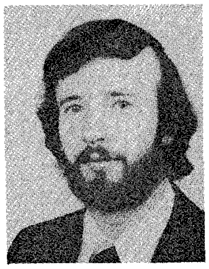

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Estimation and Tracking: Principles, Techniques, and Software, by Yaakov Bar-Shalom and Xiao-Rong Li, 1993, Artech House, xxii + 511 pages, $95.00, ISBN 0-89006-643-4.

This is an excellent book. The preface tells us that "[t]he text presents the material from a second semester graduate level course on Estimation offered in the Department of Electrical and Systems Engineering...[the] main goal of this course is to convey the knowledge necessary for the evaluation and design of state estimators that operate in a stochastic environment." To a great extent, the material is extracted from class lectures, but it does not suffer from the cryptic style commonly associated with lecture notes.

Although the authors intended the book to be used in a classroom setting, this reviewer is not an academic and, therefore, did not use the book as part of a class. Instead, the book was read in an effort to learn as much as possible about estimation and tracking principles, for immediate application on the job. It was found to be delightful and, more importantly, it was found to be helpful. The concepts were described in a clear and concise way; the equations were adequate for a detailed understanding, without being overwhelmingly complicated. There is software included in the book and it was not used extensively by this reviewer, but was found to be reasonably friendly, and certainly consistent with the textual material.

As with nearly all texts, this book begins with some review. The fundamentals of basic linear algebra and probability take the first 80 pages. In Chapter 2, the "Basic Concepts in Estimation" are discussed. The classical problems and theories of parameter estimation are discussed. Later chapters include "Linear Estimation in Static Systems," "Linear Dynamic Systems with Random Inputs," "Static Estimation in Discrete Time Linear Dynamic Systems," "Estimation for Kinematic Models," and "Computational Aspects of Estimation." Additionally, there are chapters on "Extensions of Discrete Time Linear Estimation," "Continuous Time Linear State Estimation," "State Estimation for Nonlinear Dynamic Systems," and "Adaptive Estimation and Maneuvering Targets." At the end of each chapter, there are brief bibliographical notes (i.e., identified suggested reading material), and from a few to several exercises.

The style of the text, designed to facilitate lectures, proved to be a blessing when used as a self-study guide. The material was presented in a very logical order, without unnecessary prose. The advent of faster and faster computers has enabled the field of estimation to become much more approachable to the non-expert. Although there is ample information in this text to service the future experts in this field, it is as a study guide for the non-expert that its true value will be found. Just like the tools of digital-signal processing did before it, the tools of parameter estimation will soon make their way in to every engineer's desktop toolbox. Commercial software is more available than ever: certainly more than when I took my system-identification class in graduate school! And yet, engineers are all too well aware that a tool without the proper knowledge of how to use it can be a very dangerous thing. This book could go a long way, as a vehicle to brief these non-expert parameter estimators as to how to properly use their tools, and what assumptions are built in and must not be forgotten.

The material in the text appears to be up-to-date: certainly enough so for either an introductory course, or a handbook for use by practicing engineers. Without a doubt, this book would be of value to microwave and system engineers, interested in either tracking systems or other topics related to estimation. It is easy to read, and full of useful equations. I highly recommend it.

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Fourier Array Imaging, by Mehrdad Soumekh, 1994, Prentice Hall, xv + 559 pages, $70.00, ISBN 0-13-063769-6.

In *Fourier Array Imaging*, Professor Soumekh provides a unified presentation of the theory of active and passive imaging, with real and synthetic arrays, through the use of a concept which he calls the spatial-Doppler phenomenon. With the aid of this concept, he shows how a variety of otherwise-disparate imaging modalities and geometries–such as electronically-scanned arrays, synthetic- and inverse-synthetic-aperture radar (SAR/ISAR), and geophysical probing–can be treated with a common analytical framework.

The central element of this common framework is the Fourier decomposition of the array signals, as a function of the spatial coordinate of the array. This, in turn, provides information related to the spatial-Fourier transform of the object function being imaged. In the process of this development, the author shows how this approach avoids the need for the Fresnel or Fraunhofer approximations, commonly used in the more-traditional image-formation techniques. This, in turn, permits imaging well into the near field of the object, resulting in larger scenes and/or finer resolution than what would otherwise be achieved. Although the term spatial-Doppler phenomenon is newly-coined by Professor Soumekh, it is nothing more than the use of the well-known plane- (or cylindrical-) wave-spectral representation for the (scalar) spherical-wave Green's function that describes the one-way (passive) or two-way (active) propagation between the object and the array. These representations have been used for more than a decade in medical ultrasound, sonar, and inverse scattering, but they have only recently been applied to radar-imaging applications, such as SAR and ISAR, primarily through the work of Professor Soumekh and others. Indeed, despite the generality of the plane-wave-spectral methods, Professor Soumekh uses examples almost exclusively from radar applications throughout the book.

