Design an Automatic Exudate Detection for the Diagnosis of Diabetic Retinopathy using Fundus Images

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***Abstract* - Diabetes is a group of metabolic disease in which a person has high blood sugar. Diabetic Retinopathy (DR) is caused by the abnormalities in the retina due to insufficient insulin in the body. It can lead to sudden vision loss due to DR. This method designs an automated method for the detection of exudates in retinal images with high accuracy. Color Fundus Images (CFI) taken by the medical image camera in the hospital which provides digitized data in the form of a fundus image that can be effectively used for the computerized automated detection of diabetic retinopathy. First, the image is converted to gray scale image. Then pre processing is done and regions containing exudates are identified. This preprocessed image is used for the further stages. By considering the feature extraction process, Diabetic Retinopathy is classified into Normal, Mild, Moderate and Severe conditions. It helps ophthalmologists to apply proper treatments that might eliminate the disease or decrease the severity of it.**

Keywords* - *Diabetic retinopathy, exudates, optic disc, fundus images and lesions.

I. INTRODUCTION

Diabetes is a group of metabolic diseases in which a person has high blood sugar, either because the body does not produce enough insulin, or because cells do not respond to the insulin that is produced. Diabetic retinopathy is the damage to the retina caused by complications of diabetes, which can eventually lead to blindness. The risk of the disease increases with age and therefore, middle aged and older diabetic patients are prone to Diabetic Retinopathy. Early diagnosis of Diabetic Retinopathy and treatment can prevent blindness, and therefore, systematic screening of diabetic patients is a cost-effective health care practice. However, due to the large number of people that require screening, an automated and accurate screening tool is a useful adjunct in diabetes clinics.

Diabetic retinopathy has four major stages

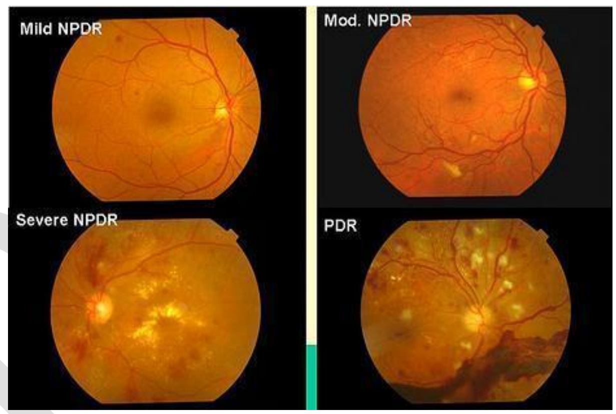

Fig.1: Different stages of Diabetic Retinopathy

a) Mild Non proliferative Retinopathy: At this earliest stage, micro aneurysms occur. They are small areas of balloon-like swelling in the retina's tiny blood vessels.

b) Moderate Non proliferative Retinopathy: As the disease progresses, some blood vessels that nourish the retina are blocked.

c) Severe Non proliferative Retinopathy: Many more blood vessels are blocked, depriving several areas of the retina with their blood supply. These areas of the retina send signals to the body to grow new blood vessels for nourishment.

d) Proliferative Retinopathy: At this advanced stage, the signals sent by the retina for nourishment triggers the growth of new blood vessels. These new blood vessels are abnormal and fragile. They grow along the retina and along the surface of the clear, vitreous gel that fills the inside of the eye. If they leak blood, severe vision loss and even blindness can result.

Exudates occur when lipid or fat leaks from blood vessels or aneurysms. Exudates are of two types namely hard exudates and soft exudates. Hard exudates are small, yellow or white waxy glistening patches with discrete margins. In the case of severe hypertensive retinopathy cotton wool exudates or soft exudates are present.

II.METHODOLOGY

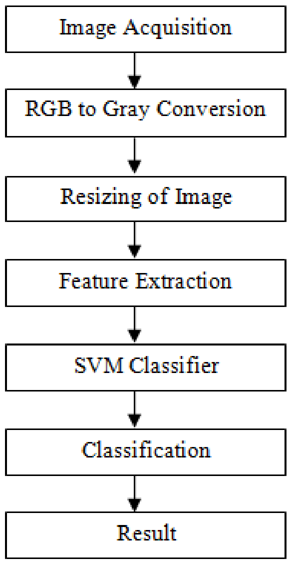

Fig.2: Complete Methodology

A. Image Acquisition

Image acquisition in image processing can be broadly defined as the action of retrieving an image from some source, usually a hardware-based source, so it can be passed through whatever processes need to occur afterward. Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible. The image that is acquired is completely unprocessed and is the result of whatever hardware was used to generate it, which can be very important in some fields to have a consistent baseline from which to work. Collect the retinal images from hospital. For the detection of stages of Diabetic Retinopathy the Color Fundus Images are considered as an input. These images are nothing but the color images which provides the details about retina of eye. The fundus camera is used for acquisition of retinal images. Color fundus images provide the information of retina in digitized format.

