

Automatic Detection of Diabetic Retinopathy Lesions

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Abstract - The domain we are working on is image processing and machine learning. The objective is to detect the different types of lesions in early diagnosis of Diabetic Retinopathy (DR). This prediction prevents the diabetic patients from permanent vision loss. The affected part of the retina is detected using image processing and comparing the infected images with the normal retinal images and to identify the diabetic retinopathy lesions. The machine learning algorithm uses specific color channels and some of the image features to separate exudates from physiological features in digital fundus images. A five-stage disease severity classification for diabetic retinopathy includes three stages of low risk, a fourth stage of severe non proliferative retinopathy, and a fifth stage of proliferative retinopathy. By implementing this we would be able to detect the diabetic retina in an earlier stage with higher accuracy. It is widely used in medical field by ophthalmologist and it is one of the developing research areas in biomedical engineering.

Key Words: Fundus, Exudates, Proliferative, Non-proliferative, ophthalmologist.

1. INTRODUCTION

The importance of human health has never been a subject of question mark. No wonder how much ever the technology and science develops, the advent of chronic patients always keeps increasing. Eyes being an essential organ like any other organ but concerns regarding the health of our eyes are often neglected. Even in frameworks for various kinds of disease and public health issues, eye health is often less likely to be highlighted.

According to the world health organization (WHO), it estimates that 285.3 million people worldwide are visually impaired. Among them 39.8 million people are blind and 246 million have low vision. Most major causes of visual impairment include myopia, hyperopia (or) astigmatism. These contribute about 43% of uncorrected refractive errors. Un-operated cataract adds up to 33% and glaucoma up to 2% other causes of blindness include glaucoma (12.3%), age-related macular degeneration (8.7%), diabetic retinopathy (4.8%), childhood blindness (3.9%) and trachoma (3.6%). Most of the time, a diabetic retinopathy disease can be precluded if diagnosed early. This paper focuses on detecting diabetic retinopathy lesions at an early stage with high accuracy rate. Software is developed to detect the different types of lesions and classify them. The input being fed here are the Infected Retina image. The data sets are stored separately for easy access. Various algorithms are being used in order for easy and accurate classification of lesions.

Age in years	Diabetic retinopathy			Prevalence (%)
	Present	Absent	Total	
0-20	2	59	61	3.28
21-40	57	458	515	11.07
41-60	581	2079	2660	21.84
61-80	448	1341	1789	25.04
>80	13	43	56	23.21

Table 1.2: Age-wise distribution of diabetic patients

2. LITERATURE SURVEY

Detection and Identification of lesions plays a very vital role in Diabetic Retinopathy. [1] identifies different types of lesions such as Micro-aneurysms, Hemorrhages, and Exudates. This survey helps for early diagnosis of diabetic retinopathy as it is one of the effective treatments or else it will lead to permanent blindness. Detection is done by evaluation of Fundus images. To facilitate lesion detection Blood vessels extraction and optic disk removal is performed. Curvelet-based edge enhancement algorithm (Identify edges and boundary) is used to detect dark lesions. The optimal band pass filter (smooth out background components and suppresses the thin vascular nets) is used to detect the bright lesion. Laplacian of Gaussian filtering along with Matched filtering produces a high response for both bright lesions and dark lesions. Then finally post-processing is done for each lesion. If the number of neighboring pixels is less than a certain threshold Micro-

