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A Deep Learning Method for Automatic Identification of Drusen and Macular Hole from Optical Coherence Tomography

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Abstract. Deep Learning methods have become dominant in various fields of medical imaging, including ophthalmology. In this preliminary study, we investigated a method based on Convolutional Neural Network for the identification of drusen and macular hole from Optical Coherence Tomography scans with the aim to assist ophthalmologists in diagnosing and assessing retinal diseases.

Keywords. Deep Learning, Convolutional Neural Networks, Optical Coherence Tomography, Drusen, Macular Holes, Retinal diseases

1. Introduction

Deep Learning (DL) systems have been demonstrated to have an important role in image-centric specialties, such as radiology, dermatology, pathology, and ophthalmology [1]. In ophthalmology, the adoption of DL methods to Optical Coherence Tomography (OCT) has shown promising results for the identification of retinal diseases [2-3]. In this work, therefore, we used a simple and efficient Convolutional Neural Network (CNN) to identify automatically drusen, which characterizes age-related macular degeneration, and macular hole (MH) from OCT images. The method forms the basis for the development of a diagnostic support system that can assist ophthalmologists during the diagnosis and assessment of retinal diseases.

2. Methods

OCT scans were extracted from the public dataset "Retinal OCT - C8" [4] and cleaned appropriately. The final dataset consisted of 9000 images randomly divided into training (70%), validation (20%) and test (10%) sets keeping class balance.

The classification of OCT images as normal, drusen or MH was performed using a VGG16 CNN network. The network was pretrained on the ImageNet dataset and fine-tuned. Data pre-preprocessing included normalization and data augmentation (horizontal flip, random brightness, and random rotation). The model was trained for 38 epochs

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(early stopping) in batches of 64 samples using Adam optimizer with a learning rate of 10^{-4} and binary cross entropy loss.

3. Results

The performances of the model were evaluated on the test set by computing confusion matrix (figure 1) and receiver operating characteristic (ROC) curves (figure 2). The system achieved kappa coefficient $\kappa = 0.92$ and macro-average AUC = 0.96. Gradient-weighted Class Activation Mapping (Grad-CAM) was used to provide visual explanation heatmaps for results interpretation (figure 3).

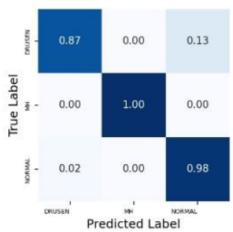

Figure 1. Confusion matrix computed on the test set.

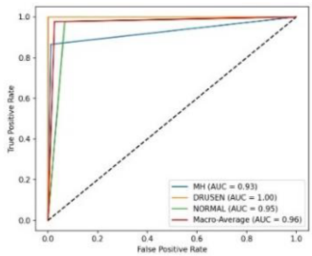

Figure 2. ROC curves for normal, drusen and MH classification.

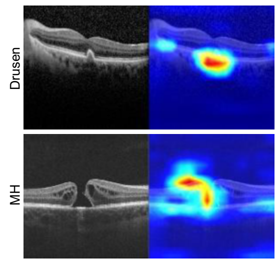

Figure 3. Visual explanation generated by Grad-CAM.

4. Discussion

The proposed method successfully identifies drusen and MH from OCT scans, reaching high classification accuracy. Kappa coefficient and macro-average AUC demonstrate that there is a high agreement between classification and ground truth. Grad-CAM images confirm that the DL model identifies characteristic features of drusen and MH.

5. Conclusions

Our preliminary study shows that a method based on DL was effective at distinguishing normal OCT from OCT presenting diseases features, identifying drusen and MH with high accuracy. This can lead to the development of a more sophisticated diagnostic support system for the diagnosis and assessment of retinal diseases.

6. References

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