Feature extraction and calculating error rate in diabetic retinopathy images using neural network

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***Abstract*—In Developing countries, Most of the working age populace are affected from eye diseases. Retinal image analysis plays an important role in medical diagnosis. Most common eye Diseases are Diabetic Retinopathy , Glaucoma, Retinal Detachment, Retinal Disorder, Age Related macular degeneration etc are of much significance today. Around 90% of the people are affected by Diabetic Retinopathy. Diabetic Retinopathy (DR) is one of the most common problems that may lead to blindness and it can be prevented or cured if detected at the earlier stage. The presence of DR can be detected by its different symptoms; the most distinctive is the presence of cotton wool and exudates which are bright lesions in the eye. It is necessary to detect the presence of bright lesions. They play a very important role in the accurate detection and classification of cotton wools and exudates. This research proposes a computer aided system which can be used for detection of lesions in the diabetic retinopathy. The research presents various algorithms on fundus retinal images by following steps like preprocessing, lesion detection, features extraction using fuzzy logic and using neural network. Neural network uses Back Propagation Algorithm which is the most efficient algorithm to deduct the results accurately. The developed method is tested on standard benchmark STARE [] database and the performance metrics is calculated.**

***IndexTerms*—Diabetic Retinopathy, Lesions , Cotton Wools , Exudates**

I. INTRODUCTION

Diabetic Retinopathy (DR) is becoming the most common problem these days. Patients suffering from diabetes usually have the retinal problems like hair growth in retina, retinal detachments etc. Detection of Diabetic Retinopathy (DR) is highly required and the severity check of the problem is also an essential part to detect in the Diabetic Retinopathy, as the high diabetic retinopathy may lead to severe damages in the eye or even it may lead to loss of vision.

The most common problems with vision are nearsightedness (myopia), farsightedness, (hyperopia), a defect in the eye caused by non spherical curvature (astigmatism) and age-related farsightedness (presbyopia), according to the National Eye Institute.

Most people will develop presbyopia in their 40s or 50s, and start needing reading glasses, Fromer said. with age, the lens gets denser, making it harder for the ciliary muscles to bend the lens, he said. The leading causes of blindness in the United States include cataracts (clouding of the lens), age-related macular degeneration (deterioration of the central retina), glaucoma (damage to the optic nerve), and diabetic retinopathy (damage to retinal blood vessels), according to the Centers for Disease Control and Prevention (CDC). Other common disorders include amblyopia ("lazy eye") and strabismus (crossed eyes),

The purpose of our research is to detect the lesions in a diabetic retinopathy and the find the features with the help of fuzzy logic and the mathematical statistics. Calculation of sum of error is also one of our basic step using neural network.

Alireza Osarehet al[2] suggested a common mode for the programmed detection of exudates which is created on the computational Intelligence method. The colored fundus retinal images were segmented by means of the fuzzy c-means clustering over the image .Feature vectors were mined from the image and classified by applying the multilayer neural network classifier. Ege et al[4] the existence of noise in the image is removed by using median filtering, segment the bright lesions and the dark lesions by applying thresholding technique, accomplishes the region growing, and then recognizing the exudate sections with Bayesian. Akara Sopharak[3] reported the result of an "automated detection of exudates" by using the low contrast digital images of the retinopathy patients with "the non-dilated" pupils by "Fuzzy C-Means clustering". Four features were mined like intensity, hue ,standard deviation on intensity image and a number of edge pixels and used on the input to "coarse segmentation using FCM clustering method." Gagnon et al [5] have presented an overview on the generic procedure in color retinal images for the detection of all important anatomical structures: the macula, the optic disk and the retinal work. "Test results show robustness against visual quality of the images and independently on the fact that the acquisition is macula or optic disk centered. Success rates of 100% is reached for optic disk detection and 95% for macula detection."[5] Niemeijeret al[8] In the color retinal images the bright lesion like exudates, cotton wool spots and drusen were distinguished. Initially the pixels were classified, subsequent in probability map that comprised the probability of each pixel to be portion of a bright lesion. Osareh et al[9] They report the development of a technique to quantitatively identify these arbitrary yellow patches in color retinal images automatically. After a color standardization and contrast improvement pre-processing step, the color retinal image is segmented using Fuzzy C-means clustering. Then categorize the segmented sections into two separate classes, exudates and non-exudates, relating the performance of various classifiers. They also trace the optic disk both to eliminate it as a candidate region and to magnitude its boundaries accurately since it is a significant landmark feature for ophthalmologists. Three different approaches are reported for optic disk

localization based on template matching, least squares arc estimation. The classification could accomplish an overall diagnostic accuracy of 90.1% for identification of the exudate pathologies and 90.7% for optic disk localization. T.Walteret al[12]"In this paper exudates were recognized from the green channel of the retinal images rendering to their gray level variation. Mathematical morphological techniques are used to determine the exudates curves. However the author overlooked particular types of errors on the boundary of the segmented exudates in their stated performances and did not distinguish exudates from cotton wool spots." Abdel-Ghafar[1] This research paper groups out the developed methods of separating normal images from the abnormal images (cases of glaucoma or diabetic retinopathy). These could be used in a screening clinic to identify at risk patients..

