Novel Stage Optimized Image Processing to Improve Deep Learning Driven Diagnosis of Early Stage Diabetic Retinopathy

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Diabetic retinopathy (DR) is the leading cause for blindness in the U.S. Current research on artificial intelligence based DR diagnosis shows promise but still has room for improvement before clinical implementation in terms of diagnostic accuracy of each stage. This research proposes a novel stage-specific analysis strategy to address the research gap. This is the first systematic report of stage optimized image processing to improve deep learning driven diagnosis of early-stage DR and reduce missed early diagnosis. To develop a DR-sensitive deep learning model, ResNet50, VGG-16, InceptionV3, and EfficientNetB7 were first explored, and ResNet50 and VGG-16 were selected for further optimizations. Image augmentation, resolution scaling, and various image processing techniques were applied to optimize each DR stage 0-4. For the first time, specific image processing methods were developed to maximize model performance for each stage of DR. Utilizing the proposed stage-specific analysis, LAB/CLAHE optimized results for stages 0, 2, and 4. Median filtering optimized results for stage 1, and the green component converted to grayscale optimized results for stage 3. This research successfully demonstrated that this strategy effectively reduces missed diagnosis of early stage DR from 6.58% to 1.32%. This is the first report with such a low missed diagnosis rate for early stage DR. Overall, the developed models had better performance at the system level as well in comparison to previous work using the same data set. The results achieved in this study are significant, as early diagnosis and treatment can decrease the risks of vision impairment by 95%. This research moves AI-driven diagnosis one step closer to clinical applications from the research phase.

Awards Won:

Second Award of $2,000