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Optimizing the Hyperparameters of CNN in predicting the presence of Retinal Disease with OCT image dataset

[1] GOKILA BRINDHA P, [2] OM PRAKASH S, [3] YASWANTH M
[1] Assistant Professor, [2][3] Student, Department Of Computer Technology - UG, Kongu Engineering College, Perundurai, Erode

Abstract: Accurate detection of diabetic macular edema (DME) is a crucial task in optical coherence tomography (OCT) images of the attention. Age-related degeneration (AMD) and diabetic macular edema disease are the leading causes of blindness being diagnosed. Fully automating OCT image detection can significantly decrease the tedious clinician labour and acquire a faithful pre-diagnosis from the analysis of the structural elements of the retina. Deep learning techniques are often applied within the prediction of the attention disease. The goal of this project is to optimize the hyperparameters of CNN model. During this work a study has been administered using grid search and random search optimization algorithms in tuning the hyperparameters of CNN model. The analysis done by evaluating the performance of those algorithms on classification of retinal disease.

Keywords: Retina, OCT dataset, Self-defined, Convolution Neural Network, Grid search and Random Search

I. INTRODUCTION

The three primary categories of illnesses taken in this paper is Diabetic Macular Edema (DME), which is the most common significant retinal illness. It destroys blood vessels in the retinal region of the eye, resulting in permanent vision loss. When DME is not treated appropriately, it can cause visual issues, and if it is not treated for a long time, vision loss can occur. Health care, as well as the costs connected with it, are quite expensive at the last stages of therapy.

Drusen are microscopic yellow fatty protein deposits, also known as lipids, that form under the eye's retina. The retina is a thin, tissue-covered layer that lies adjacent to the optic nerve, which connects the eye to the brain. For vision, the retina comprises light-sensing cells. Although Drusen has a higher risk of macular degeneration, it does not develop age-related macular degeneration.

Distortion or waviness, as well as a black / blank patch/grey in the central vision, are all symptoms of choroidal neovascularization. OCT and Spectral Domain OCT can be used to identify disorders like these. These disorders can be discovered at an early stage to avoid their severity. The retinal pictures of the eye are captured using these approaches. Over the fundus photographs are more possible with spectral-domain imaging since they can acquire high-resolution pictures. This approach is completely self-contained, therefore no artificial feature extraction from retinal OCT pictures is required. The suggested research might be used by clinical oculists to make treatment recommendation.

2. LITERATURE SURVEY

[1] In this paper, a population-based Genetic Algorithm is utilized to improve the CNN network's hyper-parameters for classifying MNIST data. In addition, the accuracy of the trained CNN network with improved hyper-parameters was determined using test data that was not utilized during the training process to check the performance of the improved parameters. The learning rate varies between 0.0004 and 0.0012. The learning rate of the back propagation neural network was found to be lower. Dropout 1 had comparable results at 0.2, but dropout 2 had values ranging from 0.16 to 0.43.

[2] In this paper, a detail survey on retinal diseases identification using image processing is discussed. The retinal diseases are glaucoma, cataract, hypersensitive retinopathy, diabetic retinopathy, age related macular degeneration. Machine learning includes Gaussian Mixture model (GMM), k-nearest neighbor (kNN), support vector machine(SVM) for image processing. The result of this paper has diseases identification using machine learning algorithms.

[3] In this paper, Deep learning approach for classification of eye diseases supported color fundus

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images. the dataset for this research is that the public STARE dataset which contains 400 of 605*700 pixels of retinal color images in 24-bit RGB format. The experiments show that the very best training accuracy is obtained from input images measuring 61X71 and 31X35 pixels. Whereas, the very best test accuracy obtained from the network configuration used is that the size of the input image with the littlest resolution of 31X35 pixels with an accuracy of 80.93%.

[4] In this paper, A dataset of OCT scans were taken from Kaggle's 'Retinal OCT Images' dataset containing images under 4 categories: CNV (Choroidal Neovascularization / wet AMD), drusen, normal and DME (Diabetic Macular Edema). The results of maximum accuracy of around 86.55% is obtained. This is often within the case where a dropout layer with a hyperparameter of 0.7 and therefore the Adam optimizer are used on the weighted class neural network.

[5] In this paper, A review of Diabetic retinopathy detection through deep learning techniques the dataset contains 88,702 high-resolution images with various resolutions, ranging from 433 * 289 pixels to 5184 *3456 pixels, collected from different cameras. The lesions are microaneurysms (MA), haemorrhages (HM), soft and hard exudates (EX). Detecting the lesions of diseases using deep learning techniques. The image number was 35000 images and its size was 512 * 512 pixels. They reported an accuracy of 85% and a sensitivity of 86%.

3. METHODOLOGY

Dataset:

The OCT image dataset contains the normal, CNV, DME and DRUSEN images of retina. Each type of the images are stored in separate folders. Again these folder are grouped as train, test and validation directories. There are 48059 training images, 32 validation images and 968 testing images. The fig.1 shows the samples of different type of retinal images used in this paper for analysis.

