Active Structural Damage-Identification of Time-Varying Rotordynamic Systems

Seminar Presentation by

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ABSTRACT

Structural health monitoring and damage identification of rotating structures is a key technology for enhancing safety and reliability in many critical engineering systems. For non-rotating systems, strategies based on monitoring changes in a structure's modal characteristics are attractive due to their non-destructive nature and ability to assess global structural health from limited sensor information. The current evolution of vibration based damage identification approaches largely depend on classical Eigenvector decomposition, where it is presumed that the measured response spectrum has a time invariant correspondence with the true natural frequencies of the structure. One important class of systems where this relationship does not necessarily hold is for periodically time varying dynamical systems. Prime examples are rotordynamic structures, such as gear systems, shafts, propellers and bladed-disks. This more complex, time varying, spectral behavior poses significant challenges for damage estimation where suitable inverse relations must be found to relate measured spectral changes to the structural system parameters. This research explores and new methods based on generalized time-varying modal decomposition and Floquet multiplier damage sensitivity paradigms which are rigorously suited for time-varying dynamical systems. These new formulations enable estimation of the severity and location of structural damages in systems with inherently time-varying dynamical behavior directly from measured vibration data. For rotordynamic systems equipped force actuators, new, actively enhanced, damage estimation strategies based on Floquet Eigenvector assignment and periodic feedback control are developed. It is shown that damage identification under multiple control tunings with active spatio-temporal stiffness variations, effectively enriches the data set and compensates for limited sensor information and enables increased damage resolution in rotating systems.

BIOSKETCH

Dr. Hans DeSmidt is currently assistant professor of aerospace engineering at the University of Tennessee. He received his B.S. degree in Engineering Science and Mechanics from Virginia Tech in 1996. He then went on to pursue graduate studies at Penn-State University where he received his M.S. and Ph.D. degrees in Mechanical Engineering in 2005. Here he was under advisement of Professors Kon-Well Wang and Edward Smith. During this time he was a NASA GSRP fellow in the Penn State Rotorcraft Center of Excellence where he conducted research in areas of structural dynamics and vibration control and where he completed his Ph.D. thesis "*Robust-Adaptive Active Vibration Control of Alloy and Flexible Matrix Composite Rotorcraft Drivelines via Magnetic Bearings: Theory and Experiment*". Prior to joining UT, Dr. DeSmidt was also postdoctoral research fellow in the Penn State Structural Dynamics and Controls Lab where he conduced NASA-JPL sponsored research in the area of deployable space structures. In August 2005, He joined the University of Tennessee where his active research thrusts are in areas of structural dynamics, vibration control, health monitoring and nonlinear rotordynamics. In 2008 Dr. DeSmidt received an NSF

CAREER award on the topic of vibration based damage identification of time-varying structures. He is also conducing NASA sponsored research on the topic of variable speed rotorcraft drive-system dynamics. Furthermore, in 2009 he received an NSF award to explore nonlinear automatic balancing of flexible rotors and bladed-disk structures. He is also an active member of ASME and AIAA where he has published and presented 14 conference papers and 7 journal papers with additional under peer review.