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Structural Digital Twins of Structures and Infrastructure

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Abstract

The resilience and safety of our mobility network are largely contingent on the structural health of our transportation infrastructure, with bridges often posing as the critical link in the network. The current methods for monitoring structural health are significantly hindered by the absence of a seamless integration between sensor data, structural modeling, and decision-making. Stand-alone data-driven structural modeling based on sensor data often falls short as it doesn't leverage physics-based predictive modeling to correlate local defects to the global health state of the structure. This results in an incomplete understanding of the structural capacity. To address this, a holistic framework is needed to bridge the gap between data-driven methods and physics-based structural modeling. The concept of a Structural Digital Twin serves this purpose by providing a dynamic representation of the structure that integrates sensor data, structural modeling, and predictive analytics for effective decision-making.

This talk will focus on the concept of Structural Digital Twin for Bridge Infrastructures. A Digital Twin of an infrastructure is a living structural simulation that brings all the data and models together, and updates itself from multiple sources to represent its physical counterpart. The Digital Twin, maintained throughout the life cycle of an asset and easily accessible at any time, provides the infrastructure owner with early insight into potential risks to mobility induced by extreme climate events, heavy vehicles, and even aging of an infrastructure. The core technical content will be centered around using physics-informed machine learning to carry out real-time structural simulation of bridges while incorporating sensor data. The talk will conclude with sharing examples of such Digital Twins for bridge infrastructure.