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Model Development and Control Design for High Performance Nonlinear Smart Material Systems

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Abstract

High performance transducers utilizing piezoceramic, electrostrictive, magnetostrictive or shape memory elements offer novel control capabilities in applications ranging from flow control to precision placement for nanoconstruction. To achieve the full potential of these materials, however, models, numerical methods and control designs which accommodate the constitutive nonlinearities and hysteresis inherent to the compounds must be employed. Furthermore, it is advantageous to consider material characterization, model development, numerical approximation, and control design in concert to fully exploit the novel sensor and actuator capabilities of these materials in coupled systems.

In this presentation, the speaker will discuss recent advances in the development of model-based control strategies for high performance smart material systems. The presentation will focus on the development of unified nonlinear hysteresis models, inverse compensators, reduced-order approximation techniques, and nonlinear control strategies for high precision or high drive regimes. The range for which linear models and control methods are applicable will also be outlined. Examples will be drawn from problems arising in structural acoustics, high speed milling, deformable mirror design, artificial muscle development, tendon design to minimize earthquake damage, and atomic force microscopy.