The selection of books for review is entirely the purview of the editorial board. The opinions reflected in any review are solely those of the reviewer. Authors may send books for consideration of possible review to the IEEE Signal Processing Society's office: 445 Hoes Lane. Piscataway, NJ 08854; no submitted books will be returned.

Fundamentals of Radar Signal Processing by Mark A. Richards, published by McGraw-Hill, 2005, ISBN 0-07-144474-2. *Reviewed by Rob Miller, (miller_rob@bah.com), Booz Allen Hamilton, USA.*

Most current radar systems require complex, digital implementations involving the proper coding of digital signal processors (DSPs) and field programmable gate arrays (FPGAs). Moreover, classical literature does not pay particular attention to the digital signal processing perspectives associated with radar. Thus, the radar community in general lacks a current text that provides a concise, unified, and modern treatment of the basic radar signal processing techniques: signal modeling, matched filtering, waveform design, Doppler processing, threshold detection, constant false alarm rate (CFAR) detection, and pulse compression. *Fundamentals of Radar Signal Processing* by Mark A. Richards fills this void quite nicely, as it introduces the fundamental concepts of radar by building upon digital signal processing concepts.

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This book represents a definite middle ground with regard to existing radar literature. Classical radar texts, such as Skolnik's *Radar Handbook*, Edde's *Radar: Principles, Technology, Applications*, and Peebles' *Radar Principles* represent solid alternative radar starting points and all will act as excellent primer material if one wants to maximally benefit from this book. Nevertheless, *Fundamentals of Radar Signal Processing* does provide a thorough covering of all of the basic radar topics, in addition to more advanced topics, such as CFAR detection, synthetic aperture radar (SAR), and space-time adaptive processing (STAP). Moreover, this book provides sufficient introduction so that readers may continue to more advanced books on SAR (e.g., *Digital Processing of Synthetic Aperture Radar Data: Algorithms and Implementation* by Cumming and Wong) and STAP (e.g., Guerci's *Space-Time Adaptive Processing for Radar*).

THIS BOOK REPRESENTS A VALUABLE RESOURCE FOR BOTH THE CLASSROOM AND THE PROFESSIONAL WORLD.

With over 20 years of experience in academia, industry, and government, Dr. Mark A. Richards has had a viable impact on the radar world. *Fundamentals of Radar Signal Processing* was actually developed over many years of teaching a Georgia Institute of Technology (Georgia Tech) graduate school course on the subject. Additionally, key excerpts from the book are used as the material for a week-long professional education course on the topic. It seems appropriate then, that this book represents a valuable resource for both the classroom and the professional world.

As the author intended, the optimal audience for this book envelopes both the graduate student and the working professional. However, the reader should have a firm background in basic discrete and continuous signal processing, in addition to some exposure to random processes. This book may therefore also be useful to some more advanced undergraduate students.

Supplementary online material is accessible (some upon request) and will prove beneficial to both students and instructors. For the instructor, a sample course syllabus, homework problems and solutions, and classroom-refined presentation materials are provided. For the student and working professional, supplemental notes (e.g., the derivation of the range-Doppler algorithm frequency response) and some limited MATLAB routines are available. I feel that coding examples are extremely helpful to solidify one's understanding of radar theory and concepts; Mahafza's book, *Radar Systems Analysis and Design Using MATLAB*, contains a bevy of coding examples and may therefore represent a suitable text accompaniment. Nevertheless, *Fundamentals of Radar Signal Processing* is clear, concise, and informative, as evidenced by its adoption by academia (e.g., Georgia Tech and Virginia Tech) and industry (e.g., Raytheon, ITT, and Lockheed Martin).

The text begins with a very readable, clear history of radar in addition to an introduction to radar systems. Chapter 2 follows with an exposition on basic radar topics such as the radar range equation, radar cross section, clutter, and Doppler shift. Chapter 3 deals with vital DSP

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topics such as sampling and quantization—topics absent in alternative literature. The author even derives the signal-to-quantization noise ratio for a B-bit uniform quantizer, again nonstandard for most radar books. The text continues with more classically covered radar topics, including a description of basic radar waveforms and a chapter on Doppler processing. Particular attention is paid to matched filtering, moving target indication, and pulse Doppler processing. Next is the chapter on detection fundamentals, where the focus is on hypothesis testing and threshold detection. Finally, the author presents chapters on CFAR, SAR, and STAP. All are well written and provide a solid foundation for more advanced reading on the subjects. Throughout the text, there are many well-placed images and illustrations. I found Figure 8.1 particularly valuable with regard to the capabilities associated with SAR. It provides a side-by-side comparison of optical and SAR aerial images of the Albuquerque airport, and emphasizes the fact that the SAR image would be available even on a dark, cloudy night.

Aside from technical merit, this book stands out in other areas. One such feature that I find particularly convenient is the fact that every chapter ends with its own reference section. It is nice not to have to search through a large reference section in the back of the book when looking for a desired reference while reading a given chapter.

[*FUNDAMENTALS OF RADAR SIGNAL PROCESSING* IS CLEAR, CONCISE, AND INFORMATIVE, AS EVIDENCED BY ITS ADOPTION BY ACADEMIA AND INDUSTRY.]

From my perspective, various aspects of this text could be improved. Lacking from each section are the problem sets common to most course textbooks. In addition, not many examples exist throughout the book. It is often helpful—to both students and working professionals—to skim through a section and modify an example to fit one's own problem. Likewise, more code listings would be of great benefit (MATLAB or C), especially because the main focus of the book is to present radar from a DSP perspective. A final recommendation would be to add a summary section to the end of each and every chapter like the one found in Chapter 2.

While maximizing the use of this text may involve reading Edde, Skolnik, and/or Peebles, it is certainly not essential. In fact, this book serves as an excellent introduction to the radar world, particularly in its current digital form. Furthermore, *Fundamentals of Radar Signal Processing* lays the appropriate foundation for more advanced SAR and STAP research. *Fundamentals of Radar Signal Processing* is an outstanding choice for the classroom and the boardroom; it is perhaps the most readable text on radar that I have encountered. In addition, it fills a much needed void by delivering a digital signal processing-based presentation of radar fundamentals. As the radar community continues to develop and implement increasingly complex systems, this book is sure to become an invaluable instructional tool and desktop reference. [SP]

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