Adaptive Co-simulation Framework Exploiting System Physics of Mechatronic Systems

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ABSTRACT

Modelling and simulation of mechatronic systems require a multi-domain approach as several physical domains interact with each other. Besides the difference in inherent physical behavior over the different subsystems of the modelled drivetrain, the modelling formalism can also differ depending on the purpose of the simulation and the required level of detail. Some parts of the system require a distributed parameter description if an accurate geometrical representation is of paramount importance whereas for others an approximate lumped parameter description suffices. Due to this heterogeneity, each subsystem respectively can benefit from a dedicated integration strategy. As the modelling engineer is up to some extent aware of the time scale of the physics of each subsystem, this information can be exploited in a co-simulation scheme by having a multi-rate integration approach. Co-simulation, which is a set of simulations computed by different solvers and coupled through a master integrator, is a technique to enables each system to be solved by its own integrator and communicate the inputs and outputs between subsystems. To facilitate this process, the Functional Mock-up Interface (FMI) initiated by Daimler AG is set forward as a general standard to set up such a co-simulation framework [1]. Although the tool is very powerful to interface between different platforms, it does not offer the freedom and versatility to set up multiple co-simulation interfaces and concurrently allow us to research various different strategies in a flexible way to set-up such an optimized simulation for an integration perspective. For this reason, the author leveraged upon the Simcenter Amesim architecture to set-up an approach for co-simulation to investigate several strategies with the application of combining flexible multibody descriptions in a lumped parameter framework. The focus of this work is more on the exploitation of the a priori knowledge of the system dynamics of each subsystem rather than the mathematical derivation of stability criteria and computational efficiency. The co-simulation framework and its demonstration on an NREL wind turbine is presented in this work [2]. The orchestration of the data exchange between subsystems is done by an adaptive algorithm to input extrapolation errors and state integration errors. A critical analysis of different interfacing choices is presented.

REFERENCES

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