ABSTRAK

Klasifikasi ras berdasarkan citra wajah merupakan salah satu tantangan dalam bidang pembelajaran mesin, terutama ketika berhadapan dengan karakteristik ras yang memiliki kemiripan warna kulit dan struktur wajah. Penelitian ini bertujuan untuk mengembangkan model klasifikasi ras wajah menggunakan *Convolutional Neural Network* (CNN) arsitektur *Residual Network* (ResNet). Penelitian dilakukan dalam dua tahap. Tahap pertama bertujuan untuk mengevaluasi performa lima varian ResNet (ResNet18, ResNet34, ResNet50, ResNet101, dan ResNet152) yang dibangun dari awal (*from scratch*) sebagai model *pre-trained* menggunakan dataset wajah dari kaggle UTKFace.

Tahap kedua merupakan proses *transfer learning* dan *fine-tuning* terhadap model terbaik dari tahap pertama dengan menggunakan dataset yang lebih spesifik dan representatif wajah orang Indonesia. Pada tahap ini dilakukan serangkaian percobaan dengan mengkombinasikan berbagai fungsi aktivasi (*ReLU*, *LeakyReLU*, *ELU*, *Swish*), optimasi (*Adam*, *SGD*, *RMSprop*), serta proporsi *layer* yang dibekukan (50%, 60%, 80%, dan seluruh *layer* di-*unfreeze*). Evaluasi model dilakukan menggunakan *confusion matrix*. Hasil penelitian menunjukkan bahwa kualitas citra input, termasuk latar belakang dan pencahayaan, sangat memengaruhi akurasi klasifikasi. Model tahap pertama diperoleh ResNet34 sebagai model *pre-trained* menghasilkan akurasi 0.90 dan tahap kedua diperoleh kombinasi *fine-tuning* dengan fungsi aktivasi *ReLU*, *optimizer RMSprop*, dan *unfreeze* 60% *layer* akhir, yang menghasilkan akurasi *test* sebesar 0.87.

Kata kunci: Klasifikasi Ras, Citra Wajah, CNN, *ResNet*, *Transfer Learning*, *Fine-Tuning*

ABSTRACT

Facial race classification is one of the challenges in the field of machine learning, especially when dealing with racial characteristics that share similar skin tones and facial structures. This study aims to develop a facial race classification model using *Convolutional Neural Networks* (CNN) based on the Residual Network (ResNet) architecture. The research was conducted in two main stages. The first stage focused on evaluating the performance of five ResNet variants (ResNet18, ResNet34, ResNet50, ResNet101, and ResNet152), which were manually constructed from scratch and trained as pre-trained models using the UTKFace facial image dataset from Kaggle. These models were implemented using the TensorFlow and Keras frameworks and structured to incorporate residual connections, allowing deeper architectures to be trained effectively without suffering from vanishing gradient problems.

The second stage involved transfer learning and fine-tuning the best-performing model from the first stage, using a more specific and representative dataset of Indonesian faces. In this stage, a series of experiments were conducted by combining various activation functions (ReLU, LeakyReLU, ELU, Swish), optimization algorithms (Adam, SGD, RMSprop), and proportions of frozen layers (50%, 60%, 80%, and all layers unfrozen). These experiments aimed to optimize performance when adapting the pre-trained model to the target dataset. Model evaluation was carried out using the confusion matrix, focusing on the model's ability to accurately distinguish between race classes. The results showed that the quality of the input images—including background and lighting—had a significant effect on classification accuracy. From the first stage, ResNet34 was selected as the best pre-trained model, achieving an accuracy of 0.90. In the second stage, the best fine-tuned result was obtained by applying the ReLU activation function, RMSprop optimizer, and unfreezing the last 60% of layers, resulting in an test accuracy of 0.87.

Keywords: Race Classification, Facial Image, CNN, ResNet, Transfer Learning, Fine-Tuning