

Model-Based Tracking Control for Real-Time Hybrid Simulation
with application to seismic protection using magnetorheological fluid dampers

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Abstract:

Substructure hybrid simulation is a powerful, cost-effective alternative for seismic testing of structural systems, closely coupling numerical simulation and experimental testing to obtain the complete response of a structure. In this approach, well-understood components of the structure are modeled numerically, while the components of interest are tested physically. Generally, an arbitrary amount of time may be used to calculate and apply displacements at each step of the hybrid simulation. However, when the rate dependent behavior of the physical specimen is important, real-time hybrid simulation (RTHS) must be employed. Computation, communication, and servo-hydraulic actuator limitations cause delays and lags which lead to inaccuracies and potential instabilities in RTHS. This presentation proposes a new model-based servo-hydraulic tracking control method including feedforward-feedback links to achieve accurate tracking of the desired displacement in real-time. The efficacy of the proposed approach is demonstrated through RTHS of a seismically excited nine-story steel building employing a 200 kN large-scale magnetorheological (MR) damper as the rate-dependent physical specimen.

Brief Bio:

B.F. Spencer, Jr. received his Ph.D. in theoretical and applied mechanics from the University of Illinois at Urbana-Champaign in 1985. He worked on the faculty at the University of Notre Dame for 17 years before returning to the University of Illinois at Urbana-Champaign, where he currently holds the Nathan M. and Anne M. Newmark Endowed Chair in Civil Engineering and is the Director of the Newmark Structural Engineering Laboratory. His research has been primarily in the areas of smart structures, stochastic fatigue, stochastic computational mechanics, and natural hazard mitigation. He is a Foreign Member of the Polish Academy of Sciences, a Fellow of ASCE, the North American Editor in Chief of Smart Structures and Systems, and the past-president of the Asia-Pacific Network of Centers for Research in Smart Structures Technology.

