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Deteksi dan Klasifikasi Jenis Cacat pada Biji Kopi Hijau Robusta Merapi Menggunakan Model YOLO V8
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DETEKSI DAN KLASIFIKASI JENIS CACAT PADA BIJI KOPI HIJAU ROBUSTA MERAPI MENGGUNAKAN MODEL YOLO V8

INTISARI

Penelitian ini dilatarbelakangi oleh proses sortasi biji kopi yang masih dilakukan secara manual sehingga berpotensi menghasilkan penilaian mutu yang kurang konsisten, terutama pada proses sortasi berulang dan skala besar. Penelitian ini bertujuan untuk memperoleh model terbaik dalam klasifikasi kecacatan biji kopi hijau (*green coffee bean*) berbasis *deep learning* menggunakan YOLOv8, serta menentukan konfigurasi pelatihan model yang optimal agar dapat diimplementasikan secara *real-time*. Objek penelitian berupa biji kopi robusta Merapi organik yang diklasifikasikan menjadi lima kelas berdasarkan karakteristik visual hasil sortasi mutu di Kelompok Tani Tunggak Semi, yaitu biji hitam, pecah, berlubang, tutul, dan normal. Penelitian dilakukan melalui tahapan pengumpulan data citra, pelabelan menggunakan Roboflow, pembagian dataset, *resizing*, augmentasi data, pelatihan model, penyetelan *hyperparameter*, hingga pengujian *realtime*. Variasi model YOLOv8 yang digunakan meliputi YOLOv8n, YOLOv8s, YOLOv8m, YOLOv8l, dan YOLOv8x. Evaluasi model dilakukan menggunakan metrik *accuracy, precision, recall*, mAP50. Hasil penelitian menunjukkan bahwa model terbaik diperoleh pada YOLOv8m menggunakan dataset augmentasi dengan nilai *accuracy* sebesar 90,7%, *precision* sebesar 93%, *recall* sebesar 94,5%, mAP50 sebesar 97,4%, dan mAP50-95 sebesar 89,0%. Selanjutnya dilakukan penyetelan *hyperparameter* menggunakan variasi *batch size, learning rate,* dan *epoch* dengan *optimizer Stochastic Gradient Descent* (SGD). Konfigurasi terbaik diperoleh pada *batch size* 32, *learning rate* 0,05, dan *epoch* 100 dengan nilai *accuracy* sebesar 91,2%, *precision* sebesar 94,1%, *recall* sebesar 94,3%, mAP50 sebesar 96,9%, dan mAP50-95 sebesar 88,8%. Pengujian *realtime* dilakukan menggunakan webcam melalui Visual Studio Code dengan tiga kali percobaan pada lima jenis objek dalam satu *frame*. Hasil pengujian menunjukkan rata-rata *accuracy* sebesar 87,8%, *precision* sebesar 89,8%, *recall* sebesar 97,6%, F1-*score* sebesar 93,5%, dan kecepatan deteksi sebesar 4,56 FPS.

Kata kunci: *deep learning,* deteksi objek, sortasi kopi, YOLOv8

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DETECTION AND CLASSIFICATION OF DEFECT TYPES IN MERAPI ROBUSTA GREEN COFFEE BEANS USING THE YOLO V8 MODEL

ABSTRACT

This study was motivated by the coffee bean sorting process, which is still performed manually, potentially resulting in inconsistent quality assessment, especially during repetitive and large-scale sorting processes. This study aimed to obtain the best model for green coffee bean defect classification based on deep learning using YOLOv8, as well as to determine the optimal model training configuration for real-time implementation. The research objects were organic Merapi robusta green coffee beans classified into five classes based on the visual characteristics of quality sorting at Kelompok Tani Tunggak Semi, namely black, broken, insect-damaged, spotted, and normal beans. The study was conducted through several stages, including image data collection, annotation using Roboflow, dataset splitting, resizing, data augmentation, model training, hyperparameter tuning, and real-time testing. The YOLOv8 model variants used in this study included YOLOv8n, YOLOv8s, YOLOv8m, YOLOv8l, and YOLOv8x. Model evaluation was carried out using accuracy, precision, recall, and mAP50 metrics. The results showed that the best model was obtained using YOLOv8m with an augmented dataset, achieving an accuracy of 90.7%, precision of 93%, recall of 94.5%, mAP50 of 97.4%, and mAP50-95 of 89,0%. Furthermore, hyperparameter tuning was performed using variations in batch size, learning rate, and epochs with the Stochastic Gradient Descent (SGD) optimizer. The best configuration was achieved with a batch size of 32, learning rate of 0.05, and 100 epochs, resulting in an accuracy of 91.2%, precision of 94.1%, recall of 94.3%, mAP50 of 96.9%, and mAP50-95 of 88,8%. Real-time testing was conducted using a webcam through Visual Studio Code with three trials involving five object types within a single frame. The testing results showed an average accuracy of 87.8%, precision of 89.8%, recall of 97.6%, F1-score of 93.5%, and detection speed of 4.56 FPS.

Keywords: coffee quality sorting, deep learning, object detection, YOLO