Index-2 Co-Simulation Approach for Solver Coupling with Algebraic Constraints

D. Lu, P. Li, B. Schweizer

Institute of Applied Dynamics
Technical University of Darmstadt
64287 Darmstadt, Germany
e-mail: lu@sds.tu-darmstadt.de

Abstract
The coupling of two mechanical models in time domain by means of a co-simulation approach [1] is topic of this paper. We consider the case that two mechanical subsystems are coupled by holonomic algebraic constraint equations. Concretely, body *i* (center of mass S_i) of subsystem 1 is coupled to body *j* (center of mass S_j) of subsystem 2 by means of an arbitrary rigid joint. The coupling points are denoted by C_i and C_j, see Figure 1.

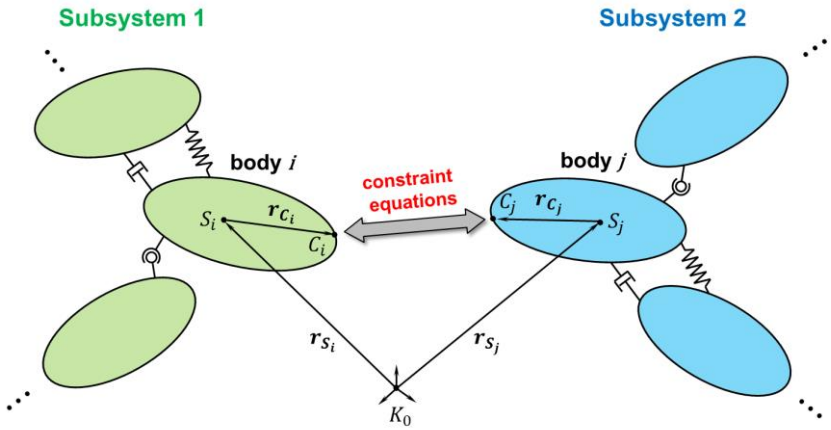

Figure 1: Two subsystems coupled by constraint equations.

In order to stabilize the co-simulation, constraints on position and velocity level are both taken into account [2], which results in an index-2 co-simulation method. The proposed approach is based on a semi-implicit coupling technique (predictor/corrector approach) [3]. For the co-simulation, a macro-time grid has to be specified. In the framework of this paper, an equidistant communication-time grid is used. The method may, however, also be applied for non-equidistant macro-time grids. Between the macro-time points, the subsystems integrate independently from each other. Therefore, the coupling variables have to be approximated in every macro-time step. Here, constant approximation is applied. Different test problems are discussed, which illustrate the practical application of the proposed method. Furthermore, stability and convergence plots are presented.

References

[1] C.W. Gear, D.R. Wells. Multirate linear multistep methods. BIT 24, pp. 484-502, 1984.

[2] C.W. Gear, G.K. Gupta, B.J. Leimkuhler. Automatic integration of the Euler-Lagrange equations with constraints. J. Comp. Appl. Math., 12&13, pp. 77-90, 1985.

[3] B. Schweizer, D. Lu. Predictor/Corrector Co-Simulation Approaches for Solver Coupling with Algebraic Constraints. ZAMM - Journal of Applied Mathematics and Mechanics, DOI 10.1002/zamm.201300191, 2014.