Detection of Diabetic Retinopathy Using Image Processing

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Abstract-*Diabetic retinopathy is one of the eye diseases where a diabetic patient suffers from a group of eye problems which may may lead to loss of vision in the worst case. It is necessary to have proper, adequate and early treatment of the disease. Since the implications of poor or late treatment are very expensive, precautionary measures are needed to be taken at an early stage.*

In this paper, we will look at the extraction of features such as microaneurysms and exudates using image processing techniques and determine the severity of diabetic retinopathy. The datasets used for this study is DATABASEDB1.

Keywords-exudates, feature extraction, microaneurysms, optic disc, retinal image.

I. INTRODUCTION

Diabetes is one of the major causes for the abnormalities in the retina, kidney and nervous system. Diabetes is also a major risk factor in cardio vascular disease.Diabetes can be classified into two types: Type 1 and Type 2. In type 1 diabetes, there is permanent damage to the production of insulin in the pancreas. In type 2 diabetes, the resistance level of insulin is increased.

A medical condition in which damage occurs to the retina due to diabetes mellitus is known as Diabetic Retinopathy or Diabetic eye disease. Diabetic Retinopathy has no early symptoms.

Thetwo types of diabetic retinopathy are -- Non-Proliferative diabetic retinopathy (NPDR).It is the early stage of the disease and Proliferative diabetic retinopathy (PDR) is an advanced stage of the disease.Diabetic Retinopathy has four stages:

a) Mild Non-Proliferative Retinopathy: At this earliest stage, tiny dark red spots within the light sensitive retina occur. b) Moderate Non-Proliferative Retinopathy: blood vessels that nourish the retina are blocked as the disease progresses. c) Severe Non- Proliferative Retinopathy: At this stage more blood vessels are blocked and several areas of retina are deprived by the supply of blood. d) Proliferative Retinopathy: This is an advanced stage, accumulation of blood in the vitreous cavity due to leakage of abnormal blood vessels leading to significant loss of vision.

The diabetic retinopathy usually begins with changes in the retinal capillaries. Mircroaneurysms are the first detectable abnormalities which are the local distensions of the retinal capillary. They also cause intraretinal hemorrhage when ruptured.

A.STRUCTURE OF HUMAN EYE

A human eye is a spherical ball which consists of the following parts: sclera: a protective white layer which is the outer covering. Cornea is the front transparent part through which light enters the eye. Iris lies behind the cornea which is a ring shaped structure. It indicates eye color. Pupil is a small opening at the centre of the eye through which light strikes the retina.

Lens is a transparent structure. It grows thicker to focus nearby objects and thinner to focus far away objects. Retina is considered as a light sensitive layer of tissue which contains numerous nerve cells. It converts an image into electrical impulses which are then sent to the brain via optic nerve.

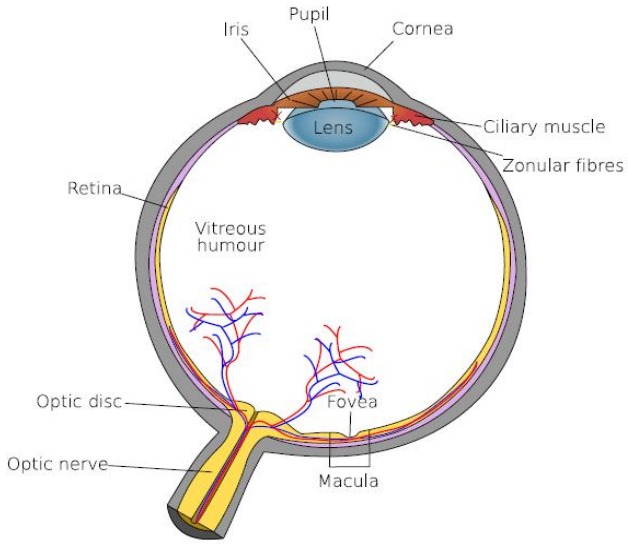


Fig1.Structure of human eye.

B.DIABETIC RETINOPATHY AFFECTED EYE

Diabetic retinopathy affected eye includes the several features such as microaneurysms and exudates(soft exudates, hard exudates).

