Detection and Analysis of Micro Aneurysms in Diabetic Retinopathy using NPRTOOL

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Abstract:- Diabetic Retinopathy (DR) is a perilous eye ailment which may cause visual impairment or vision loss. This illness has spread internationally among the general population, particularly to the individuals who are experiencing diabetes. Identification of DR in beginning stage is exceptionally hard and tedious even for specialists. Subsequently, this paper discusses a procedure which is utilized to identify micro-aneurysms in Diabetic Retinopathy utilizing retinal fundus picture has been proposed. Micro-aneurysms are viewed as the preliminary phase of DR. The proposed procedure includes pre-processing of the fundus picture and discovery of micro-aneurysms in retinal picture. The illness is analyzed utilizing Neural Network Pattern Recognition Tool (NPRTOOL) which is a module given by MATLAB. Support Vector Machine (SVM) classifier method is likewise used for classification. The aftereffects of NPRTOOL and SVM are compared.

***Keywords:** Diabetic Retinopathy (DR), micro-aneurysms, NPRTOOL, SVM.*

I. INTRODUCTION

Diabetic Retinopathy (DR) is one of the fundamental reasons that reason visual impairment. On a normal, it influences 93 million individuals [8]. It influences nearly 80 percent of the populace who are experiencing diabetes for over 20 years. Studies have found that 90 percent of such cases can be eliminated if there exists a genuine treatment and checking of eyes of the patients. At the present time, identification of DR is manual and dull procedure which needs an expert ophthalmologist to assess and analyze fundus pictures comprising of retina [8]. Specialists recognize Diabetic Retinopathy by searching for presence of lesions. These must be related with eye variations that were brought about by the disease [8]. This technique is successful yet very asset requesting. Since the quantity of diabetic patients is developing, so is the quantity of patients experiencing DR, which would require more framework to avoid visual deficiency among them [8].

Micro-aneurysms, distinguished clinically by ophthalmoscopy as dark red dots differing from 25 to 100 µm in width, are normally the main noticeable indication of diabetic retinopathy.

II. RELATED WORKS

S.Sudha,A.Srinivasan, T.Gayathri Devi et.al [1] proposed a technique in which Pre-processing technique included resizing, noise removal, and color transformation for further process of detection of Diabetic retinopathy. Weiner filter is used for deblurring the images. A contrast improvement of image is achieved by Adaptive histogram equalization. SVM was used for classification. Arslan Ahmad, Atif Bin Mansoor, Rafia Mumtaz, Mukaram Khan, S.H.Mirza et.al [2] The preprocessing step is utilized to evacuate noise in the retinal picture just as to upgrade picture differentiation and quality of fundus picture. Then the image is normalized to minimize intra-image variability. CLAHE algorithm was used to enhance the quality of the image. Features are extracted and classified using SVM and KNN algorithms. Ketki S. Argade, Kshitija A. Deshmukh, Madhura M. Narkhede, Nayan N. Sonawane, Sandeep Jore et.al [3]. Retinal pictures which are taken as input are resized or compacted into small images which help to maintain a strategic distance from time utilization and overloading. RGB images are converted in gray scale images and features are extracted from the image and KNN was used for classification. Amol Prataprao Bhatkar, Dr. G.U.Kharat et.al [4]. The abnormalities such as blood vessel dilation, exudates, lesions etc. are observed and features of blood vessels, macula, and optic disk are extracted. The next step is to classify the image which is done by MLPNN classifier. Deepthi K Prasad, Vibha L, Venugopal K R et.al [5]. Image is rescaled and is segmented into four equal sub images. The image contrast is stretched using adaptive histogram equalization. Canny edge indicator is utilized to recognize the edges. Different morphological tasks and threshold based division method are utilized for extricating the veins, exudates and MA separately. The features such as the area of exudates, blood vessels and MA in the images are extracted. OneR is used for precise classification.

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III. PROPOSED METHODOLOGY

The data for the test study is taken from “Standard Diabetic Retinopathy” Database. The primary task of this work is to identify micro- aneurysm i.e. the beginning stage of diabetic retinopathy (DR), utilizing the extracts from the pre-processed image. The picture got from the database is exposed to the pre-processing steps, such as LAB color space conversion, zero padding, average filtering, adaptive histogram equalization and segmentation. After pre-processing, features such as area, perimeter, mean, variance etc. and then the results are fed into NPRTOOL. Using this tool the image is classified as presence or absence of micro-aneurysm.

Figure 1 shows the proposed method’s Block Diagram.