Chapters 1 and 2 contain reviews of the fundamental signal-processing tools of Fourier analysis, in one and two dimensions, respectively, as well as introducing the concept of the spatial-Doppler phenomenon. These tools are the basis for the remainder of the text. The author does a good job of clearly distinguishing between temporal- and spatial-Fourier analysis of array signals, a subtle point, which is often a source of confusion in other treatments of this subject.

Chapters 3 and 4 cover real- and synthetic-aperture imaging with active arrays, respectively. This is a logical progression, which helps introduce concepts such as focusing, resolution, sampling, and so on, in a well-organized manner. The emphasis is clearly on monostatic two-dimensional geometries, and the reader may find the treatment of bistatic and interferometric (three-dimensional) imaging somewhat cursory. Nonetheless, Chapter 4 is the strongest in the book, and serves to coalesce a great deal of recent developments in SAR into a coherent presentation. A particularly nice feature is the comparison of the spatial-Doppler techniques (called "migration processing" in the SAR community) to the more-traditional Fresnel- (Stripmap SAR) and Fraunhofer- (Spotlight SAR) based algorithms.

Chapter 5 extends the results of Chapter 4 to the problem of SAR/ISAR imaging of moving targets with unknown velocity, in both open and cluttered environments. Although the techniques presented provide good academic introductions to the subject, the material is far from complete, and does not represent the state-of-the-art in techniques for imaging ground-moving targets. Even well-established focusing techniques, such as map drift and prominent-point processing, go unmentioned.

Chapter 6 covers passive-array imaging, with both real and synthetic arrays. The reviewer found this chapter the least satisfying in the book. This was particularly because of the simplistic treatment of the random signals that must be dealt with in passive-synthetic-aperture imaging, and the underlying theory of partial coherence, which provides the necessary methods for doing so. These topics should not be outside the grasp of graduate-level signal-processing students, and their inclusion would have made for a much more complete and general treatment of the subject.

Finally, Chapter 7 treats the subject of bistatic- (real-aperture) array imaging, and its application to transmission-imaging modalities, such as computed tomography. The treatment here is better organized and presented than Chapter 6, but less complete than the monostatic applications covered in Chapters 3 and 4. There is a particularly good treatment of the differences in Fourier-domain coverage afforded by different bistatic-imaging geometries, but there are no examples of the impact of these differences on the character and quality of the resultant image.

In summary, Professor Soumekh intends the book to serve primarily as a graduate-level text and research monograph for electrical engineers, interested in the use of signal-processing techniques in image formation. As such, it is presented with a strong signal-processing and linear-systems-theory flavor, but with only cursory treatment of the physical phenomenology that underlies the various imaging modalities and applications. While this is certainly an acceptable tradeoff for his principal audience (graduate-level signal-processing students), researchers in electromagnetics, optics, and/or acoustics may find the book lacking in this respect. There is little or no derivation of the "object-reflectivity function," which is the fundamental quantity being imaged, in terms of the intrinsic EM or acoustic properties of the body. Consequently, there is no discussion of the approximations inherent in this model, such as neglecting multiple interactions and frequency-dependent scattering, nor of the artifacts they produce in the image when present. There is also a lack of actual image data, with the vast majority of the results based on simple point-scatterer simulations. Finally, some readers may find his use of terminology somewhat cavalier, such as referring to a circular or spherical phase function (with no radial amplitude) as a "Green's function" in either two or three dimensions. Despite these shortcomings, Professor Soumekh has accomplished his goals, namely to provide a unified treatment of Fourier-array-imaging applications in a readable, well-organized text. I recommend this book for researchers in the field who seek to broaden their base, and augment more-detailed treatments of specific imaging techniques. I also recommend it to educators who wish to provide a graduate-level course for signal processing and/or EM students, which demonstrates how these two fields can be brought together to address real-world applications.

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Recent Books

The following is a list of recently-published books that have been received by the Associate Editor, since the last issue of the *Magazine* was published. Reviewers are sought for these books, so readers are encouraged to let the Associate Editor know if they are interested in reviewing a particular book.

An Introduction to Optimization, by Edwin K. P. Chong and Stanislaw H. Zak (John Wiley, 1995)

Analysis Methods for Electromagnetic Wave Problems, Volume Two, by Eikichi Yamashita (Artech House, 1996)

Introduction to High-Speed Electronics and Optoelectronics, by M. Leonard Riaziat (John Wiley, 1996)

Solving Interference Problems in Electronics, by Ralph Morrison (John Wiley, 1995)