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Fourier Acoustics: Sound Radiation and Nearfield Acoustical Holography FREE

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BOOK REVIEWS

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Fourier Acoustics: Sound Radiation and Nearfield Acoustical Holography

Earl G. Williams

Academic Press, London, 1999.
xi+306 pp. Price: $79.95 (hardcover), ISBN: 0-12-753960-3.

Dr. Earl Williams has made exceptional contributions to structural acoustics during his career. This book represents many of these accomplishments. Most importantly, this book provides an excellent self-contained reference for nearfield acoustical holography (NAH) and related wave number processing techniques. In addition to clear explanations of physical phenomena, Dr. Williams provides superb descriptions of the details needed to implement the processing on a computer. Figures are used expertly to make important points that are often hard to visualize with words alone.

The book does require a good background in acoustics and structural vibrations to understand all that is in it. However, as I am finding out with a new graduate student, it does provide good explanations on how to implement the NAH processing so that the student can develop the physical understanding while working with data.

I would recommend it very highly as a reference book for people using NAH in their work and as a text in a course on measurement techniques such as NAH. This could also serve as a supplemental book to a course on structural acoustics. The author provides problems at the end of each chapter.

The book begins with a review of Fourier transforms and special functions that will be used in the following chapters. The review includes a brief comparison of continuous and discrete Fourier transforms. The reference list is short, but the chapter is complete enough to provide the basic information.

Chapter 2 is a key chapter of the book and is packed with a wealth of information, showing how the plane wave can be used to study sound radiation from planar structures. The chapter begins with a basic discussion of wavenumbers, making a distinction between the wavenumber of a freely propagating plane wave and the wavenumbers in the wavenumber spectrum. The definitions of sound intensity are also presented along with a discussion of evanescent waves. Dr. Williams then presents a plane wave expansion as a means to introduce the wavenumber processing. This can help the reader understand the wavenumber spectrum, calculated from a spatial Fourier transform, in terms of a physically understandable plane wave. Finally, the expansion is applied to understanding the sound radiation from planar radiators as Rayleigh's integral is implemented with the Fourier transform. There is a good discussion of supersonic intensity. Sound radiation from baffled pistons and arrays is discussed along with edge and corner mode radiation from vibrating plates. This chapter is well done and provides a good basis to physically understand the wavenumber spectrum. A person could spend a long time working through this chapter alone.

Chapters 4 and 6 present similar material, but for cylindrical and spherical coordinates. While each is less extensive than Chap. 2, they provide excellent information on the wave functions in each coordinate. Both the interior and exterior problems are discussed. The characteristics of the sound radiation from cylindrical and spherical objects are emphasized in each respective chapter.

Chapters 3, 5, and 7 present the inverse problem in planar, cylindrical, and spherical coordinates: nearfield acoustical holography. Chapter 3 clearly describes the signal processing steps for NAH. Not only are the steps such as windowing, zeropadding, and filtering discussed, specific methods to implement each is given. The discussion of noise and filtering is especially well done. This chapter presents material that is not completely contained in the archival literature. Chapter 3 can be used as a manual for writing or understanding a NAH program.

Chapter 5 presents NAH in cylindrical coordinates. Several case studies that have been published in archival journals are presented. Chapter 7 presents NAH for spherical coordinates. While there are no examples given as in previous chapters, there is a brief discussion of the interior problem.

In the final chapter, Chap. 8, Green's functions and the Helmholtz integral are discussed for the purposes of presenting conformal NAH. This allows NAH to be extended to arbitrary geometries. While the discussion is good, no data is presented that effectively demonstrates applications. This leads to one common criticism of NAH and the Fourier transform techniques for structural radiation, that they can only be applied to nearly planar, cylindrical, or spherical shapes. This severely limits the applicability of this material to areas such as noise control where complex shapes are the norm.

This book is a valuable resource for anyone working in the area of NAH and structural acoustics. It is especially helpful to have a clear reference on NAH that combines all the material in archival journal articles into one place. Dr. Williams should be commended for clearly communicating his exceptional contributions and understanding of NAH and structural acoustics.

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The Acoustics of Speech Communication: Fundamentals, Speech Perception Theory, and Technology

J. M. Pickett

Allyn and Bacon, Boston, Massachusetts, 1999.
404 pp. Price: $64.00 (hardcover), ISBN: 0-205-19887-2.

J. M. Pickett successfully accomplished the basic aim of his book, ''to teach the technical acoustics of speech and its perception to the nontechnical student.'' His 1999 text is divided into two sections and is an updated, enhanced, and well-expanded version of his 1980 text. The first ten chapters are written by Pickett and provide a general description of the acoustics of speech, speech analysis, and English speech sound distinctions. Chapters 11–16 deal with speech perception and include chapters by Winifred Strange, Sarah Hawkins, and Sally Revoile. Chapter 17 reviews speech technology.

