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Eigenvalues and delay differential equations: periodic coefficients, impulses and rigorous numerics. (English) [Zbl 07430388]

Summary: We develop validated numerical methods for the computation of Floquet multipliers of equilibria and periodic solutions of delay differential equations, as well as impulsive delay differential equations. Using our methods, one can rigorously count the number of Floquet multipliers outside a closed disc centered at zero or the number of multipliers contained in a compact set bounded away from zero. We consider systems with a single delay where the period is at most equal to the delay, and the latter two are commensurate. We first represent the monodromy operator (period map) as an operator acting on a product of sequence spaces that represent the Chebyshev coefficients of the state-space vectors. Truncation of the number of modes yields the numerical method, and by carefully bounding the truncation error in addition to some other technical operator norms, this leads to the method being suitable to computer-assisted proofs of Floquet multiplier location. We demonstrate the computer-assisted proofs on two example problems. We also test our discretization scheme in floating point arithmetic on a gamut of randomly-generated high-dimensional examples with both periodic and constant coefficients to inspect the precision of the spectral radius estimation of the monodromy operator (i.e. stability/instability check for periodic systems) for increasing numbers of Chebyshev modes.

MSC:
34-XX Ordinary differential equations

Keywords:
impulsive delay differential equations; Floquet multipliers; Chebyshev series; rigorous numerics; computer-assisted proofs

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References:

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