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Automatic identification of the shape of retinal microaneurysms from retinal images

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Diabetes mellitus affects approximately 463 million people across the globe in 2019. One third of people with diabetes suffer from diabetic retinopathy (DR), an eye disease that could cause blindness and vision loss. Early detection and effective management of DR is essential to protect the sight for diabetic patients. Due to the rapidly rising prevalence of diabetes, manual screening DR based on the pathological features observed on retinal images will not be sustainable. Therefore, automated DR severity grading system supported by artificial intelligence (AI) has been evolving markedly in the last decade. In particular, with the recent advance in the computational power of GPUs, deep convolutional neural networks (DCNNs) have become a widely used tool for DR screening. DCNNs have achieved higher screening accuracy than the conventional AI methods because it consists of convolutional layers that act as a set of increased levels of feature extractors which learn directly from the input images without using hand-crafted features as required by the conventional methods. Most of the existing DCNN models are trained and tested on the retinal images produced from fundus photography, the standard modality for DR diagnosis. However, the resolution of fundus photographs is not sufficient to resolve the details of individual microaneurysms (MAs), one of the earliest clinically visible signs of DR. As the morphologies of MAs are correlated to the risk of their leakage or rupture, accurate classification of MAs's shape could benefit the early screening and prognosis of DR. In this work, we design a DCNN model that can perform automated segmentation of MA images from adaptive optics scanning laser ophthalmoscopy (AOSLO), which provides images with the highest resolution of all the available imaging techniques for the human retina. The extracted MAs, then, are classified into two groups, depending on their propensity to leak. Our results show that the proposed model outperforms existing models when segmenting MAs from AOSLO images and the classification of MAs reaches a precision of 0.81 and 0.86 on callback. Taken together, our study demonstrates DCNN models can be employed to detect and analyze MAs using AOSLO images at the early stage of DR, which could benefit the disease management and prevent DR progresses into severe stages.