RetinaOCT: Enhancing Retinal Abnormality Detection through Deep-Learning-based Optical Coherence Tomography Analysis

Hwanjun Yi[1], John I. Woo[1], Ian Park[2], Hwanseok Yi[1]

[1]Portola High School, [2]Northwood High School

Introduction

Optical coherence tomography (OCT) is a commonly used imaging modality for detecting retinal damage. This technology utilizes reflected coherent light to noninvasively generate high-resolution images of the retina. Prominent retinal diseases that can be detected from OCT include macular degeneration and glaucoma. However, studies have found that human ophthalmologists are prone to misinterpretation of OCT imaging. These misinterpretations can lead to critical consequences like delayed patient-care and inaccurate diagnoses. To propose a solution, our research hypothesizes that deep-learning algorithms can perform an accurate analysis of OCT imaging.

In this work, we present **RetinaOCT**, a novel multi-layered convolutional neural network (CNN) architecture that outperforms current state-of-the-art (SOTA) models in diagnosing 3 diseases that lead to blindness if left untreated: choroidal neovascularization, diabetic macular edema, and drusen.

Source Code

The source code to this project is available at:
https://github.com/23yimichael/retinaoct

Methods

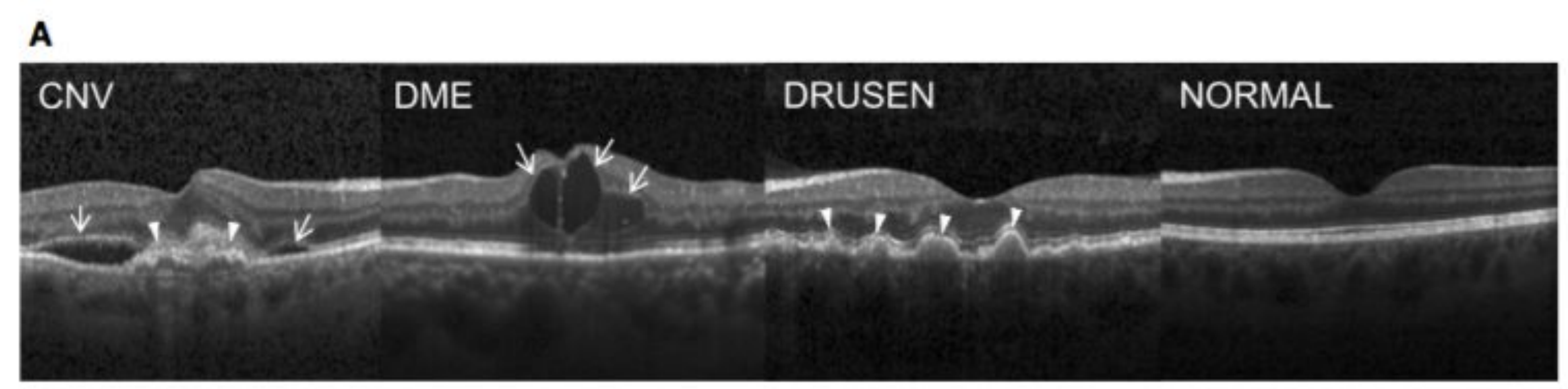

Figure 1. OCT Image Samples (Choroidal Neovascularization, Diabetic Macular Degeneration, Drusen, Normal)

1. Extract OCT imaging dataset containing (~100,000 scans representing the 4 aforementioned image classes) from Shiley Eye Institute of the University of California, San Diego, the California Retinal Research Foundation, etc.
2. Perform data augmentation by flipping images across horizontal axis, rotating 40 degrees, horizontal shift by 20%, and vertical shift by 20%.

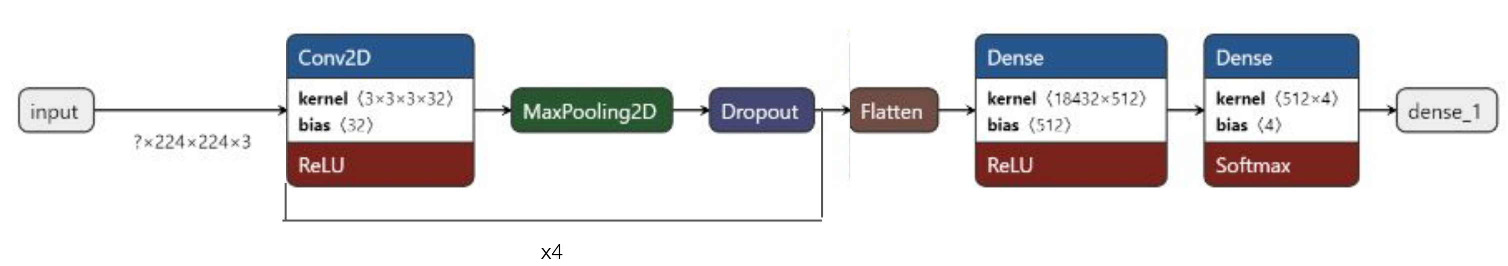

Figure 2. RetinaOCT Convolutional Neural Network Architecture

1. Establish baseline metrics by applying supervised transfer learning by fine-tuning 5 state-of-the-art convolutional neural networks on the augmented dataset.
   a. VGG16
   b. ResNet50
   c. InceptionV3
   d. MobileNet
   e. EfficientNetB7
2. Construct a custom convolutional neural network architecture consisting of four 2D convolutional layers w/MaxPooling and Dropout.
3. Train the new RetinaOCT convolutional neural network on the previously augmented dataset, evaluate based on accuracy, loss, sensitivity, specificity, PPV, and NPV.

