

ACTIVE CONTROL OF AUTOMOBILE CABIN NOISE
WITH CONVENTIONAL AND ADVANCED SPEAKERS

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(ABSTRACT)

Recently much research has focused on the control of enclosed sound fields, particularly in automobiles. Both Active Noise Control (ANC) and Active Structural Acoustic Control (ASAC) techniques are being applied to problems stemming from power train noise and road noise (noise due to the interaction of the tires with the surface of the road). Due to the low frequency characteristics of these noise problems, large acoustic sources are required to obtain efficient control of the sound field. This creates demand in the automobile industry for compact lightweight sources.

This work is concerned with the application of active control to power train noise, as well as road noise in the interior cabin of a sport utility vehicle using advanced, compact lightweight piezoelectric acoustic sources. First, a test structure approximately the same size as the automobile was built to study the principles of active noise control in a cavity. A finite element model of the cavity was created in order to optimize the positions of the error sensors and the control sources. Experimental work was performed with the optimized actuator and sensor locations in order to validate the model, and draw conclusions regarding the conditions to obtain global control of the sound field. Second, a broad-band feedforward filtered-X LMS algorithm was used to control power train noise. Preliminary power train noise tests were conducted using arrangements of four microphones and up to four commercially available speakers for control. Attenuation of seven decibel (dB) at the error sensors was measured in the 40-500 Hz frequency band. The dimensions of the zone of quiet generated by the control were measured, and show that noise reductions were obtained for a large volume surrounding the error sensors. Next, advanced speakers were implemented for active control of power train noise. The results obtained with different arrangements of these speakers were very similar to those obtained with

the commercially-available speakers. These advanced speakers use piezoelectric devices to induce the displacement of a speaker membrane, which radiates sound. Their lighter weight and compact dimensions are a significant advantage over conventional speakers, for their application in automobile. Third, preliminary results were obtained for active control of road noise. The controller used an optimized set of four reference signals to control the noise at one error sensor using one control source. Two sets of tests were conducted. The first set of tests was performed on a dynamometer, which simulates the effects of the road on the tires. The second set of tests was performed on a rough road. Reduction of two to four decibel of the sound pressure level at the error sensor was obtained between 100 and 200 Hz.

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à mes Parents
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List of Example Experiment Sounds demonstrating Active Control of Automobile Noise.

The three sounds presented below are wave-file recorded at the error sensor during three experiments. During the first ten seconds the controller is off, then after ten seconds the controller is turned on. Due to the low frequency contents of the signals, these files should be played on a system with large speakers (frequency response down to 20 Hz).

1. Active Control of Power Train Noise (*Noise_1.wav*).
2. Active Control of Road Noise; simulation at Goodyear (*Noise_2.wav*).