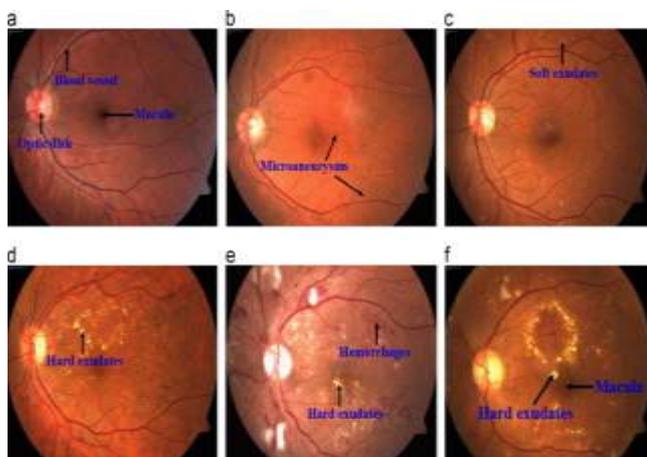


Fig: 1.1: Various Classifications of Diabetic Retinopathy lesions

aneurysms is removed. If the candidate region whose area is less than a certain threshold, Hemorrhages is eliminated. If candidate regions with an area above a certain threshold, Exudates is removed. Performance evaluation is done by selecting images from DRIVE, STARE, DIARETDBI, MESSIDOR databases, and Statistical performance is analyzed using Receiver Operating Characteristics (ROC) curve which defines the True Positive Rate (TPR=Sensitivity) False Positive Rate (FPR=Specificity). This will highlight the performance gain but the proposed method is weak to detect the red lesion.

The paper [2] presents an automatic screening system for diabetic retinopathy that focuses on the detection of the earliest visible signs of micro-aneurysms. They are small dots formed on the weak part of the capillary wall. The proposed system consists of an automatic acquisition, screening, and classification of Fundus images. As the system is based on the removal of blood vessels from the image to detect whether they are micro-aneurysms or not. In this, the pre-processing stage provides improved results for detecting the micro-aneurysms. Retina illuminated by white light and examined. Light is filtered to remove red colors, which help to improve the contrast of vessels. And they are brought into high contrast by intravenous injection of a fluorescent dye. The circular Hough transform is suitable to locate and detect objects of circular shapes (Micro-aneurysms) as it also helps to detect and find the scope of micro-aneurysms. The algorithm starts with a preprocessing stage is done by the average filter to eliminate pseudo-imaging and noise. Finally, the post-processing stage eliminates false positive region. And also the subsequent classification is performed based on the shape and size features of the micro-aneurysms. A suggested improvement of detection in Fundus images is done by using an optimal combination of preprocessing methods and candidate extractors. They use contrast-limited adaptive histogram equalization the results showed that the accuracy of the individual candidate extractors is increased. The technique proposed, improve the contrast and system performance. The major issues are the special characteristics of the micro-aneurysm and to produce better sensitivity, specificity, and accuracy.

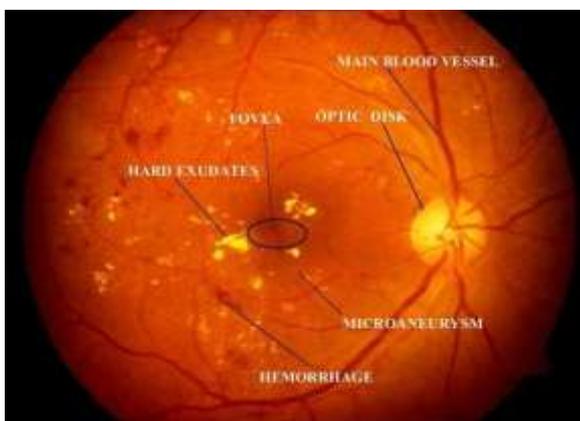


Fig: 2.1 Types of exudates

In this paper [3], a novel method for automatic detection using color Fundus images is described with the new set of shape features called Dynamic Shape Features that do not require precise segmentation between lesions and vessel segments. So it will allow automatic Diabetic Retinopathy grading. Fundus images with Diabetic Retinopathy will exhibit red lesions, such as micro-aneurysms and hemorrhages, and bright lesions, such as exudates and cotton wool spots. This paper focuses on the detection of micro-aneurysms. It is detected using morphological operations such as diameter closing and top-hat transformation. The goal is to distinguish micro-aneurysms from elongated structures. First, the input is taken as a color Fundus image with a region of interest (ROI) (i.e. the circular area surrounded by a black background). Then spatial calibration is applied to support different image resolutions. The input images are preprocessed (smoothing and normalization) for identification of potential lesions (intensity and contrast), so that the optic disc is detected to discard from the lesion. Lastly, the Dynamic Shape Features are extracted for each candidate and is classified according to their probability of red lesions. The results obtained on the Erlangen database achieve good performance on images of very high resolution. But when the spatial calibration is adjusted, most of the lesions are not detected. Diabetic retinopathy requires bright lesions. The overall computation time depends on image resolution technique and it takes about 98 seconds to process an image. So we can say that time efficiency is not performed well.