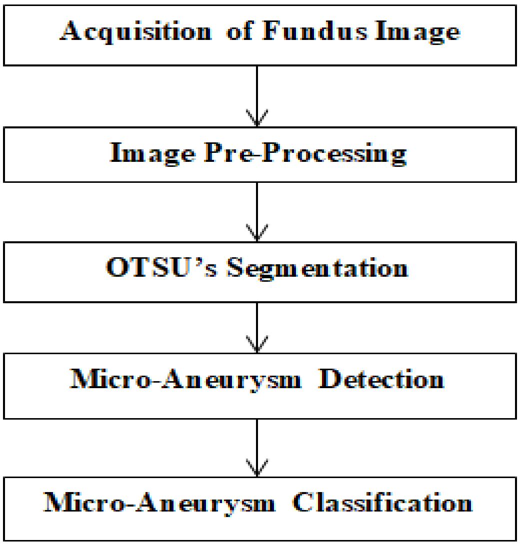

Figure 1: Proposed Method’s Block Diagram

A. Image Acquisition Color fundus pictures are gathered from the "Standard Diabetic Retinopathy Database" made by Machine Vision and Pattern Recognition research group of Lappeenranta University of Technology, Finland.

Figure 2: Input RGB image

B. Pre-Processing Stage The preprocessing stages that are followed in this process are as follows:

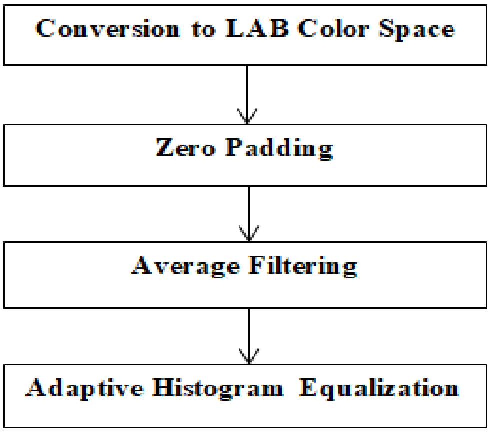

Figure 3: Block diagram for Pre-Processing

The RGB image is translated into LAB Color space to convert to an intensity image which is shown in figure 4. Zero padding is needed for appropriate edge detection. Zero padded image is shown in figure 5. The next stage is average filtering which removes the unwanted noise in the image. It is widely used as it is very effective in reducing noise. It is represented in Figure 6. To enhance the contrast of the image Adaptive histogram equalization (AHE) has been performed.

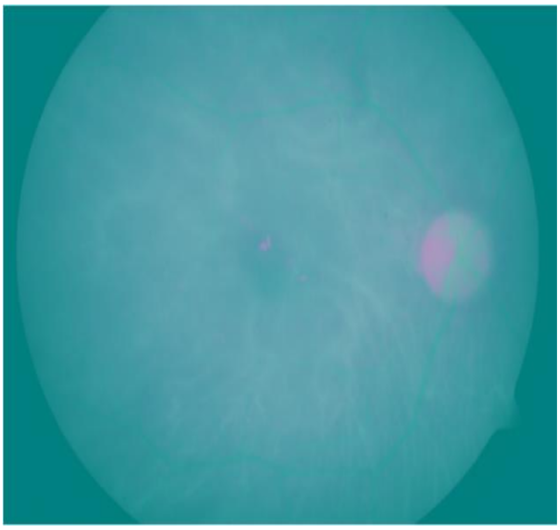

Figure 4: LAB color space

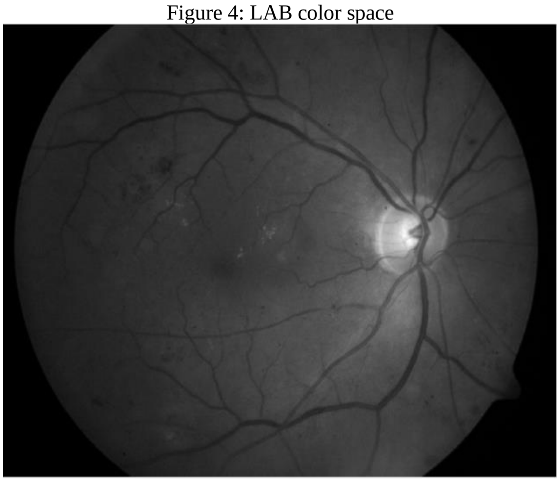

Figure 5: Zero padding

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Figure 6: Average Filtered image

