Machine Learning for Parkinson's Disease Diagnosis using Fundus Eye Images

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Purpose: Parkinson's Disease (PD) is the second most common form of neural degeneration and defined by the decay of dopaminergic cells in the substantia nigra. The current standard for diagnosing PD occurs once 80% of dopaminergic cells have decayed. The degradation of these cells has been shown to create thinning of the retina walls and retina microvasculature. This work serves to find machine learning techniques to provide PD diagnosis using non-invasive fundus eye images.

Materials and Methods: Two age and gender matched datasets where constructed using data from the UK Biobank (UKB) and data collected at the University of Florida (UF). The first dataset consists of 476 fundus eye images, 238 CN and 238 PD, sourced entirely from the UKB database. The second dataset, UF-UKB, consist of 100 images, 28 CN and 72 PD, collected at UF and 44 CN images from UKB. A second set of datasets, UKB-Green and UF-UKB-Green, were created using the green color channels to improve vessel segmentation. Vessel segmentation was performed using U-Net segmentation network. The vessel maps served as inputs to SVM classifying networks. Saliency maps were created to assess areas of interest for the networks.

Results: The top performing SVM network for the UKB and UKB-Green datasets were the sigmoid SVM networks which achieved accuracies of .698 and .719 respectively. Meanwhile the top performing networks for the UF-UKB and UF-UKB-Green datasets where the linear SVM networks which achieved accuracies of .821 and .857 respectively. The saliency maps indicate that the different networks focused on different vessel structures with the most successful networks focusing more on smaller vessels.

Conclusion: The results indicate that the machine learning networks can classify PD based on retina vasculature, with the key features being smaller blood vessels. The proposed methods further support the idea that changes in brain physiology can be observed in the eye. Machine learning networks can be applied to clinically available data and still provide accurate predictions

Clinical Relevance statement, not to exceed 200 characters: The work illustrates the feasibility of utilizing eye images as a potential method for diagnosing PD, opposed to the current method of using motor symptoms.