AMD-Network: Automatic Macular Diagnoses of disease in OCT scan images through Neural Network

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Abstract *Retinal optical coherence tomography scan images are used to diagnose retinal diseases using Convolutional Neural Network. One of the most beneficial of using Optical coherence tomography scan images is its non-invasive operation. Most ophthalmologists are using optical coherence tomography images for treating the retinal disorder in the human eye but due to its high cost of imaging, every patient can effort this imaging modality. Convolution Neural networks are now day giving lots of opportunities to classify various classes of images automatically. This method first removes noise from the images which get induced at the time of image capturing. Usually, Gaussian noise easily gets introduces in the transmission of images from one device to another. Speckle noise can be easily removed with the help of an average filter with a deviation of 0.7. Convolution Neural Network first trains the network with the help of activation functions like rectilinear Unit. The proposed method achieves 98.8% accuracy in the dataset of 50000 images*

Keywords Choroidal Neovascularization, Diabetic retinopathy, Diabetic Macular Edema, Glaucoma, Human Retinal Disease, Residual
Network, VGG16.

1 Introduction

The human eye plays a vital role in training the human brain. Retinal diseases such as diabetic macular edema, glaucoma, diabetic retinopathy, and Choroidal Neovascularization not only impact the vision of the human eye but also made a great impact on learning the visual object's behavior [1]. Optical Coherence Tomography has become a useful imaging modality now a day due to its non-invasive medical imaging method [2]. Retinal Optical Coherence Tomography allows ophthalmologists to diagnose retinal diseases such as age-related macular degeneration and glaucoma [3].

Processing Optical coherence topographical images is not an easy task due to speckle noise present in the images at the time of scanning [4].

Many research scholars [5] gave techniques to remove these speckle noise from optical coherence tomography but Gaussians filter with a standard deviation of 0.7 and mask (9,9) could efficiently remove noise from the scanned images [6].

Ophthalmology is evolving by many research scholars [7]. Eyes being a major part of the human body require advanced techniques for detection and treatment of various diseases - OCT is one such technique for imaging [8].

Handling OCT images becomes a tedious task due to various issues such as noise in the image, less visibility, unnoticeable variation in intensity between different layers of Retina, etc. OCT images are used to examine various eye diseases and to know the condition of the retinal layout [9]. Therefore, it stings a very important role in the field of Ophthalmology [10].

Denoising is usually one of the major steps in classification pre-processing [11]. There is many convolutional neural networks (CNN) based algorithm as mentioned in [12] on a chest X-ray dataset to classify medical Images of pneumonia. We have hooked upon OCT images for this process as they have a huge relevance when it comes to generating a schematic that defines multiple tissues of the eye, called the Retina [13]. It is also used for examination, by imaging the eyes of the patients with various eye conditions such as Diabetic Macular edema and diabetic retinopathy, etc [14]. Noise makes its way into the OCT images during acquisition. The sensor and circuitry of a scanner or digital camera could also raise the problem of getting noise to the image [15]. Further

ACI’2021: Workshop on Advances in Computational Intelligence, February 25-27, 2021, Delhi, India
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film grain can also add to be a reason behind image noise. Never intended to be introduced in an image it degrades the quality of an image. Hence, processing an image becomes necessary [16]. Image processing is the procedure of improving the quality and information content of the original data. Image enhancement, Restoration is amongst some relief approaches that are used to improve the quality of an image. The latest research in [17] expresses the application of deep learning in medical image processing.

2 Related Work

There are the number of classification work has been done for OCT images till date, but they are for classifying diseased eye from Normal eye. The following section describes the various works done in the classification of retinal Spectral Domain OCT (SDOCT) images.

M. Treder et al. proposed a model in [5], [18], which is based on machine learning for retinal SDOCT image categorization for Age-related Macular Degeneration with the help of a dataset obtained from Heidelberg. The authors use the Inception-v3 model for Deep Convolutional Neural Network where starting layer got trained on ImageNet and the final layer got trained for taken dataset. Their work showed a good result for age-related macular degeneration diseases. Their work was only designed for age-related macular degeneration disease and Normal eye images

Fig. 1. OCT scanning of the human eye [18].

