

ABSTRACT

The use of Unmanned Ground Vehicles (UGV) in outdoor areas requires an object detection system that can work well to help the navigation system avoid various obstacles automatically. One of the challenges in UGV navigation is detecting and measuring the distance of objects such as trees in real time in complex terrain. This research aims to design and build an object detection system using the You Only Live Once v11 algorithm combined with the Intel RealSense D435i depth camera, focusing on trees as a single object. The system is designed to support the autonomous movement of UGVs in outdoor environments. The methodology includes collecting 3,502 tree images around Building P at Telkom University, labeling the dataset using the Roboflow platform, training the YOLOv11 model with data augmentation techniques, and integrating it with the robust center algorithm to estimate distance. The training was carried out in Google Colab with an NVIDIA A100 GPU.

The performance evaluation used precision, recall, F1-score, and mean Average Precision (mAP) metrics, as well as a comparison with the YOLOv10 model. The test results show that the YOLOv11 model achieved a precision of 88.1%, recall of 85.6%, and mAP 0.5 of 90.5%. The most accurate distance estimation was obtained with a center_ratio value of 0.3 using the robust center method. The developed system supports UGV object detection in outdoor environments and has potential applications in agriculture, military, and disaster management.

Keywords: Unmanned Ground Vehicle, Object Detection, Depth Camera, YOLOv11, Robust Center, Deep Learning.