Semi-analytical methods for singularly perturbed multibody system models

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Multibody system models with either small masses or large stiffness terms will be considered. Both problems are known to cause high computation time due to high frequency oscillations. A method to integrate such problems is motivated by results from singular perturbation theory which relate the solution of the ODE

$$\dot{u} = f(u, v), \qquad \varepsilon \dot{v} = g(u, v)$$

with a small parameter $\varepsilon > 0$ to the solution of the DAE

$$\dot{u}_0 = f(u_0, v_0), \qquad 0 = g(u_0, v_0).$$

But most theorems in the literature are restricted to unconstrained problems with diagonal mass matrices and bounded stiffness terms. We extend this approach to non-diagonal matrices and investigate scaling for large stiffness terms in flexible multibody systems taking into account the structure of second order equations. Furthermore, the extension to problems with constraints is presented. The computational saving is illustrated by examples.