Active modal control of noise transmission through double panel

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Objectives

Double-panels are often used in noise control engineering when high sound transmission loss has to be achieved with lightweight structures. However, the sound transmission loss decreases rapidly toward low frequencies, where it is generally poorer than that of a single panel. Active noise control offers a solution to this problem. For light and small structures having slight modal overlap, modal approach enables concentrating control effort on high radiation efficiency modes exclusively.

Double panels

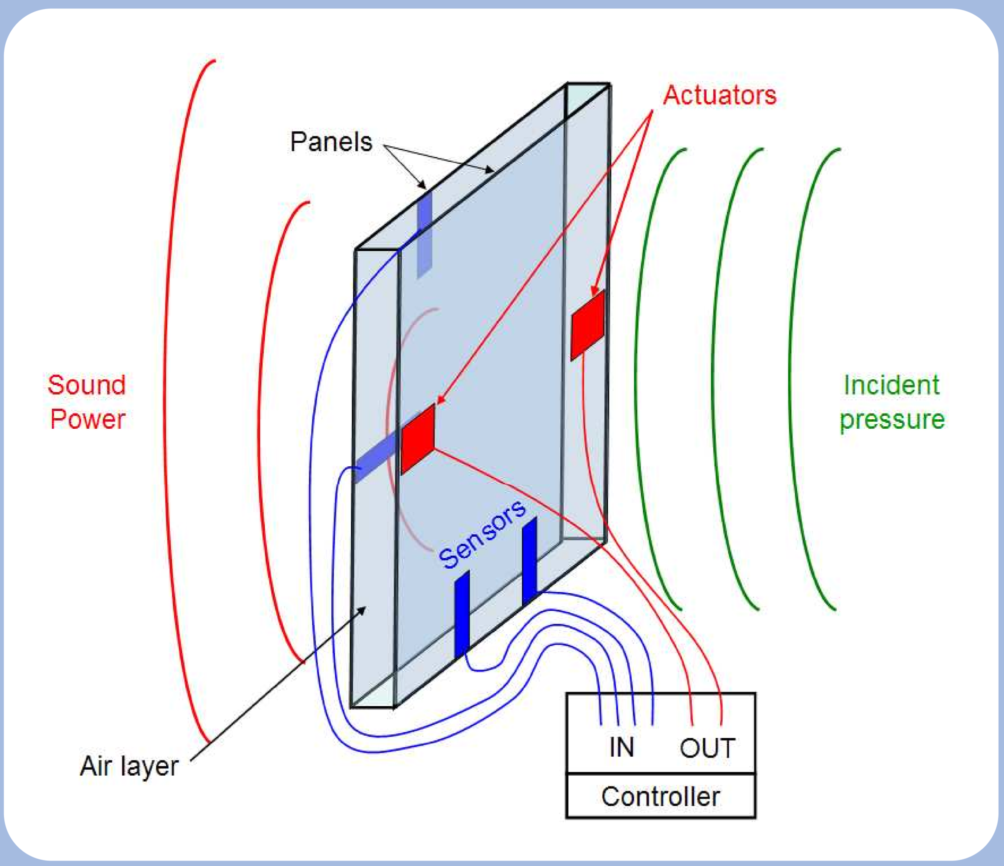

Figure 1. Equipped double panel

Objectives :

- Reduction of the sound transmission
- Active control for low frequencies
  - Complete the good passive performances at mid-high frequency
  - Lightness and small volume vs. passive devices (mass addition or foam)

Applications :

- Shielding machinery
- Transport (skin fuselage panel)
- Civil engineering (double glazed windows)

Control strategy

Modal Feedback Control (Active Structural Acoustic Control)

- Random disturbance
- Do not require reference signal
- Global control
- Minimization of number of actuators and sensors
- Control energy focused on radiating modes
- Model-based strategy which reconstructs the modal state of the system with an observer

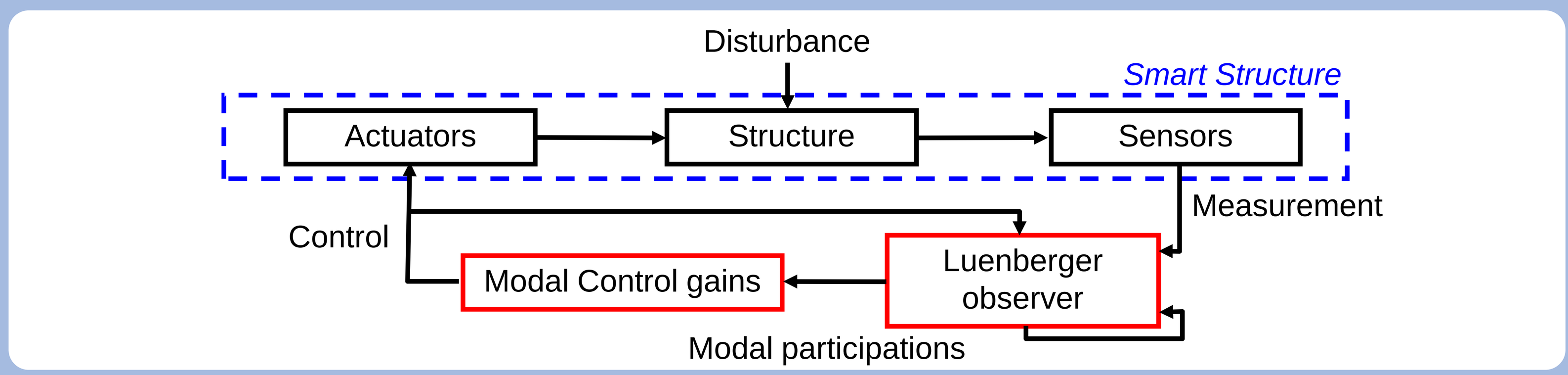

Figure 2. Modal control

Facilities

Figure 3. Disturbance room and semi-anechoic room

Disturbances :

