Diabetic Retinopathy Detection Using Deep Learning

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Abstract—Diabetic Retinopathy (DR) is a medical condition where damage occurs to the retina because of diabetes mellitus. It is the major cause of blindness in developed countries. The longer the person has diabetes the more the chance of a person having the disease. Due to damage of the blood vessels in the retina which is caused by the high level of glucose in the blood, the different extents of microstructures, such as hard exudates micro-aneurysm, and neovascularization, could occupy the retina area. The manual diagnosis of DR is highly time-consuming and labor-intensive. Deep Convolutional Neural Network (CNN) has recently been proven as a very efficient approach to analyzing biomedical images. Training with less supervision involved can be done by using a deep CNN architecture that can be trained with only binary image pair information. In our approach, we use deep CNN to detect the existence of DR in a much more accurate and efficient way without human intervention.

Keywords: Diabetic Retinopathy, Deep neural network, Diabetic Retinopathy Detection, Deep network designer

1 INTRODUCTION

Diabetic Retinopathy is an eye condition that is caused by damage to the blood vessels in the retina which can cause either partial loss of vision or blindness in people who suffer from diabetes mellitus. Prolonged sugar accumulation in the blood can lead to the obstruction of the tiny blood vessels that sustain the retina snips off its blood supply. As a result, the eye attempts to grow new blood vessels. However, these newly developed blood vessels can leak easily due to improper development. Diabetic retinopathy can present with no symptoms or only slight vision problems at first. Eventually, it may even lead to blindness. As a result, early identification and care are important for people with DR in order to reduce vision loss

Diabetic retinopathy causes the abnormal growth of blood vessels in the retina classified by two types and four stages.The two types are non-proliferative and proliferative.The complications can lead to serious vision problems which include Vitreous hemorrhage, Retinal detachment, Glaucoma, Blindness, etc. Regular eye tests, good blood sugar, and blood pressure management, and early diagnosis for vision issues can help avoid serious vision loss. Traditional methods of diagnosing Diabetic Retinopathy depend on doctors manually separating coloured 2 dimensional images of the fundus of the eye. In such cases, accuracy of detection is heavily reliant upon experience and the skills of the doctors. The appearance of abrasions associated with the disease's vascular deformities may be used to diagnose DR.Although this strategy is successful, it necessitates a lot of resources.

As a result, computer aided automated diagnosis methods are highly potential in detecting DR accurately in a shorter period, improving the screening rate.Many studies have focused on the classification of retinal and other medical photos in recent decades. Deep learning based networks having a Convolutional Neural layer known as Convolutional Neural Network (CNN) has recently been shown to be a very promising method in biomedical image processing, owing to the exponential growth of image dataset on the Internet in recent years. We used CNN to detect the existence of DR in a much more accurate and efficient way without human intervention.

2 THE PROPOSED SYSTEM

The proposed method uses coloured fundus images of the eye as input to the system. The deep neural network will be able detect whether the inputted image has diabetic retinopathy or not with high accuracy. Deep neural networks were created using multiple architectures and all of them were trained and tested on the same dataset to get the correct accuracy. From the accuracy obtained the architecture having the highest accuracy was selected as the most suitable one for the use case.

The dataset used was from Kaggle and it contains 10438 image samples which contain both DR and non-DR images. The dataset was divided into an 80:20 ratio for training and validation. Another dataset containing 2000 images was used for testing purpose.

Deep Network Designer in MATLAB was used to create the different architectures and the training and testing was done on each architecture.

A.*Network Architecture*

1)Alexnet: It is the most common model used for object detection. It has eight layers with learnable parameters. The model consists of five layers with a combination of max pooling followed by 3 fully connected layers and they use the Relu activation function in each of these layers except the output layer.

2)VGG 19: It is mainly used for image classification. It has 19 layers which include 16 convolution layers, 3 fully connected layers, 5 maxpool layers and 1 softmax layer.This pre-trained model can classify images into 1000 categories. The input image size is 224*224.

