Performance/Robustness trade off for stabilizing a flow in an open cavity

Laleh Ravanbod, Jean-Marie Buchot and Jean-Pierre Raymond *†

We study the performance/robustness trade off in some finite dimensional observer-based structure controllers used to stabilize the two-dimensional linearized Navier-Stokes equations around an unstable stationary solution by a boundary control. For this type of systems, we have already defined finite dimensional observers coupled with finite dimensional control laws.
In this work, taking advantage of the finite dimensional character of our observer, we adapt tools from finite dimensional systems to do the best performance/robustness trade off for the stabilization of a flow in an open cavity [1].
As in [2], Kalman filter gain and state gain are determined by solving two finite dimension Algebraic Ricccati Equations involving the projection of the linearized equations onto the unstable subspace of the linearized operator.
This Linear Quadratic Gaussian controller is the first observer-based structure controller; It is of high-performance (in H_2 norm sense) but not necessarily robust [3] (for example against the perturbation in the actuator dynamics).
To increase the robustness, we perform a Loop Transfer Recovery procedure [4], which results in the second observer-based structure controller. However, more this second controller is robust, lower is its performance.
Finally, an observer-based structure [5] $\mathcal{H}_2/\mathcal{H}_\infty$ controller is proposed and computed via a nonlinear and nonconvex optimization program. It is of high-performance (like LQG) and at the same time it is robust (like LTR).
The approach is tested numerically for a flow in an open cavity considering partial observation of wall-normal shear stress and pressure.

References

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*The authors are with Université Paul Sabatier, Institut de Mathématiques, UMR CNRS 5219, 31062 Toulouse Cedex 9, France. laleh.hosseini@math.univ-toulouse.fr, jean-marie.buchot@math.univ-toulouse.fr, raymond@math.univ-toulouse.fr

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