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REVIEW

Deep learning in the grading of diabetic retinopathy: A review

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Abstract

Diabetic Retinopathy (DR) grading into different stages of severity continues to remain a challenging issue due to the complexities of the disease. Diabetic Retinopathy grading classifies retinal images to five levels of severity ranging from 0 to 5, which represents No DR, Mild non-proliferative diabetic retinopathy (NPDR), Moderate NPDR, Severe NPDR, and proliferative diabetic retinopathy. With the advancement of Deep Learning, studies on the application of the Convolutional Neural Network (CNN) in DR grading have been on the rise. High accuracy and sensitivity are the desired outcome of these studies. This paper reviewed recently published studies that employed CNN for DR grading to 5 levels of severity. Various approaches are applied in classifying retinal images which are, (i) by training CNN models to learn the features for each grade and (ii) by detecting and segmenting lesions using information about their location such as micro-aneurysms, exudates, and haemorrhages. Public and private datasets have been utilised by researchers in classifying retinal images for DR. The performance of the CNN models was measured by accuracy, specificity, sensitivity, and area under the curve. The CNN models and their performance varies for every study. More research into the CNN model is necessary for future work to improve model performance in DR grading. The Inception model can be used as a starting point for subsequent research. It will also be necessary to investigate the attributes that the model uses for grading.

1 | INTRODUCTION

Diabetic Retinopathy (DR) screenings require ophthalmologists to evaluate the retinal fundus images and it has become more difficult to offer expert eye care to everyone as the diabetes population grows. However, screening of DR has to be carried out routinely for diabetic patients, which places a huge responsibility on the experts as the growing number of diabetic patients affects their efficiency and causes delays in DR diagnosis and treatments. The increasing gap has initiated the demand for automated DR screening systems and arrangements. With the advancement of technology, automated grading is a solution for DR screening that offers several advantages including increasing efficiency, reproducibility, and scalability, as efficient evaluations of retinal images are needed to support the already substantial manual laborious time-consuming screening work, which can be error-prone. Therefore, there is a need for an automated DR grading system to

Abbreviations: AUC, area under the curve; CNN, Convolutional Neural Network; DL, Deep Learning; DR, Diabetic Retinopathy; NDPR, non-proliferative diabetic retinopathy; PDR, proliferative diabetic retinopathy.

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