Active Noise Control for a Ventilation Duct System Using Adaptive Filter Technique

Background

The acoustic noise pollution is causing more and more human being's attention as the increasing industrialization and urbanization. The traditional approaches often use enclosures or barriers to attenuate the undesired noise. However, these passive approaches become costly and ineffective when they need to deal with the low-frequency noise, such as the low-frequency noise in a ventilation system ranges from 50 Hz to 500 Hz which includes the throb and rumble of turbulent airflow and the roar, hum, buzz and whine of fans, pumps, and chillers, etc..

In order to reduce the low frequency noise, the active approaches which are usually referred to as Active Noise Control (ANC) techniques have been more and more used in manufacturing, industrial operations, and consumer products. The basic idea of ANC technique is to introduce an anti-noise wave (e.g., the same magnitude and out of phase signal comparing with the original noise) through an appropriate set of secondary sources. These secondary sources could include a set of loudspeakers and a set of microphones/signal-generators and can be interconnected through an electronic system using some specific signal processing algorithms.

Fig. 1. ANC benchmark – Ventilation Duct in AUE

Fig. 2. ANC benchmark – Advanced Headset in AUE

Problem

In this project we will focus on a simplified ventilation duct system which was constructed by some previous group. As shown in Figure 1, A loudspeaker fixed at one end of the duct simulates the noise resource, several microphones locating at different positions along the duct can be used to measure the noise level. A control strategy need to be developed to drive an ANC loudspeaker (the secondary source) by using some measured information, such that the noise measured at some specific position (e.g., the other end of the duct) can be obviously attenuated. Based on this system, some previous groups have worked on the ANC strategy based on the feedback control techniques and some good results have been observed. However, we also observed the feedback control strategy is not quite efficient to deal with the wideband noise, especially when we can use more than one microphones to measure the “afterward” and “beforehand” information. This motivates us to think to use the adaptive filter technique to deal with this problem. Another benefit to use adaptive filter technique is to deal with uncertainty and non-stationary phenomena. One previous DE5 group in 2003 has successfully used the adaptive filter technique to develop an advanced headset system as shown in Fig.2. Some analyses and simulation results were pretty good, but the test results were still far away from the expectation.

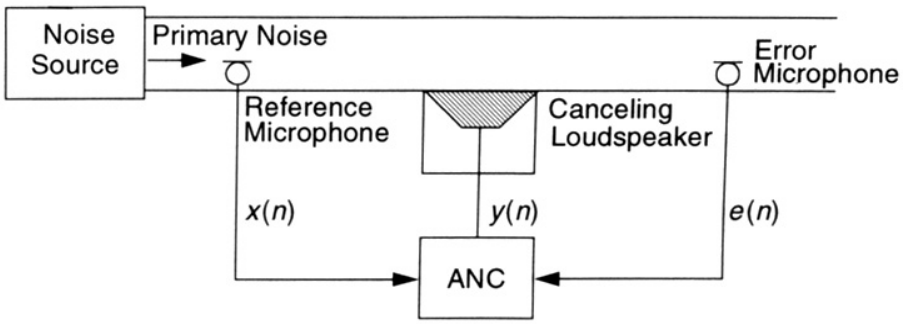

Fig.3. Principle of the feedforward ANC system (using adaptive filter technique)

Objective

The objective of this project is to design and implement an ANC system for the AUE Ventilation System using the adaptive filter technique as shown in Fig.3. Some analyses and comparison with previous work which used the feedback control techniques are expected.

Relevant previous projects: (can be available upon requirement)

- DE-7 Thesis project (Fall 2003): *Active noise control for the high-speed CD-ROM system* (cooperate with B &O A/S)
- DE-5 Gourp 542 (Fall 2003): *Active Noise Control for a Headset* (http://www.cs.aue.auc.dk/research/lce/ANC/index.htm)
- PR-6 Group 671 (Spring 2003): *Active noise control using feedback control techniques*

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