Sensitivity Analysis for Multibody Dynamics Using Spatial Operators

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Multibody systems consist of rigid and elastic bodies whose relative motions are constrained by hinges between the bodies. Examples of such systems include spacecraft, robots, vehicles, mechanisms, molecular systems and others. Sensitivities of various multibody dynamics quantities are often required as a part of multibody computational problems involving implicit ODE solvers, numerical iteration techniques, linearized dynamics etc. Examples include the sensitivities of the system Jacobian matrix, the mass matrix, Coriolis terms, the mass matrix inverse etc. In view of the complexity of the equations of motion, the computation of such sensitivity terms has traditionally been regarded as a formidable task. In this talk we describe the use of spatial operators to develop concise analytical expressions for some of these sensitivity quantities, and follow on with a description of efficient algorithms for their computation. These spatial operators provide a way to make such sensitivity computations analytically and numerically tractable. Spatial operators were introduced in the *Spatial Operator Algebra (SOA)* mathematical framework for the analysis of the dynamics of multibody mechanical systems as well as for the development of fast computational algorithms. The talk will include a background discussion of the SOA.