SEMINAR SERIES

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Data-driven Nonlinear System Identification, Physics-based Reduced-order Modeling, and Vibration of Mechanical Structures

Featuring Dr. Lucas Timmins

University of Utah

Friday, Feb. 11 | 12:00 - 1:15 pm | H&K 112

PRESENTATION ABSTRACT

An EQ-4B Global Hawk, one of the United States' most advanced and expensive unmanned aerial vehicles, lost stability and crashed in 2011 because a single screw loosened. In 2016, a Union Pacific train derailed in Mosier, Oregon due to a single loose bolt. It released 42,000 gallons of crude oil into the local environment. These two events (and many others) highlight our lack of knowledge pertaining to the long-term evolution of nonlinearities and their effect on the structure's health and dynamics. This talk will cover some of our recent progress in trying to understand the dynamics of strongly nonlinear structures through nonlinear system identification and physics-based reduced order modeling. This task necessitates the synergistic implementation of diverse theoretical, computational, and experimental techniques, such as nonlinear normal modes, wavelet transforms, and experimental modal analysis. The first portion introduces a new methodology for identifying the dynamics of strongly nonlinear, local attachments (i.e., nonlinear vibration absorbers) directly from experimental measurements. As an example, the methodology is applied to identify a mathematical model for a vibration absorber with a clearance nonlinearity installed on a model fighter jet wing. Second, we introduce a physics-based reduced-order model (ROM) for the dynamics of bolted joint loosening with an application to an axially aligned threaded joint undergoing shock excitation. The final portion presents a novel two-dimensional nonlinear vibration absorber designed to mitigate motion in NextGen commercial aircraft with ultra-high-aspect-ratio wings.

ABOUT DR. MOORE

Keegan J. Moore is an Assistant Professor in Mechanical and Materials Engineering at the University of Nebraska-Lincoln where he leads the Moore Dynamics and Analytics Laboratory (MoDAL). He received his Ph.D. from the University of Illinois in 2018 and his B.Sc. From the University of Akron in 2014. He is an expert in nonlinear dynamics and vibrations and his research lies at identification methods, non-reciprocity and energy guiding in nonlinear structures, the mechanics of loosening of bolts, autonomous vibration testing, and autonomous model updating. He is a recipient of the 2022 AFOSR Young Investigator Award.

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