
- *Hemorrhages detection:* Hemorrhages are the dark patches that are seen in the fundus image. blob detection is performed in the similar way as macula or exudates. The images used from the database mentioned earlier are less illuminated the algorithm efficiency for hemorrhage detection is 75%. All the patches are not detected due to which the severity of the disease may not be accurately determined.

Fig.5 shows the hemorrhage detection.

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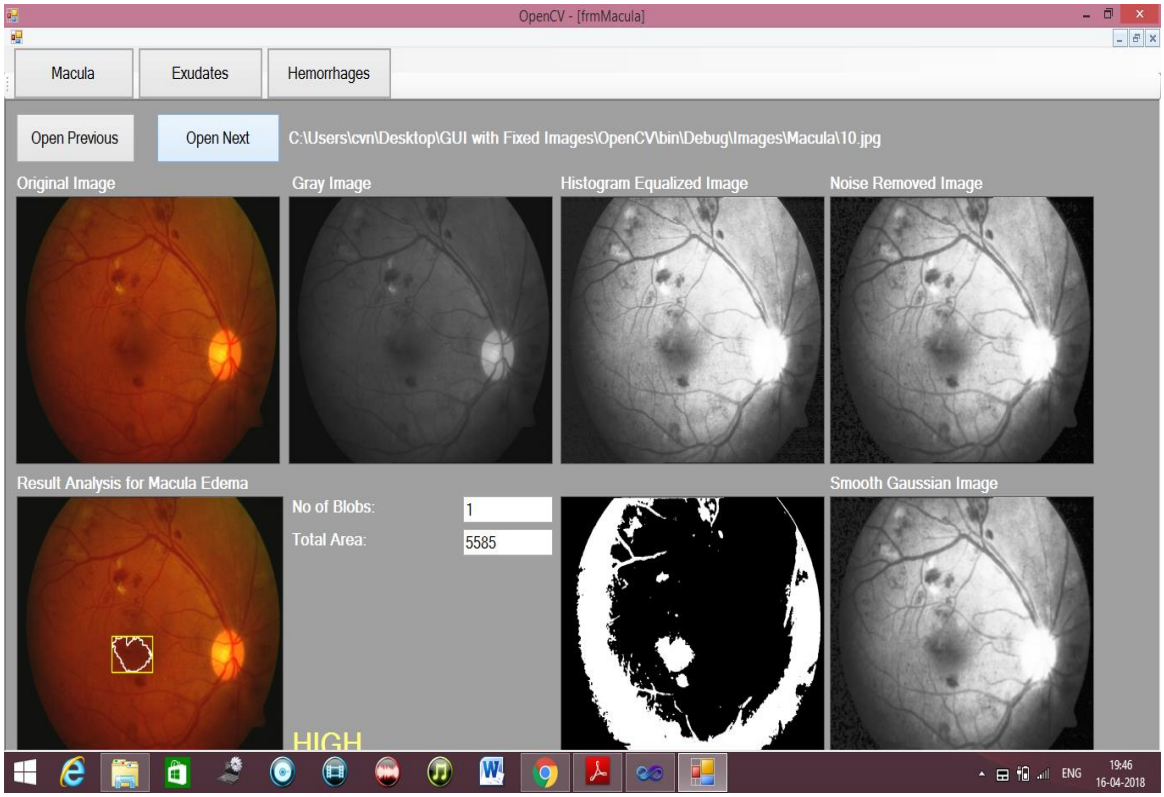

