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Research Article

Deep learning fundus image analysis for early diabetic retinopathy

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ABSTRACT

Diabetic retinopathy (DR) is a leading cause of vision impairment and blindness among working-age adults globally, making early detection and intervention crucial for preventing irreversible damage. Deep learning, particularly convolution neural networks (CNNs), has emerged as a powerful tool for automated fundus image analysis, offering promising solutions for timely and accurate DR diagnosis. This study explores the development and evaluation of a deep learning-based system designed to classify fundus images for the early detection of DR. Leveraging a large dataset of labelled retinal images, the proposed model was trained to detect subtle pathological features such as micro aneurysms, haemorrhages, and exudates that signal the onset of DR. The system demonstrated high sensitivity and specificity in distinguishing between healthy and diabetic retinopathy eyes, outperforming traditional machine learning techniques and approaching the diagnostic accuracy of expert ophthalmologists. Data augmentation, transfer learning, and model fine-tuning were employed to enhance performance and generalizability. The study also addresses challenges such as class imbalance, image quality variability, and the need for explainable AI in clinical settings. The results underscore the potential of deep learning in streamlining DR screening processes, reducing the burden on healthcare systems, and improving patient outcomes, particularly in resource-limited environments. Future work will focus on integrating the model into real-time diagnostic workflows and expanding its capability to detect additional retinal diseases.

Key Words: Deep Learning, Early Detection, Retinal Imaging, Diabetic Retinopathy, Diabetic Eye Disease.

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