Quarterly Progress and Performance Indicators Report:
Project Number and Title: 1.15 Non-contact intelligent inspection of infrastructure
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: 7/1/2022 – 9/30/2022
Submission Date: 10/8/2022

****IMPORTANT: Please fill out each section fully and reply with N/A for questions/sections with nothing to report. For ease of reporting to the USDOT, please do not remove, or change the order of, any sections/text. You may remove/add each rows in tables as needed. Thank you! *****
The report is due on the last day of the reporting period in .doc format to tidc@maine.edu.

Overview:

In this phase of research, we conduct parametric analysis of non-contact sensing using magneto-mechanical impedance. We have explored comprehensive modeling of the sensor including analytical modeling based on assumed mode method and preliminary finite element analysis. We have further conducted magneto-mechanical impedance assessment with respect to a series of influencing parameters. The major highlights are

- Construction of analytical model as well as formulation of finite element modeling with multi-field coupling;
- Parametric analysis of magneto-mechanical impedance responses under various design parameters;
- Planning of sensory system experimentation and validation.

Meeting the Overarching Goals of the Project:

The research highlights mentioned above benefit the project goals and objectives because

- while the physical principle of the non-contact sensing has been confirmed, the magneto-mechanical impedance magnitude is highly dependent on sensory parameters;
- proper sensory parameter selection will have major influence to system sensitivity and damage identification performance.

Accomplishments:

The accomplishments achieved under the project goals are

- fundamental understanding of sensory parametric influence to measurement performance;
- preliminary understanding of measurement frequency range to facilitate damage identification.

Task, Milestone, and Budget Progress:

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: Title	Start Date	End Date	% Complete
Task 1: Magneto-mechanical sensor modeling	10/1/2021	3/31/2022	100%
Task 2: Sensor design optimization and tuning	4/1/2022	9/30/2022	100%

Task 3: Deep learning neural network establishment	10/1/2022	3/31/2023	0%
Task 4: Network training for decision making	4/1/2023	9/30/2023	0%
Phase 1 Overall	10/1/2021	9/30/2023	50%
Phase 2 Overall	N/A	N/A	N/A
Phase 3 Overall	N/A	N/A	N/A

Table 2: Milestone Progress			
Milestone #: Description	**Corresponding Deliverable**	**Start Date**	**End Date**
Milestone 1: Magneto-mechanical sensor modeling	Sensor model	10/1/2021	3/31/2022
Milestone 2: Sensor design optimization and tuning	Sensor tuning criteria	4/1/2022	9/30/2022
Milestone 3: Deep learning neural network establishment	Neural network training	10/1/2022	3/31/2023
Milestone 4: Network training for decision making	Decision making	4/1/2023	9/30/2023

Table 3: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date (include the date)**
Phase 1: $156,846.10	Enter Phase 1 Full Spend Amount (Federal + Cost Share)	Enter Phase 1 % Spent
Phase 2: N/A	Enter Phase 2 Full Spend Amount (Federal + Cost Share)	Enter Phase 2 % Spent
Phase 3: N/A	Enter Phase 3 Full Spend Amount (Federal + Cost Share)	Enter Phase 3 % Spent

Is your Research Project Applied or Advanced?

☐ **Applied** (*The systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met.)*

☒ **Advanced** *(An intermediate research effort between basic research and applied research. This study bridges basic (study to understand fundamental aspects of phenomena without specific applications in mind) and applied research and includes transformative change rather than incremental advances. The investigation into the use of basic research results to an area of application without a specific problem to resolve.)*

Education and Workforce Development:

Answer the following questions (N/A if there is nothing to report):

1. Did you provide any workforce development or training opportunities to transportation professionals (already in the field)? If so, what was the training? When was it offered? How many people attended? (i.e. The research team provided an in the field training for the SAR technology for 3 maintenance crew members of the MassDOT on 3/31/2021. The members learned how to use the technology and interrupt the data.)
   N/A

2. Did you hold meetings with any transportation industry organizations or DOTs? If so, what was the meeting's purpose? When was it offered? How many people attended? (i.e. The research team held a meeting with MaineDOT to update them on the progress of the research findings and how the findings can be implemented on 3/31/2021. 15 DOT maintenance members were present at the meeting.)
   N/A
3. Did you host/participant in any K-12 education outreach activities? If so, what was the activity? What was the target age/grade level of the participants? How many students/teachers attended? When was the activity held? (i.e. 25 8th graders and 2 teachers visited the concrete lab and created small concrete trinkets like Legos on 3/31/2021. They learned about the different types of fibers that can be used in the concrete.)
   N/A

