Solving simultaneous stabilization BMI problems with PENNON

Didier Henrion*† Michal Kočvara‡ Michael Stingl§

Abstract

A class of iterative methods for convex nonlinear programming problems was introduced by Ben-Tal and Zibulevsky and named PBM. The framework of the algorithm is given by the augmented Lagrangian method; the difference to the classic algorithm is in the definition of a special penalty/barrier function satisfying certain properties. A generalization of the PBM method for convex semidefinite programming problems was recently proposed by Kočvara and Stingl. The algorithm was implemented in the code PENNON, that proved to be very efficient for linear SDP problems. Recently, the algorithm has been generalized to nonlinear semidefinite programming problems.

In this talk, the resulting algorithm is applied to a special class of nonlinear semidefinite programming problems, where a linear objective is minimized with respect to bilinear matrix inequalities (BMI). We will present numerical results of the method for a class of optimization problems coming from control theory, the simultaneous stabilization problem. Simultaneous stabilization consists in finding one unique controller that stabilizes a set of given linear plants. This problem arises when seeking a robust control law for systems potentially subject to actuator or sensor failures.

Following a pure algebraic/polynomial approach, the simultaneous stabilization problem can be formulated as a BMI problem in the parameters of the controller, whose order can be fixed from the outset. This is in stark contrast with other approaches to simultaneous stabilization, for which it is very often difficult to bound the order of the controller. Another advantage of the polynomial formulation over the (more classical) state-space formulation for this robust control problem is that there is no need to seek a Lyapunov matrix certifying stability. The number of decision variables in the design BMI is then drastically reduced.

*Laboratoire d'Analyse et d'Architecture des Systèmes, Centre National de la Recherche Scientifique, 7 Avenue du Colonel Roche, 31077 Toulouse, cedex 4, France (henrion@laas.fr).

†Also with the Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic, Prague.

‡Institute of Applied Mathematics, University of Erlangen, Martensstr. 3, 91058 Erlangen, Germany (kocvara@am.uni-erlangen.de). On leave from the Czech Academy of Sciences.

§Institute of Applied Mathematics, University of Erlangen, Martensstr. 3, 91058 Erlangen, Germany (stingl@am.uni-erlangen.de).