3)ResNet-152: It is a very deep network with 152 layers.The input image size of this network is 224*224. Among the ResNet architectures like ResNet 18, ResNet 34,ResNet 50 and ResNet 101,ResNet 152 achieves the best accuracy.

*4)Inception V3:*It is a pretrained model with 48 layers. Inception V3 requires less computational power when compared to other inception architectures.The Inception V3 algorithm has several techniques for optimizing the network and loosening the constraints for better and efficient model adaptation.

5)Inception ResNet V2:Inception-ResNet-v2 is a CNN architecture that is based on the Inception architecture family but includes residual connections. It has 164 layers and can categorize photos into 1000 different item groups. InceptionResNetV2 requires a 299*299 input image.

3 IMPLEMENTATION

Deep Network Designer inside MATLAB was used to create and tune the different architectures used for training and testing. Pre-trained networks available were selected and then the hyperparameters were changed according to our needs. Multiple layers were also changed from each architecture to suit the specific use case. Training was done on the networks after all the hyperparameters were set. The dataset used is labelled into two categories those with diabetic retinopathy and those without diabetic retinopathy. The dataset is then split into training and validation sets in an 80:20 ratio. Another dataset containing 2000 images is used for testing purposes. The training process involved 20 epochs and a minibatch size of 200 images.

System specifications:

The models were trained, validated, and tested on a Windows laptop with a GeForce GTX 1070 with 32GB RAM with an INTEL i7 processor with graphics card NVIDIA GeForce GTX 1070. Using the system we ran models on Matlab and got improving accuracies for the different models.

5 RESULT

5.1 Alexnet

A total of 2000 fundus images were taken for testing the alexnet model for diabetic retinopathy detection. From this dataset 1837 were accurately predicted and 163 were either false positives or false negatives.The network obtained an accuracy of 91.8%.

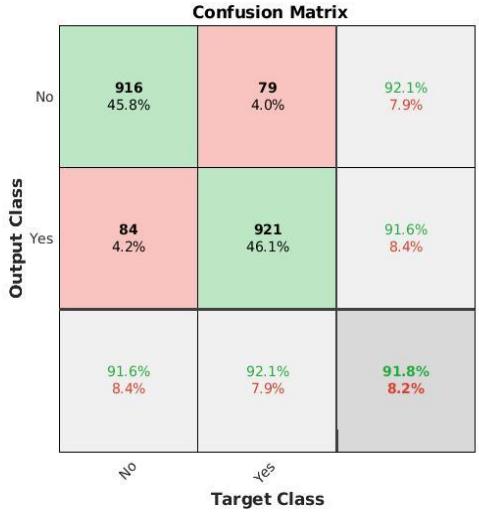

Fig 5.1:Alexnet

5.2 VGG-19

A total of 2000 fundus images were taken for testing the VGG-19 model for diabetic retinopathy detection. From this dataset 1863 were accurately predicted and 137 were either false positives or false negatives. The network obtained an accuracy of 93.2%

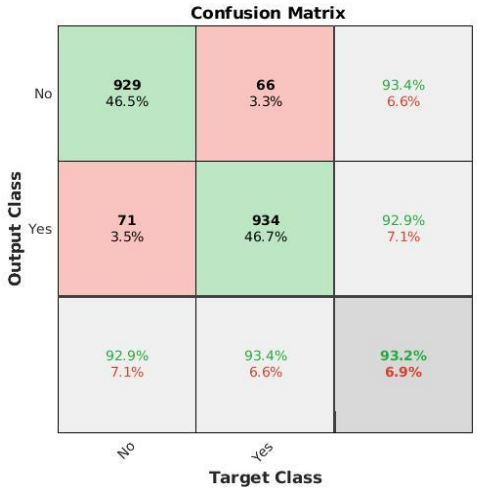

Fig 5.2: VGG-19

5.3 ResNet-152

A total of 2000 fundus images were taken for testing the ResNet-152 model for diabetic retinopathy detection. From this dataset 1911 were accurately predicted and 89 were either false positives or false negatives.The network obtained an accuracy of 95.5%.

