Books

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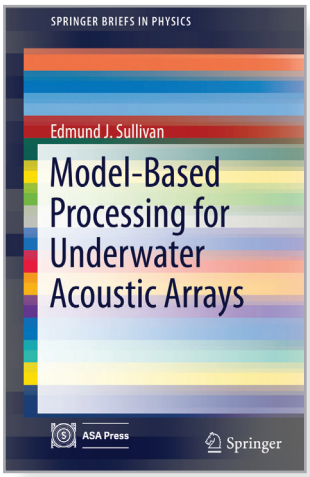

Model-Based Processing for Underwater Acoustic Arrays

Author: Edmund J. Sullivan
ISBN: 978-3-319-17556-0
Pages: 113 pp., 25 illus., 14 illus. in color
Available formats: Softcover, $54.99, eBook, MyCopy
Publication Date: 2015
Publisher: Springer International Publishing

This monograph presents a unified approach to model-based processing for underwater acoustic arrays. The use of physical models in passive array processing is not a new idea, but it has been used on a case-by-case basis, and as such, lacks any unifying structure. This work views all such processing methods as estimation procedures, which then can be unified by treating them all as a form of joint estimation based on a Kalman-type recursive processor, which can be recursive either in space or time, depending on the application. This is done for three reasons. First, the Kalman filter provides a natural framework for the inclusion of physical models in a processing scheme. Second, it allows poorly known model parameters to be jointly estimated along with the quantities of interest. This is important, since in certain areas of array processing already in use, such as those based on matched-field processing, the so-called mismatch problem either degrades performance or, indeed, prevents any solution at all. Thirdly, such a unification provides a formal means of quantifying the performance improvement. The term model-based will be strictly defined as the use of physics-based models as a means of introducing a priori information. This leads naturally to viewing the method as a Bayesian processor. Short expositions of estimation theory and acoustic array theory are presented, followed by a presentation of the Kalman filter in its recursive estimator form. Examples of applications to localization, bearing estimation, range estimation and model parameter estimation are provided along with experimental results verifying the method. The book is sufficiently self-contained to serve as a guide for the application of model-based array processing for the practicing engineer.

Book Review

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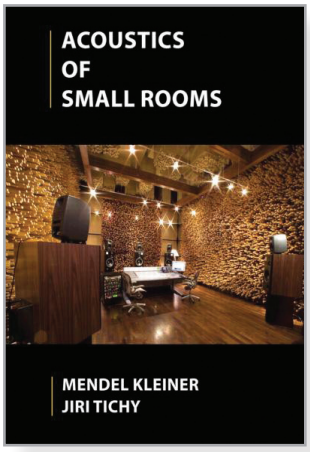
– Philip L. Marston, *Book Review Editor*



Acoustics of Small Rooms

Authors: Mendel Kleiner and Jiri Tichy
ISBN: 978-041-5779-30-2
Pages: 491 pp
Binding: Hardcover
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Price: $107.96
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Acoustics of Small Rooms is a physics and engineering textbook by Mendel Kleiner and Jiri Tichy, senior teachers and researchers in acoustics, with vast experience in research and its application in architectural acoustics, and who are interested in music. The topic of this book is the acoustics of small rooms. It focuses on "small rooms with interior vol-

umes from a few cubic meters to a few hundred cubic meters." Thus, "rooms as diverse as car cabins and small lecture rooms, reverberation and anechoic chambers might fit the description." The book therefore excludes large auditoria, performance spaces, industrial buildings, etc. It discusses room acoustics; it does not discuss building acoustics (e.g., room-to-room transmission).

This book contains 491 pages and 14 chapters. The book begins with chapters on the basic properties of, and physics related to, sound and sound in enclosures, such as sound pressure, acoustical impedance, and solutions to the wave equation for various boundary conditions. Further chapters discuss absorption and diffusion, and then human hearing and psychoacoustics—the human perception of sound. Then, the content becomes more specific to small rooms in chapters on sound reproduction, low-frequency sound fields, geometric acoustics, and rooms for music practice. The final two chapters focus on room-acoustical modeling and measurement.

