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Structure preserving time discretization of port-Hamiltonian systems

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Port-Hamiltonian systems are becoming increasingly important in the modelling of physical systems. The key feature of this class of systems is the coupling of different subsystems using energy as the "lingua franca" . Although obtaining structure preserving space discretizations is quite straightforward, structured time discretizations of pH systems are more challenging. For the latter, the main goal is to have an energy balance for the time-discrete system that resembles the energy balance of the original model. This is especially challenging for nonlinear systems.

In this talk, we present a structure preserving scheme based on a Petrov-Galerkin-type procedure that is suitable for nonlinear systems. The approach uses a piecewise polynomial ansatz to approximate the trajectory of the pH system, which allows for an arbitrary order of convergence. We show that the scheme leads to the satisfaction of a discrete-time energy balance and present an a posteriori estimate for the approximation error. Finally, we illustrate the effectiveness of the approach with numerical examples.

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