II. METHODOLOGY

The research work comprises of the following steps :

PREPROCESSING

There is a huge variance in contrast, brightness and luminosity inside the retinal images , which make it composite and extort retinal features. Therefore, image pre-processing is fundamentally required to eliminate the occurrence of noise in the image and equalization of the unbalanced illumination present inside the fundus retinal images .The image pre-processing includes the following steps :

1) Conversion of RGB Image to HSI Image : This conversion is required to extract the intensity values of the pixels from the image
2) Adding salt and pepper noise to remove the unwanted particles from the image
3) Applying median filtering to remove salt and pepper noise .
4) Applying CLAHE (CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALISATION) : To get even illumination, "contrast limited adaptive histogram equalization" is used. With the help of this the darker area of the input image turns out to be the brighter area in the output image. It keeps the uniform illumination in the image.

LESION DETECTION

Manually the threshold value of lesions is calculated for 50 images in database. On the basis of observation of manual thresholding a general mathematical equation is formed to calculate a general threshold value for each image as follows :

$$K = ((\min (M) + \max (M)) / 2) + (\max (M) / 4) \quad \text{.....(1)}$$

M = Intensity value of pixel

min (M) = minimum intensity value of pixel
max (M) = maximum intensity value of pixel
If the intensity value of the pixel in the image is less then the threshold value calculated from the general equation, then new value for that pixel value is zero whereas if the intensity value of the pixel in the image is greater then the threshold value calculated from the general equation, then the new pixel value is one.The resultant image will consist of the lesions in the image.

FEATURE EXTRACTION

There are number of features that can be extracted to detect the problem which classifies the "diabetic retinopathy." The nine features are been extracted from the lesions to fed into a neural network model to classify the problem causing "diabetic retinopathy." The following are the features that are extracted: *AREA :*Area is the total number of pixels in a particular lesion in a given image .*PERIMETER :* Perimeter can be defined as the total number of pixels at the boundaryof the lesion.*COMPACTNESS :* The feature compactness defines that how closely or compactly thetotal number of pixels in a lesion are attached or joins. The formula to calculate the compactness of a lesion is (perimeter *perimeter) / 4* pi* area . *HUE FEATURES :* The pure color of a lesion is described by a color attribute known as hue" . Average hue and Standard deviation of a hue helps in determining the color of an lesion. The MATLAB function is used to calculate the average hue and standard deviation of hue. *SATURATION FEATURES* : "Saturation gives a measure of the degree which the amount of white light mixed with the hue ". Average saturation and Standard deviation of a saturation helps in determining the color of an lesion. The MATLAB function is used to calculate the average saturation and standard deviation of saturation. *INTENSITY FEATURES* : The lightness, intensity or value is related to the color luminance"[4]. Average intensity and Standard deviation of a intensity helps in determining the color of an lesion. The MATLAB function is used to calculate the average intensity and standard deviation of intensity.
A fuzzy system consists of the fuzzy rules which are formed on the basis of two components size and color. On the basis of these fuzzy rules classification is followed for exudates and cotton wools. Size describes the variation in structure of lesions. The graphical representation to classify the lesion on the basis of their sizes is a trapezoidal function. Color describes the shade of lesions. Color helps in classifying the type of a lesion. We use Gaussian function in determining the color. Fuzzy rules for color are as follows :

$$\text{fuzzyW} = \text{large}(R) * \text{large}(G) * \text{large}(B) \quad \text{.....(2)}$$
$$\text{fuzzyY} = \text{large}(R) * \text{large}(G) * \text{low}(B) \quad \text{.....(3)}$$

Here the value of fuzzyR, fuzzyG, fuzzy B is $\exp -(x-u)^2/2\sigma^2$where value of σ is taken as 0.5 and n is the value of color ranging between 0 to 255.

NEURAL NETWORKS

Neural Network is an aritificial network divided into two main learning's known as supervised learning and un supervised learning. Our research work consist of back propagation algorithm to find the error rate. The back propagation algorithm is a multi-layer network using a weight adjustment based on the sigmoid function, like the delta rule. The back propagation method, as well as all the methods previously mentioned are examples of supervisedlearning, where the target of the function is known. Our research work uses a general back propagation algorithm in MATLAB.

