A Novel Lightweight Convolutional Neural Network for Efficient Brain Tumor Classification, Designed to Reduce Computational Cost and Energy Use, Enabling Deployment on Embedded or Portable Diagnostic Devices in Resource-Constrained Settings

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Brain health plays a critical role in overall well-being. Conditions like brain tumors can disrupt normal function and if malignant, will spread to other tissues with potentially fatal consequences. Early detection and accurate classification of brain tumors are essential for effective treatment and improved patient outcomes. Although Magnetic Resonance Imaging (MRI) images are widely adopted modalities for brain analysis and recent advancements in artificial intelligence (AI) have enhanced diagnostic capabilities of brain tumors, the development of lightweight models that are optimized, accurate, scalable, computationally efficient, and environmentally sustainable remains a significant challenge. To overcome these problems, this study proposes a custom 3.3M parameter, 5-fold cross validated convolutional neural network (CNN) architecture, which is designed to classify the brain tumors into 4 classes (glioma, meningioma, no tumor, pituitary). Our proposed model was compared against other CNN-based architectures, VGG-16, ResNet50, and MobileNetV2, and was the most lightweight, optimized model, performing against test data with an accuracy of 76.21%.

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