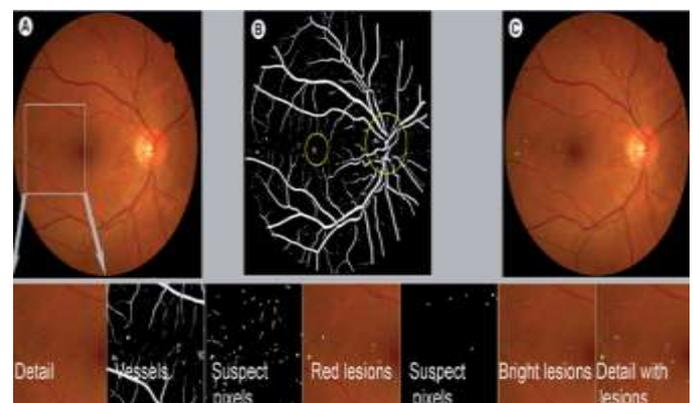


Fig: 2.2 Types of lesions

3. PROPOSED METHOD

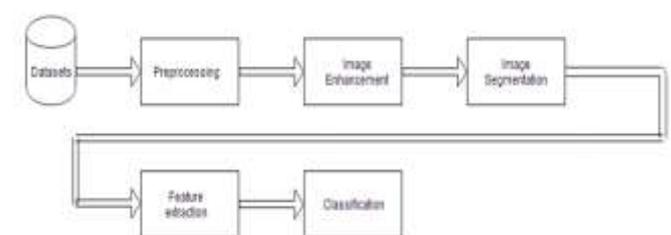


Fig-3.1: Flow Diagram

System Architecture:

The system software consists of various levels of Image processing and segmentation used for filtering and extracting the affected retinopathy lesions with high degree of accuracy.

The flow diagram of the proposed method is shown in Fig-3.1 with different steps as follows.

A. Image acquisition:

The technique described right here, is evaluated on datasets. The datasets we use were notably used by distinct researchers to check the effectiveness of their segmentation strategies. The 40 shade Fundus retinal snap shots had been captured with a Canon 3CCD digital camera with a 450 discipline-of-view (FOV). Each photograph is represented in eight bits which consists of color plane and the photos gets saved in JPEG format.

B. Pre-processing and image enhancement:

All the snap shots have been resized to 720 × 576 pixels at the same time as keeping the authentic issue ratio preceding to assessment. Following this, green coloration plane is modified (Fig-3.2) and used within the evaluation as it suggests the high-quality contrast between the retina and the vessels. The grey degrees are normalized with the aid of stretching the picture contrast using CLAHE (evaluation-restricted adaptive histogram equalization) (Fig-3.2) to cover the entire pixel dynamic variety, apart from the encompassing dark border pixels and any photograph labels. It limits amplifying any noise in the low assessment region of the picture.

C. Image segmentation:

The green factors depth is inverted. After inverting the inexperienced issues depth the aspect detection is completed. The border is then detected and a disk formed structuring element (SE) of radius 8mm is created with morphological beginning operation (erosion observed with the aid of the use of dilation). Next, subtract the eroded photograph with the original picture and the border or boundary is received. Afterwards, adaptive histogram equalization (CLAHE) is accomplished to enhance the comparison of the image and to accurate choppy illumination. A morphological starting operation (erosion then dilation) is completed to highlight the blood vessels. From the subtracted picture, the picture is converted from grey-scale to binary by means of using price of 0 (or) 1. Median filtering is finished to do away with "salt and pepper" noise. The boundary is acquired after subtracting the border with disk fashioned structuring element (SE) from photograph with median filtering. The border is then removed after filling the holes that don't touch the brink to reap the final photo. The pixel values of the photo are inverted to get only the blood vessels with black history.