[*M.H. reviewed this book as a senior acoustics professor who teaches engineering acoustics to undergraduate and graduate students, and who does research, mainly in architectural acoustics from engineering and physics perspectives, with a strong interest in how sound in rooms affects the health, well-being, communication, and productivity of the occupants.*]

What are the book's strengths; what is it good for? The book is well-written and organized, with many useful illustrations and extensive references. It is a comprehensive review of the state of the art on many important topics in small-room acoustics, presented by authors with much knowledge and practical experience. It discusses small rooms from both objective and subjective points of view. It is a compilation of conventional and less conventional material. The introductory chapters are fairly conventional, but introduce relevant correlation functions, convolution, and sound intensity. The chapter on room sound fields focuses on diffuse fields, but discusses the characteristics of non-diffuse fields. The chapter on sound diffusion and diffusers includes a brief discussion of volume scattering; does the book ever say that scatterers reduce reverberation, independent of absorption effects? The section on scattering and diffraction in the chapter on geometric acoustics is welcome. The brief chapter on the ear (i.e., the human auditory system—I was surprised to meet this in the middle of the book) discusses its physical response characteristics and head-related transfer functions (HRTFs). The chapter on psychoacoustics helped me consolidate my understanding of room acoustics from the occupant perspective, but I wondered what my psychologist post-doctoral fellow would think of it (see below). Chapter 8 is a very useful, less conventional, review of spatial hearing, including the precedence effect, cocktail-party effect and spaciousness, as well as the effects of reverberation. As a researcher who does not focus on rooms for music, Chapters 9 (on sound–music, not speech–reproduction) and 10 (on sound-field optimization, including active control) helped me upgrade my knowledge of this subject. Chapter 9 introduces the modulation transfer function in application to loudspeakers and music. It discusses early reflections (but not early-to-late energy fractions), the effects of the replay loudspeaker, and stereo, binaural, and surround-sound reproduction. Chapter 11 on rooms for sound reproduction discusses the designs of recording studies and home listening rooms; the theme of Chapter 12 is music rehearsal and practice rooms, ending with a very brief discussion of rooms for speech. These somewhat unconventional sections are very comprehensive in their discussions of major design issues such as room geometry and diffusion, and bring together a lot of relevant practical information. The final two chapters provide a comprehensive review of low- and high-frequency prediction and measurement methods used in room-acoustical research and design, including less conventional topics such as scale modeling, numerical methods, and auralization for prediction, as well as particle-velocity and sound-intensity measurement, the principle of reciprocity, and, briefly, binaural recording and listening tests.

What are this book's shortcomings? It is a summary of the authors' knowledge of the aspects of architectural acoustics that they are interested in, have studied, and applied—that is, mainly rooms for music—not a thorough treatment of all relevant topics. There are missing topics, some of them highly relevant today, such as classrooms, small open offices and industrial workrooms, speech intelligibility, early/late energy fractions, reverberation rooms, the Lombard effect, edge diffraction, sound-masking systems, "green" buildings, etc. The book is a review of existing knowledge; some data is taken from old, unsubstantiated, sources; apparently no new work was done specifically for this book to make it more complete. Some topics are introduced, then dismissed in one or two brief, conceptual paragraphs that do not say much, but may provide useful references; maybe these topics will be expanded in the second edition. The book's index could be more comprehensive; for example, the preface says that the book is relevant to reverberation rooms, but I found little on this topic, and it was not listed in the index.

Who should read this book? Students, researchers, and practitioners who want to learn the state-of-the art on small-room acoustics will find this book an interesting, useful reference. I will recommend to my new graduate students that they start their reading here, but warn them that they will then need to go further and deeper.

