Micro Aneurysms(MA) detection using Deep Learning

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Abstract— **Diabetic Retinopathy (DR) is the prominent cause of blindness in the world. Early detection of diabetic retinopathy can provide operative treatment. Early treatment can be conducted from detection of micro aneurysms(MA). Micro aneurysms(MA) are the earliest clinical sign of diabetic retinopathy and they appear as small red spots on retinal fundus images. Microaneurysms (MA) are reddish in color with a diameter less than 125 µm. The existing trained eye care specialists are not able to screen the growing number of diabetic patients. So there is a need to develop a technique that is capable to detect microaneurysms as a part of diagnosis system, so that medical professionals are able to diagnose the stage of the disease with ease. We are using a Convolutional Neural network using Deep Learning In MATLAB.**

I. INTRODUCTION

Due to modern living style, a list of people is getting affected with Diabetes. The World Health Organization evaluated that 135 million people have diabetes mellitus worldwide and the number of people with diabetes will increase to 300 million by the year 2025. Diabetes is a systematic and chronic end organ disease that occurs when the pancreas does not secrete enough insulin or the body is unable to process it properly [2]. A side effect of diabetes is Diabetic Retinopathy in which different parts of the retina get affected. Diabetic retinopathy is a medical condition where the retina is damaged because fluid leaks from blood vessels into the retina. Doctors recognize diabetic retinopathy by examining the features, such as blood vessel area, exudates, hemorrhages, microaneurysms and texture. Diabetic retinopathy can be divided into three stages of non-proliferative retinopathy: mild, moderate, and severe and one stage of proliferative retinopathy.

Different retinal features are blood vessels, optic disk, macula and fovea as shown in Fig. 1. Due to diabetic retinopathy different parts of the retina get damaged and lead to vision loss. Also, the characteristics are changed due to different pathological conditions. Due to changes in retinal features, new features such as microaneurysms, exudates, and hemorrhages appear in the retina as shown in Fig. 2. Diabetic Retinopathy is a frequent complication of diabetes and the

most common cause of blindness in the working population of the western world.

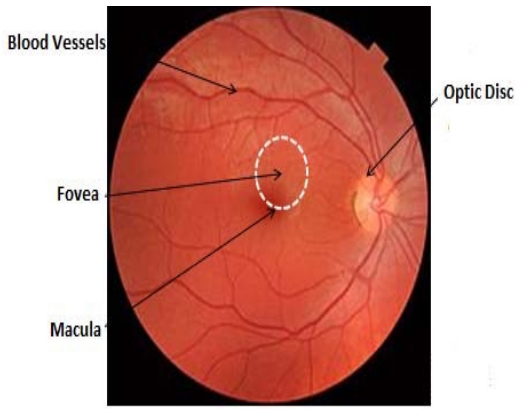

Fig.1.Normal Retinal Fundus Image

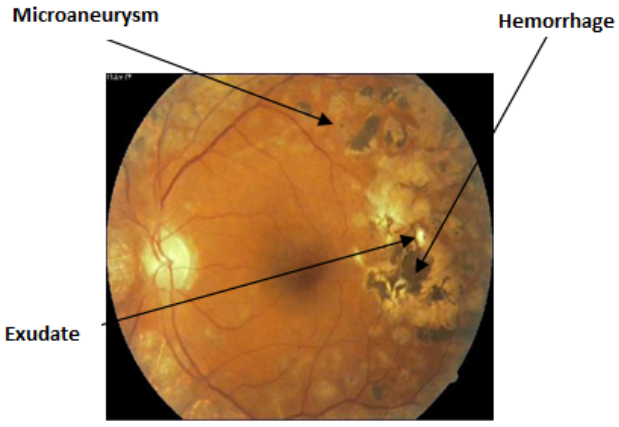

Fig.2.Retinal Fundus Image Containing DR Lesions

Fleming et al. [4] have shown the role of micro aneurysm(MA) and hemorrhage in automatic grading of diabetic retinopathy. One of the most important steps in the automated detection of DR is the detection of micro aneurysms. Micro aneurysms are amongst the earliest observable signs of the presence of diabetic retinopathy. Due to a large number of patients, the available ophthalmologists are not sufficient in handling all the patients, especially in rural areas. Therefore, automated early detection of microaneurysms could ease the burden of ophthalmologists. Automated microaneurysms detection can also help the ophthalmologists in investigating and treating the disease more efficiently.

In this paper, we compare some of the methods for automatic detection of microaneurysms on the basis of two parameters: sensitivity and specificity. The objective of this paper is to review the relevant literature in the field of microaneurysm detection and to provide researchers with a detailed resource of the available methodologies used for microaneurysm detection.

II. MATERIAL AND DATA SET

Fundus photography is the creation of a photograph of the interior surface of an eye, including the retina, optic disc, macula, and posterior pole. The fundus image of the retina is basically acquired with the digital fundus camera, which is a specialized camera that images the retina via the pupil of an eye. The fundus camera has the illumination system. Modern systems image at high-resolution and in color with Nikon or Canon digital SLR camera backends. The field of view (FOV) of the retina that is imaged can usually be adjusted from 25 to 60 (as determined from the pupil) in two or three small steps. The smaller FOV has better detail but this is at the expense of a reduced view of the retina. There are various publicly databases which are available online for the research purpose such as Messidor database, STARE, DRIVE, DIARETDB1 Database and private database from hospital. The databases available are for the study, research purpose. In this database various images along with annotation file is provided in which pathological result for each image such as retinopathy grade and features which are present such as micro aneurysm, exudates, hemorrhages, neovascularization is mentioned.