Results

Model Name	Sensitivity	Specificity	PPV	NPV
RetinaOCT	89.37%	97.09%	91.11%	96.48%

Table 1. RetinaOCT Evaluation Metrics

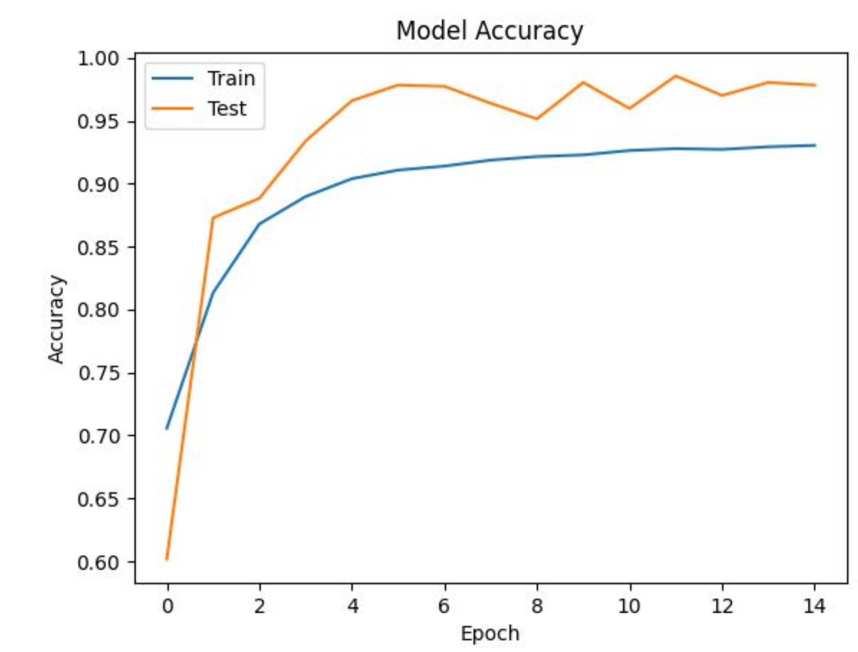

Figure 3. RetinaOCT Training Accuracy Graph

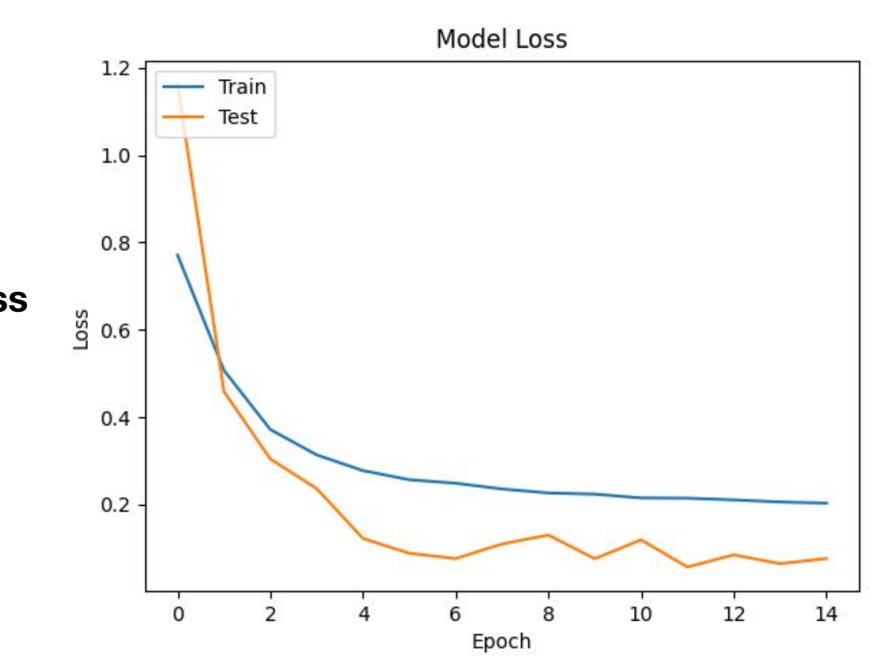

Figure 4. RetinaOCT Training Loss Graph

Model Name	Accuracy	Validation Accuracy	Loss	Validation Loss
RetinaOCT	90.19%	95.73%	0.27	0.12
VGG16	82.52%	85.10%	0.47	0.35
ResNet50	56.97%	44.90%	1.08	1.33
InceptionV3	84.55%	87.71%	0.42	0.31
MobileNet	88.58%	96.25%	0.33	0.15
EfficientNetB7	42.06%	24.79%	1.28	1.63

Table 2. Comparison of RetinaOCT to Current State-of-the-Art Models

Conclusion

As shown through our study, deep-learning-based OCT analysis is capable of diagnosing retinal abnormalities with impressive accuracy. In fact, its performance is comparable performance to that of a human ophthalmologist. **RetinaOCT** achieves an average improvement in accuracy of 19.25% over prior baselines, thus establishing it as a new state-of-the-art model for retinal abnormality detection. We hope that our findings, as well as future research on retinal abnormalities, will help to improve medical diagnoses and patient care.