An ESDIRK Method with Sensitivity Analysis Capabilities

A new algorithm for numerical sensitivity analysis of ordinary differential equations (ODEs) is presented. The underlying ODE solver belongs to the Runge-Kutta family. The algorithm calculates sensitivities with respect to problem parameters and initial conditions, exploiting the special structure of the sensitivity equations. A key feature is the reuse of information already computed for the state integration, hereby minimizing the extra effort required for sensitivity integration. Through case studies the new algorithm is compared to an extrapolation method and to the more established BDF based approaches. Several advantages of the new approach are demonstrated, especially when frequent discontinuities are present, which renders the new algorithm particularly suitable for dynamic optimization purposes.