Graduate Opportunities in Safe Transportation and Resilient Systems

GAANN- GOSTARS Fellowship Project

Adviser: Islam M. Mantawy, Ph.D., PE

Title: Machine Learning Based Structural Health Prediction for Infrastructure Systems from Global to Local Structural Responses

Description: Resilience is often defined as the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events. Resilience is assessed using 4R-Methodology including robustness, rapidity, redundancy, and resourcefulness. Machine Learning-based structural health monitoring (ML-SHM) can enhance resilience of infrastructures by reducing impeding factors caused by mobilizing equipment, inspection crew, and onsite structural assessment that may lead to shorter recovery time after an event and provide continuous monitoring of structures for enhanced resourcefulness throughout life. This project aims at developing machine learning models using different techniques to predict the vulnerability of reinforcing bars to fracture. The project will utilize available experimental data from large scale testing of 2-span bridge specimen conducted as part of the Adviser PhD topic. In addition, an experimental program is proposed to test different sizes of reinforcing bars under low cycle fatigue loading to obtain additional data for training/testing of machine learning models.

Impact on GAANN: The study attempts to address a national need to enhance infrastructure resilience by reducing the effects of impeding factors. The success of this project will provide tools for decision-makers to assess the damage level in infrastructure systems in global and local domains solely from data obtained from the global response of the systems which can be obtained from wireless sensors. In addition, this project will provide an opportunity for interdisciplinary research from civil engineering to computer science to sensor technologies.

Impact on GOSTAR: This proposed GAANN project prepares a graduate student to be able to develop machine learning techniques for structural health prediction. The graduate student will also be able to utilize available testing data and perform experimental work to acquire additional data to support the development of machine learning techniques. This interdisciplinary research will provide a unique opportunity to the graduate student to develop scales across different areas such as structural engineering, earthquake engineering, fatigue and fracture, machine learning (ML), artificial intelligence (AI), and sensor technologies. The graduate student will be ready to join different industries, academia or even tech companies.

Tentative Plan

Semester	**1**	**2**	**3**	**4**	**5**	**9**	**7**	**8**	**9**
Task 1: Literature Search	✓	✓							
Task 2: Development of preliminary machine learning techniques from available dataset		✓	✓	✓					
Task 3: Experimental program for reinforcing bars				✓	✓	✓			
Task 4: Refining the developed models in Task 2						✓	✓	✓	
Task 5: Final Deliverables								✓	✓
Outcome	Learning and developing ML models using different techniques and networks			Development of experimental program to collect data to test the accuracy of ML models			Testing the robustness of the developed ML models		
Deliverable	Publish in refereed conference proceedings and journals			Publish in refereed conference proceedings and journals			Publish in refereed conference proceedings, journals, and final report.		
Graduation									**Summer 2025**