Technology Transfer:

Complete all of the tables below and provide additional information where requested. Please provide ALL requested information as this is one of the most important sections for reporting to the USDOT. ***ONLY provide information relevant to this reporting period.***

Use the table below to complete information about conference sessions, workshops, webinars, seminars, or other events you led/attended where you shared findings as a result of the work you conducted on this project:

Table 4: Presentations at Conferences, Workshops, Seminars, and Other Events

Type	Title	Citation	Event & Intended Audience	Location	Date(s)
i.e. Conference, Symposium, DOT/AOT presentation, Seminar, etc.	N/A				

Use the table below to report any publications, technical reports, peer-reviewed articles, newspaper articles referencing your work, graduate papers, dissertations, etc. written as a result of the work you conducted on this project. Please list only completed items and exclude work in progress.

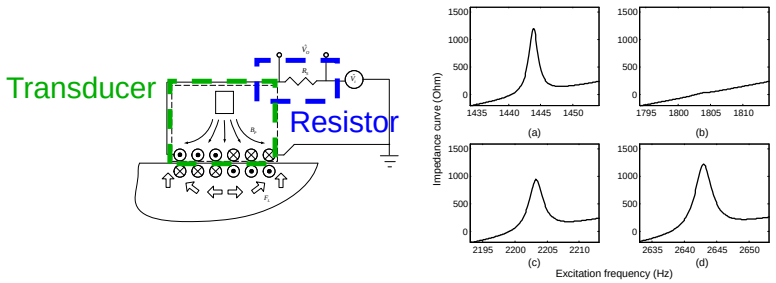
Table 5: Submitted/Accepted Publications, Technical Reports, Theses, Dissertations, Papers, and Reports

Type	Title	Citation	Date	Status
i.e. Peer-reviewed journal, conference paper, book, policy paper, magazine/newspaper article	N/A	N/A		N/A

Answer the following questions (N/A if there is nothing to report):

1. Did you deploy any technology during the reporting period through pilot or demonstration studies as a result of this work? If so, what was the technology? When was it deployed?
   N/A
2. Was any technology adopted by industry or transportation agencies as a result of this work? If so, what was the technology? When was is adopted? Who adopted the technology?
   N/A
3. Did findings from this research project result in changing industry or transportation agency practices, decision making, or policies? If so, what was the change? When was the change implemented? Who adopted the change?
   N/A
4. Were any licenses granted to industry as a result of findings from this work? If so, when? To whom was the license granted?
   N/A
5. Were any patent applications submitted as a result of findings from this research? If so, please provide a copy of the patent application with your report.
   N/A
6. Did industry organizations or DOTs provide cost-share (cash or in-kind) to your research during the reporting period? Who was the organization? Please provide an in-kind support invoice from the organization with your report (this is kept confidential and used for record keeping purposes only).
   N/A

Please add figures/images that can be included on the website and/or in marketing/social media materials to further clarify your research to the general public. This is very important to our Technology Transfer initiatives.



This figure illustrates the basic mechanism of the non-contact sensor as well as the impedance measurement. The modeling of the sensing measurement has been established. Parametric analysis has been conducted to elucidate basic design criteria of the sensory system to acquire impedance measurement for damage identification.

Describe any additional activities involving the dissemination of research results not listed above under the following headings:

Outputs:

Definition: Any new or improved process, practice, technology, software, training aid, or other tangible product resulting from research and development activities. They are used to improve the efficiency, effectiveness, and safety of transportation systems. List any outputs accomplished during this reporting period:

- Parametric analysis of sensory design with respect to measurement performance has been conducted, and optimal design parameters have been preliminarily identified.. A comprehensive plan for experimental validation is in place which allows us to conduct thorough examination of the sensory system.