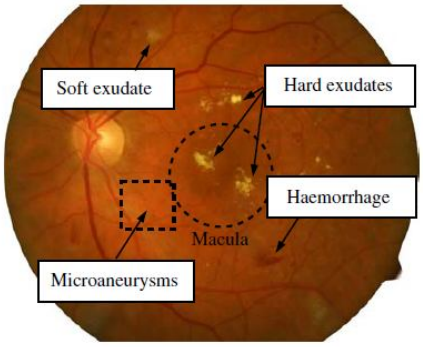


Fig2. Retinal image of diabetic retinopathy affected eye.

The natural formation of new blood vessels and a functional micro-vascular network capable of pre-fusion of blood cells is known as Neo-vascularization. It serves as collateral circulation and response to local poor pre-fusion(inadequate blood supply to organs). Edema is an abnormal accumulation of fluid which causes severe pain due to swelling of the macular region.

II. OVERALL APPROACH

Here automated detection of diabetic retinopathy using feature extraction from digital fundus image. This is done using MATLAB. The features studied are microaneurysms and exudates. When the usable data of the image is represented by close contrast values.

The below figure (fig 3) gives overall approach for the extraction of features and detection of diabetic retinopathy. The success rate of every step in different modules of this system determines the overall output.

The input image is pre-processed by techniques such as enhancement, restoration and obtaining an invariant image.

A.*Image Pre-processing*

Image pre-processing is the initial step in retinal pathology diagnosis which includes techniques such as image denoising, contrast enhancement, intensity conversion, etc.

Intensity Conversion: the input RGB image is converted to gray scale image.

Histogram Equalization:The image enhancement techniques are used to improve the quality of an image.Histogram equalization is a technique for adjusting image intensities to enhance contrast. Global contrast of many images can be increased. The histogram of a digital image with intensity levels in the range [0, L-1] is a discrete function

$$h(r_k) = n_k,$$

where,$r_k$is the k^{th}intensity value and $n_k$is the number of pixels in the image with intensity r_k.

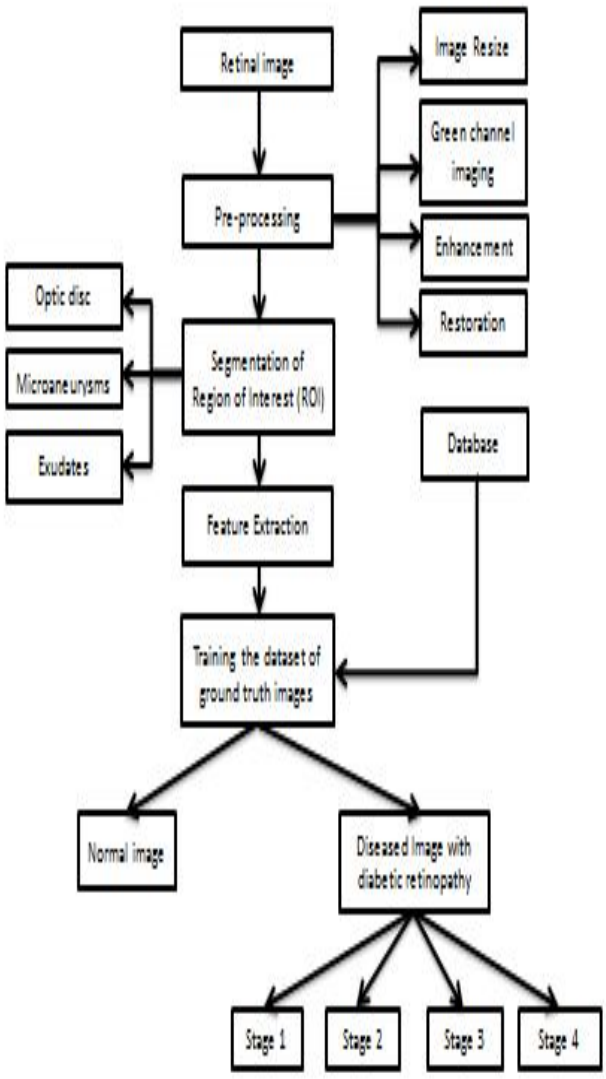


Fig3.Block diagram.

