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Detection of Diabetic Retinopathy using Neural Network

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Abstract - Diabetic retinopathy is a leading cause of blindness among working-age adults. Early detection of this condition is critical for good prognosis. In this paper, we demonstrate the use of convolutional neural networks (CNNs) on color fundus images for the recognition task of diabetic retinopathy staging. Our network models achieved test metric performance comparable to baseline literature results, with validation sensitivity of 95%. We additionally explored multinomial classification models, and demonstrate that errors primarily occur in the misclassification of mild disease as normal due to the CNNs inability to detect subtle disease features. We discovered that preprocessing with contrast limited adaptive histogram equalization and ensuring dataset fidelity by expert verification of class labels improves recognition of subtle features. Transfer learning on pre-trained GoogLeNet and AlexNet models from ImageNet improved peak test set accuracies to 74.5%, 68.8%, and 57.2% on 2-ary, 3-ary, and 4-ary classification models, respectively.

Index Terms - Diabetic Retinopathy, Convolutional Neural Networks

I. INTRODUCTION

A. What is Diabetic retinopathy?

Diabetic retinopathy is a leading cause of blindness and it is affecting people worldwide on a large scale. Diabetic retinopathy, also known as diabetic eye disease, is a medical condition in which damage occurs to the retina due to diabetes mellitus. It is a leading cause of blindness.

Diabetic retinopathy affects up to 80 percent of those who have had diabetes for 20 years or more. At least 90% of new cases could be reduced with proper treatment and monitoring of the eyes. The longer a person has diabetes, the higher his or her chances of developing diabetic retinopathy. Each year in the United States, diabetic retinopathy accounts for 12% of all new cases of blindness. It is also the leading cause of blindness in people aged 20 to 64.

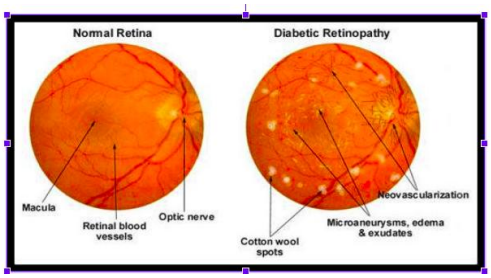
B. What causes Diabetic retinopathy?

Diabetic retinopathy is a disease affecting the eyes that's caused by changes in the blood vessels of the retina. It occurs when blood vessels in the eyes begin to swell or leak. In some cases, new blood vessels may grow on the surface of the retina. Over time, the condition worsens, potentially causing vision loss. The various classification of diabetic retinopathy is background retinopathy, pre-perfolative retinopathy and perfolative retinopathy.

2. PROBLEM STATEMENTS

1. Manual inspection of fundus image to check development of features is a very time-consuming and tedious work.
2. Often eye-specialists are not available in remote areas
3. Patients need to have regular appointments with doctor

FIGURE I



COMPARISON OF HEALTHY EYE AND A DR AFFECTED EYE

3. SOLUTION

A. Solution outline

1. We apply Machine learning algorithms to train a model which classifies the fundus image of the eye to be infected or healthy.
2. If the user is found positive, the application might proceed with suggesting the user with nearby doctors for further treatment.

FIGURE 2

A HIGH LEVEL VIEW OF PROPOSED SYSTEM

A. Detailed solution

We propose a CNN approach to diagnosing DR from digital fundus images and accurately classifying its severity. We develop a network with CNN architecture and data augmentation which can identify the intricate features involved in the classification task such as micro-aneurysms, exudate and haemorrhages on the retina and consequently provide a diagnosis automatically and without user input. We train this network using a high-end graphics processor unit (GPU) on the publicly available Kaggle dataset and demonstrate impressive results, particularly for a high-level classification task. On the data set of 80,000 images used our

proposed CNN achieves a sensitivity of 95% and an accuracy of 75% on 5,000 validation images.

1. Convolutional Neural Network

In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of deep neural networks, most commonly applied to analyzing visual imagery.
CNNs are regularized versions of multilayer perceptrons. Multilayer perceptrons usually mean fully connected networks, that is, each neuron in one layer is connected to all neurons in the next layer. The "fully-connectedness" of these networks makes them prone to overfitting data.
CNNs use relatively little pre-processing compared to other image classification algorithms. This means that the network learns the filters that in traditional algorithms were hand-engineered.

2. Layers in Convolutional Neural Network

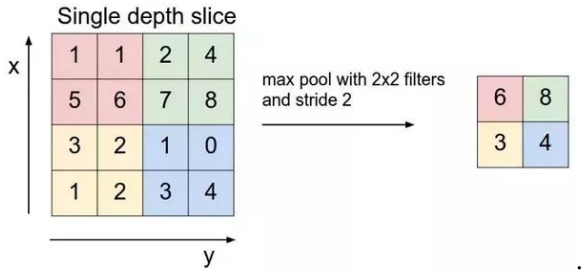
a. Convolutional layer

Convolution is the first layer to extract features from an input image. Convolution preserves the relationship between pixels by learning image features using small squares of input data. It is a mathematical operation that takes two inputs such as image matrix and a filter or kernal.

b. Pooling layer

Its function is to progressively reduce the spatial size of the representation to reduce the amount of parameters and computation in the network. The most common approach used in pooling is max pooling.

FIGURE 3



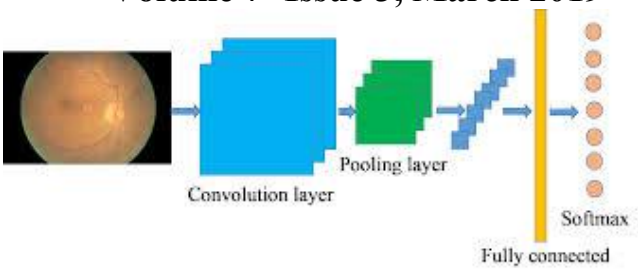
MAX POOLING

c. Fully connected layer

The layer we call as FC layer, we flattened our matrix into vector and feed it into a fully connected layer like neural network.

3. System Architecture

FIGURE 3



SYSTEM ARCHITECTURE DIAGRAM

ACKNOWLEDGMENT

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