B. RGB to Gray Conversion

Take the color image of an eye as an input image and convert it to a grayscale image. To convert any color to a grayscale representation of its luminance, first obtain the values of its red, green, and blue (RGB) primaries in linear intensity encoding. Then, 30% of the red value, 59% of the green value, and 11% of the blue value is added together. Colors in an image may be converted to a shade of gray by calculating the effective brightness or luminance of the color and using this value to create a shade of gray that matches the desired brightness.
Then calculate effective luminance of a pixel by using the formula,
Y= 0.3 Red + 0.59 Green + 0.11 Blue.

C. Resizing of Image

The input color fundus image can be of variable dimensions. Thus the image is resized according to the requirement of the system. The various methods are available for resizing of an image such as bicubic interpolation, bilinear interpolation and Nearest-neighbor interpolation. In bicubic interpolation, the output pixel value is a weighted average of pixels in a nearest 4x4 neighborhood. When the output pixel value is a weighted average of pixels in a nearest 2x2 neighborhood, it is known as bilinear interpolation. In Nearest-neighbor interpolation, the output pixel is assigned the value of the pixel that the point falls within while no other pixels are considered.

By comparing the results generated by these resizing methods, the accuracy of bicubic interpolation method is more than others.

D. Median Filtering

The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing. Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. The median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value.

E. Feature Extraction

1. Entropy: A scalar value representing the entropy of an intensity image. Entropy is a statistical measure of randomness that can be used to characterize the texture of the input image. Entropy is defined as – sum (p.*log2 (p)) where p contains the histogram counts.
2. Mean: The mean is the arithmetic average of a set of values, or distribution. Here in the eye image, it is obtained by adding all of the pixel values together, then dividing by the number of original values.
3. Standard Deviation: The Standard deviation for an image is found by squaring each pixel values of all the individual samples, and then calculating average for the number of

samples, N.

4. Contrast: Contrast Gray scale color map to enhance image contrast.
CMAP = CONTRAST(X, M) returns a gray contrast enhancing color, map that is a M-by-3 matrix with 3 identical columns, so that IMAGE (X) COLORMAP (CMAP) has a roughly equi-distributed gray scale histogram. If M is omitted, the current color map length is used. Contrast works best when the image colors are ordered by intensity. Returns a measure of the intensity contrast between a pixel and its neighbor over the whole image. It is computed by formula

$$\sum_{i,j} |i-j|^2 p(i,j)$$

5. Energy: Returns the sum of squared elements in the GLCM. It is computed by formula

$$\sum_{i,j} p(i,j)^2$$

6. Eccentricity: Scalar that specifies the eccentricity of the ellipse that has the same second-moments as the region. The eccentricity is the ratio of the distance between the foci of the ellipse and its major axis length. The value is between 0 and 1. (0 and 1 are degenerate cases; an ellipse whose eccentricity is 0 is actually a circle, while an ellipse whose eccentricity is 1 is a line segment.) This property is supported only for 2-D input label matrices

III. SVM CLASSIFIER ALGORITHM

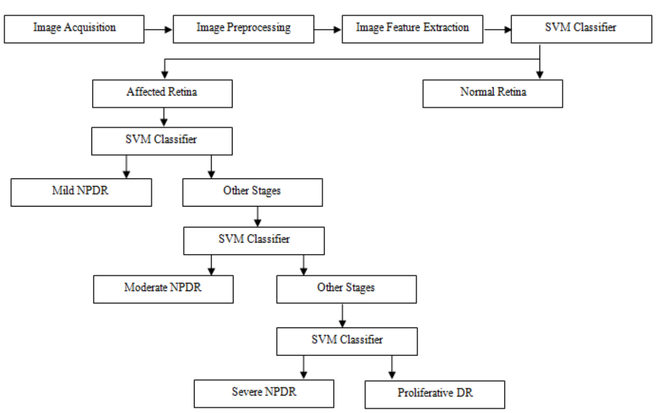

Fig.3: Block diagram of SVM used

After the feature extraction methods, give the extracted features of images as an inputs to SVM. SVM is used to classify the group of eye images as either affected or normal depending on the feature values. Support vector machines (SVMs) are a set of related supervised learning methods used for classification and regression. A Support Vector Machine (SVM) performs classification by constructing an N dimensional hyper plane that optimally separates the data into two categories.

