ABSTRAK

Bayam merupakan salah satu sayuran hijau yang paling banyak dikonsumsi di Indonesia, namun produktivitasnya kerap terganggu oleh serangan penyakit daun dari jamur dan serangan hama yang selama ini masih diidentifikasi secara manual melalui pengamatan visual petani. Akan tetapi, telah banyak penelitian yang membahas penerapan CNN ringan untuk mengidentifikasi penyakit daun secara otomatis. Maka dari itu, penelitian ini berupaya untuk mengetahui kinerja arsitektur SqueezeNet dalam mendeteksi penyakit daun bayam, serta menganalisis dan menentukan konfigurasi *hyperparameter* yang menghasilkan performa paling optimal. Penelitian ini menggunakan metodologi CRISP-DM dengan dataset citra daun bayam yang terbagi ke dalam lima kelas (*Anthracnose, Bacterial Spot, Downy Mildew, Healthy,* dan *Pest Damage*), dengan pembagian data latih, validasi, dan uji sebesar 80:10:10 serta augmentasi data pada data latih. Eksperimen dilakukan melalui sembilan skenario kombinasi tiga nilai *learning rate* (0,0002; 0,002; dan 0,02) dan tiga jenis *optimizer* (Adam, Adamax, dan Nadam), yang dievaluasi menggunakan *confusion matrix*. Hasil penelitian menunjukkan bahwa hanya *learning rate* 0,0002 yang berhasil membawa ketiga *optimizer* mencapai performa yang stabil dengan akurasi uji berkisar 81,39%-82,18%, sedangkan *learning rate* 0,002 dan 0,02 menyebabkan *optimizer* Adam dan Nadam mengalami *gradient explosion* dan gagal belajar dengan akurasi terjebak pada 20%, meskipun Adamax masih mampu belajar walau performanya menurun signifikan seiring naiknya nilai *learning rate*. Kombinasi *optimizer* Nadam dengan *learning rate* 0,0002 terbukti sebagai konfigurasi paling optimal, dengan akurasi uji tertinggi sebesar 82,18%, test loss terendah sebesar 0,5097, dan *F1-Score* rata-rata tertinggi sebesar 0,8196, serta waktu pelatihan tercepat yaitu 166,2 menit.

Kata Kunci: SqueezeNet, *Hyperparameter, Learning Rate, Optimizer*, Deteksi Penyakit Daun Bayam, *Convolutional Neural Network*.

ABSTRACT

Spinach is one of the most widely consumed leafy greens in Indonesia, but its productivity is often hampered by leaf diseases, which have so far been identified manually through farmers' visual observations. However, there have been many studies that have explored the use of lightweight CNNs for the automatic identification of leaf diseases. Therefore, this study aims to evaluate the performance of the SqueezeNet architecture in detecting spinach leaf diseases, as well as to analyze and determine the hyperparameter configuration that yields the most optimal performance. This study employs the CRISP-DM methodology using a dataset of spinach leaf images categorized into five classes (Anthracnose, Bacterial Spot, Downy Mildew, Healthy, and Pest Damage), with a split of 80:10:10 for the training, validation, and test sets, respectively, and data augmentation applied to the training set. The experiment was conducted using nine scenarios combining three learning rate values (0.0002, 0.002, and 0.02) and three types of optimizers (Adam, Adamax, and Nadam), which were evaluated using a confusion matrix. The results of the study show that only a learning rate of 0.0002 enabled all three optimizers to achieve stable performance with test accuracies ranging from 81.39% to 82.18%, whereas learning rates of 0.002 and 0.02 caused the Adam and Nadam optimizers to experience gradient explosion and fail to learn, with accuracy stuck at 20%, although Adamax was still able to learn, even though its performance declined significantly as the learning rate increased. The combination of the Nadam optimizer and a learning rate of 0.0002 proved to be the most optimal configuration, with the highest test accuracy of 82.18%, the lowest test loss of 0.5097, the highest average F1-score of 0.8196, and the fastest training time of 166.2 minutes.

Keywords: *SqueezeNet, Hyperparameter, Learning Rate, Optimizer, Spinach Leaf Disease Detection, Convolutional Neural Network.*