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CLASSIFICATION BASED METHODOLOGY FOR DIABETIC RETINOPATHY DETECTION

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Abstract- Diabetes is a disease in which the blood glucose levels are too high. Diabetes can encourage disorders in the body of patients, if not diagnosed and treated in time. One such disorder caused due to diabetes is related to the retina of human eyes that ways affects the retina known as Diabetic Retinopathy. It damages the retina of the eye leading to vision loss. Thus the objective of this thesis is to detect diabetic retinopathy using image processing based on the analysis of the extraction and classification. Thus diagnosing and detecting the severity of the disease.

Keywords: Microaneurysm, Classification, Segmentation, Retinopathy.

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INTRODUCTION

In the optical sciences, the human eye is often related to a camera (1). Light reflected from an object is focused on the retina after passing through the cornea, pupil and lens.

This is comparable to light passing through the camera optics to the film or a sensor. In the retina, the incoming information is received by the photoreceptor cells which detect light. From the retina, the information is further transmitted to the brain, where the sensation of sight is produced via the optic nerve. During the transmission, the information is processed in the retinal layers. A cross-section of the eye is presented below,
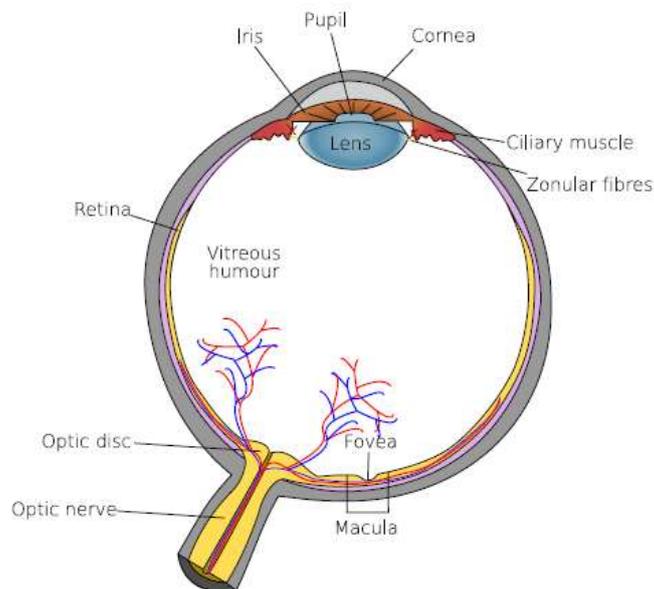

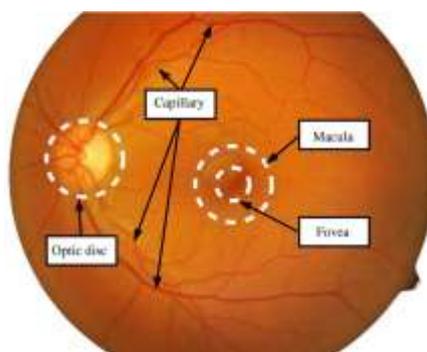**Fig. 1. Cross-section of eye**

Fig. 2. Fundus Image of eye.

Diabetic retinopathy (2) is a micro-vascular barrier caused by diabetes which can lead to vision loss. In early stages of diabetic retinopathy typically there are no observable signs but the severity of irregularities in the retina increase during the time (3)(4) .

There are 2 types of Retinopathy:

Non proliferative diabetic retinopathy: In this condition, the capillaries of retina get damaged and microscopic leaks are formed in the vessels. Leakage causes retina to swell, which interferes with normal vision .

• Micro-aneurysms

• Hard exudates

• Soft exudates

• Dot and blot haemorrhages

Proliferative diabetic retinopathy: In this condition, the capillaries of retina are shut down causing new blood vessels to grow in retina.

• Vitreous haemorrhage

• Pre retinal haemorrhage

Subsequently in order to classify the DR types of the fundus images based on Classification(5)(7) image processing techniques(6) are applied to extract the features providing accurate results.

II. PROPOSED SYSTEM

The proposed system highlights on determining the types of DR. These types can be extracted using fundus images of patients and processing it through appropriate image processing techniques. Based on the presence and the amount of DR types in the fundus image the level of DR is determined in patients.

The analysis of the fundus image is done by the following steps:

(i) Pre-processing

(ii) Segmentation

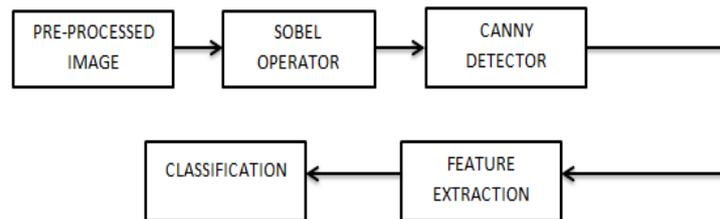(iii) Feature Extraction

(iv) Classification

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Fig.3. Block diagram of proposed system.

A. Database

The fundus images required for the analysis are taken from DIARETDB1 database. It consists of 89 color fundus images of which 84 contain at least mild non-proliferative signs (Ma) of the diabetic retinopathy and 5 are considered as normal.

B. Pre-Processing

The block Diagram depicts the Pre-processing of fundus image which includes the following techniques,
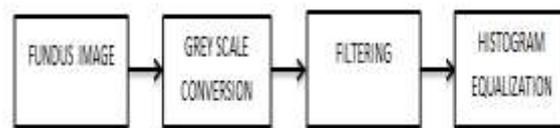

Fig.4. Block diagram of pre-processing system.

1) Grey Scale Conversion: Gray scale images are often the result of determining the intensity of light at each pixel in a single band of the electromagnetic spectrum.

