# Finding a Better Way to Quiet Noisy Environments

April 5 2006

Researchers at UCSD report in the April 4 issue of the *Journal of Sound and Vibration* a new mathematical algorithm designed to dramatically improve noise-cancellation technologies that are used to quiet everything from airplane cabins to commercial air conditioning systems. The new technique improves the ability to achieve destructive interference, the generation of anti-noise signals that combine with and destroy unwanted sounds.

“Noise cancellation is a hidden technology that most consumers aren’t aware of, but vehicles made by BMW, Mercedes, Honda, and other companies are now using it,” said Raymond de Callafon, co-author of the paper and a professor of mechanical and aerospace engineering at UCSD’s Jacobs School of Engineering. “Our new technique should greatly expand the potential of active noise-cancellation technologies.”

Basic active noise-cancellation is composed of four inter-related parts: a microphone that measures incoming noise and feeds that information to a computer, a computer processor that converts the noise information into anti-noise instructions, and an audio speaker that is driven by the anti-noise signal to broadcasts sound waves that are exactly 180 degrees out of phase with the unwanted signal and of the same magnitude. In addition, a downstream microphone monitors residual noise and signals the computer as part of a process to optimize the anti-noise signal.

This “feedforward” active-noise control can reduce unwanted helicopter and cabin noise or the steady roar of industrial air handling systems by

40 decibels or more. However, most commercial systems suffer from acoustic feedback because the anti-noise signal produced by the noise-cancellation speakers can feed back into the microphone and become amplified repeatedly until the resulting sound becomes an ear-splitting squeal or whistle.

“Most people ignore this acoustic coupling but we took it into account and designed the feedforward noise cancellation knowing that the acoustic coupling is there,” said de Callafon.

Some makers of active noise cancellation avoid acoustic coupling by shielding microphones from speakers, or by using directional microphones and speakers that are pointed away from each other. “This works fine in the case of noise-reduction headphones and air-conditioning ducts, but it’s impractical in hundreds of other applications,” de Callafon said.

For example, the algorithm developed by de Callafon and Ph.D. candidate J. Zeng may be adapted to cancel unwanted complex signals that are moving, such as the sound of bustling urban traffic coming through a ventilation opening.

“We think we’ve developed a totally new approach that works by generating the ‘feedforward’ noise cancellation signals and adaptively changing them in the presence of acoustic coupling,” de Callafon said. “This has been a really complicated problem to solve and we think the approach we’ve taken will have a significant impact on the field.”

Source: University of California, San Diego