INTERVAL-BASED SYNTHESIS OF OPTIMAL ROBUST CONTROLLER

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1. Context

The goal of a controller is to guarantee some prescribed performance of a given system. For example, a car speed controller ensures that the appropriate gas flow is fed into the motor so as to maintain a prescribed speed. Controller synthesis is the problem of designing a controller given a system (plant) specification and desired performance specification. When the plant contains uncertainties, robust controller synthesis is the problem of designing a controller that guarantees the specification in spite of the uncertainties. Finally, when an objective criterion is considered, optimal robust controller synthesis is the problem of designing a robust controller that minimizes this criterion.

Optimal robust controller synthesis can be formulated as a robust optimization problem:

$$\begin{array}{rl} & \min_x f(x) \\ s.t. & \forall p \in P \;\; g(x,p) \leq 0 \end{array}$$

where x are variables representing the controller design, p are the uncertain plant parameters picked in a set P, f represents the objective criterion and g the performance specification. The traditional approach [1] to this problem consists in considering only a finite set of plant uncertainties $P = \{p_1, \dots, p_n\}$ and to pose the problem as a standard optimization problem:

$$\begin{array}{rl} & \min_x f(x) \\ s.t. & g(x,p_1) \leq 0 \\ & \vdots \\ & g(x,p_n) \leq 0 \end{array}$$

This approach cannot really be considered robust since the uncertainties are generally continuous in practice. Few work have considered continuous uncertainties until now [2, 3], and not in an optimization context.

2. Goal

The proposed subject is to investigate continuous uncertainties using interval-based methods. The work plan is as follows:

(1) Review the literature.
(2) Design the models for several simple optimal robust controller synthesis problems.
(3) Solve these models using interval-based methods.
(4) Report the results, identifying the limits of the approach and how they could be alleviated.

3. Organization

Supervisors are based at IRCCyN and LINA. The student(s) will have the opportunity to visit these two labs.

References

[1] Yossi Chait and Oded Yaniv. Multi-input/single-output computer aided control design using the quantitative feedback theory. *International Journal of Robust and Nonlinear Control*, 3:47–54, 1993.
[2] Luc Jaulin and Éric Walter. Guaranteed tuning, with application to robust control and motion planning. *Automatica*, 32(8):1217–1221, 1996.
[3] P. S. V. Nataraj. Interval QFT: a mathematical and computational enhancement of QFT. *International Journal of Robust and Nonlinear Control*, 12:385–402, 2002.