

ABSTRAK

Deep learning, khususnya *Convolutional Neural Network* (CNN) dengan arsitektur VGG-19, telah banyak di terapkan dalam klasifikasi citra medis. Namun, performa VGG-19 berbasis *transfer learning* sering kali tidak optimal akibat penerapan pengabaian teknik *preprocessing* standar, seperti *mean subtraction*, serta kurangnya penerapan *fine-tuning* untuk mengadaptasi fitur generik ImageNet ke karakteristik spesifik citra medis. Penelitian ini bertujuan untuk mengevaluasi pengaruh *mean subtraction* dan strategi *fine-tuning* pada model VGG-19 dalam mengklasifikasikan empat tahap penyakit Alzheimer: *Alzheimer's Disease* (AD), *Early Mild Cognitive Impairment* (EMCI), *Late Mild Cognitive Impairment* (LMCI), dan *Cognitively Normal* (CN). *Dataset* bersumber dari *Alzheimer's Disease Neuroimaging Initiative* (ADNI) sebanyak 518 citra 3D MRI yang diproses menjadi 4.662 citra 2D. Tahapan *preprocessing* meliputi *skull stripping*, pemilihan *slice* kunci, *resizing*, konversi *grayscale* ke RGB, *mean subtraction*, dan *augmentasi*. Evaluasi model dilakukan melalui 12 skenario pengujian variasi *learning rate* dan *dropout*, divalidasi dengan *5-fold cross-validation*, dan diakhiri dengan pengujian *test set* 10%. Hasil penelitian menunjukkan bahwa penggunaan *scaling* 0-1 menghasilkan akurasi 50.00%, sedangkan penerapan *mean subtraction* meningkatkan akurasi menjadi 86.54%. Penambahan strategi *fine-tuning* dengan *learning rate* 0.00001 dan *dropout* 0.5 menghasilkan performa validasi tertinggi sebesar 92.31%. Pada pengujian akhir menggunakan data uji model mencapai akurasi keseluruhan sebesar 94.23%, dengan tingkat *recall* kelas AD dan EMCI mencapai 100%. Kesimpulannya, integrasi teknik *mean subtraction* dan *fine-tuning* dengan *learning rate* rendah terbukti efektif dalam memaksimalkan performa arsitektur VGG-19 untuk pengenalan pola penyakit Alzheimer.

Kata Kunci : *Alzheimer's Disease*, CNN, VGG-19, *Transfer Learning*, *Fine-tuning*, *Mean subtraction*

ABSTRACT

Deep learning, particularly Convolutional Neural Networks (CNN) with the VGG-19 architecture, is increasingly being applied in medical image classification. However, the performance of VGG-19 based on transfer learning is often not optimal due to the neglect of standard preprocessing techniques, such as mean subtraction, as well as the lack of implementation of fine-tuning to adapt ImageNet's generic features to the specific characteristics of medical images. This study aims to evaluate the effect of applying mean subtraction and fine-tuning strategies on the VGG-19 model in classifying four stages of Alzheimer's disease: Alzheimer's Disease (AD), Early Mild Cognitive Impairment (EMCI), Late Mild Cognitive Impairment (LMCI), and Cognitively Normal (CN). The dataset comes from the Alzheimer's Disease Neuroimaging Initiative (ADNI) consisting of 518 3D MRI images processed into 4,662 2D images. The preprocessing stages include skull stripping, selection of key slices, resizing (224x224), conversion from grayscale to RGB, mean subtraction. The preprocessing stages include skull stripping, key slice selection, resizing (224x224), grayscale to RGB conversion, mean subtraction, and augmentation. Model evaluation was conducted through 12 testing scenarios varying learning rate and dropout, validated using 5-fold cross-validation, and concluded with testing on a 10% test set. The research results showed that using 0-1 scaling only yielded 50.00% accuracy, whereas applying mean subtraction drastically increased accuracy to 86.54%. Adding a fine-tuning strategy with a learning rate of 0.00001 and dropout of 0.5 resulted in the highest validation performance of 92.31%. In the final test (test data), the model achieved an overall accuracy of 94.23%, with recall rates for the AD and EMCI classes reaching 100%. In conclusion, the integration of mean subtraction techniques and fine-tuning with a low learning rate proved to be very crucial and effective in maximizing the performance of the VGG-19 architecture for Alzheimer's disease pattern recognition.

Keyword : *Alzheimer's Disease, CNN, VGG-19, Transfer Learning, Fine-tuning, Mean subtraction.*

