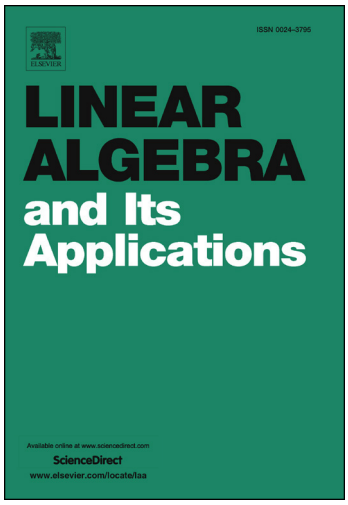

Robust stability optimization for linear delay systems in a probabilistic framework

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Robust stability optimization for linear delay systems in a probabilistic framework

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Abstract

This paper is concerned with an eigenvalue based stabilization method for linear autonomous delay systems with uncertain parameters, modeled by a random vector. The dependence of the characteristic matrix on the uncertain parameters can be nonlinear; also delay values can be subject to uncertainty. Unlike the stability optimization methods for deterministic problems, which minimize the spectral abscissa, our approach shows better robust properties based on a more realistic model, where the uncertainty is taken into account by minimizing an objective function, consisting of the mean of the spectral abscissa with a variance penalty. The properties of the spectrum of delay differential algebraic equations of retarded type are analyzed and an integration method to compute the mean and variance of the spectral abscissa, which describes the stability property of the system, is presented. Subsequently the analysis of the behavior of the gradient of the characteristic roots is addressed, and a suitable explicit formula of the gradient of the objective function is presented. Finally, for designing the controller a suitable optimization routine, requiring the objective function and its gradient, is presented. The efficacy of the method is illustrated with numerical examples, including a model of an experimental heat-exchanger. The algorithms developed are publicly available.

Keywords: Eigenvalue analysis and optimization, delay differential algebraic equations of retarded type, uncertainty quantification, integrability of the spectral abscissa and its gradient.
2000 MSC: 65F15, 90C31, 60H35

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