DeepRet: Novel Multi-Stage Deep Learning-Based Low-Cost Retinal Imaging System to Enable Accessible Glaucoma Screening in Low-Resource Environments

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The world's leading cause of irreversible blindness, glaucoma is an aggressive collection of progressive optic neuropathies degrading the retina-brain connection. The primary challenge of glaucoma lies in its asymptomatic nature, necessitating a timely diagnosis to prevent progression into blindness. However, several barriers to diagnosis exist in low-resource environments such as the inaccessibility of ophthalmologists and necessary equipment to perform diagnostic tests, causing disproportionate rates of blindness in these areas. Despite advances in automated methods of retina-based glaucoma diagnosis, real-world application of these algorithms struggles to extend beyond controlled, in silico contexts. To overcome the variability and complexities of clinical settings, this study proposes DeepRet, a novel, multi-stage deep learning-based diagnosis framework specifically designed for integration into low-powered retinal imagers. DeepRet is trained on several task-specific datasets for image processing, super-resolution, and diagnosis and fused together to create a single, more powerful system. Evaluated on several metrics, DeepRet either meets or outperforms the state-of-the-art, demonstrating the broad performance of the system. This study also introduces a first-of-a-kind retinal fundus imager (RFI), combining low-cost electronics, 3D-printed parts, and a companion mobile application to create an accessible diagnostic device that is significantly cheaper and more portable than existing equipment. DeepRet is integrated into this imaging system and is validated in its practical performance to enhance the capabilities of low-powered equipment.

Awards Won:

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