Relative Consistency and Robust Stability Measures for Sequential Co-simulation

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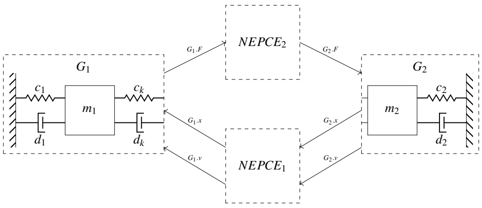
The paper introduces a matrix co-simulation model for the purpose of evaluating co-simulation masters. It assumes that co-simulation slaves solve a linear time invariant differential equations using general linear methods. Any non-linear systems providing the Jacobian matrix are covered by presented methods. The co-simulation is orchestrated by a sequential master with linear extrapolation elements. An example of such a system is illustrated in Figure 1.



$$\sigma_{12}(r) = \begin{cases} 1, & r = 1 \\ 2, & r = 2 \end{cases}$$

$$\sigma_{21}(r) = \begin{cases} 2, & r = 1 \\ 1, & r = 2 \end{cases}$$

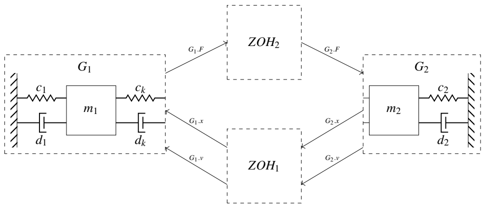


Figure 1. The paper presents the example of tuning the co-simulation master for a simple two-mass oscillator system. There is a choice between two extrapolation methods, namely *NEPCE* and *ZOH*, and two different calling sequences of co-simulation slaves.

The developed co-simulation model is used for the calculation of relative consistency and robust stability. A co-simulation master with a better consistency is shown to have a smaller co-simulation error. In addition, it is shown how a robust stability measurement based on spectral radius can be used to measure robustness to slave parameter changes. In order to utilize the calculation both objectives can be plotted with respect to the co-simulation step size (Figure 2). The plot allows a visual comparison of co-simulation masters. The paper proposes multi-objective optimization in order to automate the manual work. Such a procedure enables the choice of a co-simulation master prior to the co-simulation run.

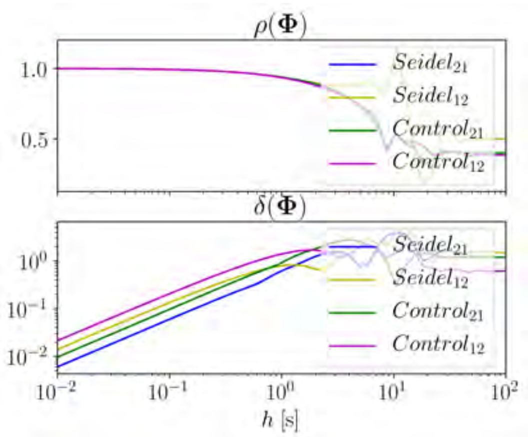


Figure 2. The relative consistency and the robust stability calculation can be used to evaluate the co-simulation step size.