ABSTRAK

Penelitian ini bertujuan untuk mengimplementasikan model YOLOv11 berbasis *Convolutional Neural Network* (CNN) dalam mendeteksi jalan berlubang pada citra digital. Permasalahan jalan berlubang membutuhkan sistem deteksi yang mampu bekerja secara cepat, objektif, dan adaptif terhadap variasi kondisi jalan. Penelitian ini menggunakan dataset gabungan sebanyak 947 gambar, yang terdiri atas 537 gambar primer hasil pengambilan langsung di lapangan dan 410 gambar sekunder dari Kaggle. Data tersebut melalui tahapan *pre-processing*, pembagian dataset, pelatihan model, evaluasi, dan implementasi sistem. Model YOLOv11 dievaluasi menggunakan metrik *Precision*, *Recall*, *F1-score*, dan *mAP@0.5* pada data validasi. Hasil evaluasi menunjukkan bahwa model memperoleh nilai *Precision* 0,919, *Recall* 0,888, *F1-score* 0,903, dan *mAP@0.5* 0,953. Hasil tersebut menunjukkan bahwa YOLOv11 memiliki performa yang baik dalam mendeteksi dan melokalisasi objek jalan berlubang. Implementasi model dilakukan melalui aplikasi dengan fitur *Upload Image* dan kamera *smartphone* berbasis *real-time*. Sistem mampu menampilkan hasil deteksi berupa bounding box, label objek, dan status kondisi jalan. Dengan demikian, model YOLOv11 dapat diterapkan sebagai sistem deteksi otomatis untuk membantu pemantauan kerusakan jalan pada kondisi nyata.

Kata Kunci: CNN, deteksi jalan berlubang, *real-time*, visi komputer, YOLOv11

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ABSTRACT

This study aims to implement the YOLOv11 model based on Convolutional Neural Network (CNN) to detect potholes in digital images. The pothole detection problem requires a detection system that can operate quickly, objectively, and adaptively to varying road conditions. This research uses a combined dataset of 947 images, consisting of 537 primary images taken directly in the field and 410 secondary images from Kaggle. The data undergoes pre-processing, dataset splitting, model training, evaluation, and system implementation. The YOLOv11 model is evaluated using Precision, Recall, F1-score, and mAP@0.5 metrics on the validation data. The evaluation results show that the model achieves Precision of 0.919, Recall of 0.888, F1-score of 0.903, and mAP@0.5 of 0.953. These results indicate that YOLOv11 performs well in detecting and localizing pothole objects. The model is implemented through an application with real-time features such as Upload Image and smartphone camera. The system can display detection results in the form of bounding boxes, object labels, and road condition status. Thus, the YOLOv11 model can be applied as an automatic detection system to aid in real-time monitoring of road damage.

***Keywords**: CNN, computer vision, pothole detection, real-time, YOLOv11*

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