The next step that comes is Segmentation. Segmentation is a process of dividing an image into regions. This technique is a mid-level processing technique. This further aims to segment the OCT images and work further on the results obtained [19]. Here, Technique aim at diagnosing a various disease that comprises the retina of the eye. The method needs to find the thickness of each layer after finding different layers, to examine the eye for various diseases. Different layers may consist of different diseases which need to be diagnosed. What adds to the problem is that the gradient amongst the layers is decent and hence it further becomes a tedious task to segregate the layers. In this paper, AMD-net is used that works on cross-validation which aims to figure the classification hence, generating the desired classification or clustering of images.

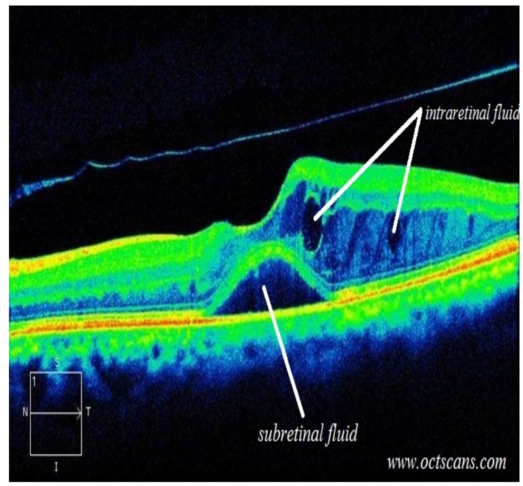

Fig. 2. Accumulation of retinal fluid in layers [17]

3 Dataset

Dataset of optical coherence tomographic retinal images which is used in this proposed work is freely available on the Kaggle repository. In the taken dataset there are four classes of images names Diabetic Macular edema, Diabetic Retinopathy, Glaucoma, and Healthy eye. Total 50000 images over which convolutional neural networks have been trained.

4 Proposed Work

The proposed word showed the classification of retinal images with an accuracy of 98.8%. This work uses Neural Network to train the neurons in the network and provide a feature vector for the identification of features of the particular disease.

Convolutn_two_dim(submatrics=16, mask_shape=(5,5), S_rate=1, stuffing='valid', act_funtn ='relunit', input_shape=size)

Convolutn_two_dim (submatrics =16, mask_shape =(5,5), S_rate =1, stuffing ='valid', act_funtn ="relunit ')

MxPoolingLayer_two_dim(pool_sz=(4,4))

Convolutn_two_dim (submatrics =32, mask_shape =(5,5), S_rate =1, stuffing ='valid', act_funtn ="relunit ')

Convolutn_two_dim submatrics =32, mask_shape =(5,5), S_rate =1, stuffing ='valid', act_funtn ='relunit ')

MxPoolingLayer_two_dim (pool_sz=(4,4))

Convolutn_two_dim (submatrics =64, mask_shape =(5,5), S_rate =1, stuffing ='valid', act_funtn ="relunit ')

Convolutn_two_dim (submatrics =64, mask_shape =(5,5), S_rate =1, stuffing ='valid', act_funtn ='relunit ')

MxPoolingLayer_two_dim (pool_sz=(4,4))

Convolutn_two_dim (submatrics =128, mask_shape =(5,5), S_rate =1, stuffing ='valid', act_funtn ="relunit ')

Convolutn_two_dim (submatrics =128, mask_shape =(5,5), S_rate =1, stuffing ='valid', act_funtn='relunit')

MxPoolingLayer_two_dim (pool_sz=(4,4))

Table 1. Classification of OCT Scan images as per the classes.

