

ACTIVE VIBRATION CONTROL OF STRUCTURES AND IN THE INNER EAR

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Abstract

The low frequency sound and vibration inside a number of aircraft and cars is now attenuated using commercial active control systems. These operate either using loudspeakers to directly drive the sound field, or with shakers acting on the structure to modify its vibration and hence reduce excitation of the sound field.

As the structure becomes larger, the number of actuators and sensors required for effective control rises significantly. Conventional, fully coupled, control systems then become costly in terms of weight and sensitivity to individual failures. An alternative strategy will be discussed, of distributing the control over multiple local controllers, which has been shown to be effective in a number of cases. Recent work will also be presented on tuning these local control loops to maximise the power they absorb from the structure, which may allow the mass production of generic active control modules that include an actuator, sensor and self-tuning controller.

The workings of the inner ear also provide a remarkable natural example of distributed active vibration control, whose objective is to enhance the motion within the cochlea. A simple model for this cochlear amplifier, in which each of the outer hair cells act as local control loops, will be described and its use illustrated in predicting the otoacoustic emissions generated by the ear. These emissions are used clinically to screen the hearing of young children and so it is important to understand how they are generated within the cochlea.

Prof Steve Elliott

Steve Elliott graduated with first class joint honours BSc in physics and electronics from the University of London, in 1976, and received the PhD degree from the University of Surrey in 1979 for a dissertation on musical acoustics.

After a short period as a Research Fellow at the ISVR and as a temporary Lecturer at the University of Surrey, he was appointed Lecturer at the Institute of Sound and Vibration Research (ISVR), University of Southampton, in 1982. He was made Senior



Lecturer in 1988, Professor in 1994, and served as Director of the ISVR from 2005 to 2010. His research interests have been mostly concerned with the connections between the physical world, signal processing and control, mainly in relation the active control of sound using adaptive filters and the active feedback control of vibration. This work has resulted in the practical demonstration of active control in propeller aircraft, cars and helicopters. His current research interests include modular systems for active feedback control and modelling the active processes within the cochlear.

Professor Elliott has published over 200 papers in refereed journals and 400 conference papers and is co-author of *Active Control of Sound* (with P A Nelson 1992), *Active Control of Vibration* (with C R Fuller and P A Nelson 1996) and author of *Signal Processing for Active Control* (2001). He is a Fellow of the Acoustical Society of America, the IET and the IOA and a senior member of the IEEE. He was jointly awarded the Tyndall Medal from the Institute of Acoustics in 1992 and the Kenneth Harris James Prize from the Institution of Mechanical Engineers in 2000.

He was made a Fellow of the Royal Academy of Engineering in 2009.

Selected Publications

Elliott, S.J. (2010) Active noise and vibration control in vehicles (Chapter 11). *In* Wang, Xu *ed. Vehicle Noise and Vibration Refinement*, Oxford, Woodhead Publishing, 235-251

Elliott, S.J. and *Stothers, I.M. (2010) Active noise control in vehicles. *In ed. McGraw-Hill Yearbook of Science & Technology*, New York, McGraw-Hill Professional, 3-5

Elliott, S.J. (2009) Active control in vehicles and in the inner ear: A review, *International Journal of Acoustics and Vibration*, 14(4), 212-20

Aoki, Y., Gardonio, P. and Elliott, S.J. (2008) Modelling of piezoceramic patch actuator for velocity feedback control, *Journal of Smart Materials and Structures*, 17(1), 1-13

Aoki, Y., Gardonio, P. and Elliott, S.J. (2008) Rectangular plate with velocity feedback loops using triangularly shaped piezoceramic actuators: Experimental control performance, *Journal of the Acoustical Society of America*, 123(3), 1421-1426

Engels, W.P. and Elliott, S.J. (2008) Optimal centralized and decentralized velocity feedback control on a beam, *Smart Materials and Structures*, 17(2), 10pp ,Paper 025009

Jones, M. and Elliott, S.J. (2008) Personal audio with multiple dark zones, *Journal of the Acoustical Society of America*, 124(6), 3497-3506

Zilletti, M., Elliott, S.J. and Gardonio, P. (2010) Self-tuning control systems of decentralised velocity feedback, *Journal of Sound and Vibration*, 329(14), 2738-2750