

ABSTRACT

Brain tumor diagnosis and classification pose significant challenges in modern medicine, considering their complexity and impact on patients' quality of life. While magnetic resonance imaging (MRI) is a primary diagnostic tool, manual interpretation often leads to variable results, necessitating automated approaches for more accurate and consistent image feature extraction and interpretation. This study developed a multi-class classification model for brain tumor MRI images using a Hybrid Dual Deep CNN architecture integrated with the XGBoost algorithm. The model combines EfficientNetV2-M and InceptionV3 for multiscale feature extraction, utilizing an MRI brain image dataset from Kaggle.com classified into four categories: Glioma, Meningioma, Pituitary, and *No Tumor*. Data underwent preprocessing, including resizing, normalization, and data augmentation to enhance training data variation and quality. Training results showed the FC-Dual Deep CNN model suffered from overfitting, yielding low *precision*, *recall*, and F1-scores during testing. Conversely, the XGBoost-Dual Deep CNN model demonstrated significantly improved performance, with the best result achieving average *precision* of 0.9865, *recall* of 0.9864, and an F1-score of 0.9684. The integration of XGBoost effectively mitigated the pure CNN model's generalization limitations. Classification accuracy for non-tumor patients reached 100%, which is crucial for preventing False Positives in medical diagnostics. This model holds great potential as a rapid, accurate, and reliable Deep Learning-based brain tumor diagnostic aid.

Keywords: Multi-class Classification, Brain Tumor, MRI, Deep Learning, CNN, EfficientNetV2-M, InceptionV3, XGBoost, Image Augmentation, Overfitting.