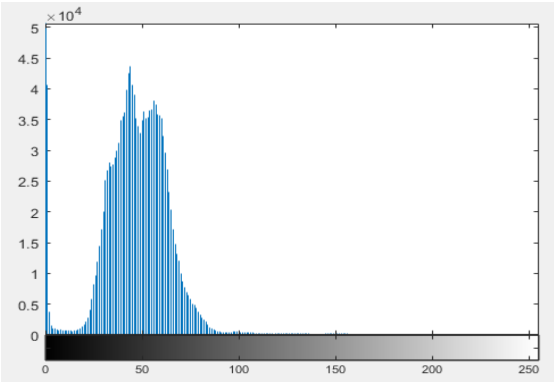

Figure 7: Histogram before applying AHE

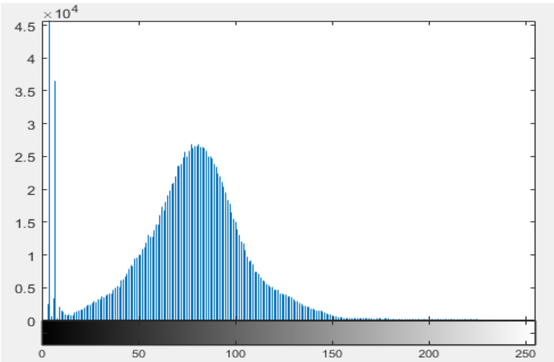

Figure 8: Histogram after applying AHE

C. Segmentation Stage The pre-processed image is segmented using OTSU's thresholding algorithm. The thresholding value obtained using this algorithm is 0.039.

D. Feature Extraction Stage Features such as mean, variance, area, perimeter has been extracted from the enhanced binary image.

E. Disease Detection and Classification After extracting the features the results are fed NPRTOOL and then the neural network is trained to identify the presence or absence of micro-aneurysms in the fundus image.

Figure 9: micro-aneurysms are present

IV. EXPERIMENTAL RESULTS

Features such as area, mean, variance, and perimeter are provided as input to NPRTOOL which are obtained from the pre-processed image. The target data is a combination of binary 0 and 1 where 0 represents healthy and 1 represents unhealthy. The implementation is carried out using Matlab. The sensitivity (1), accuracy (2) and specificity (3) are calculated using the formulas.

Sensitivity=TP/TP+FN (1)

Accuracy=TP+FN/TP+TN+FP+FN (2)

Specificity=TN/TN+FP (3)

Here,
TP = True Positive,
TN = True Negative,

FP = False Positive,
FN = False Negative

TP= A number of micro-aneurysm correctly detected.
FP= A number of micro-aneurysm which are detected wrongly as micro-aneurysm.
FN= A number of micro-aneurysm that were not detected.
TN= A number of micro-aneurysm that were correctly identified as non-micro-aneurysm.

Table 1 shows the result of classification using two techniques.

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Model	Accuracy	Sensitivity	Specificity	Misclassification
NPRTOOL	86.6%	72.01%	48.45%	13.4%
SVM	55.05%	63.26%	40%	47.19%

Table 1: Result

Figure 10a shows the confusion matrix for training data. Out of 726 images 508 images are used to train the neural network (70% of dataset). Figure 10b shows testing confusion matrix. 15% of the images are used for testing i.e. 109 images. Figure 10c shows the validation confusion matrix. 109 images were used for validation i.e. 15% of the overall dataset.

