

# Review Paper on Monitoring Structural Integrity and Water levels and Advanced Techniques for Crack Detection

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## Abstract

This study presents a unified approach to enhancing infrastructure monitoring and water resource management using advanced digital technologies. The first part focuses on automated pavement crack detection through an ensemble of convolutional neural networks (CNNs) without pooling layers. This method improves spatial accuracy and, combined with structured prediction and probability fusion, delivers high performance in detecting and measuring various crack types. Morphological analysis and skeleton extraction further enable precise crack width and length estimation, validated on benchmark datasets with superior results compared to traditional methods. The second part introduces a digital twin-based platform for dam and watershed management, developed for Korea's Sumjin River basin. The platform integrates high-resolution 3D geospatial modeling using aerial LiDAR and drone photogrammetry with real-time data on dam operations, rainfall, and river conditions. It supports smart decision-making through AI-powered water level prediction, flood simulation, and levee safety evaluation. The platform also incorporates automated drones and AI-driven CCTV monitoring for enhanced surveillance and response. Together, these solutions demonstrate how deep learning and digital twin technologies can modernize civil infrastructure, enabling accurate monitoring, proactive planning, and data-driven decision-making for safer and more sustainable systems.

**Keywords**— Automated pavement crack detection, Deep learning , Ensemble network, Convolutional neural network, Segmentation, Morphological, Dam, River management, Watershed, Water resource.