Adaptive Numerical Methods for Sensitivity Analysis of Differential-Algebraic Equations and Partial Differential Equations

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Sensitivity analysis of differential-algebraic equation (DAE) systems generates essential information for design optimization, parameter estimation, optimal control, model reduction, process sensitivity and experimental design. Recent work on methods and software for sensitivity analysis of DAE systems has demonstrated that forward sensitivities can be computed reliably and efficiently. However, for problems which require the sensitivities with respect to a large number of parameters, the forward sensitivity approach is intractable and the adjoint (reverse) method is advantageous. In this talk we give the adjoint system for general DAEs and investigate some of its fundamental analytical and numerical properties. We describe our new adjoint DAE software and outline some issues which are critical to the implementation.

Defining the adjoint sensitivity system and writing the appropriate software to describe it can be a very challenging problem for large-scale engineering systems, particularly when it comes to finding appropriate boundary conditions for the adjoint partial differential equation (PDE) system. Therefore our goal for both DAE and PDE systems has been the development of methods and software in which generation and solution of the sensitivity system are transparent to the user. This has been largely achieved for DAE systems. We will propose a solution to this problem for PDE systems solved with adaptive mesh refinement.