Filtering: The noise in the fundus image is removed using a filter. for robust approach median filter is used .It has the capability to filter any outliers especially for the removal of salt and pepper noise , suppressing isolated noise without fading sharp edges. This is done by replacing a pixel by the median value of its neighborhood pixels.

$$f(x,y) = median\{g(s,t)\}$$

Where (s,t) $\epsilon\ S_{xy}$

Image Adjustment: It increases the contrast of the image by mapping the value of the input intensity image to new values such that, by default, 1% of the data is saturated at high and low intensities of the input data.

B. *Feature Extraction*

For further analysis features such as optic disc, exudates and microaneurysms are extracted.

Features are extracted based on morphological operations. Here a threshold value is set and the technique used is histogram thresholding.In this technique, based on histogram obtained for a particular pre-processed image, a threshold point is selected .The selected threshold value will segment the image in order to obtain the required contour (region of interest).

A hole is defined as a background region surrounded by a connected border of foreground pixels. The imfillfunction contributes for a flood-fill operation on a gray scale or binary image. In binary image imfill changes 0's to 1's.Thus it is based on set dilation, complementation and intersection for filling holes in an image.

Exudate*s:*Exudates are yellow white patches with sharp margins and having different shapes. They are one of the early occurring lesions. Soft exudates are cotton wool spots.

Microaneurysms:Microaneurysms are the first clinical abnormalities noticed in the eye which appears in clusters (haemorrhage).

For optic disk detection every marking in the image is defined by a centroid along with a graphical directive. The graphical directive is thus used for used for every medical finding type over the image set consistently. Confidence values are predetermined by experts and stored which can also be defined by user.

C. *Classifier*

Classifier is an algorithm with features as input. It is based on information that is encoded into the classifier algorithm and its parameters. The output is usually a label and it also contains confidence values.

In image processing image classification is an important task. For automatic processing of data there is a requirement of efficient pattern classification techniques.Support Vector Machine (SVM) was introduced by Boser, Vapnik and Guyon in 1992.

Support vector machines (SVMs) are a set of supervised learning methods which are mainly usedfor regression and classification. SVM belongs to the family of linear classifiers. They areclassification and regression prediction tool that is used to maximize predictive accuracy.

Support Vector machines can be defined as systems which are trained with a learning algorithmfrom optimization theory which implements a learning bias derived from statistical learningStrength and Weakness of SVM: The major strengths of SVM is that the training is easy.

It scales well to high dimensional data also the trade-off between complexity of the classifier anderror can be controlled. The weakness is that it needs a good kernel function.

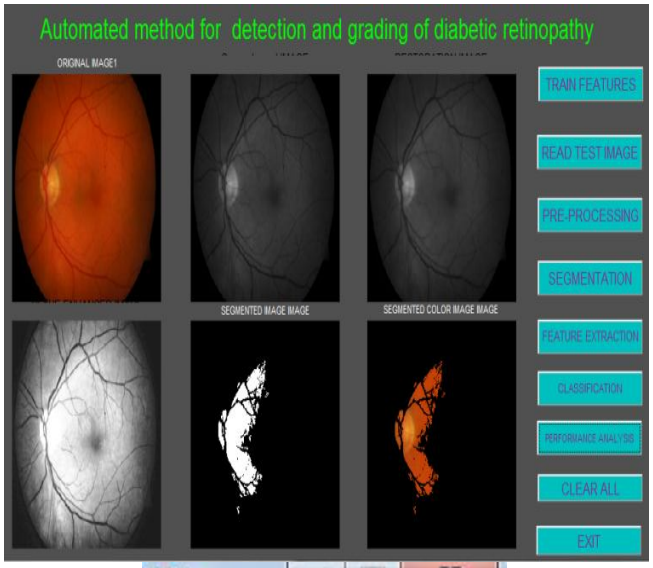
III. RESULT

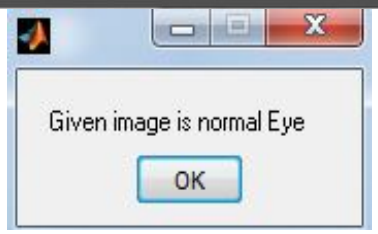
Initially, green channel image is obtained from an original input RGB image. The green channel image is processed into annoiseless image through the enhancement and restoration method.