Bright Lesions Segmentation (Fig-3.2) Exudates appear as vivid yellow-white deposits at the retinal layer. Their form and period varies progressively with particular ranges of retinopathy. Initially extracted green channel photo is converted into grey-scale picture after which pre-processed for uniformity. Then morphological last operation is performed to do away with the blood vessels. Morphological very last includes dilation discovered with the aid of manner of erosion. Being the terrific spots at the image, adaptive histogram equalization is carried out two times observed with the aid of picture segmentation to make the exudates seen. Obtained bright features are then in contrast with large vicinity removed photo the use of AND common place feel as a way to get rid of exudates. Red Lesions Detection seems as tiny red dots on retinal Fundus photo.

D. Feature Extraction and classification:

Area of blood vessels, Area of exudates, and Area of micro aneurysms are extracted along aspect texture houses. These metrics are later used to categorize the snap shots accurately.

There are certainly normal of seven competencies which encompass area calculations (exudates and blood vessels) and 5 texture features.

Sparse Representative Classifier (SRC) is used to classify the snap shots into normal and bizarre (Fig-3.2). The photos with lesions are bizarre and photos without lesions are normal. The basic operation of SRC is to finding the hyper-plane those fantastic separates vectors from every education in characteristic space at the equal time maximizing the distance from every elegance to the hyper plane. It is composed of each linear and nonlinear strategy for this hyper aircraft creation. SRC is a concept in statistics and a technological understanding for a set of associated analyzing techniques that observe information and recognize patterns.

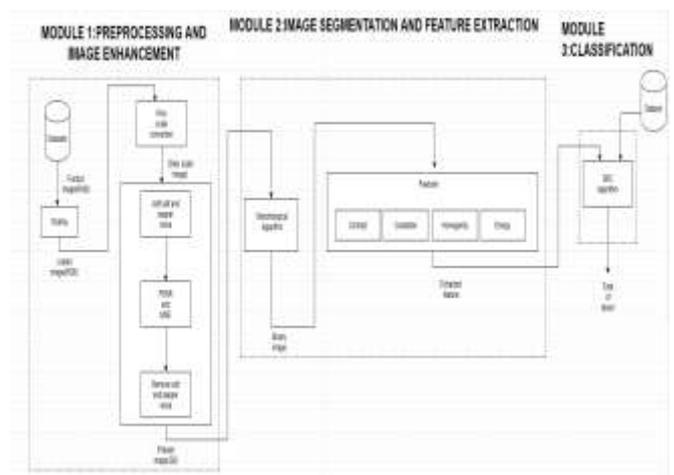


Fig-3.2: Data-collection and preprocessing

4. SYSTEM IMPLEMENTATION:

Data-collection and Preprocessing:

Images required for this study was obtained from the datasets available on net. Fundus images of the retina were required for this system and we have used about 20 images with both micro aneurysm and hemorrhages containing lesions. Normal retina images are also included so that they can be used to compare, detect and classify them based upon conditions like saturation, reflected light, and blurs which made the task challengeable.

