Paper Review 04

Performance Analysis of Glaucoma Detection Using Deep Learning Models

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Purpose of This Research

The purpose of this research is to analyze the performance of three deep learning architectures, including CNN models using max pooling and average pooling, and the Transfer Learning Xception model, in detecting glaucoma. The study used public datasets containing 1250 images to evaluate the performance of the models based on training accuracy and validation accuracy. The CNN model using max-pooling achieved a training accuracy of 87.99% and the highest validation accuracy of 89.11%. The CNN model using average pooling achieved a training accuracy of 86.94% and the highest validation accuracy of 87.83%. The Xception model achieved the highest training accuracy of 97.63% and the highest validation accuracy of 98.11%. These results demonstrate the potential of deep learning in detecting glaucoma for early prevention of blindness.

Previous Research Gap

Computer-aided diagnosis (CAD) systems are important in making a precise and swift diagnosis of glaucoma. Several machine learning (ML) and deep learning (DL) techniques have been proposed in the literature to detect glaucoma, which can be used by physicians to validate their findings. These techniques offer potential benefits for improving the accuracy and efficiency of diagnosing glaucoma.

- Saxena et al detected glaucoma with a 6 layer Convolutional Neural Networks (CNN) using ORIGA and SCES datasets with an AUC value of 0.822 and 0.882 respectively.
- VGG16 with CNN in a supervised way was used by Ghamdi et al using the RIM-ONE dataset with an accuracy of 81.25%.
- Sreng et al proposed three models for segmenting the optic disk region in medical images. The maximum accuracy achieved was 99.53% for the ACRIMA dataset by combining Deep Labv3+ with MobileNet. This study highlights the potential of these models for accurately segmenting the optic disk region in medical images.
- Serener et al applied ResNet-50 and GoogLeNet for detecting glaucoma in an earlier stage. The study showed that ResNet achieved around 90% accuracy, while GoogLeNet showed slightly better accuracy of approximately 91%. These deep learning models have potential for detecting and diagnosing glaucoma in its early stages.
- Fu et al proposed a CNN architecture of 6 layers for automated detection of glaucoma. The study achieved 84.29% accuracy for the SCES dataset and 74.95% accuracy for the SINDI dataset using this CNN architecture. These

results demonstrate the potential of CNNs in detecting glaucoma accurately and efficiently.

- Fu et al solved the challenge of optic disk and optic cup segmentation in detecting glaucoma by calculating the CUP-to-Disk-Ratio (CDR).
- Chandra Sau and colleagues compared deep learning models for detecting glaucoma by analyzing previous research papers. They calculated the automatic ROI (Region of Interest) and segmented, optimized, and classified the deep features to identify glaucoma.
- U Raghavendra et al proposed a novel Computer-Aided Diagnosis (CAD) tool using a deep learning technique to accurately detect glaucoma. The study used a Convolutional Neural Network (CNN) with 18 layers to extract features from fundus images, which are photographs of the back of the eye.
- InceptionV3 was used by Sharmila et al using the ORIGA dataset where accuracy was 91.36%.

In this paper the researcher compares the performance of two different pooling methods, max pooling and average pooling, in combination with a CNN model and a transfer learning-based Xception model for detecting glaucoma. Transfer learning uses knowledge learned in one situation to apply to an allied problem and ensures model performance with a small dataset. CNN has made considerable advances in image classification, from LeNet-5 to the latest SENet model. The study conducted several experiments to compare the performance of these methods in detecting glaucoma. The novelty of the paper is the comparison between the CNN and transfer learning model.

Proposed System

The proposed methodology for detecting glaucoma is based on convolutional neural network algorithms. The study involved data collection, dataset preprocessing, and augmentation, which included generating augmentations, resizing, creating numpy arrays, and labeling. The study then used three different CNN models: Max pooling layer, Average Pooling Layer, and Xception Model. The performance of the models was evaluated using accuracy, precision, and sensitivity measurements. This approach has potential for accurately detecting and diagnosing glaucoma using deep learning techniques.

