Fatigue Monitoring, Diagnosis and Prognosis of Fracture Critical Structures

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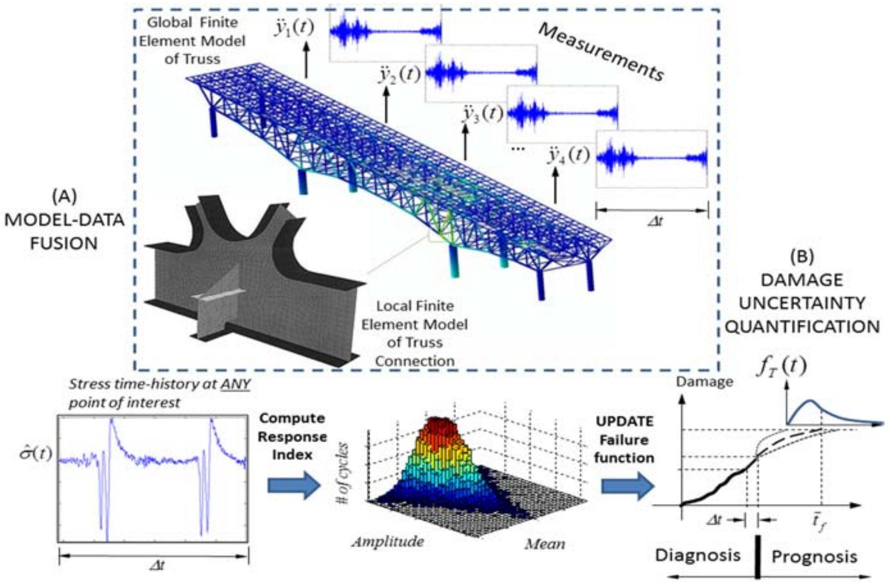
ABSTRACT



Traditional vibration-based structural health monitoring rests upon the following assumptions: (i) "damage" is related to loss of stiffness, (ii) "damage" will produce a change in the identified dynamic characteristics of the structure with respect to the "undamaged" state. Recent research has shown that for fracture critical structures the traditional approach to SHM is not adequate, especially for those structures susceptible to cumulative damage such as fatigue. In this presentation Dr. Hernandez proposes an approach to SHM of fracture critical structures based on *Multiscale Model-Data Fusion*.

The three components of the proposed framework are: (A) Multi-scale model-data fusion, (B) Damage uncertainty quantification and (C) Damage Prognosis. *Model-Data Fusion* is the process of recursively and optimally combining measured data of system's response with a model of that system to obtain an estimate of the trajectory of the system's state. Once the state of the system is estimated, all other response quantities such as stress, strain and their resultants can be reconstructed at all locations consistent with the model. *Multiscale Modeling* refers to the modeling approach that relies of various models to represent the behavior of a system at different scales. In the case of fatigue damage, the global structural behavior ($\mathcal{O}$ *meters*) is linear and can be considered loosely coupled from the local nonlinear fatigue damage that occurs at the finer scales ($\mathcal{O}$ *milimeters*). In the proposed approach multiple models are used to perform the assessment and prognosis, each model interacts with the others with a finite number of variables, typically much less than the necessary to perform a complete coupling between them. *Uncertainty Quantification* is necessary due to the inherent uncertainty that is present in fatigue damage models and stress estimation. The proposed framework is illustrated in the context of simulations and experimental laboratory results.

Speaker Bio

Dr. Eric Hernandez is an assistant professor in the College of Engineering and Mathematical Sciences at the University of Vermont. He holds a PhD is Civil Engineering from Northeastern University. He is particularly interested in discovering new ideas for solving large scale inverse problems under uncertainty and their application to the reliability analysis of operational and instrumented structural systems. Areas of expertise include direct and inverse problems in structural dynamics, structural health monitoring, reliability analysis and uncertainty quantification and propagation. His research has been funded by the National Science foundation and the Vermont Agency of Transportation. In 2015 Prof. Hernandez was awarded an NSF CAREER Award titled: "Structural Health Monitoring, Diagnosis and Prognosis of Minimally Instrumented Structural Systems". Prior tom joining academia, Dr. Hernandez practiced structural engineering in the United States and abroad. His experience spans seismic analysis and design of nuclear infrastructure systems, buildings, bridges and other structures. For more information visit www.uvm.edu/cems/smdp/