Influence of spatial discretization of flexible structures on the stability of coupled simulations

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In advanced system simulation, the numerical simulation of several coupled subsystems, i.e. the co-simulation, becomes more and more important. Especially, the simulation of kinematically coupled subsystems is widespread, e.g. in automotive engineering.
Recently, we developed a new approach, which kinematically couples mechanical subsystems in an efficient and robust way. In our approach, we use algebraic coupling constraints to formulate a force-displacement coupling and, thus, we do not introduce an artificial coupling stiffness into the system. Moreover, the algebraic constraints allow very general coupling joints, leading to a wide range of possible applications for the approach.
Our main application is the coupled simulation of rigid multibody systems and flexible structures. In general, the flexible structure is described mathematically as partial differential equation and is transformed into an ordinary differential equation via spatial discretization. Consequently, we analyze how the spatial discretization of the flexible structure influences the stability of our co-simulation approach. We will see that a subsystem mass ratio is decisive for stable co-simulation and can be improved by refining the discretization.
To illustrate the presented coupling approach, we first apply our method and the stability considerations on a test problem. Afterwards, to show the potential of the new approach, a complex nonlinear cable model is coupled with a multibody system.