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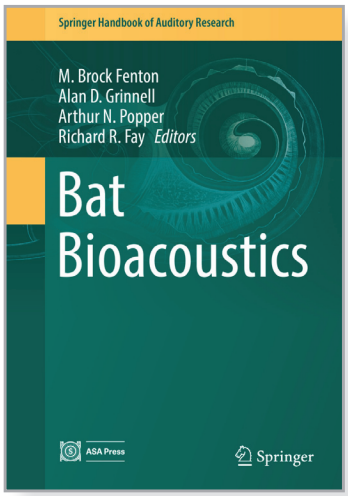
Bat Bioacoustics



Authors:
M. Brock Fenton,
Alan D. Grinnel,
Arthur N. Popper,
and Richard R. Fay

Publisher: Springer Science+Business Media, New York, 2016, 304 pp.

Price: $139.00 (hardcover)

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This book is a "must have" for anyone studying bat behavior, the bat sensory system, bat echolocation and foraging strategy and behavior, communications, all aspects of bat hearing, and so on. The editors have organized an impressive list of contributors that are "world class" researchers and have been able to contribute by writing chapters in this book. Scientists from ten countries are represented in this volume. This organizing task cannot be taken lightly with the busy schedule that top notch scientists and academics keep. The book is dedicated to the memory of Annemarie Surlykke (1955–2015) of the University of Southern Denmark who did stellar research in both bat and dolphin biosonar.

A history of the study of echolocation in bats is the subject of the first chapters written by Alan Grinnel, Edwin Gould, and M. Brock Fenton. This chapter sets a good tone for the rest of the book and is very thoughtfully written, enlightening, and interesting with good pictures of bat scientists performing field work, having fun and enjoying each other's company. As a dolphin researcher interacting with the "bat people" for many years at different scientific meetings I always knew that many of them shared great comradery, but kept their independent perspectives and ideas. Yet many of them were very cooperative, had friendly and often heated arguments and enjoyed competition of ideas and shared a common joy of field work most likely in distant jungles, rugged mountain terrain, and large caves. Field work and laboratory studies are intermixed in this area of study with several chapters discussing results from both field and lab work in a seamless fashion. The first chapter provided a good history in the development of bat bioacoustics research, highlighting the key individuals and their contributions and the development of knowledge and understanding gained in the past sixty plus years.

The book is very broad in scope consisting of 11 chapters. The "Overview" at the end of Chapter 1 describing the layout of this book and a summary of each chapter is excellent and will not be repeated here. One worthwhile statement in the overview that is worth quoting is "Although this book focuses on the bioacoustics of bats, it repeatedly connects to topics in basic biology, functional morphology, evolution, and diversification." This single sentence emphasizes my earlier statement that this book is a "must" for anyone interested in studying bats.

Biosonar and communications are the principle features of bat bioacoustics. The same organs are used for the production and reception of signals. Communications cover longer distances than biosonar since biosonar by its nature is for shorter ranges mainly because of the low reflectivity of prey and the two way versus one way acoustic propagation loss. The biosonar function is extremely complex, perhaps much more than we can appreciate. The prey (mainly moths and insects) are moving rapidly, not in a linear manner but in a somewhat haphazard fashion. The bat is also moving, chasing the prey. The bat must detect, discriminate, localize, and compute the trajectory of the prey. It must compensate for its own speed and using sonar returns compute a trajectory that will cause it to intercept the insect prey. Often, the preys are flying amongst branches and leaves of trees which act as unwanted clutter. This process is going on while other bats are also hunting and introducing interference by their signals or reflection from prey from their signals. It should also be noted that not all species of bat echolocate. Some species of bat tend to eavesdrop on the echoes from insect that other bats are ensonifying while others listen for sounds that certain insects such as crickets produce. *Bat Bioacoustics* covers all the elements involved with the bat biosonar and acoustic communications from the production and anatomy of the sound generation mechanism, the neurophysiology of hearing and echolocation, the anatomy of receptor (ears) along with the micromanipulation of the ear shape to best improve echo signal-to-noise and signal-to-cutter ratio in

order to solve the complex biosonar problem. Dynamic and sophisticated signal processing is required along with fine neural control of simultaneous fine flight dynamics and the biosonar function. Most of the insect eating bats use some type of frequency modulated pulses and the bat's receiving system including its auditory cortex has a fine tonal topic mapping for multi-frequency processing. However, some species of bat emit long duration tonal-like signals. There is even a section on olfaction which has little or nothing to do with acoustics but may involve fruit eating bats. It is sufficient to state that the acoustic system of bats is extremely complex and any book that seeks to cover the topic in depth will also be complex. Some relatively new topics discussed in the book are the molecular basis of hearing from a candidate gene approach and a genomic approach.

