Sensitivity Shaping under Degree Constraint: Nevanlinna-Pick Interpolation for Multivariable and Time-Delay Systems

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Abstract

This thesis is a collection of papers about generalizations and applications of the theory of the analytic interpolation with complexity constraint by C. I. Byrnes, T. T. Georgiou and A. Lindquist. The first paper is about a generalization to the bi-tangential interpolation problem. A smooth and complete parameterization of interpolants is given by solving a convex optimization problem similar to previous works. There is a new feature such that the class of free parameters may be specified to obtain lower degree of interpolants.

In the second paper, the theory is generalized to the two-sided Nudelman interpolation problem. The interpolation problem includes Carathéodoy-Fejer, Nevanlinna-Pick, and bi-tangential Nevanlinna-Pick with multiple interpolation points. For an application, a benchmark problem of the H_∞ control is considered in terms of the generalized theory.

In the third paper, the unweighted H_∞ sensitivity shaping of systems with time delays is considered. It was pointed out by C. Foias, A. Tannenbaum and G. Zames in 1987 that the unweighted H_∞ sensitivity minimization of systems with time delays can be cast as a finite-dimensional Nevanlinna-Pick interpolation problem. This problem is studied in terms of the theory of the Nevanlinna-Pick interpolation with degree constraint.

In the fourth paper, a uniqueness of an ARMA modeling filter for a solution to the rational covariance extension problem in the multivariable case is given. For given covariance data and specified MA part of the modeling filter, there exists a unique AR part of the modeling filter. The MA part of the modeling filter provides a complete parameterization of all positive rational extensions of a covariance sequence. This uniqueness of the multivariable ARMA modeling filter is shown by applying degree theory to a nonlinear map which is homotopic to a nonlinear map determining the maximum entropy solution.

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