IV. RESULT

The input preprocessed image is given to the support vector machine. As the support vector machine is trained with the data collected from our data base which we have collected. The features of the input image are extracted and given as an input to the support vector machine; Based on the comparison with the parameters of database support vector machine generates the output. The various parameters values extracted for training of SVM are as listed in table.

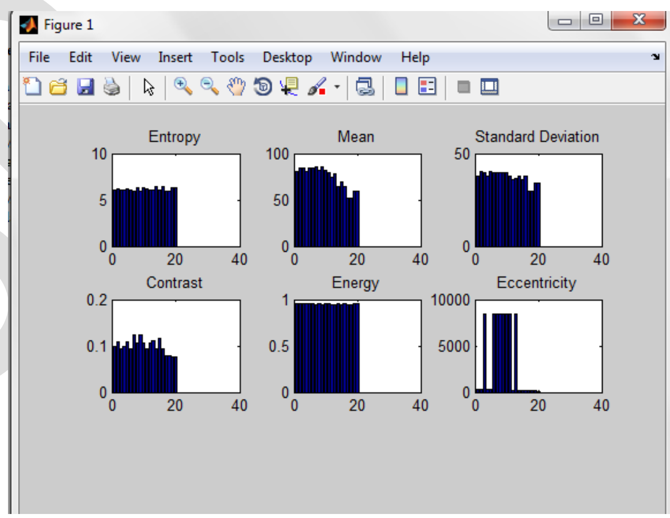

Fig.4: Figure window of different parameters for various images

By analyzing the different parameters values mentioned in table, we come to know that there is a significant difference in mean, standard deviation and contrast. Table contains the range of the different parameters. So we are considering these parameters for training of SVM. Depending upon these parameters the SVM is trained and multiple SVM classifiers are used as we have to classify further stages of diabetic retinopathy.

TABLE I
COMPARISON OF DIFFERENT STAGES WITH THE VARIOUS PARAMETERS

Parameters		Entropy	Mean	Standard Deviation	Contrast	Energy	Eccentricity
Normal Retina	Min	5.6013	80.1812	37.78028	0.094545	0.311169	0.376946
	Max	6.1133	86.1576	40.26566	0.123232	0.381333	0.389954
Mild	Min	5.4763	74.2489	36.12831	0.092525	0.298328	0.990125
	Max	5.8238	78.8786	37.7347	0.110505	0.329374	0.991406
Moderate	Min	5.5096	64.7017	36.24695	0.093535	0.212116	0.924496
	Max	5.7187	68.9718	37.59669	0.11596	0.343697	0.981898
Severe	Min	5.2374	54.3246	27.94059	0.067677	0.242658	0.871826
	Max	5.5624	59.7552	34.17053	0.093131	0.644547	0.991521
PDR	Min	4.4604	30.5352	20.57282	0.053131	0.294579	0.894037
	Max	5.2170	51.3417	29.37783	0.07899	0.400283	0.98169

V. DISCUSSION AND CONCLUSION

Image processing technique plays an important role in the detection of the diseases in biomedical applications. In this work we have implemented an intelligent algorithm for effective detection of intermediate stages of diabetic retinopathy. The preprocessing techniques were employed to improve the suitability of input color fundus image for further processing. Some significant parameters were investigated and extracted by effective feature extraction techniques.

This system can directly detect the stage of the diabetic retinopathy which reduces the time as well as the burden of an ophthalmologist. The system is more useful for the patients from rural areas as they are more aware of the diabetic retinopathy.

TABLE II
Result of overall classified images

Classes	No. of Trained Images	No. of Tested Images	No. of Correctly Classified Images	Classification (%)
Normal	50	30	29	96.67
Mild NPDR	50	30	27	90
Moderate NPDR	50	30	28	93.34
Severe NPDR	50	30	27	90
PDR	50	30	30	100

Our results show that the classifier is able to identify all the PDR class. In the case of Mild NPDR and severe NPDR, our classifier is able to identify their class up to 90 % For Normal class up to 96.67 % and for Moderate class it is up to 93.34 %. The overall percentage of accuracy of the proposed system is 94.00 %.

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