ABSTRAK

Pelanggaran lalu lintas di Indonesia mencapai 2.146.128 kasus pada tahun 2024, dengan tingkat kepatuhan yang masih rendah. Sistem pengenalan plat nomor kendaraan menjadi solusi strategis untuk pengawasan dan penegakan hukum yang lebih efektif. Penelitian ini membandingkan performa YOLOv12 dan Faster R-CNN yang diintegrasikan dengan PaddleOCR untuk deteksi dan pengenalan plat nomor kendaraan bermotor di Indonesia.

Dataset penelitian terdiri dari 1.577 citra kendaraan yang telah melalui proses *preprocessing* meliputi anotasi, splitting (70% *training*, 15% validation, 15% testing), resize 640×640 piksel, dan augmentasi data. YOLOv12s dilatih selama 50 epoch dengan optimizer AdamW, sedangkan Faster R-CNN dengan *backbone* ResNet-50 dilatih selama 15 *epoch* menggunakan SGD *optimizer* dengan *early stopping*. Evaluasi dilakukan dalam tiga tahap: evaluasi deteksi objek menggunakan metrik *precision*, *recall*, F1-*score*, mAP, dan IoU; evaluasi OCR mengukur *plate accuracy* dan *character accuracy*; serta evaluasi *end-to-end* untuk mengukur performa sistem secara keseluruhan.

Hasil penelitian menunjukkan YOLOv12s unggul dalam metrik *training* dengan *precision* 0.926, *recall* 0.962, F1-*score* 0.944, mAP50 0.9778, dan mAP50-95 0.65254, serta kecepatan deteksi 2.56 kali lebih cepat (12.416 FPS) dibanding Faster R-CNN (4.841 FPS). Namun, Faster R-CNN menghasilkan *Average* IoU lebih tinggi (84.57% vs 83.11%) yang berdampak pada performa OCR, mencapai *plate accuracy* 70% dan *character accuracy* 79.12%, lebih tinggi dari YOLOv12s (60% dan 73.99%). Pada evaluasi *end-to-end*, Faster R-CNN + PaddleOCR mencapai E2E *accuracy* 70%, unggul 10 poin persentase dari YOLOv12s (60%). Analisis korelasi menunjukkan kualitas IoU berpengaruh signifikan pada keberhasilan OCR di Faster R-CNN (0.213) dibanding YOLOv12s (0.014).

Penelitian ini membuktikan bahwa Faster R-CNN lebih optimal untuk aplikasi yang memprioritaskan akurasi tinggi seperti sistem tilang elektronik, sedangkan YOLOv12s lebih sesuai untuk *monitoring real-time* dengan toleransi *error* lebih besar.

Kata Kunci: Plat Nomor Kendaraan, *Object Detection*, YOLOv12, Faster R-CNN, PaddleOCR, *Deep Learning*

ABSTRACT

Traffic violations in Indonesia reached 2,146,128 cases in 2024, with compliance rates remaining low. Automatic license plate recognition systems have become a strategic solution for more effective traffic monitoring and law enforcement. This research compares the performance of YOLOv12 and Faster R-CNN integrated with PaddleOCR for detecting and recognizing vehicle license plates in Indonesia.

The research dataset consists of 1,577 vehicle images that underwent preprocessing including annotation, splitting (70% training, 15% validation, 15% testing), resizing to 640×640 pixels, and data augmentation. YOLOv12s was trained for 50 epochs using AdamW optimizer, while Faster R-CNN with ResNet-50 backbone was trained for 15 epochs using SGD optimizer with early stopping. Evaluation was conducted in three stages: object detection evaluation using precision, recall, F1-score, mAP, and IoU metrics; OCR evaluation measuring plate accuracy and character accuracy; and end-to-end evaluation to measure overall system performance.

Results show that YOLOv12s excels in training metrics with precision 0.926, recall 0.962, F1-score 0.944, mAP50 0.9778, and mAP50-95 0.65254, with detection speed 2.56 times faster (12.416 FPS) compared to Faster R-CNN (4.841 FPS). However, Faster R-CNN produces higher Average IoU (84.57% vs 83.11%) which impacts OCR performance, achieving plate accuracy 70% and character accuracy 79.12%, higher than YOLOv12s (60% and 73.99%). In end-to-end evaluation, Faster R-CNN + PaddleOCR achieves E2E accuracy 70%, outperforming YOLOv12s by 10 percentage points (60%). Correlation analysis shows that IoU quality significantly affects OCR success in Faster R-CNN (0.213) compared to YOLOv12s (0.014).

This research demonstrates that Faster R-CNN is more optimal for applications prioritizing high accuracy such as electronic ticketing systems, while YOLOv12s is more suitable for real-time monitoring with greater error tolerance.

Keywords: *Vehicle License Plate, Object Detection, YOLOv12, Faster R-CNN, PaddleOCR, Deep Learning*