Abstract

Thesis title - Radiology and Histopathology Induced Computer Vision for Neurological Disorder Detection

Brain abnormalities, including tumors and neurodegenerative diseases, are rising due to pollution, unhealthy lifestyles, and stress. Diseases like Alzheimer's and Epilepsy remain incurable and difficult to diagnose. The brain's complexity complicates identifying their causes, necessitating computational advancements. This thesis leverages computer vision for diagnosing and treating brain disorders, focusing on Alzheimer's and brain tumors.

For brain tumors, we developed a 3D segmentation model using a deep graph cut (DGC) approach that refines UNet probability maps, outperforming existing methods. Since classification is essential for treatment planning, we introduced a coarse-to-fine model using 3D CNNs and Graph Convolutional Networks (GCNs) on radiology and histopathology data, achieving 91.4% accuracy on CPM-RadPath2020. Additionally, we proposed a biomarker prediction model for gliomas using Whole Slide Images (WSI) and genetic data. A composite loss function captured biomarker relationships, achieving state-of-the-art results on a benchmark dataset, aiding prognosis and treatment planning.

For neurodegenerative diseases, we classified Alzheimer's into four stages using Diffusion Tensor Imaging (DTI). Separate CNNs trained on DTI-derived values and a Random Forest Classifier on regional averages achieved 92.6% accuracy on ADNI. We also improved hippocampus segmentation, critical for neurodegenerative diagnosis, using a 3D Attention UNet with a Histogram of Oriented Gradients (HOG) loss function. Our method outperformed existing techniques, and further refinement enabled hippocampal subfield segmentation via a deep graph cut approach incorporating shape priors, enhancing accuracy and efficiency.

This thesis highlights the impact of computer vision in improving brain disorder diagnosis and treatment, providing valuable tools for clinicians and researchers.