2) Filtering: Median filter is the nonlinear filter more used to remove the impulsive noise from an image. It uses a 2-D mask that is applied to each pixel in the input image to center it in a pixel, evaluating the covered pixel brightness. The median value is then determined by placing the brightness in ascending order and selecting the center value. Thus the obtained median value will be the value for that pixel in the output image.

3) Histogram Equalization: Histogram equalization is a method of contrast adjustment using the image's histogram. This method usually increases the global contrast of many images thus allows areas of lower local contrast to gain a higher contrast.

C. Segmentation:

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The aim of image segmentation is to partition an image into a set of areas with uniform and identical attributes

Edge detection is a type of image segmentation techniques which determine the presence of an edge in image to reduce the amount of data to be processed. Edges are determined using various types of Edge detector operators. In this thesis the blood vessels are segmented from the fundus images by applying Sobel operator followed by Canny detector.
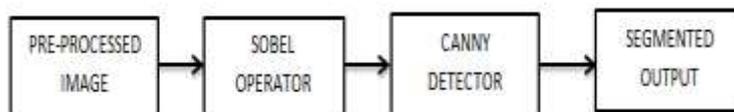

Fig. 5. Block diagram of Segmentation system.

1) Sobel Operator:

The sobel operator performs a 2-D spatial gradient measurement on an image. The sobel edge detector uses a pair of 3 x 3 convolution kernels mask to estimate the gradient in x direction (columns) and other for y-direction (rows).The magnitude of the gradient is calculated by using the formula

2) Canny Detector:

The canny detector detects if the gradient magnitude is larger than those of pixels at both its sides in the direction of maximum intensity changes to classify a pixel as an edge.

Gradients at each pixel are determined by applying the Sobel-operator followed by non-maximum suppression which is used to suppress any pixel value that is not considered to be an edge. After suppression, Double Thresholding is carried out wherein edge pixels stronger than the high threshold are marked as strong; edge pixels weaker than the low threshold are suppressed.

D. Feature Extraction:

The feature extraction is a process wherein various features of the segmented image are extracted and given to a classifier.

Gray-level co-occurrence matrix (GLCM) is a method of observing the textures that consider the spatial relationship of the pixels. By calculating how often pairs of pixel with specific values occur in an image the GLCM functions depict the texture of an image creating a GLCM, and then extracts statistical measures from this matrix.

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The following features of the segmented fundus image are extracted and applied as an input to the classifier;

1) Contrast: Contrast of an image yields a measure of the intensity contrast between a pixel and its neighbor over the image.

2) Energy: Energy relates to the mean squared value of the image measured with respect to the global mean value.

3) Homogeneity: Homogeneity of image gives a value that measures the closeness of the distribution of elements in the matrix to the GLCM diagonal

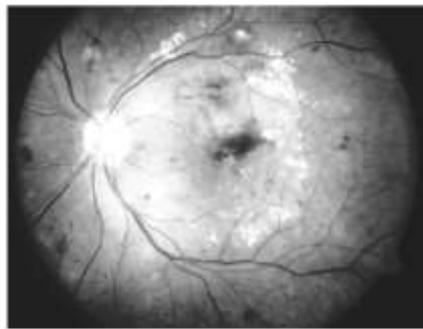4). Correlation: The correlation returns a measure of how correlated a pixel is to its neighbor over the image.

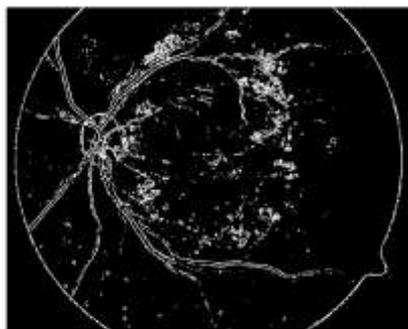**Fig.6. Image after Pre-processing of fundus image.**

Fig.7. Output after applying segmentation

E. Classification:

Artificial Neural Networks consist of a large number of highly inter connecting processing elements (neurons) connected with each other. The strengths of the connections are called weights. It consists of a layer of input neurons, a layer of output neurons and one or more

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hidden layers. The number of input neurons taken is 4 and output neuron is 2, and the number of hidden unit neuron is chosen as 40.

So for the purpose of training and testing the 89 fundus images were divided into 2 classes.

The most popular approach to finding the optimal number of hidden layers is by trial and error. Rapid execution of the trained network is the main advantage of using this type of Artificial Neural Networks. In most applications, the weights are determined by means of the backpropagation algorithm. Backpropogation is based on examining an error surface as a function of ANN weights using gradient descent for points with least error.

So basically classifier classifies the fundus images into 2 classes; Normal Retinal Images and Images affected by Microaneurysm.
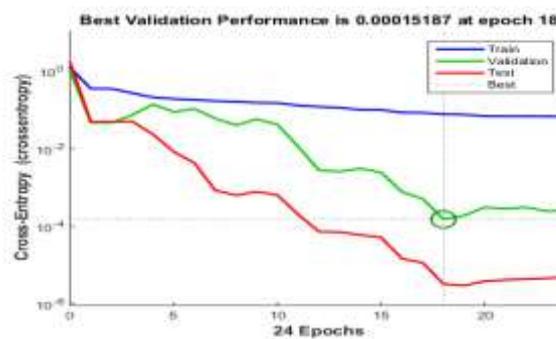

Fig.7. Confusion Plot

Fig.8. Performance Plot

CONCLUSION

In this paper, the neural network classifier is developed as an analytical implementation to aid physician in the classification of normal and Diabetic Retinopathy affected images. Total 4 features namely Contrast, Energy, Correlation and Homogeneity are extracted in order to classify the images accordingly contributing to accurate diagnosis.

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