Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Algorithms and Applications* **11 (2004)** 393-410

A CHARACTERIZATION OF ROBUST SPR SYNTHESIS FOR SYSTEMS WITH l_p PARAMETRIC UNCERTAINTY

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Abstract. The filter synthesis problem for robust strict positive realness ($RSPR$) of systems with l_p parametric uncertainty is addressed. A general characterization of the solutions of the $RSPR$ problem in this framework is derived. The proposed characterization is then exploited in order to devise synthesis procedures which yield polynomial or rational filters of bounded degree with guaranteed SPR robustness margin in the l_2, l_∞, and l_1 cases.
Keywords. Filter design, robustness, strict positive realness, uncertain systems, parametric uncertainty.

1 Introduction

The invariance of the Strict Positive Realness (SPR) property of rational functions with respect to numerator and denominator perturbations is relevant to many problems in the analysis of absolute stability of nonlinear Lur'e systems and the design of adaptive schemes (see, e.g., [1]-[14]). For instance, convergence of several recursive identification algorithms or adaptive schemes is ensured provided that a suitable family of rational functions enjoys the SPR property (see, e.g., [15]-[17]).

The key issue is the robust SPR ($RSPR$) problem. Given a set $\mathcal{P}$ of polynomials and a region Λ of the complex plane, determine if there exists a polynomial or a rational filter F such that each rational function P/F, $P \in \mathcal{P}$, is strictly positive real over Λ. For instance, in the context of recursive identification schemes, the set $\mathcal{P}$ can be viewed as a model of the uncertainty about the true plant and Λ is the region of the complex plane where the power spectral density of the regressor is concentrated.

Several results are available on the existence and construction of F for different choices of $\mathcal{P}$ and Λ. In [4],[6],[7],[13],[14] the continuous-time and