[*J.H. reviewed this book from the perspective of a recent mechanical-engineering graduate with experience in the study, research, and practice of building acoustics, who is very interested in music, who has studied acoustics at a graduate level and is currently taking on small-scale consulting projects, as well as working to design and commercialize a line of acoustical products. As such, he was most interested in extracting practical information from this book.*]

The content of this book is similar to many graduate-level room-acoustics texts, except for the intentional exclusion of phenomena pertaining to large rooms, such as concert halls and lecture auditoria. The examples and practical content are largely focused on rooms for sound reproduction and rooms for music; both authors note they are fans of music. Information specific to industrial and office acoustics is not included.

Although the authors acknowledge that "the construction of satisfactory listening rooms is very demanding and requires an extensive knowledge of their building construction," this book only provides generalized practical considerations and is missing information on construction detailing and prescriptive design processes. The theory is well-covered, however, most of the physics and math content was not relevant to my current interests.

For me, the book could have served a better purpose by delving into more detail, providing design guidelines, and forgoing long sections on the basics of room acoustics. The content in chapters on absorption, diffusion, modeling, and rooms for sound reproduction fell flat, as I have read books with more detailed and exhaustive coverage on these topics. However, I did find the chapter on "Small rooms for voice and music practice" particularly interesting, as I recently designed and built a 230 m^3 rehearsal studio.

The premise for this book is intriguing, but it did not meet my expectations for the amount of new information or for insight specific to small rooms. It is a useful book to have for reference on a number of topics, but it may be overshadowed by greater texts in an acoustics library.

[*L.S. reviewed Chapter 7: Psychoacoustics of this book from the perspective of a recent doctoral graduate in Environmental Psychology, pursuing research involving room and psychoacoustics, and who had to quickly get up-to-speed on these topics.*]

The chapter aims to provide an overview of the key issues in psychoacoustics. From my perspective, it overemphasizes technical aspects of the physical aspects of sound and underemphasizes the relevant psychological processes.

What is missing? Beyond this discussion of the perceptual aspects of sound, I would expect that this chapter (or another chapter in this book) might discuss other psychological aspects of sound in small rooms. For example, many studies have investigated the effects of sound on office workers' performance, finding variations according to the complexity of the task, demographic factors such as age, and characteristics of the sound, such as novelty. Another large body of research has examined the effects of sound on academic performance in children and teachers. Other than performance, sound in small rooms is linked to a number of psychological outcomes, including well-being, social behavior, and health outcomes. While such work may be of relevance to readers from other disciplines (e.g., psychology), perhaps it is beyond the scope of the current book.

The reader requires knowledge of various acoustical terms and methods to fully follow the chapter. While this may be achieved by reading earlier chapters, this requisite knowledge reduces the accessibility of the chapter for interdisciplinary readers.

Some of the sections are lacking psychological explanations. The section on meaning alludes to the fact that sound has meaning, but says little about the way that the meaning of sound is constructed (with the exception of modulation). Sound acquires meaning in other ways too, such as through classical and operant conditioning, statistical learning and language, and cultural and evolutionary processes. The section on types of signals discusses three types: aperiodic, periodic, and quasi-periodic; I did not see how each is clearly linked to perception, except for some anecdotal examples. The section on source center is a brief description of the source centers of various sounds; a more explicit discussion of how this relates to perceptual outcomes would be helpful.

Some of the terms and explanations may be confusing for the psychological reader. For example, in the section on per-

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ceptual restoration, the term "restoration" is confusing. My understanding of restoration from cognitive psychology describes the recovery from depleted cognitive resources following exerted cognitive effort (e.g., attention restoration); I do not know how homophonic induction is restorative in this sense. Had the book initially explained the definition of restoration, it would have helped. Then again, perhaps this term will be understood by the audience for which this chapter is intended. On the other hand, the text on continuity is interesting; we know that continuity is a general cognitive principle that applies to speech and reading, but I had never considered it acoustically.

Despite these issues, a number of concepts, such as pitch and virtual pitch, the definition and measurement of critical-band filters, coloration, and modulation, were clearly explained and, thus, informative to an interdisciplinary/novice audience who may wish to incorporate acoustics into their research.