An Adaptive Time Stepping Scheme for Rate-Independent Systems with Non-Convex Energy

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We investigate a local incremental stationary scheme for the numerical solution of rate-independent systems. Such systems are characterized by a (possibly) non-convex energy and a dissipation potential, which is positively homogeneous of degree one. Due to the non-convexity of the energy, the system does in general not admit a time-continuous solution. In order to resolve these potential discontinuities, the algorithm produces a sequence of state variables and physical time points as functions of a curve parameter. The main novelty of our approach in comparison to existing methods is an adaptive choice of the step size for the update of the curve parameter depending on a prescribed tolerance for the residua in the energy-dissipation balance and in a complementarity relation concerning the so-called local stability condition. It is proven that, for tolerance tending to zero, the piecewise affine approximations generated by the algorithm converge (weakly) to a so-called $\mathbb{V}$-parametrized balanced viscosity solution. Numerical experiments illustrate the theoretical findings and show that an adaptive choice of the step size indeed pays off as they lead to a significant increase of the step size during sticking and in viscous jumps.

References:

[1] https://arxiv.org/abs/2204.05860

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