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Pothole Detection Using YOLOv12 for Intelligent Transportation

Abstract

An intelligent transportation system is one of the SDG of the UN, which emphasizes how to offer seamless transportation services to the end users. Due to the varying climatic conditions, roads are very susceptible to damage, and the severity varies, resulting in potholes of varying sizes.

This research presents a YOLOv12-powered framework for real-time pothole detection and monitoring, tailored for road transportation. The YOLOv12 model is trained with the Roboflow pothole dataset, comprising varied textures, lighting conditions, and Surface irregularities prevalent in urban and semi-urban environments. A comparative analysis of YOLOv5, YOLOv7, YOLOv8, and YOLOv12 was conducted to evaluate detection accuracy, inference speed, and robustness under domain-specific constraints. YOLOv12 outperformed earlier versions with performance metrics, mAP50, mAP50-90, precision, recall, parameters, and inference time. An extensive comparative analysis is also performed with the vision transformer models and inferred that YOLOv12 is suitable for pothole detection.

This research contributes to the development of intelligent transportation systems by offering a validated, high-performance pothole detection pipeline. Future directions include federated learning across municipal zones and integration with GIS-based maintenance scheduling for proactive infrastructure management in the smart city ecosystem.