Quarterly Progress Report:
Project Number and Title: 1.6 Progressive fault identification and prognosis of railway tracks based on intelligent inference
Research Area: #1 Transportation infrastructure monitoring and assessment for enhanced life
PI: Jiong Tang, Department of Mechanical Engineering, University of Connecticut
Co-PI(s): N/A
Reporting Period: 4/1/2020 – 6/30/2020
Submission Date: 8/26/2020

Overview: (Please answer each question individually)

In this phase of research, we continue improving the multi-objective optimization framework to facilitate damage detection and identification based on piezoelectric admittance measurement. To expedite the identification procedure, we have developed a reinforcement learning based hyper heuristic algorithm. The new approach can rapidly identify various fault scenarios using actual sensor input.

Provide context as to how these activities are helping achieve the overarching goal(s) of the project…

Our goal is to utilize computational intelligence to replace tedious, labor-intense, and error-prone manual inspection by human operators. The research activities accomplished in this phase of research provide enabling elements toward this goal. In particular, we leverage upon reinforcement learning technique, an emerging computational intelligence approach, to realize inverse identification of damage scenario (location and severity), which can fully replace human judgment.

Describe any accomplishments achieved under the project goals…

The major accomplishment in this phase of research is the development of highly efficient damage identification algorithm which can adequately utilize the new piezoelectric admittance sensor to facilitate decision making. Essentially, the piezoelectric sensor combined with the new inverse identification algorithm can conceptually replace the current inspection system that is labor intense and subjective.

Complete the following tables to document the work toward each task and budget (add rows/remove rows as needed, make sure you complete the Overall Project progress row and include all tasks even if they have ended or have not been started)…

Table 1: Task Progress			
Task Number	**Start Date**	**End Date**	**% Complete**
Task 1:	09/2018	03/2020	100%
Task 2:	04/2020	03/2021	40%
Task 3:	03/2021	03/2022	15%
Task 4:	04/2022	09/2023	35%
Overall Project:	*Enter Actual Start*	*Enter Planned/Actual End*	

Table 2: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date***
Information will be provided by the Institution Lead		

Include the date the budget is current to.

Describe any opportunities for training/professional development that have been provided…

This project has involved one M.S. student, Yixin Yao, who carries out the numerical and experimental investigations, and one Ph.D. student, Yang Zhang, who focuses on improving the fault identification and prognosis algorithms. Starting in Fall 2019, 4 undergraduate senior students from UConn Management and Engineering of Manufacturing Program, Alexander Biron, Kelly Quinn, Jason Trieu, and Meghan Palumbo, have been developing an experimental testbed which is partially supported by this project as their senior design project. These involvements provide opportunity for training. In May 2020, the senior design project was successfully completed. The project progress is being communicated with industry collaborator, Sperry Rail Service, which provides another opportunity for training of state-of-the-art knowledge of active materials and advanced signal processing techniques for working professionals.

Describe any activities involving the dissemination of research results (be sure to include outputs, outcomes, and the ways in which the outcomes/outputs have had an impact during the reporting period. Please use the tables below for any Publications and Presentations in addition to the description of any other technology transfer efforts that took place during the reporting period.)… Use the tables below to complete information about conferences, workshops, publications, etc. ***List all other outputs, outcomes, and impacts after the tables*** *(i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings).*

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
Presentation title	Name of event (i.e. TIDC 1st Annual Conference)	i.e. Conference, Symposium, Seminar,		
Structural Damage Identification using Multi-objective Optimization based Inverse Analysis	2020 SPIE Smart Structures & NDE Conference	Conference	Virtual	04/23/2020

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
i.e. Peer-reviewed journal, conference paper, book, policy paper	Publication title	Full citation		I.e. Submitted, accepted, under review
Conference paper	Structural Damage Identification Using Multi-Objective Optimization Based Inverse Analysis	Proceedings of 2020 SPIE Smart Structures & NDE Conference	04/2020	published

Encouraged to add figures that may be useful (especially for the website)…

Insert figures here

Participants and Collaborators:

Use the table below to list all individuals who have worked on the project.

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members			
Individual Name	**Email Address**	**Department**	**Role in Research**
	Email is not included in the external report and is only used for internal purposes.		
Jiong Tang	jiong.tang@uconn.edu	Mechanical Engineering	PI

Use the table below to list all students who have participated in the project during the reporting. (This includes all paid, unpaid, intern, independent study, or any other student that participated in this project.)

Table 6: Student Participants during the reporting period				
Student Name	**Email Address**	**Class**	**Major**	**Role in research**
	Email is not included in the external report and is only used for internal purposes.	(i.e. Junior, Master's Ph.D)		
Yixin Yao		M.S.	Mechanical Engineering	Carry out simulation and experiment
Yang Zhang		Ph.D.	Mechanical Engineering	Carry out inverse identification
Alexander Biron		Senior	MEM	Assist testbed setup
Kelly Quinn		Senior	MEM	Assist testbed setup
Jason Trieu		Senior	MEM	Assist testbed setup
Meghan Palumbo		Senior	MEM	Assist testbed setup

Use the table below to list any students who worked on this project and graduated during this reporting period.

Table 7: Student Graduates			
Student Name	**Role in Research**	**Degree**	**Graduation Date**
N/A			

Use the table below to list organizations have been involved as partners on this project and their contribution to the project.

Table 8: Research Project Collaborators during the reporting period						
Organization	**Location**	**Contribution to the Project**				
		Financial Support	**In-Kind Support**	**Facilities**	**Collaborative Research**	**Personnel Exchanges**
Sperry Rail Service	Shelton, CT		X	X		
Connecticut Manufacturing Simulation Center	Storrs, CT		X	X		

List all other outputs, outcomes, and impacts here (i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings). Please be sure to provide detailed information about each item as with the tables above.

Have other collaborators or contacts been involved? If so, who and how? (This would include collaborations with others within the lead or partner universities; especially interdepartmental or interdisciplinary collaborations.)

Table 9: Other Collaborators			
Collaborator Name and Title	**Contact Information**	**Organization and Department**	**Contribution to Research**
N/A			(i.e. Technical Champion)

Who is the Technical Champion for this project?
Name: Jan Kocur
Title: Director of Engineering
Organization: Sperry Rail Service
Location (City & State): Danbury, CT
Email Address:

Changes:

Discuss any actual or anticipated problems or delays and actions or plans to resolve them…
N/A
Discuss any changes in approach and the reasons for the change…
N/A

Planned Activities:

The next phase of the research will focus on completion of fault diagnosis and then start energy harvesting investigation.