Computing Optimal Uncertainty Models from Frequency Domain Data

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Uncertainty models are an essential ingredient in robust control design. In addition, because of the tradeoff between uncertainty and performance, the uncertainty model should be as ‘tight’ as possible. Given a set of multivariable frequency response measurements, we show that the computation of multivariable nonparametric uncertainty models which are consistent with the data (i.e. not invalidated), reduces to a linear matrix inequality (LMI) feasibility problem. Our method simultaneously searches for the responses of both the nominal system and the uncertainty weights that give an optimal uncertainty model. We then show that computing the optimal or least conservative model for the data can be done using semidefinite programming (SDP). Noise and fitting errors are explicitly factored into the computation using a bounded set approach. A state space uncertainty model can then be obtained from the optimal nonparametric model using frequency domain subspace identification techniques. The proposed technique is demonstrated on a generic MIMO example, where it outperforms the average-based approach by almost a factor of two (5dB), in the frequency range with largest uncertainty.