Hydrodynamic force elements: A PDAE approach

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The simulation of mechanical systems results often in multi-component phenomena with different time scales or different solution strategies which influence each others problem characteristics. In our case we have a flexible multibody system coupled with special force elements. The modelling of elastohydrodynamic bearings in combustion engines leads to a coupled system of partial differential algebraic equations, which is represented by a flexible multibody system model of crankshaft and bearing and by the Reynolds equation that describes the non-linear effects in the fluid film. The hydrodynamic forces depend strongly on the position and the elastic deformation of crankshaft and bearing shell. Therefore a fine spatial discretisation is needed.
The influence of the spatial discretisation on accuracy and numerical effort will be discussed. Since a fine one substantially slows down the numerical solution, we propose an asymptotic analysis with methods from singular perturbation theory to speed-up time integration. The interplay of this semi-analytical approach with index reduction techniques for the multibody part is studied for the fourbar test problem.
Numerical tests for a realistic benchmark problem illustrate the advantages of this approach.