Early-Onset Schizophrenia Detection via Novel Diffusion Tensor Machine Learning of Cingulate-Orbitofrontal Tractography

Tandon, Utkarsh (School: Cupertino High School)

This interdisciplinary study develops a novel diagnostic and monitoring tool for early stage schizophrenia (SCZ) by modeling diffusion MRI tractography abnormalities and discovering regions of risk associated with disease onset through machine learning. Schizophrenia affects an estimated 51 million people worldwide and yet lacks comprehensive diagnostic and visualization mechanisms to quantitatively assess onset and progression. Diffusion Tensor Imaging (DTI) is a promising modality for mapping white matter tractography with unprecedented detail, enabling abnormality localization and axon deformity analysis of microscopic structures in the brain beyond basic structural MRI. This research develops a machine learning-driven Random Forest ensemble to analyze DTI tractographs and predict early-stage SCZ with state-of-the-art 82.3% accuracy on CIDAR. Most profoundly, the research utilizes multi-tensor diffusion morphological characteristics across 52 subjects to unearth brain regions of interest (ROIs) potentially associated with the disease through Gini-impurity weighted sensitivities to neural-distortions. Tensor properties of diffusion are modeled to automatically segment 57 pathways and localize abnormalities such as axon demyelination attributed to SCZ. This novel identification of the right hemisphere cingulate and orbitofrontal cortices as being sensitive to SCZ onset is coupled with development of a 3D interactive white matter visualization highlighting SCZ tract abnormality severity in a given patient. Such a system defines an entirely new monitoring paradigm for early-SCZ in which neurologists can conduct early diagnosis of the disease, enable better monitoring for patients, and allow targeted dose-adjusting for therapeutics associated with these ROI proposals.

Awards Won:

Second Award of $2,000