

Course 103:

Theory, Experiments & Applications for Structure Monitoring & Machine Learning – Design, Build & Analyze Real Data Using Low Cost Sensors

Sunday, February 11, 2018 | 1:00 p.m.–5:00 p.m.

Course Description

Structural health monitoring (SHM) has been receiving significant attention in the community as a means to quantify the different levels of performance and safety of structural systems. One of the core of SHM systems are the data acquisition systems that enable collecting data of interest for designers, managers, and decision makers. Data acquisition systems are expensive and in general complex to be operated by inspection personnel who were not trained to use them before. The implementation of monitoring could become accessible and affordable if the sensing monitoring were “groomed” by those beginners who have not run DAQ or build sensors before. If owners of infrastructure can build their own sensors on their own desk, then they will become familiar with the technology and willing to implement more advanced systems. Once the sensor is built and used, the value of machine learning from that data becomes tangible. This course will present advantages of using low-cost data acquisition platforms to measure simple responses of structures and algorithms to identify changes on damage and performance using quantitative data analysis. The students will design, build, and test a low-cost sensor that combines low-cost microcontrollers, tilt-meters, and accelerometers. The data collected can be analyzed, clustered, and intelligently classified using fundamental exposure to machine learning protocols and definitions

Course Objective

Structural health monitoring (SHM), embedded sensing, remote sensing, data processing for structural performance assessment, data clustering, off-the-shelf sensing technology, and experimental dynamics hands-on exposure.

Who Should Attend

First or second year graduate students who want to learn about sensors, data acquisition systems, signal processing, and machine learning, and want to become familiar with experimental processes related to structure monitoring. Engineers, researchers and graduate students who deal with structural design, inspection, and assessment and want to become familiar with using vibration measurements using lowcost sensing technologies and quantitative data post-processing.

Course Fee/Cancellation

The regular fee is \$500 and the student fee is \$250. Course fee includes course handout material and refreshment breaks. Lodging, additional food and other materials are not included. If the course is cancelled for any reason, the Society for Experimental Mechanics' liability is limited to the return of the course fees.

Course Outline

Theory: Structural Health Monitoring

- Theory of cyber physical systems
- Maintenance, repair, replacements
- Consequence-based decisions: Structural performance
- Machine learning approaches for data quantification and understanding

Experiment: Off-the-shelf Sensing Assemblage

- Off-the-shelf micro-controllers
- Commercial DAQ
- Comparison of both systems
- Components descriptions
- Hardware assemblage
- Software assemblage
- Testing and validation

Applications: Structure Monitoring/Characterization

- Topic 1: shake table test for structure characterization
- Topic 2: human-induced floor vibration monitoring

Conclusions

- Industry applicationFuture work: wireless, battery, solar panels, robust learning, prognostic
- Survey and feedback

Instructor(s):

Haeyoung Noh—Carnegie Mellon University

Anders has Hae Young Noh is an Assistant Professor in the Department of Civil and Environmental Engineering with a courtesy appointment in the Electrical and Computer Engineering at Carnegie Mellon University. Noh's research interests focus on indirect sensing to infer information about dynamic structural systems using statistical signal processing and machine learning techniques, particularly algorithm development for smart structures and systems to conserve energy and resources, provide safe, functional, and sustainable environments, and improve occupant's quality of life.

Fernando Moreu, PE—University of New Mexico

Dr. Moreu is currently an Assistant Professor at the Department of Civil Engineering at the University of New Mexico. Dr. Moreu's main research interests include structural health monitoring, performance assessment and quantification, and structural dynamics of civil structures; remote sensing; and structural optimization using consequence-based structural dynamics. He has eleven years of experience in the design, construction and replacement of bridges in the US. His research is funded by the National Academy of Sciences, USDOT, NASA, New Mexico Consortium, and Los Alamos County.