Active Control of Noise and Vibration

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This 1267-page book is more than a treatise on active control of noise and vibration; it covers the fundamentals of acoustics and vibrations as well as the theory of active control systems.

Chapter 1 is in introduction which gives the background of active control. The early work of Lueg and Olson is described; the chapter also gives an overview of potential applications of active control, feedback, and feedforward systems.

Chapter 2 covers the fundamentals of acoustics and vibrations. This includes a derivation of the wave equation (including sources and one-dimensional mean flow). The discussion then turns to the fundamentals of mechanics, including Newton's laws and some of the important concepts in analytical mechanics. The vibrations of continuous systems (beams, plates, and shells) are then reviewed. The chapter continues with a review of the theory of Green's functions in unbounded spaces, enclosed spaces, and ducts. Following that formalism, impedance and sound intensity are discussed. The material on impedance leads directly to an explanation of radiation efficiency. Mechanical impedance is also covered, and intensity in both air and structures is reviewed.

Chapter 3 is a review of spectral analysis and digital filtering. Chapter 4 covers modal analysis - both theoretical and experimental.

The theory of active noise and vibration control begins in Chapter 5 with a review of modern control theory. This includes discrete-time models, frequency domain analysis, and random processes.

Feedforward systems, including various formulations of LMS algorithms are covered in Chapter 6. The discussion leads naturally into adaptive filtering. There is also material on adaptive filtering using neural networks.

Chapter 7 begins the discussion of one of the first applications of active control, active control in ducts. Examples of various configurations of active cancellation systems are given. This chapter also includes material on active headsets.

Chapter 8 is devoted to control of sound radiation in a free field. The use of a canceling source near the actual source (modeled as a dipole) is discussed - as is the control of radiation from structures such as panels. Next comes an exposition - in Chapter 9 - on control of sound fields in enclosed spaces. Examples of control of aircraft and automobile interior noise is given.

Chapter 10 is devoted to feedforward control of vibration in beams in plates, and Chapter 11 continues with material on feedback control using a modal description of flexible structures. Chapter 12 covers active vibration isolation.

Electronic issues, such as analog to digital conversion, are covered briefly in Chapter 13, and the discussion then turns to sources and sensors in Chapter 14. Sources and sensors for both airborne sound and for vibration control are covered.

Throughout the book, there are numerous references to current activity in the field. There is one appendix in the book which is a brief review of linear algebra.

One subject not covered is patents. The authors have given a brief discussion of this topic in the preface, and point out that this is a very complex issue. They suggest that any company entering the field to develop a product have patent rights. They say that "It seems that lawyers and judges have made more money from active control than any engineering company. They urge reason with regard to patent rights - since these problems can slow down new product development (and enrich the legal profession).