Comprehensive Survey on Diabetic Retinopathy Detection Using Fundus Imaging: Advances, Challenges, and Future Directions

Tejashri Kakad[1] and Neeta Deshpande[2]

Dept. of Computer Engineering

R. H. Sapat College of Engineering, Management Studies and Research, Nashik, India

tejashrikakad55@gmail.com and neeta.deshpande@ges-coengg.org

Abstract: *Diabetic Retinopathy (DR) is a leading cause of vision impairment, particularly among individuals with diabetes. Early detection and accurate classification of DR are critical for effective disease management and prevention of irreversible vision loss. With recent advancements in Artificial Intelligence (AI), particularly deep learning (DL) and machine learning (ML), automated DR detection and grading have witnessed significant improvements. This review provides a comprehensive analysis of AI-driven techniques for DR assessment, covering classification, detection, early diagnosis, segmentation, and severity grading. We explore AI-powered workflows, discussing data preprocessing techniques, feature extraction methods, and model architectures. Additionally, real-world case studies are examined to highlight the practical implementation of AI in clinical settings. Furthermore, the integration of Explainable Artificial Intelligence (XAI) is reviewed for model interpretability and clinical validation. Key benchmarking datasets, evaluation metrics, current challenges, and future directions in AI-based DR research are discussed, with an emphasis on multimodal data fusion and improved generalization for robust DR prediction and detection...*

Keywords: Diabetic Retinopathy, Classification, Deep Learning, Machine Learning