ABSTRACT

The formation of potholes on road surfaces is a significant issue that affects road safety and traffic flow, particularly in developing countries. Potholes contribute to road accidents, fatalities, injuries, and increased vehicle operating costs. Current detection methods, such as public reporting systems and road sensors, face limitations, including time delays, inadequate verification personnel, and inconsistent monitoring. Several studies have explored the automation of pothole detection. This study introduces a direct comparison of three versions of the latest YOLO models (YOLOv9, YOLOv10, YOLOv11), evaluating their strengths and weaknesses in pothole detection by adjusting various hyperparameters and datasets that simulate real road conditions. The novelty of this study, compared to previous research, lies in demonstrating how advancements in YOLO architectures through comparisons of the three model variants— YOLOv9, YOLOv10, and YOLOv11—enhance automated pothole detection and address challenges such as the diverse characteristics of potholes, including varying shapes, sizes, depths, and appearances under different lighting conditions, weather, and road surface textures. Furthermore, the detection process overcomes factors such as shadows, water-filled potholes, and similar-looking road features that can lead to false positives. YOLOv11, particularly the medium variant (YOLOv11m), demonstrates superior performance compared to YOLOv9 and YOLOv10, achieving mAP50 scores of 0.957 and 0.894 on the training and test sets, respectively. The smaller variant (YOLOv11s) offers fast inference (0.3554 seconds at 640x640) while maintaining high accuracy, providing a practical solution for real-time implementation

.**Keywords**: *pothole detection, YOLOv9, YOLOv10, YOLOv11*