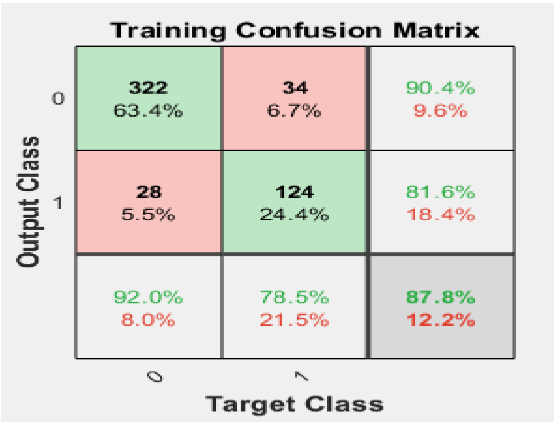


Figure 10a: Confusion Matrix for Training Phase

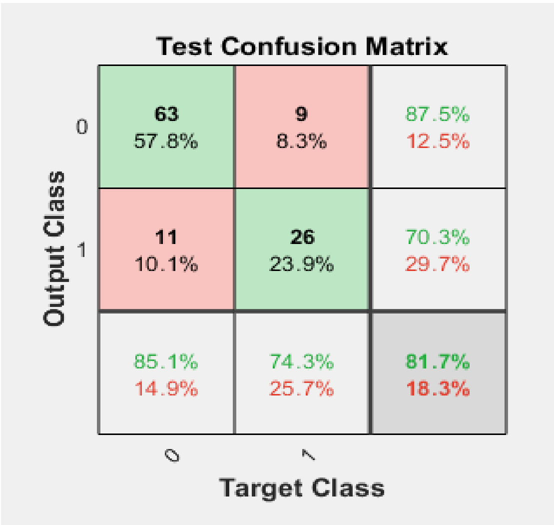


Figure 10b: Confusion Matrix for Testing Phase

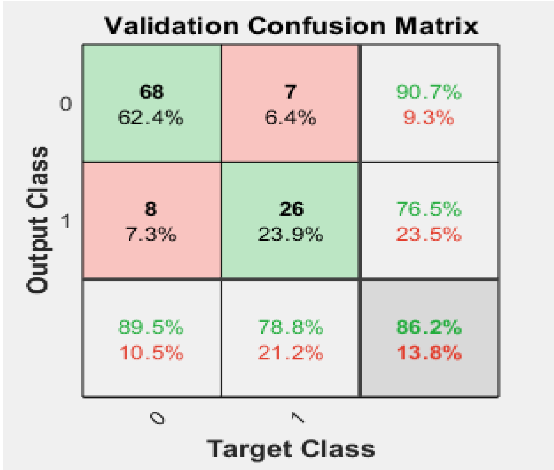


Figure 10c: Confusion Matrix for Validation Phase

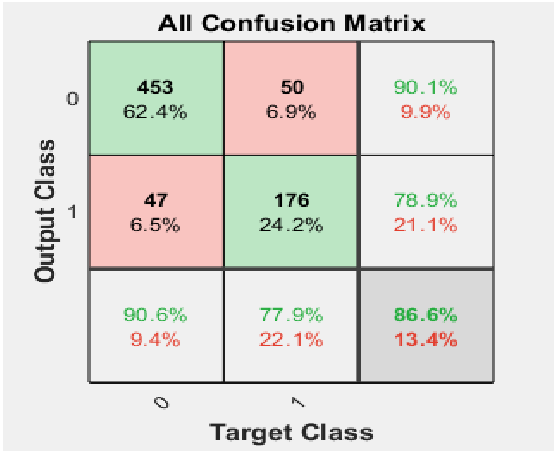


Figure 10d: Overall Confusion Matrix.

Figure 10d shows the overall confusion matrix which is generated using NPRTOOL.

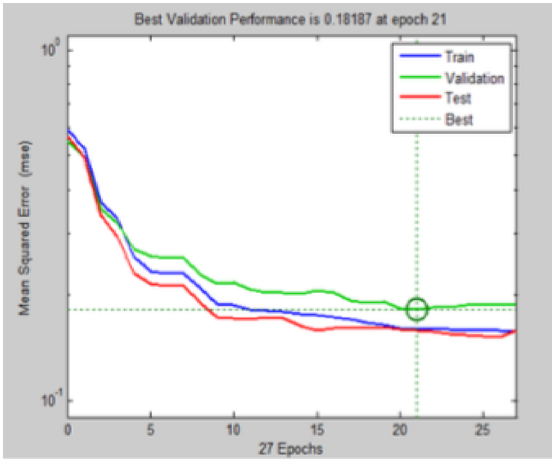


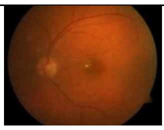
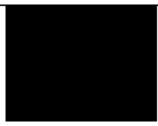
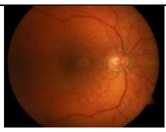
Figure 11: Mean squared error curve.

Figure 11 shows the mean squared error curve obtained using NPRTOOL. It is a graph plotted between mean square error and the epochs. The above figure is the plot for training, validation and test performance which are indicated by blue green and red curves respectively. Best performance is taken from the epoch with the lowest validation error. Accordingly the best performance occurs approximately after 21 iterations.

V. CONCLUSION

This paper introduces the recognizable procedure of micro-aneurysms in DR by using MATLAB NPRTOOL. Standard Diabetic Retinopathy Database is used for identification of micro-aneurysms in fundus image. Adaptive Histogram equalization of uneven brightening of the fundus picture is one of the key accomplishments of this technique. Bleeding and Red spots have been effectively distinguished applying the portrayed technique. Determined accuracy rate is 86.6% and misclassification rate is 13.4%. The results are compared with SVM technique and the accuracy of using SVM is 52.8% with misclassification rate of 47.19%. Suggestions are taken from the doctor and those results are compared with the results obtained from the proposed model.

The correctness of the results obtained from the proposed model has been verified by medical personnel. The accuracy obtained is 91.01%.

Input Image	Output Image	Remark
		Micro-aneurysms are present and correctly classified.
		Micro-aneurysms are present and correctly classified.
		Micro-aneurysms are not present and correctly classified.
		Micro-aneurysms are present and correctly classified.
		Micro-aneurysms are present and wrongly classified.
		Micro-aneurysms are present and correctly classified.
		Micro-aneurysms are not present and wrongly classified.
		Micro-aneurysms are not present and correctly classified.
		Micro-aneurysms are present and correctly classified.
		Micro-aneurysms are not present and wrongly classified.

VI. FUTURE ENHANCEMENT

Detection of Diabetic Retinopathy can be done using deep learning algorithms such as Convolution neural networks (CNN). Also, Models like Long short Term Memory (LSTM) could be used for better detection.

VII. ACKNOWLEDGMENT

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VIII. REFERENCES

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