Dual-Perspective Brain MRI AI: Clinical Tumor Segmentation and Structural Biomarker Analysis

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Abstract

This work describes a dual-perspective pipeline for the analysis of brain MRI that couples automated tumor segmentation with research-oriented structural biomarker extraction. The system processes four MRI modalities (T1, T1CE, T2, FLAIR) using a pretrained 3D U-Net model, localizing and quantifying tumor regions, and further performs tissue-based volumetry and hemispheric asymmetry on T1 scans to estimate ray matter, white matter, and cerebrospinal fluid volumes. The complete workflow was implemented as an automated Google Colab environment, creating visual overlays, volumetric metrics, and a structured PDF output. It is designed for use in medical education, clinical AI exploration, and neuroscience research, while it has been deliberately designed not to be diagnostic for structural biomarkers.

Index Terms

MRI, Brain Tumor Segmentation, Volumetry, Biomarkers, MONAI, U-Net, ANTs