Further, the features are extracted from the original image using SVM classifier. The obtained resultis classified into 4 stages based on the severity of the disease. The result thus obtained is as shown below:

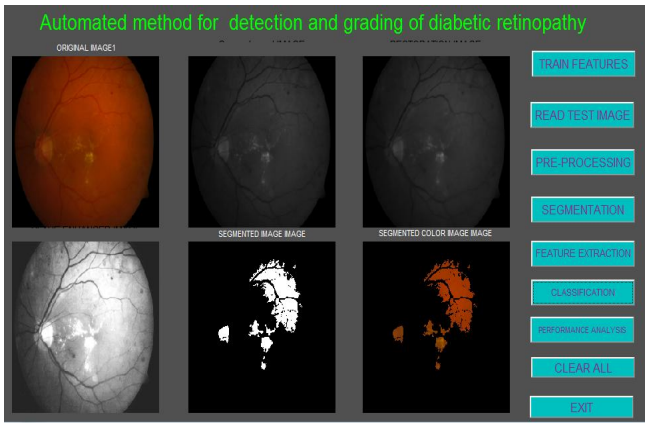
RESULT OBTAINED:

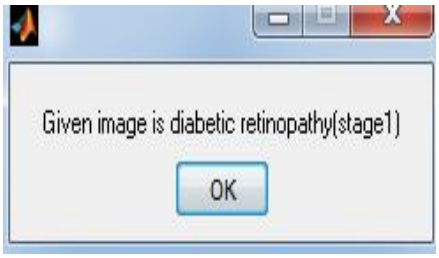
- Normal eye:



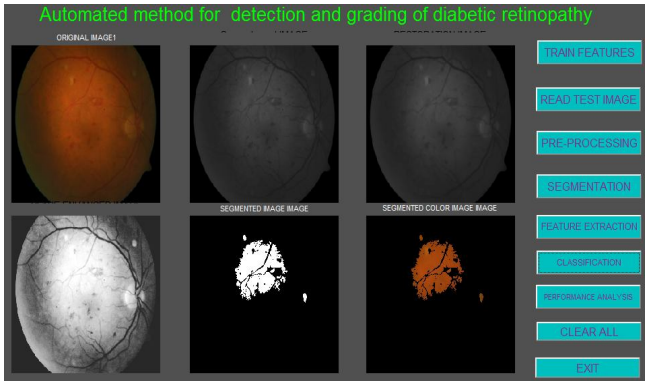


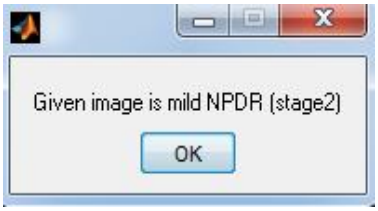
➢ Stage 1 (Mild non proliferative diabetic retinopathy) :



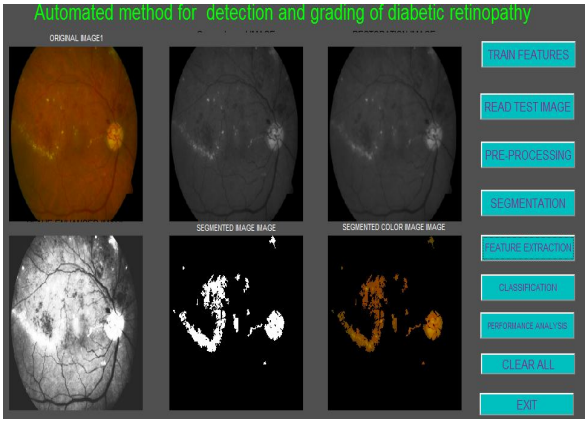


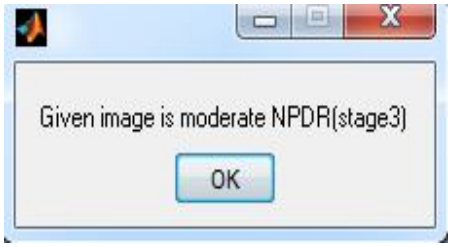
Stage 2 (Moderate non proliferative diabetic retinopathy) :



