Fast Model-order Reduction for Mechatronic Systems

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We present recent advances in the mixed symbolic and numeric model reduction techniques for automatically extracting the dominant system behavior of multiphysical systems. A unique feature of our approach is to compute approximated symbolic formulas for linear and nonlinear system characteristics, rigorously reducing the complexity of symbolic expressions while controlling a user-given error bound. Yielding a symbolic description in terms of crucial design parameters we handle problems not feasible using purely numeric methods. We improved our established methods for extensively analyzing industrial-sized systems and extended insights into their behavior.
Our results contributed to *Analog Insydes 2012* [1], our recent Mathematica toolbox for modeling, analysis, and design of analog systems, tailored specifically for industrial applications. Originating from electronic circuits design our approach had been extended for analyzing and modeling of mechatronic systems [2]. We will introduce an updated model library for basic mechanical components and an add-on package for Analog Insydes which allows for seamlessly integrating mechanical and electronic components.
Furthermore, we present two extended techniques supporting the fast and robust model order reduction of [3, 4]. On the one hand, we improved our model export techniques for generating reduced behavioral models. This supports hardware description languages like VHDL, Verilog-A, and Cadence Spectre's Compiled Model Interface (CMI). Here the new concept of test benches for a device under testing (DUT) allows for validating subcomponent models in multiple setups. This guarantees wide applicability of the reduced model.
On the other hand, we simplified the support of sequential equation structures. To improve performance and stability this feature is utilizing structural information encoded by a special equation setup. It reduces the system complexity of coupled systems without any loss in the model accuracy. Thus, a more efficient numeric evaluation significantly accelerates solving and simulating. Additionally, the compact symbolic formulation contributes to the computational robustness such that large industrial-sized systems can be simulated. While this had been tied to Analog Insydes' built-in device models now you can instantly apply our improved procedures to custom models without further knowledge of the sequential syntax.
The proposed improvements accelerate the overall design process and contributes significantly to the optimization of analog circuits and mechatronic systems.

References

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