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Adaptive active noise control in the presence of time-varying compensator parameters.

Doctoral School: EEATS Grenoble
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Key words:
Adaptive regulation, time-varying parameters, system identification, active noise control.

The Context:
Research in the area of adaptive active noise control in the presence of unknown and time varying characteristics of the noise disturbances has been carried on in the Control Dept GIPSA-LAB since a number of years. A thesis on this issue will be soon finished and several publications are available (see below). This development has been made possible by the long standing effort made at GIPSA- LAB from many years in the field of active vibration control (see the book Landau et al, Springer 2016) which has strong similarities with the field of active noise control from the control engineering point of view. The laboratory is equipped with a test bench for testing active noise control methodologies (see photo below and diagram).

Adaptive feedback and adaptive feedforward techniques (as well as combination of feedback and feedforward) have been developed and tested experimentally. Multiple narrow band noise disturbances as well as broad band noise disturbances have been considered. All these developments have been done under the assumption valid in many applications, that the dynamic model of the compensator system remains almost constant during operation.

It turns out that new strategic applications related to the active noise control in exhaust gas devices for ships, trunks, cars, rise the crucial problem of the large and rapid variations of the compensator dynamic characteristics as a function of the gas temperature as well as a function of the rate of variation of the temperature of the gas. Other physical variables may also influence these dynamic characteristics. To be able to apply active noise compensation techniques it is necessary to consider the problem of unknown and time varying variations of the dynamic model of the compensator.

The problem
The active noise control system for exhaust gas devices has a structure similar to that of the GIPSA bench test shown in figure 2 (which for this research will be equipped with a heating system). The output of the system is the residual noise measured at the end of what is called the primary path. To compensate the noise produced by the exaust gas (reproduced here by the loudspeaker 1) a compensator speaker 2 is acting through what is called the "secondary path" (from speaker 2 to the residual noise measurement microphone). To build an active noise control system (using either a feedback approach or a feedforward approach) one needs the knowledge of the dynamic model of the secondary path (compensatory path). For system with constant behavior this model is easily obtained by system identification from experimental data. In the new context this model will be time varying and unknown to a large extent.

The objective
To develop a methodology for active noise control for time varying and unknown noise characteristics in the presence of rapid and mostly unpredictable variations of the dynamic model of the compensatory path. This methodology has to be analyzed theoretically and validated by simulations and experiments.

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Research program

Several steps are considered

1. Study of the present methodology for adaptive active noise control (theoretically and experimentally) using the available tools and experimental facilities available at GIPSA
2. Study of the literature concerning existing proposed solutions for handling the variability of the compensatory path (a short survey of the various attempts is available- see Lopes et al)
3. Experimental identification of the model of the GIPSA Bench test as a function of the inside air temperature.
4. Exploring adaptive control techniques "performance oriented" for handling systems with rapid and unknown variations of the parameters. Among the possible approaches one should consider: adaptive control systems with performance switching, simultaneous adaptation of the compensator filter and real time model estimation of the secondary path, use of over parametrized Youla Kucera structures from the feedforward compensator and feedback compensator
5. Development and implementation of the methodology on the GIPSA Bench test.

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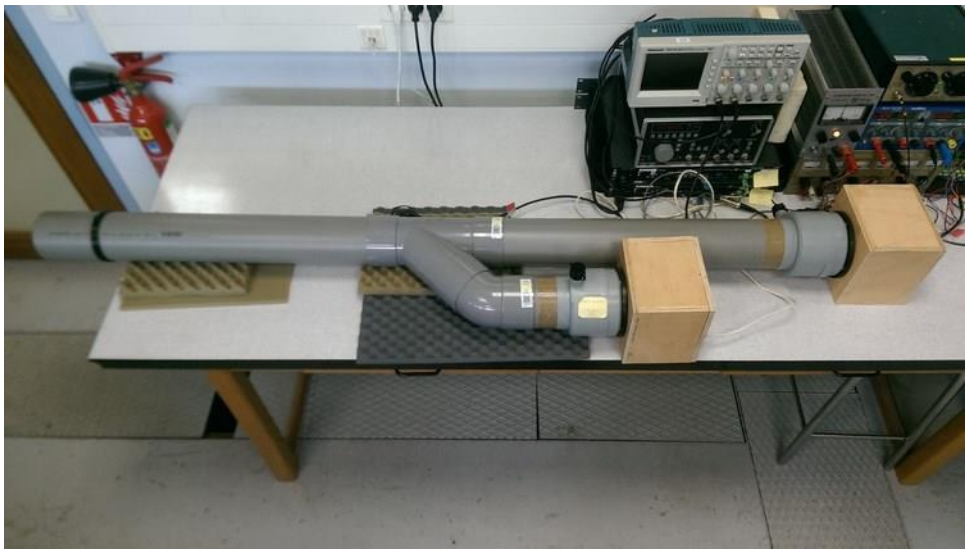
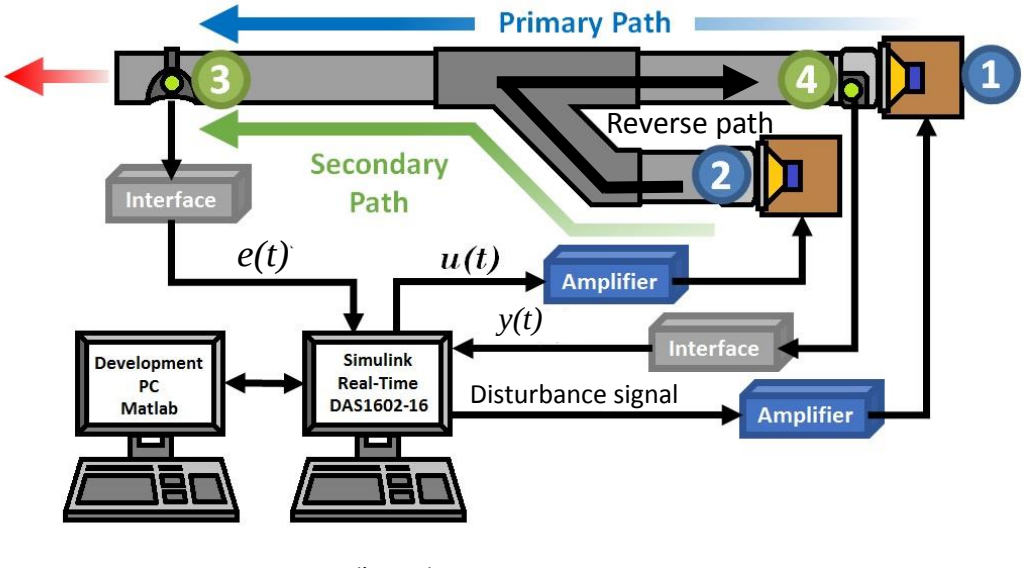


Active noise control test bench (photo)



Active noise control test bench (diagram)

GRANTS: No specific grant attached to this subject. The candidate has to postulate for the grants offered by various organizations.

Expected background: the candidate should have a good background either in mechanical or in control engineering, but with, at least, a basic background in control.

Place: The research will be carried on mainly at GIPSA-LAB, Grenoble

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