

ABSTRACT

PERFORMANCE ANALYSIS OF THE VISION TRANSFORMER (ViT) MODEL VIA MAGNETIC RESONANCE IMAGING (MRI) IN BRAIN TUMOR DETECTION

By

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Accurate brain tumor detection using Magnetic Resonance Imaging (MRI) poses a significant challenge in medical diagnosis. This study aims to analyze the performance of Vision Transformer (ViT) model in brain tumor classification and identify critical factors affecting its performance. The dataset consists of 7,023 MRI images classified into four classes: glioma, meningioma, pituitary, and no tumor. Research stages include data preprocessing (grayscale, Gaussian blur, thresholding, morphology, contour detection, cropping, and bone color mapping), data augmentation, and ViT model fine-tuning using AdamW optimizer. Experiments were conducted under two scenarios: data balancing through class weighting and augmentation, and comparison between comprehensive versus partial fine-tuning strategies. Results demonstrate that ViT model achieves optimal performance with 97.08% accuracy, 97.01% precision, 97.01% recall, and 97.01% F1-score. Data balancing improves training stability and model generalization with 0.57% accuracy enhancement. Comprehensive fine-tuning proves 7.47% superior compared to partial fine-tuning despite requiring longer computational time. Benchmarking with previous studies confirms ViT performance competitively to the best CNN architectures. This research contributes to the development of reliable artificial intelligence-based diagnostic systems for brain tumor detection.

Keywords: Vision Transformer, brain tumor, MRI, classification, fine-tuning.

ABSTRAK

ANALISIS KINERJA MODEL *VISION TRANSFORMER* (ViT) MELALUI CITRA *MAGNETIC RESONANCE IMAGING* (MRI) DALAM DETEKSI TUMOR OTAK

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Deteksi tumor otak secara akurat menggunakan citra *Magnetic Resonance Imaging* (MRI) merupakan tantangan utama dalam diagnosis medis. Penelitian ini bertujuan menganalisis kinerja model *Vision Transformer* (ViT) dalam klasifikasi tumor otak serta mengidentifikasi faktor-faktor kritis yang memengaruhi performanya. Dataset terdiri atas 7.023 citra MRI yang diklasifikasikan ke dalam empat kelas: glioma, meningioma, pituitary, dan no tumor. Tahapan penelitian mencakup preprocessing data (*grayscale*, *Gaussian blur*, *thresholding*, morfologi, deteksi kontur, *cropping*, dan *bone color mapping*), augmentasi data, serta *fine-tuning* model ViT dengan *optimizer* AdamW. Eksperimen dilakukan dengan dua skenario: penyeimbangan data menggunakan pembobotan kelas dan augmentasi, serta perbandingan strategi *fine-tuning* komprehensif versus parsial. Hasil penelitian menunjukkan bahwa model ViT mencapai kinerja optimal dengan akurasi 97,08%, presisi 97,01%, recall 97,01%, dan F1-score 97,00%. Penyeimbangan data meningkatkan stabilitas pelatihan dan generalisasi model dengan peningkatan akurasi sebesar 0,57%. *Fine-tuning* komprehensif terbukti 7,47% lebih unggul dibandingkan *fine-tuning* parsial meskipun membutuhkan waktu komputasi lebih lama. *Benchmarking* dengan penelitian terdahulu mengonfirmasi performa ViT yang kompetitif dengan arsitektur CNN terbaik. Penelitian ini berkontribusi pada pengembangan sistem diagnosis berbasis kecerdasan buatan yang andal untuk deteksi tumor otak.

Kata kunci: *Vision Transformer*, tumor otak, MRI, klasifikasi, *fine-tuning*