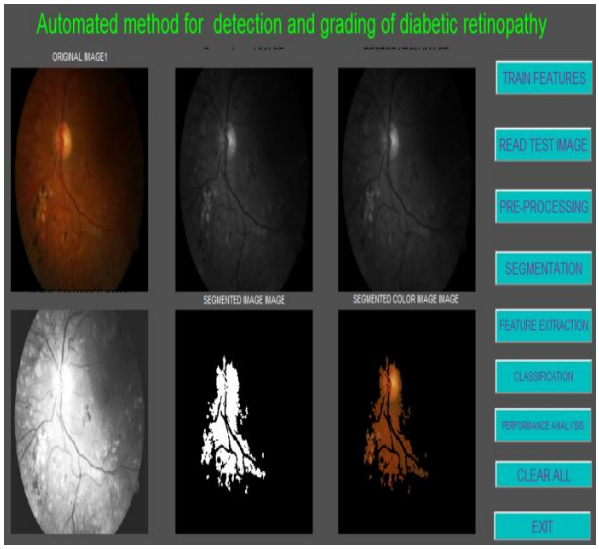


➢ Stage 3 (Sever non proliferative diabetic retinopathy) :

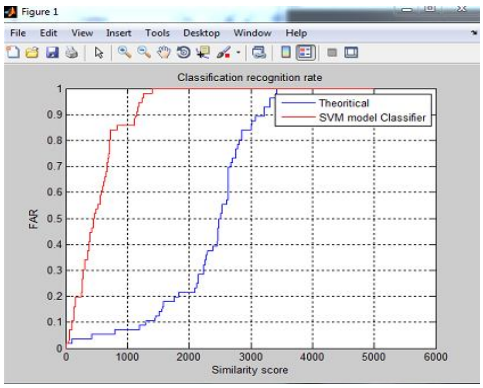


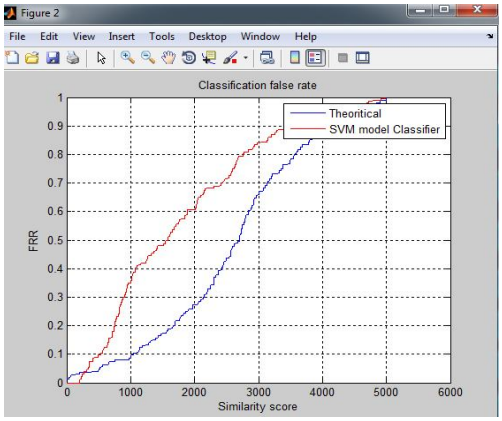


➢ Stage 4 (Proliferative diabetic retinopathy) :



➢ Performance analysis :





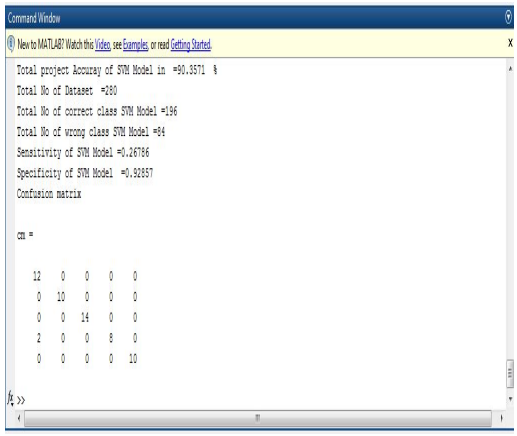


Fig 4.Obtained Result

IV. CONCLUSION

Diabetic retinopathy is the most common disease found in majority of the population which can also lead to blindness. Early detection of the disease is needed to cure the disease.

For the detection of this disease, an image database and ground truth was used. The features like microaneurysms, exudates, optic disc are extracted andthus classified into the stages of severity. The severity of the disease are Stage 01~Mild Non-proliferative, Stage 02~ Moderate Non-proliferative, Stage 03~ Severe Non-proliferative, Stage 04~ Proliferative Diabetic Retinopathy.

The result obtained so far is helpful for the detection of this diseaseat the earliest stage where expert opinion is necessary and also in places where medical facilities are inadequate(especially rural areas).

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