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Methods for the Real-Time and Hybrid Co-Simulation of Multibody System Dynamics Applications

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Abstract

Co-simulation is a flexible and effective approach to extend the capabilities of multibody system dynamics software. It can be used to provide the ability to consider multiphysics effects, such as hydraulics, electronics, or thermal phenomena, during the dynamics simulation of a mechanical system; it also provides a means to distribute the computational load associated with large problems between several processing units, and to adjust the selection and configuration of solver tools to the particular characteristics of each subdomain under study. Co-simulation requires the careful coordination of the execution of the different solvers to prevent inaccurate and unstable behaviour, especially when iterative coupling schemes cannot be used. This is often the case of real-time and hybrid co-simulation applications, in which at least one subsystem in the co-simulation environment is a physical, real-world component. Indeed, Human/Hardware-in-the-Loop (HiL) applications such as haptics and cyber-physical systems can be considered instances of hybrid co-simulation setups; cyber-physical benches for the testing of automotive components are a representative example. Depending on factors such as the information that is available to the co-simulation manager, several approaches can be adopted to solve the issues derived from the discrete-time exchange of data at the interface between the subsystems. We provide here an overview of these approaches, and discuss their suitability for their use in practical real-time environments.