- Acoustic (Loudspeaker)
- Structure-borne (PZT actuators)

Performance evaluation :

- Sound intensity measurement

Actuators (PZT) and sensors (PVDF) :

- Light, cheap, tiny

Figure 4. Actuators and sensors

Implementation

Controller-Observer model :

- Do not require numerical modeling
- Do not require impedance meter
- Identification from a reduced modal analysis (RFP algorithm)

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Experimental model

Decentralized modal controllers

- Several independent feedback loops
- Improvement of model quality
- Reduction of observation and control spillovers
- Control energy of actuators in different frequency bands
- Better optimization of control gains

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High performance

Experimental Results

Studied configuration :

- Symmetric duraluminium panels (0.6x0.4x0.001m³)
- Shallow air cavity (10mm thick)
- 6 sensors, 2 actuators

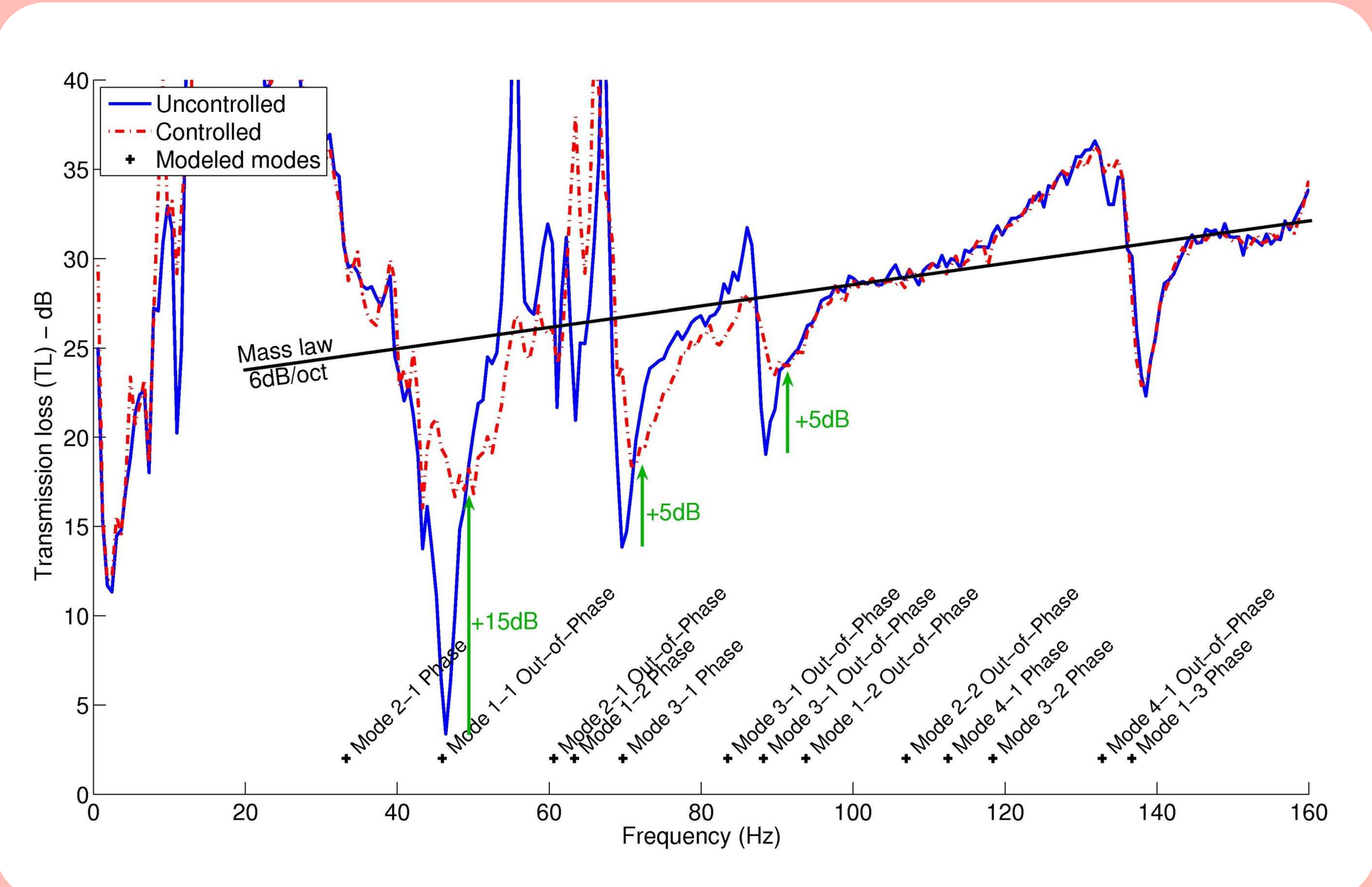

Figure 5. Transmission loss – Uncontrolled and controlled double panel

Transmission Loss :

$$TL = 10\log\left(\frac{W_{Incident}}{W_{Transmitted}}\right)$$

Performance
↑ Improvement
↓ Deterioration

➡ **Transmission loss improved**
➡ **Reduction of modal behavior**
➡ **Low spillover**

with

- Experimental model
- Few active components
- Decentralized modal control

Conclusions

Methods :

- Feedback modal control (ASAC) – Model based control strategy
- Experimental model built from reduced modal analysis (RFP)
- Decentralized modal control

Results :

- Reduction of modal behavior with modal damping
- Reduction of the sound power (acoustic and structure-borne disturbance)
- Improvement of transmission loss
- High sensibility of the double panel to temperature changes ➔ Robustness problem
- Validation of developed methods on a simple panel

Contacts

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