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Ph.D. DISSERTATION DEFENSE

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Location:	Pierce 116
Title:	Multi-scale Multi-modal Monitoring of Structures Using AI-Powered Smart Sensors and Robots
Chairperson:	Prof. Yi Bao, CEOE, Stevens Institute of Technology
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ABSTRACT

Traditional Structural Health Monitoring (SHM) methods rely on periodic visual inspections, point sensors, and manual data analysis, which are time-consuming and hinder real-time monitoring of large-scale infrastructure. This dissertation explores the use of artificial intelligence, machine learning, smart sensors, and computer vision to enable accurate, scalable, and autonomous monitoring at both global and local levels. A multi-modal approach is developed, combining distributed sensors, computer vision, and smart robots powered by machine learning to monitor structural behavior during construction and operation, reducing manual effort. The research is organized into three core themes. First, it investigates Distributed Fiber Optic Sensors (DFOS) for early-age concrete monitoring, focusing on sensor-concrete interaction and thermal-hydration effects. Second, it presents a machine learning framework for detection and prediction of different damage using DFOS data. Third, it introduces a drone-based system for autonomous vibration measurement, using computer vision and deep reinforcement learning for navigation. Together, drones and DFOS support global and localized infrastructure assessment. This work advances SHM through real-time, multi-scale monitoring with intelligent sensing technologies.