Architecture

The study proposed three different Architecture for detecting glaucoma: a CNN model with two convolutional layers, Max Pooling 2D, and Average Pooling 2D layers; an Xception model that replaced the standard Inception Architectures with depthwise divisible convolutions.

Max Pooling layer for reducing the dimensionality of images by reducing pixel numbers in the output. The model had a total of 15,755,425 parameters and no Non-trainable parameters, with images shaped into (256,256,3). The pool size was set to (2,2), and the convolution layer had 32 nodes that underwent ReLu activation function. The fully connected layer used the sigmoid activation function to detect glaucoma accurately.

Average Pooling for feature mapping and creating output, which is a generalized computation that considers all values. The model had a total of 15,755,425 parameters and no Non-trainable parameters, and the other parameters were set the same as the Max Pooling layer to enable comparison of accuracy between the two architectures.

Xception model, a developed version of Inception Architecture with depthwise divisible convolutions, for glaucoma detection. The researchers first froze the base layer of the Xception model using the command (include_top=False) and added their trainable layer on top. The trainable layer used images of size (256,256,3) with Average Pooling operations applied. The pool size of the Average Pooling was set to (7,7), and there were 128 hidden nodes in this layer. The Adam Stochastic gradient descent algorithm was used for optimization, and the ReLu activation function was applied in that layer. In the output layer, the Softmax activation function was used with two nodes for detecting glaucoma positive and glaucoma negative. For backpropagation, a learning rate of 0.01 was set.

These findings demonstrate to detect glaucoma accurately

Experimental Procedure

Max Pooling layer used here includes an input layer with a convolutional 2D layer using ReLu activation, followed by a max pooling 2D layer. The next layer is another convolutional 2D layer with ReLu activation, followed by another max pooling 2D layer. The output of these layers is flattened and fed into a dense layer with ReLu activation, which is then connected to the final dense layer with sigmoid activation for detecting glaucoma. Average Pooling layer used here includes an input layer with a convolutional 2D layer using ReLu activation, followed by an average pooling 2D layer. The next layer is another convolutional 2D layer with ReLu activation,

followed by another average pooling 2D layer. The output of these layers is flattened and fed into a dense layer with ReLu activation, which is then connected to the final dense layer with sigmoid activation for detecting glaucoma. Xception used here involves concatenating three convolutional layers, followed by a 3x3 convolution and a 1x1 convolution. The output of these layers is then fed into the input layer for glaucoma detection.

The CNN architecture with Max Pooling achieved 87.99% accuracy in epoch number 21, while the CNN architecture with Average Pooling achieved 86.94% accuracy in epoch number 19. The Xception transfer learning model showed the highest accuracy of 97.63% in epoch number 18, outperforming both CNN-based architectures. In terms of data loss, the Xception model had the lowest percentage at 4.24%, which was significantly better than that of the two CNN-based models. These findings demonstrate the potential of deep learning techniques, especially the Xception model, in accurately detecting and diagnosing glaucoma. In validation images accuracy rate the Xception architecture had the highest accuracy of 98.11%, while Max Pooling operation and Average Pooling operation achieved accuracies of 88.68% and 87.49%, respectively. Researcher used 250 images as validation data and built a confusion matrix using the Xception model, computing precision, recall, and accuracy accordingly. The model was capable of accurately identifying the main class of a single picture. These findings demonstrate the potential of deep learning techniques, particularly the use of the Xception model, for accurate identification and diagnosis of glaucoma.

Future Plan

The researcher have found out that the Xception model shows better accuracy instead of the CNN-based Max Pooling operation and Average Pooling operation. The Xception model outperforms traditional CNN architecture, in future researcher will try to show the comparison between various transfer learning models with more data images. For further work, they propose to use a larger dataset to train our model. they will try to implement these models in several different glaucoma datasets.

References

1. Performance Analysis of Glaucoma Detection Using Deep Learning Models by Nazmus Shakib Shadin, Silvia Sanjana, Sovon Chakraborty, Nusrat Sharmin