III. RESULTS

PREPROCESSING

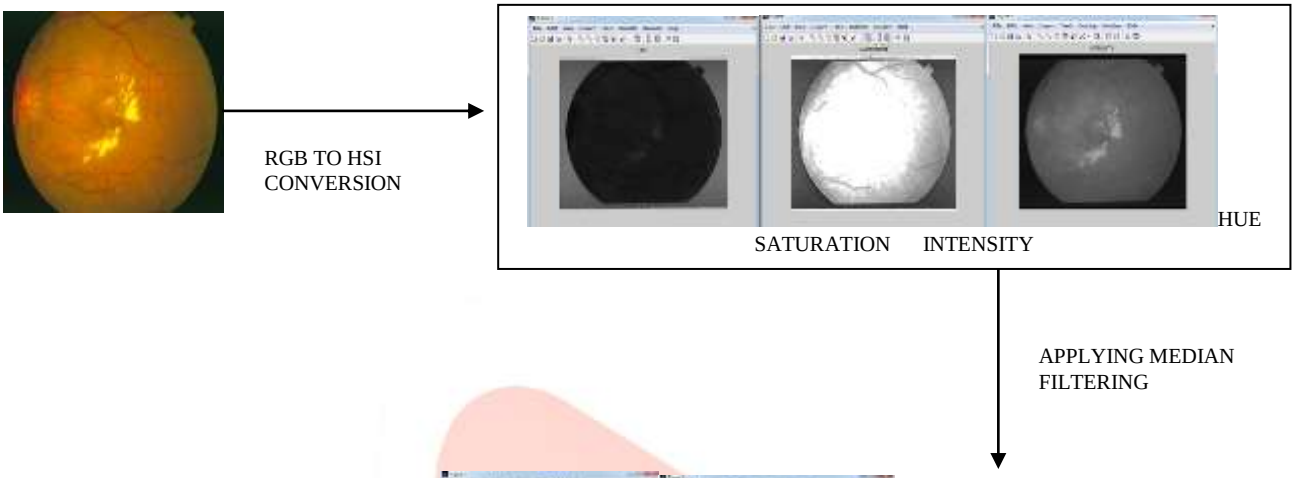

FIG 1

LESION DETECTION

FIG. 2

FEATURE EXTRACTION

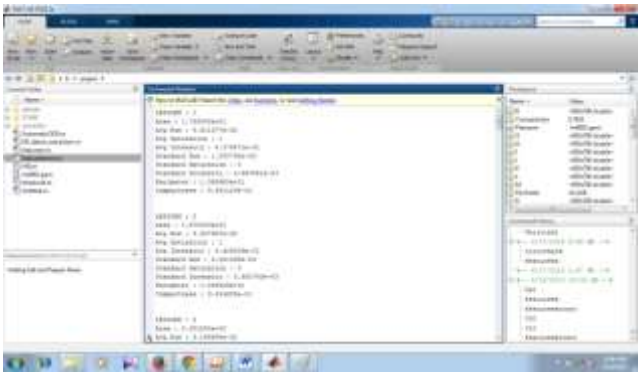

FIG 3

NEURAL NETWORK : BACK PROPAGATION

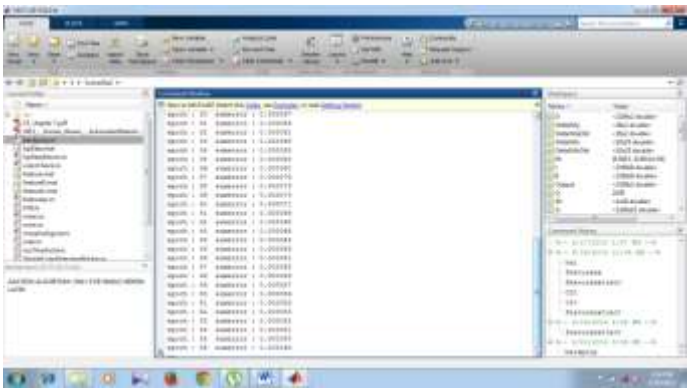

FIG 4

We have performed various experiments in back propagation neural network model to check the performance of the network with the desired features extracted .

Performed various experiments using different architecture , hidden neurons , learning rate , momentum to receive the lowest error rate in the model.

IV CONCLUSIONS

This project compromises of the detection of lesions and the extraction of reduced features in the lesions. Using of neural network (Back propagation learning algorithm) helps in classification between the two problems of "diabetic retinopathy" , "(cotton wools and exudates)" and detection of the presence of the "diabetic retinopathy." Knowing the lesenic srea in the eye helps in taking the step earlier for cure of disease

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