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A Fast Barzilai-Borwein Residual Minimization Algorithm for Optimal Damping

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We consider damped vibrational systems of the form $M\ddot{q}(t) + D(\nu)\dot{q}(t) + Kq(t) = 0$, where M and K are positive
definite and $D = D_{\text{int}} + D_{\text{ext}}(\nu)$ with D_{int} representing some Rayleigh damping and $D_{\text{ext}}(\nu) = \sum_{i=1}^{k} \nu_i \; d_i d_i^T$ representing some external damping caused by k dampers. Optimal damping consists of determining a viscosity vector $\nu \in \mathbb{R}_+^k$ that maximizes the rate of decay of the energy of the system as t tends to infinity.
Several algorithms have been proposed to solve this problem but without the stability constraint on the vibrating system nor the nonnegative constraint on ν. We present a new approach that addresses both constraints.
We start with a test that checks a priori for stability of the system for all $\nu \geq 0$. Assuming that the system is stable, we derive the Karush-Kuhn-Tucker (KKT) conditions associated with the optimisation problem. We show that the linear independence constraint qualification (LICQ) holds, which is a crucial requirement for the validity of the KKT conditions at a feasible point. We also derive second order sufficient conditions.
We solve the KKT system with a residual minimization algorithm combined
with Barzilai-Borwein stepsize.

This is joint work with Qingna Li (Beijing Institute of Technology).

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