Researchers have taken good advantage of the technological revolution in electronics and microelectronics and microcontrollers. Faster and smaller computers with high speed multichannel simultaneous digital acquisition instruments allowing for the use of up to 16 or more microphones to record the biosonar signals as the bats homed in on dangling or flying prey have been used in bat flight rooms. These systems also include the acquisition of simultaneous video images. The results of recording inflight dynamics of the biosonar process have expanded the understanding of the "auditory scene" in the bat's world. A chapter is devoted to this topic. Another chapter reviewed how the continual development of miniaturizing electronic circuitry has allowed for developing electronic packages that can be attached to the head of flying bats as they forage for prey. The book also considers topics as diverse as acoustic communications in different species, the role of temporal resolution in echolocation and the corresponding neural coding associated with temporal and spectral resolution. Neural adaption for processing of specialized signals used by many bats is also discussed.

The book closes with a chapter titled "Perspective and Challenges for Future Research in Bat Hearing." Here, we have three proven, world class, long time bat researchers sharing their thoughts on future directions in research. This is the pot of gold at the end of the rainbow that any bat researcher would be glad to have. Some may not agree with the three authors of this chapter, Lutz Wiegrebe, Alan Grinnel, and Brook Fenton, but the material in this chapter gives much food for thought. Nine specific areas are mentioned with fruitful discussion on some of the major issues and questions that need to be addressed in future work.

In closing, it is my opinion that this book is a "must have" for anyone interested in learning and understanding the process involved with the biology of bats and their sensory system.

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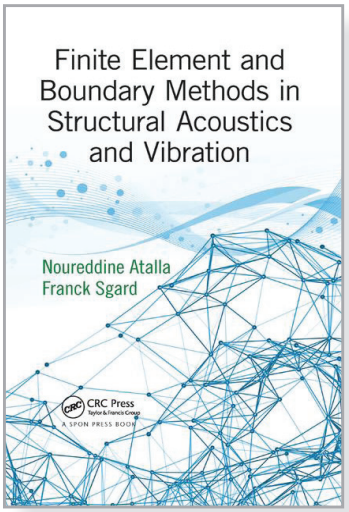
Finite Element and Boundary Methods in Structural Acoustics and Vibration



Authors: Noureddine Atalla and Franck Sgard

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This book concisely describes the basic theory, use and implementation of the finite element (FE) and boundary element (BE) methods applied to vibroacoustics problems. Both authors have had a long research history in the fields of propagation in complex environments and fluid-structure interaction. The book is divided into eight chapters.

Chapter 1, Introduction, describes the fluid-structure problem in the context of scattering theory and its classification into interior, exterior and interior/exterior problems, accompanied by examples.

Chapter 2, Basic Equations of Structural Acoustics and Vibration, describes the fundamental equations governing the three classical problems in mechanics: linear acoustics, linear elastodynamics and linear poro-elasticity.

Chapter 3, Integral Formulation of the Problem of Structural Acoustics and Vibration, introduces classical methods for obtaining the variational integral formulation associated with some common problems in continuum mechanics. This chapter also discusses important topics like principles of stationarity, virtual work and minimum potential energy with many good examples.

Chapter 4, The Finite Element Method: An Introduction, discusses fundamental concepts of the finite element method through the study of the solution of the one-dimensional wave equation. The chapter concludes with several examples for different boundary conditions and use of various finite element basis functions.

Chapter 5, Solving Uncoupled Structural Acoustics and Vibration Problems Using the Finite Element Method, revisits the step by step finite element methodology introduced in Chapter 4 with several examples, applied to the uncoupled 3D acoustic and structure problems. The appendices describe various shape functions in two and three dimensions and present formulas for their numerical integration over various elements, accompanied by useful Fortran codes.

Chapter 6, Interior Structural Acoustic Coupling, discusses the coupled interior acoustic problem. It introduces various formulations with emphasis on the classical pressure-displacement formulation. The implementation of this method using the uncoupled modes of the structure is discussed in detail.

Chapter 7, Solving Structural Acoustics and Vibration Problems Using the Boundary Element Method, provides a detailed description of the acoustic application of the BE method. Its various formulations (direct, indirect and variational) are presented with an emphasis on numerical implementation and techniques to reduce the difficulties associated with the calculation of singular integrals. The non-uniqueness problems associated with the BE method is discussed and both the CHIEF and the Burton-Miller methods are described in detail.

Chapter 8, Problem of Exterior Coupling, discusses the fluid-structure interaction for the exterior problem. This chapter presents various formulations combining the FE method for the structure and the BE for the unbounded fluid medium and discusses their advantages and disadvantages. Like some other chapters, this chapter uses examples to illustrate the accuracy of the methods by comparing the resulting solutions with those obtained from analytical or other FE-based solutions.

The book contains a rich collection of references and includes MATLAB codes that can readily be used and expanded. I find the latter particularly useful in understanding the concepts. I have a few comments about the writing of the book. I think there is some loss in translation. For example, the use of the word 'resolution' apparently as a substitute for 'solution' or '…vibrations' instead of '…vibration' in the title of Chapter 3 or the omission of the article 'The' in the title of Chapter 8. There are probably other cases that I haven't caught, but some might just be typos. Despite these minor issues, I find the book very useful and highly recommend it to students and researchers in science and engineering.

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