ME Seminar

Applying Characteristic Value Decomposition in Modal Identification and Nonlinear Model Order Reduction

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ABSTRACT

Data-driven modal identification and reduced-order modeling (ROM) are increasingly of interest in nonlinear dynamics research. This work introduces a generalized characteristic value decomposition (GCVD) framework to address challenges in physical interpretation and data availability. GCVD unifies various output-only data-driven modal analysis methods, revealing them as special cases under specific data matrix selections. It delivers enhanced accuracy and noise robustness compared to traditional techniques. By decoupling the characterization of dynamics from ROM considerations, the GCVD-based ROM approach offers versatility, enabling ROMs to replicate full-scale dynamics across parameter spaces with just one training dataset. Additionally, a computational framework for continuation and bifurcation analysis using linear projection-based ROMs is presented, supporting rigorous validation of ROM fidelity in capturing the complexity of the approach; the framework is applied to the discretized von Kármán beam and shallow arch partial differential equations. These examples highlight the capability of the GCVD-based ROM strategy to handle complex scenarios involving modal coupling, multiple time scales, and internal resonances, demonstrating its robustness and versatility in nonlinear dynamic systems analysis.

ABOUT THE SPEAKER

Dr. David Chelidze is a professor of mechanical engineering at the University of Rhode Island, where he directs the Nonlinear Dynamics Laboratory. He obtained his Ph.D. in Engineering Science and Mechanics from the Pennsylvania State University. He is a recipient of the NSF CAREER award and the Edmund and Dorothy Marshall Award for Faculty Excellence in Research.

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