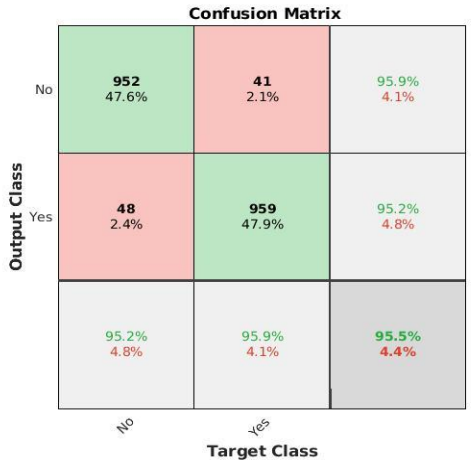

Fig 5.3: ResNet-152

5.4 Inception V3

A total of 2000 fundus images were taken for testing the Inception V3 model for diabetic retinopathy detection. From this dataset 1943 were accurately predicted and 57 were either false positives or false negatives. The network obtained an accuracy of 97.2%

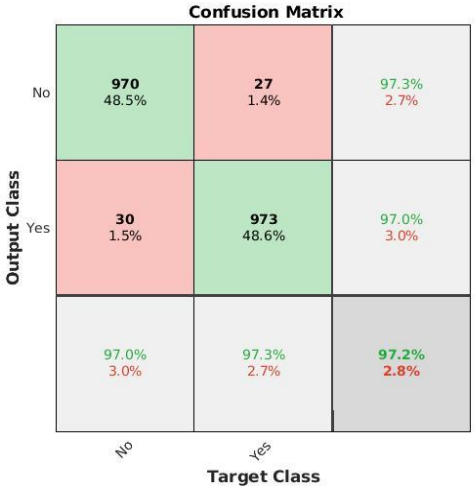

Fig 5.4: Inception V3

5.5 Inception ResNet V2

A total of 2000 fundus images were taken for testing the InceptionResnet V2 model for diabetic retinopathy detection. From this dataset 1963 were accurately predicted and 37 were either false positives or false negatives. The network obtained an accuracy of 98.2%

Fig 5.5: Inception ResNet V2

Network	No:of layers	Training execution time - one time process (HH:MM)	Correctly detected out of 2000	Validation Accuracy	Testing Accuracy
Alexnet	8	5:11	1837	93.5	91.8
VGG-19	19	10:23	1863	96.15	93.2
Resnet 152	152	13:54	1911	97.65	95.5
Inception V3	48	17:7	1943	98.9	97.2
InceptionResnet V2	164	21:49	1963	99.5	98.2

Table 5.1: Various models and their accuracies in the binary classification model

6 CONCLUSION

Diabetic Retinopathy (DR) is a medical condition where damage occurs to the retina because of diabetes mellitus. Microstructures such as micro-aneurysms, hard exudates, and neovascularization can occupy the retina area as a result of damage to the blood vessels in the retina caused by high blood glucose levels. The manual diagnosis of DR is highly time-consuming and labor-intensive. Deep learning-based Convolutional Neural Network (CNN) has recently been shown to be a promising method in biomedical image processing. In this project we have used different types of CNN models to classify images and detect the different stages of DR in a much more accurate and efficient way without

human intervention. Here we have analyzed the different existing models of the DR detection methods and have implemented a model in which detection efficiency and accuracy have been increased by several times. Through training and testing of several models with a 10438 image dataset in binary class model we came to a conclusion that the model that can be used to detect the diabetic retinopathy in humans is the InceptionResNet-V2 model which had highest accuracy of 98.2% in the binary class model using 10438 images.

7 REFERENCE

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