DIARETDB1 was initiated by Tomi Kauppi for diabetic retinopathy detection from digital fundus images. This dataset is publicly available. It consists of 89 retinal fundus images of which 84 images contain some signs of diabetic retinopathy like microaneurysm and 5 images are considered as normal which do not contain any signs of diabetic retinopathy. These images were collected from a screening program and taken under a fixed imaging protocol. It contains the ground truth collected from several experts and a strict evaluation protocol

III. METHODOLOGY

In this paper we Implemented our custom built Convolutional Neural Network using MATLAB.

Data Preparation:
We had 89 Retinal Fundus Images along with the groundtruth consisting of coordinates that marked centers of MA lesions for each image. The images from the dataset were not directly used by model but they were first converted into patches of size 28*28 pixels that could be used for training. Using groundtruth, we were able to generate 211 MA patches and 1300 nonMA patches. The number of MA patches generated were not sufficient for the purpose of training so data augmentation was used to increase the number of MA Patches before initiating the training phase.

Data Augmentation:
We performed augmentation on MA patches taken out from dataset for training using rotation and reflection functions such that we were able to produce 1000 more MA patches. Our training data consisted of 1000 patches from each of the classes and the testing data consisted of 22 patches from each of the classes after splitting.

Training:
Our model used 100 epochs to iterate over the training set with 0.0001 as learning rate. It used Stochastic Gradient Descent technique to optimize loss function. We used Relu as the activation function and Softmax layer for classification.

Testing:
Once the data is trained into the system, we conducted testing on 44 image patches, 22 MA and 22 Non-MA patches and were able to achieve 0.9048 accuracy.

IV. RESULTS

The training curve(fig.3) shows the decent of loss and rise of accuracy over each epoch.

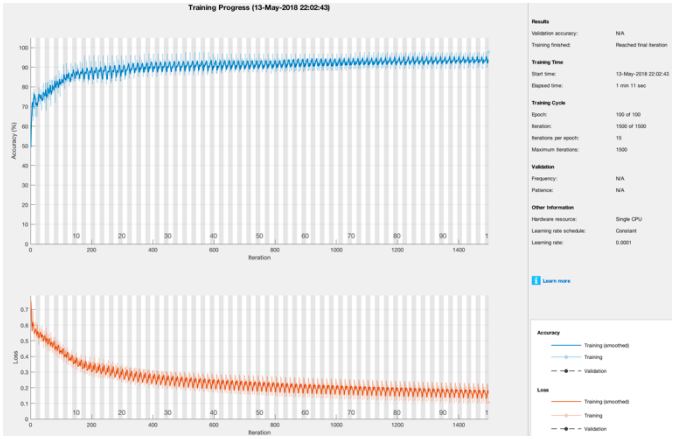

Fig.3. Accuracy and loss graph of the training data

We were able to achieve an accuracy of 0.9048 over testing dataset after performing 100 epochs.

Validation:
The best validation curve (fig. 4) shows that the error rate substantially kept decreasing until the fifth epoch.

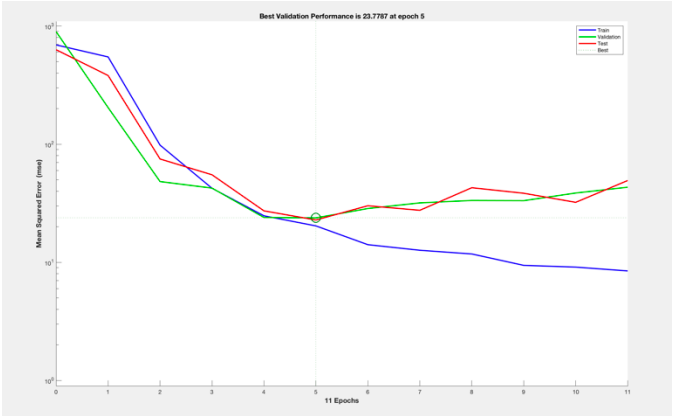

Fig.4.Validation curve.

The Error histogram(fig.5) shows the distribution of error over the training, testing and validation phases.

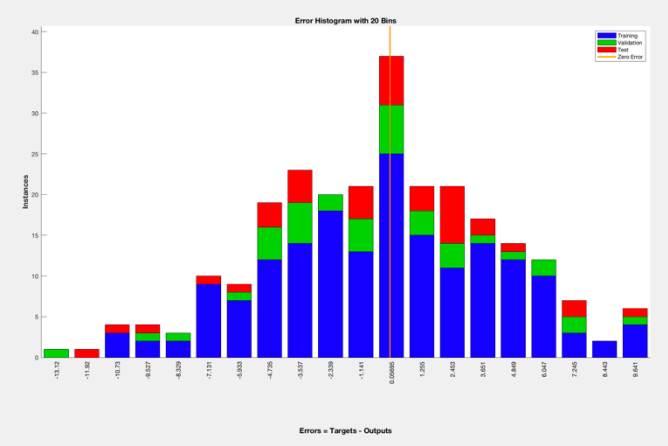

Fig.5. Error Histogram.

V. CONCLUSION.

MA DETECTION IS VERY DIFFICUKLT BECAUSE OF THE SIZE, AND THE BLOOD VESSELS SOMETIMES HAVE THE SAME COLOUR AS THE MA'S. IN THIS PAPER THE APPROACH OF DETECTION OF MA'S IS DEEP LEARNING, USING MATLAB HAS ACHIVED AN ACCURACY OF 0.9048 WHICH IS 90.48%.

VI. REFERENCES

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