Adaptive multi-rate interface: development and experimental verification for real-time hybrid simulation - DTU Orbit (12/10/2019)

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Real-time hybrid simulation (RTHS) is a powerful cyber-physical technique that is a relatively cost-effective method to perform global/local system evaluation of structural systems. A major factor that determines the ability of an RTHS to represent true system-level behavior is the fidelity of the numerical substructure. While the use of higher-order models increases fidelity of the simulation, it also increases the demand for computational resources. Because RTHS is executed at real-time, in a conventional RTHS configuration, this increase in computational resources may limit the achievable sampling frequencies and/or introduce delays that can degrade its stability and performance. In this study, the Adaptive Multi-rate Interface rate-transitioning and compensation technique is developed to enable the use of more complex numerical models. Such a multi-rate RTHS is strictly executed at real-time, although it employs different time steps in the numerical and the physical substructures while including rate-transitioning to link the components appropriately. Typically, a higher-order numerical substructure model is solved at larger time intervals, and is coupled with a physical substructure that is driven at smaller time intervals for actuator control purposes. Through a series of simulations, the performance of the AMRI and several existing approaches for multi-rate RTHS is compared. It is noted that compared with existing methods, AMRI leads to a smaller error, especially at higher ratios of sampling frequency between the numerical and physical substructures and for input signals with high-frequency content. Further, it does not induce signal chattering at the coupling frequency. The effectiveness of AMRI is also verified experimentally.

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