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Discrete gradient methods for semi-explicit port-Hamiltonian DAEs

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Port-Hamiltonian systems extend Hamiltonian systems to incorporate network structure and energy exchanges through ports, enabling the modeling of open and interconnected systems from various physical domains. The interconnection of network components often leads to differential-algebraic equations (DAEs), which also include algebraic constraints, for example Kirchhoff's laws. To ensure that these constraints are not violated, additional care is necessary when applying numerical methods to DAEs.

In this talk we discuss the application of discrete gradient methods to nonlinear port-Hamiltonian DAEs, with a focus on the case of semi-explicit DAEs. Discrete gradient methods are particularly suitable for the time discretization of port-Hamiltonian systems, since they are structure-preserving regardless of the form of the Hamiltonian, unlike other common methods whose structure-preserving characteristics are limited to quadratic Hamiltonians, like the implicit midpoint rule or other Gauss-Legendre collocation schemes. We also present numerical results to demonstrate the capabilities of our methods.

This is joint work with Philipp Kinon (KIT) and Philipp Schulze (TU Berlin).

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