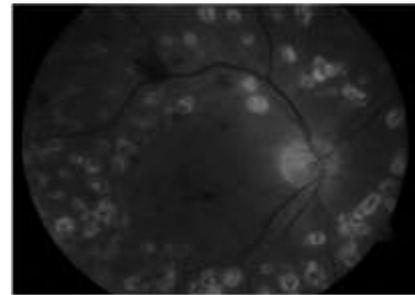
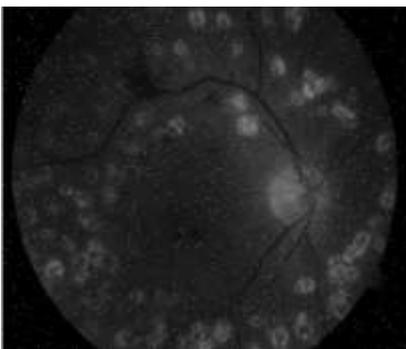
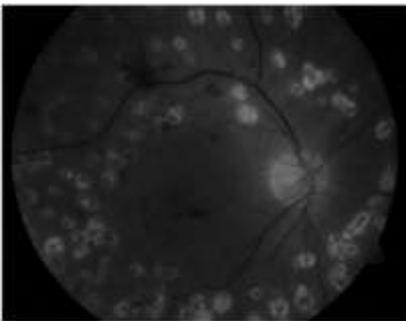
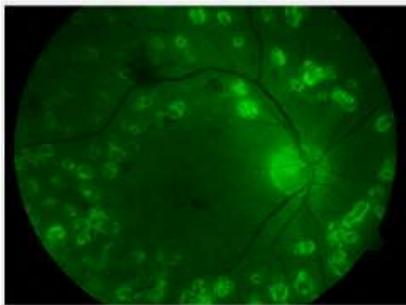
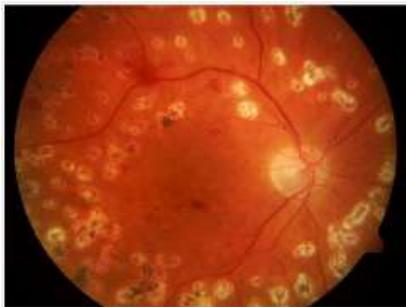


Fig: 4.1 a) Fundus image b)Extracted green channel c)Grey scaled image d)Salt and pepper noise image e)Filtered image

In pre-processing (Fig-4.1) we first apply scaling algorithm so that the Fundus image of retina can be easily be processed. The green channel of the Fundus retina images of RGB(Red, Green, and Blue) are used since it provides better visibility of the lesions if present inside them in further process. Here the image is enhanced using which the RGB(Red, Green, Blue) image is converted to Grey scale image(Fig-4.1) where the image is divided into 3*3 matrix for which an average is found and replaces the old values. While enhancing the image(Fig-4.1) we add salt and pepper noise and find Peak Signal to Noise Ratio (PSNR) along with Mean Square Error (MSE).Then we remove the added salt and paper noise so that the image is more clearly visible without unwanted noises.

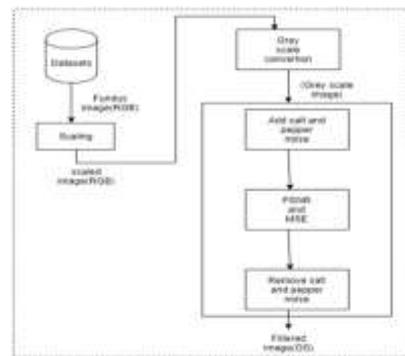


Fig-4.2:Pre-Processing and Image Enhancement

Image Segmentation And Feature Extraction:

For segmentation morphological algorithm is applied where the image is converted into Binary image where each pixel in the image is replaced with the value 1 or 0 i.e. Black or white color. For the extraction of feature we again use the grey scaled image and search for the availability (Fig-4.2) of any of the feature contrast, correlation, homogeneity (or) energy where contrast is the difference in luminance i.e., a color that makes an object distinguishable, correlation basic operation to extract information from a image, Homogeneity and energy are used to identify the texture in the image (Fig-4.2). This is done using Grey scale co-occurrence matrix and statistical methods like mean, standard and variance.

