Automated Synthesis of QFT Prefilters using Interval Constraint Satisfaction Techniques

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Abstract

Quantitative feedback theory (QFT) is well-known technique for designing robust feedback systems for the plants having large parametric uncertainties. In the two-degree-of-freedom structure used in QFT, a prefilter is required to meet the desired tracking specifications. The synthesis of prefilter in QFT is usually carried out manually, and largely depend on the designers skill and experience. Thus, a good design is not always assured by the manual design process. In the QFT literature, there is no method for automation of the prefilter design. This gap in the QFT literature motivates us to automate the procedure for synthesis of QFT prefilters of a specified structure. The benefits of automatic design of prefilter are quite obvious. For instance, in the $n \times n$ MIMO design case of QFT, where n^2 number of prefilters are designed sequentially, any overdesign of the prefilter in a loop may lead to controller overdesign in the subsequent steps. In this paper, we pose QFT prefilter synthesis problem as an interval constraint satisfaction problem and solve using existing efficient interval constraint satisfaction techniques (ICST) like HC4 and BC5. The main features of the proposed approach are: a)the method is fully automated, b)the structure of the prefilter transfer function can be pre-specified by the designer, c)if a solution of the specified structure exists for the given parameter domain, then all prefilter solutions lying in the domain are generated. It also computationally verify the existence (or non-existence) of a QFT prefilter solution, for a specified prefilter structure and an initial domain of prefilter parameter values. To validate the above design approach we apply this to a benchmark problem to obtain simple, low order prefilters in quick time. We also synthesis a prefilter for the experimental setup of the industrial emulator and achieve desired tracking specifications.

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