State-Space Model-Based Fault tolerant Active Noise Control

Background

Active noise control (ANC) is an efficient way to attenuate low frequency noise that is very difficult and/or expensive to control using passive means. ANC has been extensively investigated by using adaptive filter theory in recent decades. From the control point of view, ANC problem can also be formulated into some standard control problems, such that some matured control theory can be employed for the ANC design. One recent interesting topic is to use the modern (state-space based) control method for ANC design. For example, Hull and Radcliffe proposed a linear SS model for a one-dimensional acoustic duct system [1], based on this model they discussed the pole-placement method and Kalman filter theory for the ANC design [2]. Some other modern design such as using the H_∞ control design and MPC design can also be found in relevant literatures.

Problem

Within this project, the fault tolerance issue of the ANC design will be focused. The reason is quite obvious: if the developed ANC system is not reliable, the users will expose in a big risk that the vague system might amplify the noise instead of attenuating noise. This will lead to a confliction with the fundamental purpose of using ANC technique. On the other hand, this kind of driving-by-wire system is indeed fragile to component/system failures.

In order to improve the ANC reliability, the model-based fault tolerant control method could be employed for ANC design.

Content

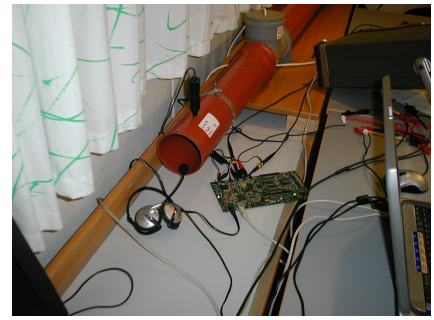
The project could compose of the following contents:

- Improve the existing ANC equipment suitable for FTC purpose, such as using more than one canceling speakers and more than one error microphones (adding redundancy) in the physical system;
- Extend the improved Hull and Radcliffe's model [1,3] so as to be able to describe the MIMO system;
- Possible fault scenario analysis and definitions, especially regarding to the canceling speakers and measuring microphones;
- Set up Fault Detection and Identification (FDI) strategy for the considered system;
- Set up reconfiguration strategy with respect to the detected failures;
- Validation of the proposed approach by using the improved physical system.

The robustness issue is preferred to be considered within each step. There is the potential to use the developed method and model to study the high-speed CD-ROM noise problem originally proposed by one industrial partner – B&O A/S [4].

Remark

- Required equipments are available in the E-Laboratory.



Key words:

State space model, MIMO, fault tolerant control, fault detection and identification, active noise control, spectrum analysis

Reference (available upon request)

[1] A. J. Hull and C.J. Radcliffe, "An eigenvalue based acoustic impedance measurement technique", J. of Viberations and Acoustics, Vol.113, Apr. 1991, pp.250-254.

[2] A.J. Hull, C.J. Radcliffe and S.C. Southward, "Global Active Noise Control of a One-Dimensional Acoustic Duct Using a Feedback Controller", Journal of Dynamic Systems, Measurement, and Control, Vol.115, 1993, pp. 488-494.

[3] Zhenyu Yang, "Active Noise Control for a One-dimensional Acoustic Duct Using Feedback Control Techniques: Modelling and Simulation", *WEAS Transactions on Systems, Issue 1, Volume 3, Jan. 2004, pp.46-54.*

[4] Diploma Afgang project (Fall 2003): *Active noise control for the high-speed CD-ROM system* (cooperate with B &O A/S)

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