Outcomes:

Definition: The application of outputs; any changes made to the transportation system, or its regulatory, legislative, or policy framework resulting from research and development activities. List any outcomes accomplished during this reporting period:

- N/A

Impacts:

Definition: The effects of the outcomes on the transportation system such as reduced fatalities, decreased capital or operating costs, community impacts, or environmental benefits. The reported impacts from UTCs are used for the assessment of each UTC and to make a case for Federal funding of research and education by demonstrating the impacts that UTC funding has had on technology and education. NOTE: The U.S. DOT uses this information to assess how the research and education programs (a) improve the operation and safety of the transportation system; (b) increase the body of knowledge and technologies; (c) enlarge the pool of people trained to develop knowledge and utilize technologies; and (d) improves the physical, institutional, and information resources that enable people to have access to training and new technologies. List any outcomes accomplished during this reporting period:

- The new magneto-mechanical impedance sensor can lead to paradigm shift in non-contact sensing and inspection of infrastructure.

Participants and Collaborators:

Use the table below to list individuals (compensated or not) who have worked on the project other than students.

Table 6: Active Principal Investigators, faculty, administrators, and Management Team Members				
Individual Name & Title	**Dates involved**	**Email Address**	**Department**	**Role in Research**
Jiong Tang, Professor	10/1/21-present	jiong.tang@uconn.edu	Mechanical Engineering	PI

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

Table 7: Student Participants during the reporting period								
Student Name	**Start Date**	**End Date**	**Advisor**	**Email Address**	**Level**	**Major**	**Funding Source**	**Role in research**

				Email is not included in the external report and is only used for internal purposes.	(i.e. UG, MS, PhD)		(i.e. TIDC, Other university funds, , unpaid intern, etc.	What work are they conducting? Please be descriptive. Student research assistant is not enough info.
Yang Zhang	10/1/21	present	Jiong Tang		PhD	Mechanical Engineering	TIDC, NASA	Carry out sensor design and inverse analysis
Ting Wang	10/1/21	present	Jiong Tang		PhD	Mechanical Engineering	TIDC, NSF	Carry out energy harvesting and sensor networking analysis

Use the table below to list any students who worked on this project and graduated or received a certificate during this reporting period. Include information about the student's accepted employment during the reporting period (i.e. the student is now working at MaineDOT) or if they are continuing their students through an advanced degree (list the degree and where they are attending).

Table 8: Students who Graduated During the Reporting Period

Student Name	Degree/Certificate Earned	Graduation/Certification Date	Did the student enter the transportation field or continue another degree at your university?
N/A			Please list the organization or degree

Use the table below to list any students that participated in Industrial Internships during the reporting period:

Table 9: Industrial Internships

Student Name	Degree/Certificate Earned	Graduation/Certification Date	Did the student enter the transportation field or continue another degree at your university?
N/A			Please list the organization or degree

*Use the table below to list **organizations** that have been involved as partners on this project and their contribution to the project during the reporting period.*

Table 10: Research Project Collaborators during the reporting period						
Organization	**Location**	**Contribution to the Project**				
		Financial Support	**In-Kind Support**	**Facilities**	**Collaborative Research**	**Personnel Exchanges**
		List the amount	List the amount	Mark with an "x" where appropriate		
CT DOT	Newington, CT				X	

*Use the table below to list **individuals** that have been involved as partners on this project and their contribution to the project during the reporting period. (**List your technical champion(s) in this table.** This also includes collaborations within the lead or partner universities who are not already listed as PIs; especially interdepartmental or interdisciplinary collaborations.)*

Table 11: Other Collaborators				
Collaborator Name and Title	**Contact Information**	**Organization and Department**	**Date(s) Involved**	**Contribution to Research**
Andrew Mroczkowski, Transportation Engineer 3		CT DOT	10/1/2021 - present	Technical champion

Use the following table to list any transportation related course that were taught or led by researchers associated with this research project during the reporting period:

Table 12: Course List						
Course Code	**Course Title**	**Level**	**University**	**Professor**	**Semester**	**# of Students**
ME3220	Mechanical Vibrations	Undergrad	University of Connecticut	Jiong Tang	Spring 2022	89

Changes:

List any actual or anticipated problems or delays and actions or plans to resolve them (list no-cost extension requests here)…
N/A
List any changes in approach and the reasons for the change…
N/A

Planned Activities:

List the activities planned during the next quarter.

- The next phase of research will focus on the experimental acquisition of sensory measurement to establish machine learning framework.