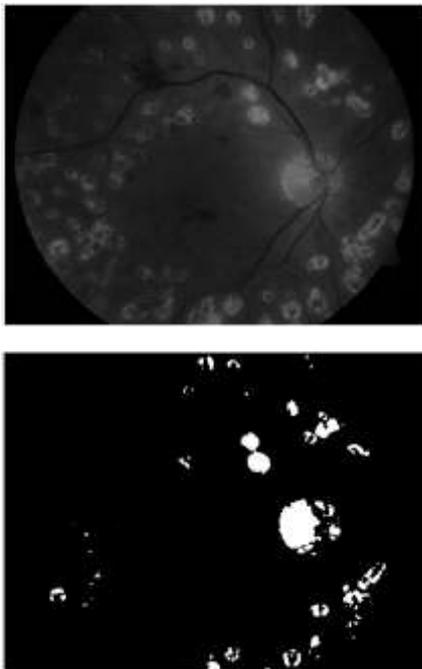


Fig: 4.3 Grey-scale and Binary image

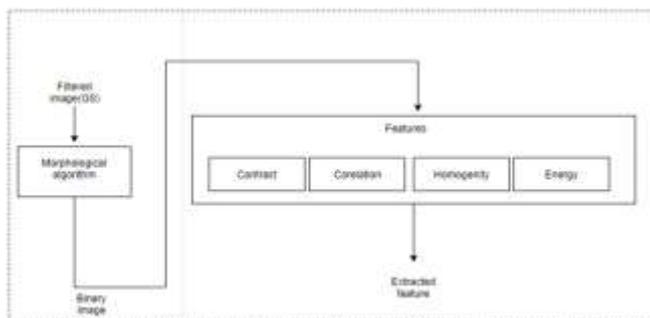


Fig-4.4: Image Segmentation and Feature Extraction

Analysis And Classification:

The features extracted are given to the Sparse Representative Classifier (SRC) along with the normal retina image so that both the images are compared (Fig-4.3) and the diabetic retina is identified and classified as micro-aneurysm and hemorrhages.

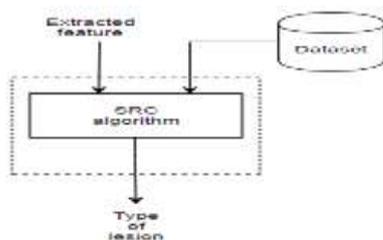


Fig-4.5: Analysis and Classification

Result and discussion

This method proposes automated lesion detection scheme with steps like pre processing, Image enhancement, Image segmentation, Feature extraction and Classification with several imaging practices which provides high degree of accuracy up to 94.83%. To investigate the effectiveness this technique, entire rule was run on all the datasets and results for lesion detection were collected. The samples of every dataset are stored 100 percent for testing. So MATLAB code for a picture takes fifteen seconds to execute, employing a computer with associate Intel i3 Processor and a pair of 2GB RAM. So that Automatic detection of retinal lesion detection in diabetic retinopathy images is carried out. Pre-processing steps deals on some set of pixel values. Parts of retina of the eye are extracted. Image segmentation and feature extraction is done by applying different filters and techniques. And then lesions are differentiated by sparse representative classifiers (SRC) for obtaining accurate result (Fig 5.1 and Fig 25.2). The affected images are differentiated into mild, moderate and severe manner. It also distinguishes between hemorrhages and micro-aneurysms (Fig:5.1) It is worth notable that given approach was not only assessed on a larger dataset of retinal images (including 25 abnormal and 15 normal) but also generated performance metrics. To evaluate the performance of the system, performance measures like sensitivity, specificity and accuracy are calculated.

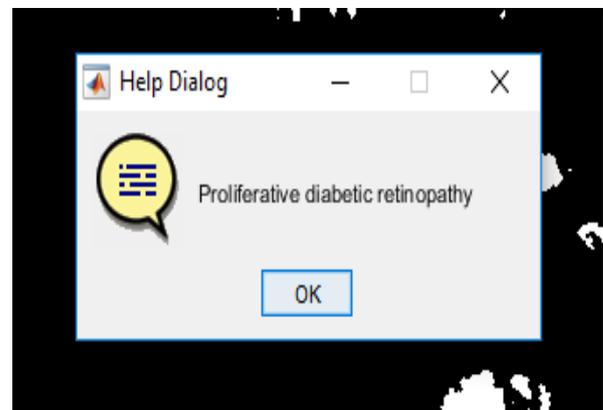


Fig 5.1 Type of lesion

Conclusion and Future scope

This method concludes an improved performance over the existing methods with an accuracy of 95.83% and robustness in detecting various types of lesions with intrinsic properties. It also provide best precise results with less error rate and give more efficient outcome. We conclude that by collaboration of techniques related to image processing. The future scope is to include more number of features in order to decrease the rate of fatalness.

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