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ResNet-n/DR: Automated diagnosis of diabetic retinopathy using a residual neural network

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ABSTRACT

Diabetic retinopathy (DR) is a progressive eye disease associated with diabetes, resulting in blindness or blurred vision. The risk of vision loss was dramatically decreased with early diagnosis and treatment. Doctors diagnose DR by examining the fundus retinal images to develop lesions associated with the disease. However, this diagnosis is a tedious and challenging task due to growing undiagnosed and untreated DR cases and the variability of retinal changes across disease stages. Manually analyzing the images has become an expensive and time-consuming task, not to mention that training new specialists takes time and requires daily practice. Our work investigates deep learning methods, particularly convolutional neural network (CNN), for DR diagnosis in the disease's five stages. A pre-trained residual neural network (ResNet-34) was trained and tested for DR. Then, we develop computationally efficient and scalable methods after modifying a ResNet-34 with three additional residual units as a novel ResNet-n/DR. The Asia Pacific Tele-Ophthalmology Society (APTOS) 2019 dataset was used to evaluate the performance of models after applying multiple pre-processing steps to eliminate image noise and improve color contrast, thereby increasing efficiency. Our findings achieved state-of-the-art results compared to previous studies that used the same dataset. It had 90.7% sensitivity, 93.5% accuracy, 98.2% specificity, 89.5% precision, and 90.1% F1 score.

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1. INTRODUCTION

Recent developments in artificial intelligence (AI) have paved the road for significant advances in automatic diagnosis in various medical fields compared with manual methods. Computer-aided diagnosis systems (CADs) are a rapidly growing field in healthcare. Researchers are increasingly focusing on making it an influential contributor to assessment in the early detection of disease because it helps avoid disease exacerbations and increases the likelihood of recovery. CADs could provide features such as reducing human error, supporting medical decisions, and improving patient care [1]-[3].

Deep learning (DL) is an artificial neural network with representation learning. DL enables the development of high-performance AI systems in various fields, including computer vision, speech recognition, and natural language processing [4], [5]. DL can identify hidden patterns, extract features, and learn them by incorporating multiple hidden layers into a neural network [6], [7].

The biomedical imaging analysis that was previously dependent on using traditional machine learning techniques (ML) increasingly recognizes the benefits of DL networks spatially with convolutional neural