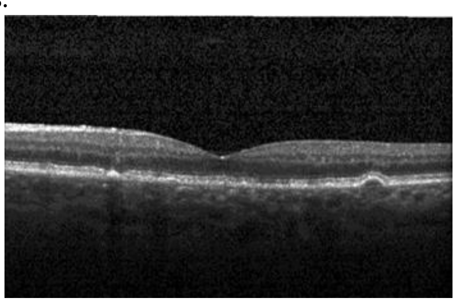

Fig. 1(a) DME Image

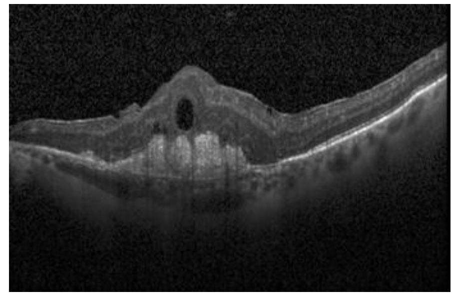

Fig. 1(b) DRUSEN image

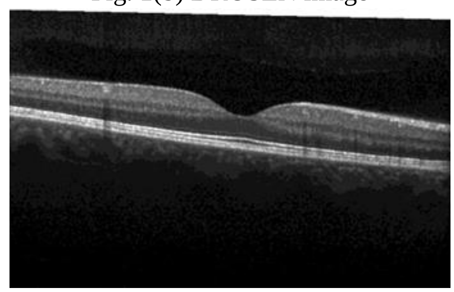

Fig.1(c) CNV Image

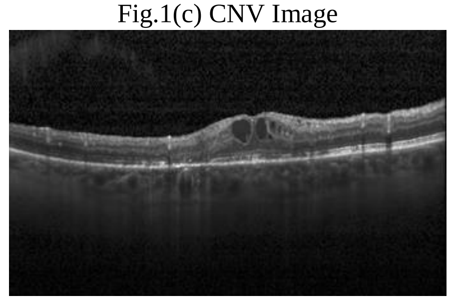

Fig. 1(d)Normal Image

Fig No.1 The Image of Diseased and Normal Retinal Image

Materials and Methods:

Each image is rescaled from (0-255) to (0-1). Each OCT image are of various size ({496, 512, 3}, {512, 512, 3}, {496, 768, 3} extra). The images are converted into (256,256,3) tensors before sending it to the network. Once pre-processing is over the images are passed through several CNN layers. We have trained a self-defined CNN.

Self – Defined : A Convolution layer stack, Batch Normalization, and Max Pooling are performed 4 times, followed by a Dense Layer and another Dense Layer. As the optimizer and a sparse categoric cross entropy the lost is utilised as an Adam optimizer with a learning rate which will be tuned in hyperparameter-search. The model input is an octave picture tensor of 256 x 256 x 3 dimensions. In the first layer of Convolution filters of size 3 x 3 are utilised and relu as a loadstandardization, followed by Max Pooling of size 2 x 2. Filters with size 3 x 3 in the second Conv layer and relu as activation feature.

Then batch standardisation and max size 2 x 2 pooling. Filters of 3 x 3 size with re-activation in Third Conv layer. Then batch standardisation and kernel size Max pooling 2 x 2. In the fourth Conv layer, filters are activated as 3 x 3 size and relu. Then batch standardisation and Max batch with 2 x 2 size. The latter is followed by a 0.5% dropout with a dense layer of 256 devices and a relu as an activation, followed by a 4% dense with SoftMax as an activation.

This network has 27,244,804 trainable parameters. The implementation history is recorded and compiled to comprehend the resulting models. From this space [0.1,0.01,0.001,.001,0.0001,0.2,0.3] 0.1 is selected as the optimum learning rate using Random Search and Grid Search.

In optimising hyperparameters other than Grid and Random Search, Nature-Inpired algorithms can be implemented. Other hyperparameters can also be used to get good results.

4. EXPERIMENTAL RESULT ANALYSIS

The hyperparameters of CNN are epoch, learning rate, number of layers, number of filters, dropout and activation functions. The optimization algorithms are applied to get the best value for these parameters .In this study only tuning of hyper parameter like learning rate is done. The tuning is done using the GridSearch and Random Search algorithms. After tuning 0.1 is the best learning rate given both the algorithms.

Model Name	Test accuracy
Self defined	89%
Grid search	28%
Random search	26%

Table No. 3.1 Test Accuracy of Models

The above table represents the test accuracy obtained by the self defined CNN models and after optimization. The Self - Defined has test accuracy of 89%. The Grid Search has a test accuracy of 28%. The Random Search has a Test accuracy of 26%. Here only the learning rate has been optimized but there are various other hyper parameter, tuning of these can increase the performance of the algorithm.

5. CONCLUSION

Drusen, DME, and CNV are the diseases that may be detected by OCT scanning, and early diagnosis can assist to avoid vision loss. The focus of the article is on using CNN models to predict sick retinas. This study concludes that optimizing the learning rate alone does not improved the model. As higher end system is needed to execute the optimization algorithms to optimize the hyper parameter, this becomes a limitation for carrying out the further optimization. As a future work this can be tried so as to improve the network's performance.

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