Recent Developments On Robust Adaptive Compensation For Real-Time Hybrid Simulation

Gaston FERMANDOIS, Cristobal GALMEZ

Real-time hybrid simulation (RTHS) is a reliable and cost-effective experimental technique for structural performance assessment. One of the critical aspects of RTHS is the design of stable and accurate control algorithms to satisfy synchronization between numerical and experimental substructures. Dynamic compensation techniques have been proposed in the literature, and recently methods based on adaptive control have gained further traction. Regardless, it is known that adaptive control does not offer robustness guarantees under certain unfavorable conditions such as model uncertainty and noisy signals. Therefore, this study explores recent developments in robust adaptive compensation for RTHS testing. We propose a robust offline calibration approach for adaptive model-based compensation of single and multi-axial RTHS setups with unknown specimen-actuator interaction. The main idea is that compensators designed independently from the specimen interaction can avoid initial identification tests that may cause premature damage to the physical specimens before the actual RTHS test. Then, through adaptation during the actual test, the experimental dynamics and interaction is captured, and the control parameters of the loading system are updated in real-time. The adaptation capacity allows maintaining excellent compensation against uncertainty in the experimental substructure properties, providing robustness to the experimental setup. A small-scale shake table RTHS test is performed to validate this methodology experimentally with a set of varying structural properties to simulate specimen uncertainty.