Structure preserving integrators and technical simulation

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Backward differentiation formulae (BDF) are the most popular class of time integration methods in various fields of technical simulation like nonlinear system dynamics, circuit simulation and multibody system dynamics. They do not share the favourable nonlinear stability properties of variational integrators and structure-preserving integrators in the long-term integration of conservative systems but prove to be very efficient in the application to engineering systems with dissipative terms resulting, e.g., from control structures or friction.
In the talk, we will discuss several classes of variational integrators and structure-preserving integrators for mechanical systems and the potential fields of application in technical simulation. The modelling in nonlinear configuration spaces with Lie group structure proves to be advantageous since it may be combined with time integration methods that respect this nonlinear structure by construction (Lie group time integration).
For practical application, these methods were generalized to constrained systems using index reduction techniques that are well known from the theory of differential-algebraic equations (DAEs) in linear spaces. Variable step size implementations are based on step size control with an appropriate local error estimate. For linear systems, the method is unconditionally stable and the amount of algorithmic energy dissipation may be controlled by a single algorithmic parameter. In this sense, the method is much more flexible than classical BDF solvers that are characterized by a large amount of numerical energy dissipation.