A Novel Super-Resolution AI Engine and Multi-Stage Abnormality Detection Pipeline for Early Blindness Prevention

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Diabetic retinopathy (DR) is a leading cause of blindness. The eye disease is particularly pervasive in developing countries, where there exists a severe insufficiency of ophthalmologists. Consequently, there has become a pressing need for accurate eye screening methods in the absence of doctors. To meet this need, this research developed an AI pipeline for the automated detection of DR. It consists of four comprehensive stages: (1) a super-resolution image enhancement engine to optimize important features and increase the resolution of retinal scans; (2) a machine learning ensemble of image recognition models for DR diagnosis; (3) a small-object detection framework serving as the first to localize major retinal abnormalities; and (4) a clinical model that prognosticates and triages patients into five categories of DR severity based on blood biomarkers and electronic health record data. The diagnosis ensemble model attained an accuracy of 97.7% and an F1-score of 97.8%. Explanatory AI visualizations identified abnormal retinal patterns. The object detection algorithm localized DR lesions with an intersection-over-union score of 0.853±0.017, a 30% increase in precision over prior studies. The multi-tree XGBoost model discovered glycated albumin and fructosamine as highly-correlated DR biomarkers ($p<0.001$). Patient risk stratification and time-series analysis forecasted blindness progression n years in advance with an accuracy of 93.6%. This work presents a fully-automated, cost-effective, and scalable solution to globalize early blindness prevention. Support from ophthalmologists, medical device inventors, and clinical professors for prototype system deployment with FDA-cleared, smartphone-based eye cameras to rural villages is underway.

Awards Won:
Third Award of $1,000
Patent and Trademark Office Society: Top Award of $1,000, and an American flag and a framed copy of the first patent granted in the USA