

Space-borne Monitoring of Transportation Infrastructure: A Decade of Satellite Remote Sensing across Canadian Bridges

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Abstract

Satellite-based interferometric synthetic aperture radar (InSAR) offers a transformative paradigm in structural health monitoring. Delivering millimeter-scale displacement tracking along transportation infrastructure assets over time, spaceborne InSAR enables automated non-intrusive early-warning systems to flag vulnerable assets before critical failures occur.

Beyond subsidence and thermal displacement time series, integrating multispectral satellite imagery provides essential environmental intelligence. Assessing river current dynamics, including flow velocities and localized vortex formations, directly enhances pier scour risk assessments – mitigating one of the primary causes of bridge collapse globally.

Drawing on over a decade of National Research Council Canada (NRC) research partnerships and nationwide case studies – spanning short- and long-span highway and railway bridges monitored via multi-satellite constellations – this contribution provides a comprehensive evaluation of spaceborne remote sensing for critical transportation infrastructure.

This presentation synthesizes real-world operational benefits, technical limitations, and deployment strategies for integrating satellite data into decision-support early-warning monitoring platforms for structural integrity issues and asset performance management. Furthermore, it gives an outlook on emerging AI-driven methods designed to automate data processing workflows, streamline radar data interpretation, and accelerate structural anomaly detection across aging transportation infrastructure.