Pickett begins Chap. 1 by describing the difference between a phoneme and an allophone and the importance of the syllable. He provides a cursory review of anatomy to aid in the understanding of the sound source and radiation characteristics. In ten chapters, he successfully moves the reader from the phonetic segment to conversational speech. Chapter titles are

Language, Phonetics, and Speech Production
Sounds, Resonance, and Spectrum Analysis
Vowel Shaping and Vowel Formants
The Glottal Sound Source and the Spectra of Vowels
Prosodic and Tonal Features
Consonant Features, Glides, and Stops
Consonants: Nasal, Stop, and Fricative Manners of Articulation
Consonants: Features of Place of Articulation
The Flow of Speech

Chapter 10 does a very nice job tying everything together for the reader and presents the big picture of speech production. Pickett emphasizes the need to attend to conversational speech and not get lost in the segment. He shares his hope that future analyses will be able to use the movement flow instead of the segment as the fundamental starting point. Throughout the text, Pickett provides nice examples that keep the reader interested and allow the beginning student to grasp difficult concepts. Common scenarios that relate to specific physiological functions are frequently included. For example, the glottal source sound is compared to a New Year's noisemaker. When a vocal track or horn is added to the sound source, the resultant sound is altered. An additional helpful aspect of the text for the beginning student is the inclusion of specific rules. For example, to help understand the many variables related to formant changes, Pickett provides length and constriction rules and discusses why they affect specific formants. Moreover, the selection of diagrams and figures included in the text is excellent and greatly aids understanding.

An advantage of the text is the cross-linguistic, disordered, and developmental information interspersed throughout the book. Phonology note boxes in each chapter describe how the phonological patterns of different languages fit into the acoustic information just presented. These will be very useful to the instructor who is trying to facilitate student understanding of the differences between English phonemes and phones as well as cross-linguistic differences. Further, the inclusion of disordered speech examples makes this text an excellent choice for beginning speech-language pathology students. After reading the first section of the text and studying the helpful figures, one should have a stable understanding of the acoustic elements of English phonemes and comprehend important differences between specific manners and places of articulation.

Part two of the text discusses the perception of speech. Winifred Strange walks the reader through the perception of vowels and consonants in Chaps. 11 (Perception of Vowels) and 12 (Perception of Consonants). The acoustic differences between place of articulation and voicing and the resulting perceptual properties are carefully discussed. Categorical and continuous perception of speech and nonspeech acoustic signals are thoroughly explained. Further, the complexities in the perceptual processes that enable the listener to understand the phonetic message even when the acoustic patterns vary as speech speeds up and slows down is discussed. In Chap. 13 (Auditory Capacities and Phonological Development: Animal, Baby, and Foreign Listener), Sarah Hawkins presents information on general auditory capabilities, phonological development, and infant and animal perception. Specific speech perception research methodologies are described and selected results are presented. Hawkins carefully describes and evaluates the two classical speech perception theories: Lieberman's motor theory and Steven's quantal theory in Chap. 14 (Looking for Invariant Correlates of Linguistic Units: Two Classical Theories of Speech Perception). More recent theories such as direct realist theory of speech perception (Fowler, 1986), articulatory phonology (Browman and Goldstein, 1992), and Diehl and colleagues' auditory enhancement theory are presented in Chap. 15 (Reevaluating Assumptions about Speech Perception). In this chapter the strengths and weaknesses of each theory are defined and compared. Moreover, Hawkins provides an overview of models of developmental perception and a complete evaluation of the assumptions of speech perception and the presented theories.

Sally Revoile leads the reader through a hearing evaluation of an individual with a hearing loss in Chap. 16 (Hearing Loss and the Audibility of Phoneme Cues). She explains which acoustic characteristics present the greatest problems for a hypothetical individual with a hearing loss and helps the reader understand why specific sounds are problematic. Figures visually help the reader understand the acoustic properties that are audible to individuals with normal hearing and individuals with different levels of hearing loss.

The final chapter of the book, Speech Technology, discusses speech technology and includes segments by Pickett, Juergen Schroeter, Corine Bickley, Ann Syrdal, and Diane Kewley-Port. The reader is given a brief history of speech synthesis and speech recognition. Common problems and newer systems are described and evaluated. Additionally, clinical applications of synthesized speech are discussed.

A major benefit to the text is found in the appendices. Appendix A discusses the need to incorporate laboratory exercises into any course of speech and hearing science. Several acoustic software packages are named and references for more complete reviews are included. Pickett has developed a lab to go with each of the chapters in the text. He notes that the labs are not completely self-explanatory and students will need the guidance of their instructor. Notes to the instructor are included and should help avoid common trouble areas. Appendix B provides book reviews that will be of interest to phoneticians, linguistics, and speech-language pathologists.

Pickett's text is easy to read, enjoyable, and an excellent choice for the nontechnical student. This reviewer highly recommends this text for introductory speech and hearing science courses.

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