Optimal Control of Delay-Differential Algebraic Equations

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Optimal control problems arise in many application fields, especially in the area of mechanical engineering, e.g., for the derivation of test-rig loads, in trajectory planning for robots or in flight path optimization. The dynamical systems considered in these areas are often rigid or flexible multibody systems, possibly extended by models of other mechatronical devices. The mathematical description of these models is typically in terms of differential-algebraic equations (DAEs), whence, one is faced with optimal control problems involving DAEs.
In addition, due to modelling effects, *delay terms* may appear in the DAE description. That is, the state and control variables have to be evaluated not only at the current time, but also at delayed (also retarded) instances of time. Accordingly, optimal control problems for delay-DAEs have to be considered. In this talk, we present a corresponding optimal control formulation. We derive necessary optimality conditions for optimal control problems with index-2 delay-DAEs. To this end, a solution-operator is introduced that maps control functions to the corresponding delay-DAE solution. Continuity and Fréchet-differentiability of the solution operator are proved.
We illustrate our results with an academic example from vehicle engineering.