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Ph.D. DISSERTATION DEFENSE

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Degree:	Doctor of Philosophy
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Date:	Friday, April 28th, 2023
Time/Location:	10:00 a.m. to 11:30 a.m. / Davidson Lab, Room 235
Title:	Development and applications of distributed fiber optic sensor network for intelligent monitoring of pipelines
Chairperson:	Dr. Yi Bao, Department of Civil, Environmental and Ocean Engineering, School of Engineering and Science, Stevens Institute of Technology
Committee Members:	Dr. Weina Meng, Department of Civil, Environmental and Ocean Engineering, School of Engineering and Science, Stevens Institute of Technology Dr. Ying Huang, Department Civil, Construction and Environmental Engineering, College of Engineering, North Dakota State University Dr. Henry Du, Department of Chemical Engineering and Materials Science, School of Engineering and Science, Stevens Institute of Technology

ABSTRACT

Extensive efforts have been made in inspection of more than 2.8 million miles of energy pipelines in the U.S., but there is lack of research on developing an effective technology to monitor multiple types of anomalies for safety and effective management of pipelines. This dissertation aims to develop a distributed fiber optic sensor (DFOS) network for intelligent monitoring of pipelines, which can simultaneously detect, locate, quantify, and visualize cracks, dent deformation, corrosion, and their interactive effects along pipelines in real time. Specifically, this study focuses on three main research topics: (i) quantifying crack width at multiple scales with an improved accuracy using distributed fiber optic sensor based on optical frequency domain reflectometry and visualizing cracking map on structures before visually-inspectable; (ii) developing an effective and engineer-friendly shape sensing method for complex eccentric buckling shape reconstruction; (iii) quantifying corrosion mass loss as well as visualizing and warning for pipe corrosion severity conditions; and (iv) exploring the interaction of dent deformation and corrosive environments using distributed fiber optic sensors. The dissertation research is conducted through experimental testing and analysis with intelligent algorithms. A distributed sensor network is developed and characterized under individual and interactive anomalies, and advanced algorithms are incorporated for intelligent data analytics. This dissertation study is expected to greatly advance intelligent monitoring of multiple pipeline anomalies using DFOS and effectively improve pipeline safety and management.