ABSTRACT

Checkout system efficiency in the retail industry plays a crucial role in improving customer satisfaction, especially in today's fast-paced digital era. Traditional barcode-based checkout systems often lead to long queues due to the manual scanning process required for each item which affect customer satisfaction. Amazon Go concept has proven the feasibility of deploying self-checkout systems in practical environments by leveraging a sensor technologies and deep learning-based object recognition. Object detection models such as YOLO have been widely applied to support self-checkout systems. However, the demand for lightweight, fast, and accurate models remains a challenge, particularly for deployment on resource-constrained devices. This study focuses on optimizing the YOLOv11 model through hyperparameter tuning and quantization techniques to detect retail products within the FMCG (Fast-Moving Consumer Goods) category, specifically food and beverage items. The dataset used consists of 1,000 manually collected and annotated product images via Roboflow. Three hyperparameter configurations were tested, with the best results which obtained a mAP50 99.40%, mAP50:95 96.89%, and Precision, Recall, and F1-Score 0.98. The model was quantized into INT8 format using ONNX Runtime, reducing its size to 9.39 MB a 74% decrease from the original. While minor accuracy degradation was observed after quantization, detection performance remained stable. Implementation tests were conducted across Google Colab, local devices, and a NodeJS-based web environment to assess the model's cross-platform consistency. The results indicate that quantization improves storage efficiency and enhances deployment potential

on edge devices, although its impact on inference speed is highly dependent on hardware capabilities.

Keywords *: Hyperparameter Tuning, Object Detection, Quantization, Self-Checkout, YOLOv11.*

ABSTRAK

Efisiensi sistem *checkout* di industri ritel memainkan peran penting dalam meningkatkan kepuasan pelanggan, terutama di era digital yang serba cepat saat ini. Sistem kasir tradisional berbasis *barcode* sering kali menyebabkan antrian panjang karena proses pemindaian manual yang dilakukan untuk setiap barang yang mempengaruhi kepuasan pelanggan. Konsep Amazon Go telah membuktikan kelayakan penerapan sistem kasir mandiri di lingkungan yang praktis dengan memanfaatkan teknologi sensor dan deteksi objek berbasis *deep learning*. Model pendeteksi objek seperti YOLO telah banyak diterapkan untuk mendukung sistem checkout mandiri. Namun, permintaan akan model yang ringan, cepat, dan akurat tetap menjadi tantangan, terutama untuk penerapan pada perangkat yang memiliki sumber daya terbatas. Penelitian ini berfokus pada pengoptimalan model YOLOv11 melalui *hyperparameter tuning* dan teknik kuantisasi untuk mendeteksi produk ritel dalam kategori FMCG (*Fast-Moving Consumer Goods*), khususnya produk makanan dan minuman. Dataset yang digunakan terdiri dari 1.000 gambar produk yang dikumpulkan secara manual dan dianotasi melalui Roboflow. Tiga konfigurasi hyperparameter diuji, dengan hasil terbaik yang memperoleh mAP50 99,40%, mAP50:95 96,89%, serta Precision, Recall, dan F1-Score 0,98. Model dikuantisasi ke dalam format INT8 menggunakan ONNX Runtime, mengurangi ukurannya menjadi 9,39 MB, berkurang 74% dari ukuran aslinya. Meskipun ada sedikit penurunan akurasi setelah kuantisasi, kinerja deteksi tetap stabil. Pengujian implementasi dilakukan di Google Colab, perangkat lokal, dan lingkungan web berbasis NodeJS untuk menilai konsistensi lintas platform model. Hasilnya

menunjukkan bahwa kuantisasi meningkatkan efisiensi penyimpanan dan meningkatkan potensi penerapan pada *edge device*, meskipun dampaknya terhadap kecepatan inferensi sangat bergantung pada kemampuan perangkat keras.

Kata Kunci : Deteksi Objek, Hyperparameter Tuning, Kuantisasi, Self-Checkout, YOLOv11