TeleAEye: Low-Cost Automated Eye Disease Diagnosis Using a Novel Smartphone Fundus Camera With AI

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One billion people are blind or visually impaired due to a lack of access to eye care. The World Health Organization has established early detection as a key factor in the prevention and treatment of ophthalmic diseases. However, due to the shortage of health professionals, cost of diagnosis equipment, and COVID-19 restrictions, widespread early detection is unachievable through traditional diagnosis methods. This project presents an automated diagnosis system, TeleAEye, capable of addressing this challenge through population screening using telemedicine and fundus photography. TeleAEye consists of two novel components: “multi-step transfer learning” trained diagnosis models and a low-cost, smartphone-integrated non-mydriatic fundus camera. The diagnosis models achieved an average AUROC of 92.5% in two test environments with six common ophthalmic diseases, 25.8% and 12.4% higher than models with random weight initializations and ResNet50 ImageNet weights, respectively. This study demonstrates the effectiveness and cross-industry potential of multi-step transfer learning. To aid the understanding of diagnosis results, classification outcomes are explained through visual and text mediums by saliency heatmaps and a chatbot. The smartphone-integrated fundus camera functions independently of medical practitioners through a 3D-printed enclosure that enables natural pupil dilation and adjustment for visual refractive errors. With a production cost of $6.80 USD (~1/1000 of comparable camera prices), TeleAEye could democratize eye care and improve patient outcomes by increasing early diagnoses and monitoring in developing regions, extending disease datasets to underrepresented minorities, and providing eye care to patients during the COVID-19 pandemic.

Awards Won:
First Award of $5,000