Layer (type)	Output Shape	Param #
Convolutn @1 (Convtn2Dm)	(Null, 254, 254, 8)	80
Convolutn @2 (Convtn2Dm)	(Null, 252, 252, 8)	584
Maxpoollayer@1 (MaxPoolingtwodim	(Null, 126, 126, 8)	0
Convolutn @3 (Convtn2Dm)	(Null, 124, 124, 16)	1168
Convolutn @4 (Convtn2Dm)	(Null, 122, 122, 16)	2320
Maxpoollayer@2 (MaxPoolingtwodim	(Null, 61, 61, 16)	0
Convolutn @5 (Convtn2Dm)	(Null, 59, 59, 32)	4640
Convolutn @6 (Convtn2Dm)	(Null, 57, 57, 32)	9248
Maxpoollayer@3 (MaxPoolingtwodim	(Null, 28, 28, 32)	0
Convolutn@7 (Convtn2Dm)	(Null, 26, 26, 64)	18496
Convolutn@8 (Convtn2Dm)	(Null, 24, 24, 64)	36928
Maxpoollayer@4 (MaxPooling2dm	(Null, 12, 12, 64)	0
loosingvalues@1 (Dropout)	(Null, 12, 12, 64)	0
flattenofcurvature@1 (Flatten)	(Null, 9216)	0
compact_1 (Compact)	(Null, 128)	1179776
compact_2 (Compact)	(Null, 4)	516

Overall attribute: 2,153,756
learnable attribute: 2,153,756
Non-learnable attribute: 0

5 Results and Analysis

Implementation results are elaborated in Table 2 for the hyper attribute of the experimented network.

Table 2 Hyper attribute of the experimented network

Hyper	Value
Damage	'categorical
Tiny group size	200
Epoch	250
Premature	12 val loss
Typical Barrier	Was_opt_5
stuffing	'valid'
Optimization	'diffGrad'
multiprocessing	'Null'

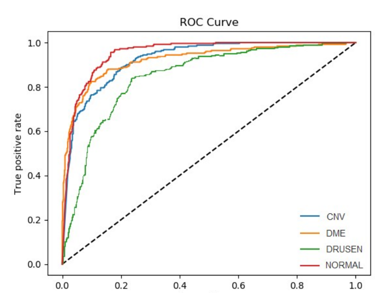

Fig. 3 Training and testing values of the Network on retinal images

Table 3 Confusion matrix for the proposed model

True label		OCT Images			
	DR	23 4	5	3	2
	DME	3	254	2	4
	Glau- coma	21	2	237	6
	Healt hy	1	1	1	219
		DR	DME	Glaucoma	Healthy

Precision = TP/(TP+ FP) (1)

Recall = TP/(TP+FN) (2)

F1-Score
= 2*(precision*recall)/(precision + recall) (3)

Table 4 Precision-recall values for proposed model

	Precision	**recall**	**f1-score**	**support**
DR	**0.798**	**0.998**	**0.980**	**250**
DME	**0.883**	**0.864**	**0.983**	**250**
GLAUCOMA	**0.890**	**0.780**	**0.931**	**250**
Healthy	**0.845**	**0.876**	**0.965**	**250**
accuracy			**0.952**	**1000**
macro avg	**0.954**	**0.952**	**0.922**	**1000**

Table 5 Learning time and validation time of experimented model

Per epoch training time is 3600sec

Type	**Time**
training Time	355000 sec
validation Time	125 sec

Table 6 Processing time and classification time of proposed AMD-Net

Type	**Time**
Processing Time	0.112 sec
Classification Time	1.061 sec
Total Time	1.173 sec

6 Conclusion

The table shown above depicts the results in the processing time of the experimented convolutional neural network as 0.112 sec which is less than the processing time of the previous research till now. Further, the classification time of the experimented convolutional neural network is 1.061 sec which is 19 sec less than the time taken by ResNet50 for the set of retinal images. So if we talk about the total time taken to process the retinal OCT images for classification is 1.173 sec, which is less than the time taken by ImageNet and ResNet50 on the same retinal OCT images.

7 References

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