Glaucoma Detection on Cardiovascular Patients via Ensemble Deep Learning

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Introduction

Glaucoma is the leading cause of global irreversible blindness, which is predicted to affect about 111 million people worldwide in 2040[1]. Since glaucoma is asymptomatic in the early stage[2], it is necessary to detect it before worsening. Glaucoma is the progressive degeneration of retinal ganglion cells and loss of their axons, which can be detected from structural optic nerve head (ONH) and retinal nerve fiber layer (RNFL) changes, such as RNFL thinning, disc hemorrhages, etc, so the common way of glaucoma detection focuses on features extraction from retinal fundus images[3]. However, other diseases would influence the accuracy of glaucoma detection, such as cardiovascular disease, which could trigger and develop a relatively rapid progression of glaucoma and cardiovascular disease would cause abnormality on retinal fundus that would affect glaucoma detection more or less[4]. Previous research only considered the cardiovascular risk factors in glaucoma detection[5] but never considered real cardiovascular diseases' influence or used cardiovascular patients' retinal fundus images in glaucoma detection. Our research is aimed to improve the glaucoma detection accuracy of cardiovascular disease patients from retinal fundus images. Recently, deep learning models have been widely used in medical image classification and feature extraction. As the complexity of medical problem increase and more raw data take into account, the probability of human error might increase as well. Therefore, deep learning models, which have exhibited impressive performances in mimicking humans in various fields, become a popular tool in medical image classification, such as chest X-ray for pneumonia classification, multi-phase CT images for focal liver lesions, and Magnetic resonance imaging (MRI) for brain and kidney[6]. Some deep learning models, such as Inception-v3, VGG, and ResNet have been widely used in disease detection from retinal fundus images. Our research would firstly compare operating characteristic curve (AUC) of different deep learning models for glaucoma detection on cardiovascular patients and non-cardiovascular people and then based on the comparison results, create an ensemble deep learning model, which would consist of several Inception-v3 blocks with additional convolutional neural network layers and pooling layers to achieve a higher AUC. We would show the ensemble deep learning model could achieve the state-of-the-art result and is relatively lightweight to save training time. The model would finally be used not only on glaucoma detection but also on other disease detection.

Conclusion

Our goal is to create a new deep learning model to achieve better glaucoma detection on cardiovascular patients to ensure the accuracy from retinal fundus images. We already got some preliminary results with an AUC of 0.92 for glaucoma detection on non-cardiovascular people on the UKbiobank dataset. After improving, our model would have better accuracy of glaucoma detection on cardiovascular patients. However, our model is not limited to glaucoma detection. Ultimately, the model could benefit other disease detection with no or few architecture changes.

References

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