Fig 3:- maculadetection

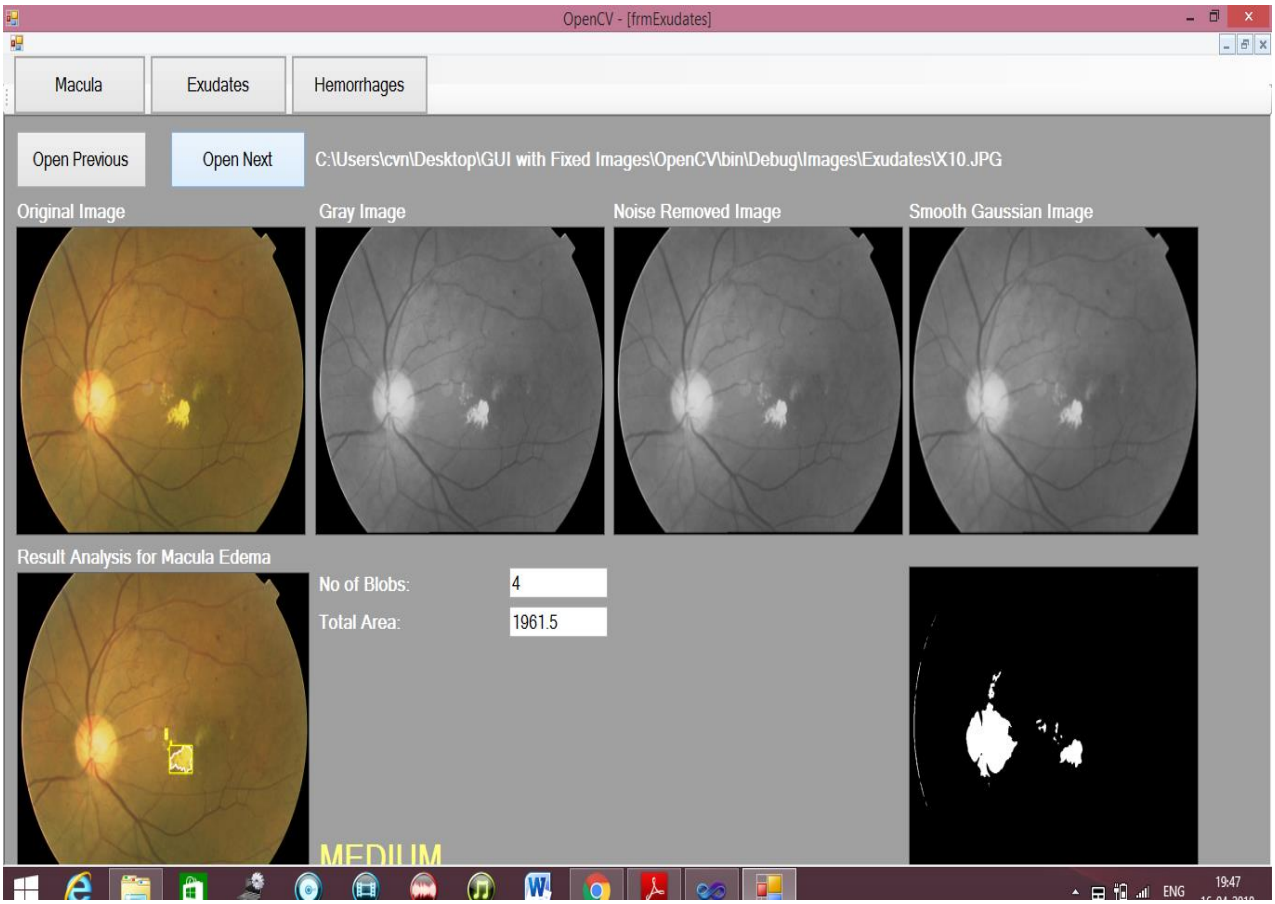

Fig 4:- exudatesdetection

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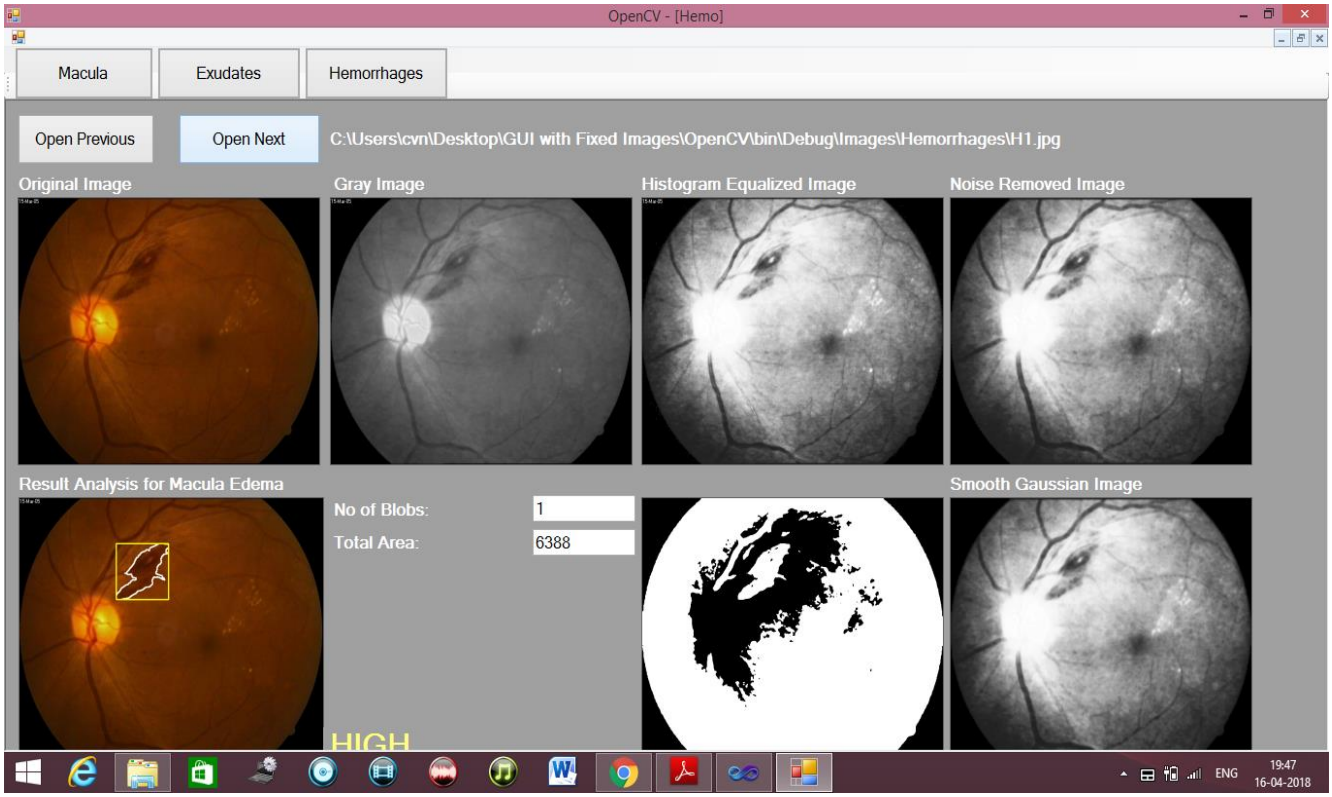

Fig 5:- Hemorrhagesdetection

III. DATA AND RESULT

C. Database

Database for fundus images are available on websites like STARE and DRIVE. The DRIVE database has been established to enable comparative studies on segmentation of blood vessels in retinal images. The data included in this database can be used, free of charge, for research and educational purposes. The photographs for the DRIVE database were obtained from a diabetic retinopathy screening program in The Netherlands.

D. Softwares: OpenCV and Visual studio 2010

Software used is OPENCV since it is a open source software. It stands for 'Open Source Computer Vision Library' initiated by some enthusiast coders in '1999' to incorporate Image processing into a wide variety of coding languages. It has C++, C, and Python interfaces running on Windows, Linux, Android and Mac. it is a 'library', so to use the functions available in the library a compiler is needed.

Feature	Number of images	Accurate detection	Percentage detection
Macula	14	12	85.71%
Exudates	10	6	60%
Hemorrhages	12	10	83.33%

IV. CONCLUSION

Diabetic Retinopathy (DR) is a complication of diabetes and it is the leading cause of blindness and visual disability. Regular eye examination is essential for an early detection of retinopathy in order to reduce visual loss and blindness caused by DR. In today's era retinopathy analysis is cost effective as medical image analysis. According to analysis rate of diabetic retinopathy patients was low in previous years compared to current status. Due to hectic and busy lifestyle the rate of diabetic retinopathy is increasing. Awareness about diabetic retinopathy must be created so as to avoid permanent loss of vision. As the number of patients is increasing day by day automated detection system like this must be installed in every clinic and hospitals which will help ophthalmologist to analyse and cure the patient faster. The classification of fundus image without software by ophthalmologists would consume lot of manpower and of course time. Also human errors may give unwanted results. Softwares like this will detect diabetic retinopathy in no time. Hence DR can be detected at early stages.

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