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High Order Integration and Sensitivity Analysis of Differential Algebraic Equations using Differential Algebra

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Abstract. Under certain conditions, the solution of differential algebraic equations can be expanded in Taylor series in the independent variable. In these cases, good approximations of the solution can be obtained by computing the respective Taylor expansions. A solver is presented in this work which makes use of differential algebra to address the computation of the Taylor expansions. In particular, based on the consideration that it is often possible to transform a given system of differential algebraic equations into an equivalent system of implicit ordinary differential equations, differential algebra is used to develop a single-step time integration scheme that expresses the solution within the time step as high order Taylor expansions in time. As a side and important result, the use of differential algebra enables the expansion of the solution not only in time, but also in initial conditions and dynamical model parameters, so providing a valuable mean to carry out high order sensitivity analysis. The generalization of the solver to allow sensitivity analysis with respect to dynamical model parameters is presented and the performances of the resulting algorithm are illustrated on the integration of the motion of a controlled double-link manipulator.

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