Distributed Active Vibration Control of Elastic Beams

Mihael Lobrovic†, Andrej Jokic†, and Marko Jokic*

* † Faculty of Mechanical Engineering and Naval Architecture
University of Zagreb
Ivana Lucica 5, 10000 Zagreb, Croatia
e-mail: {mlobrovic, ajokic, mjokic}@fsb.hr, web page: http://www.fsb.hr/

ABSTRACT

In the past two decades there have been significant research efforts on the topic of distributed controller synthesis. Distributed control is a tractable alternative to centralized control and fully decentralized control. Centralized control structure is characterized with a single control unit which collects all available measurements and commands all the actuators. In fully decentralized control, there is a set of independent local controllers, with no mutual coordination between the controllers. In contrast to the above, distributed control structure incorporates mutual communication and coordination between the local controllers, but there does not exists a single control unit which has all the information. While centralized control theory has reached its maturity in the case of linear time invariant (LTI) systems and decentralized control has in general shown to be intractable [1], certain classes of optimal distributed control problems have recently been shown to be both computationally tractable, scalable and with efficiency comparable to centralized solutions.

In parallel with development of suitable theory, recent advances in communication, sensing and actuation technology has enabled design and real life use of smart structures. In particular, piezoelectric elements can be mounted on flexible structural elements (e.g., beams, plates) and, acting as both sensors and actuators, actively change dynamical behaviour of the structure. Typical application is damping of undesired vibrations.

In this research we formulate active vibration control of a smart structure with piezoelectric elements as distributed optimal control problem. While limiting our focus on elastic beams, the work is summarized as follows.

- Development and presentation of a structured model representing system's dynamics, which is suitable for synthesis of a distributed controller. The model includes behaviour of piezoelectric elements and is a finite dimensional LTI system obtained via finite element method.
- Optimal control problem formulation in terms of minimization of $\mathcal{H}_\infty$ norm of a closed loop system, with external forces acting on a beam as disturbances and deflections as controlled outputs to be minimized. The controller synthesis has been based on results presented in [2].
- Simulation results of the closed loop behaviour, together with comparison relative to optimal centralized control solution, are presented.

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REFERENCES

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