DEPARTMENT OF MECHANICAL ENGINEERING
Purdue School of Engineering and Technology

IUPUI

SPRING 2004 SEMINAR SERIES

Date: Monday, March 1, 2004
Time: 10:15 pm - 11:15 pm
Room: SL 165

Everyone is invited

ACTIVE AND ADAPTIVE-PASSIVE CONTROL OF ACOUSTIC IMPEDANCE WITH APPLICATION TO THERMOACOUSTIC COOLING

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Abstract. This research involves both active and adaptive-passive control problems that are related to thermoacoustic cooling. The basic issue is acoustic impedance control for one-dimensional sound wave in ducts. The goal is to replace the duct of a standing wave tube with a controlled or tunable boundary and thus reduce space requirements. In the active control approach, a secondary driver was used to force the sound field as desired. Both single-input-single-output and two-input-two-output control schemes of impedance matching were formulated and implemented. Robust repetitive control was incorporated in both schemes, and satisfactory results from experiments demonstrated the feasibility of the proposed method. For the adaptive-passive control scheme, a tunable Helmholtz resonator was developed as an attachment to the existed thermoacoustic cooler to control the boundary conditions. A motor-driven mechanism drives the piston in the resonator such that the compliance of the end impedance can be changed. The cooling power was chosen as the variable to be maximized, as it is a better performance index to evaluate the cooling system. The acoustic impedance control was achieved implicitly. Extremum seeking control was applied for the tunable thermoacoustic cooler to maximize the cooling power via tuning the piston position and the driving frequency. Experimental results showed the effectiveness of such control schemes in searching for the optimal cooling power with fixed and varying operating conditions. Improvement of transient performance was observed by incorporating an additional dynamic compensator in the control loop. The present research is extended to extremum seeking control with nonlinear equality constraints, aiming to maximize the driver efficiency while maintaining a given level of cooling power for the tunable thermoacoustic cooler. The proposed control framework and some preliminary simulation results will be introduced.