Solid Waste Detection in Diverse Environments Using Deep Learning Models

***Abstract*—The precise identification of solid waste is crucial for effective environmental monitoring, pollution source management, and developing appropriate waste management strategies across diverse ecosystems. However, detecting the wide variety of waste materials under complex environmental conditions remains challenging. Previous YOLO object detectors often struggle with lower accuracy on small or occluded items, less precise localization, and difficulty distinguishing visually similar classes. This study directly addresses these needs by quantitatively comparing solid waste detection performance between YOLOv11andthe recently released YOLOv12. Both models were trained on a diverse dataset and evaluated under challenging conditions (variable lighting, occlusion, complex backgrounds) using key metrics including precision, recall, and mean Average Precision (mAP@0.5 and mAP@0.5:0.95). Results conclusively show that YOLOv12 demonstrates superior accuracy compared to YOLOv11, achieving a 3.5% higher mAP@0.5:0.95 score. This indicates significantly improved object localization and classification capabilities, with particular strength observed in detecting smaller, varied, and partially obscured waste items, while operating at speeds compatible with real-time implementation needs. These findings highlight how advanced YOLO architectures for solid waste monitoring and strongly suggest that YOLOv12 offers significant advantages in developing more effective automated waste management and environmental protection solutions.**