On Finite Element Method - Flux Corrected Transport Schemes for Partial Differential Algebraic Equations

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Time-dependent advection-dominated flows appear in many computational fluid dynamics problems that involve the transport of scalar quantities, e.g., density or temperature. Since the classical finite element Galerkin discretization is known to produce unphysical oscillations for this type of problems, it is necessary to introduce a stabilized finite element formulation.

The idea of most stabilization techniques, such as the SUPG, SOLD, and LPS schemes, is to modify the bilinear form defining the finite element method. In contrast, the stabilization technique we are interested in, the finite element method - flux corrected transport schemes (FEM-FCT), works by modifying the system matrix and the right hand side vector at the algebraic level. It is a nonlinear high-resolution scheme which switches between high- and low order time discretizations due to the local smoothness of the solution [1].

In this work we apply the FEM-FCT in the context of partial differential-algebraic equations. As a model problem we choose the time-dependent advection-diffusion equation formulated as a differential-algebraic system by appending the boundary conditions by means of Lagrange multipliers. The combination of different time integrators (linear-implicit/implicit or implicit/implicit) and the handling of the additional entries in the system matrix due to the Lagrange multipliers are the main focus of our analysis.

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References

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