A Novel Segmentation-Based AI Approach for the Early Detection of Diabetic Retinopathy and Macular Edema (DREAM) via Analysis of Retinal Fundus Images

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According to the CDC, approximately 37.3 million people have diabetes mellitus in the US. Diabetic Retinopathy (DR) is a microvascular eye complication associated with diabetes and is the leading cause of blindness in American adults. It occurs in roughly 1⁄3 of diabetes cases and leads to Diabetic Macular Edema (DME) ~60% of the time. However, traditional diagnostic approaches are too late to prevent irreversible vision loss as they are time-consuming, inaccessible, and expensive. This study proposes a novel U-Net-segmentation-based feature-aware deep learning model to screen retinal fundus images for a severity prediction of DR and DME. First, two modified Attention U-Nets were developed to semantically segment retinal features like blood vessels and lesions identified in DR/DME: microaneurysms, hemorrhages, and hard and soft exudates. Next, three transfer-learned Inception-v3 image classification models were built: two for the severity prediction of DR and one for the risk prediction of DME. Input images were automatically segmented into a retinal vessel and multi-lesion segmentation maps which were passed on to the DR and DME classification models. The DR models were then ensembled together. The segmentation Attention U-Nets and DR/DME classification models achieved accuracy scores greater than 97% and 90% respectively, exceeding benchmark accuracies. DREAM will allow for a cost-effective, rapid, and non-invasive tool that can be deployed on smartphones and easily used by ophthalmologists across the globe to accurately monitor DR and DME in patient populations where access to eye care and advanced diagnostic equipment is limited.

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Arizona State University: Arizona State University ISEF Scholarship (valued at up to $52,000 each)
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