ADVANCED 3D MRI-TO-SPECT TRANSLATION FOR DOPAMINERGIC ACTIVITY VISUALIZATION IN PARKINSON'S DIAGNOSIS

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Abstract

Parkinson's Disease (PD) is a progressive neurodegenerative disorder primarily characterized by the degeneration of dopaminergic neurons in the substantia nigra pars compacta, leading to a reduction in dopamine levels within the striatum. Early detection and quantitative assessment of dopaminergic dysfunction are critical for accurate diagnosis, disease staging, and therapeutic monitoring. While Single Photon Emission Computed Tomography (SPECT) provides functional imaging of dopamine transporter (DAT) activity, it involves radioactive tracers, higher cost, and limited accessibility. Magnetic Resonance Imaging (MRI), on the other hand, offers high-resolution structural imaging without ionizing radiation but lacks direct functional dopaminergic information. This proposes a novel computational framework for Dopamine Neuron Activity Visualization from MRI Sensors through 3D MRI-to-SPECT Synthesis. The system employs advanced deep learning–based volumetric modeling to synthesize SPECT-like functional images from structural MRI data. Using a 3D convolutional neural network (CNN) architecture, specifically a 3D U-Net–based regression framework, the model learns the mapping between anatomical MRI features and dopaminergic uptake distributions. The synthesized SPECT images are further analyzed to compute striatal uptake metrics and visualize dopamine-related regions in three dimensions.