COMMUNICATIONS AND SENSING ARE two key applications of electromagnetic waves. While the former discipline has attracted the majority of researchers’ attention in recent years, investigation in the latter discipline is progressing actively but more quietly. The 1,400-page book, *Novel Radar Techniques and Applications*, presents a variety of new concepts and techniques that are being researched in radar-related areas. Since most have yet to find their way into operational use, why would this work be of interest to the antennas and propagation (AP) community? The answer is that this is an excellent opportunity for AP professionals to catch a glimpse of promising radar concepts and, during the process, to perhaps identify how AP research can impact radar-sensing technology.

The editor of the book, Dr. Richard Klemm, is a renowned expert on radar signal processing and adaptive clutter cancelation. He spent a distinguished career at FGAN FHR (now the Fraunhofer Institute for High Frequency Physics and Radar Techniques, Wachtberg, Germany). Dr. Klemm is also a superb classical pianist. I had the privilege to listen to a passionate performance of his for attendees of a 1999 NATO radar workshop in Spain that he organized. He has obviously invested the same kind of passion in this book, ensuring that the wealth of knowledge built up over the years can be passed on to developers of tomorrow’s radar.

The work contains a total of 34 chapters, and approximately 25% of them were contributed by researchers from the Fraunhofer Institute. The book consists of five separate topics, i.e., electronically steered arrays, synthetic aperture imaging, passive/multistatic radar, waveform diversity/cognitive radar,
and tracking/data fusion. Each topic is overseen by a coeditor who is a leading expert in that particular area. Due to the immense size of the book, it is split into two volumes.

**TOPIC 1**

Topic 1 deals with real aperture array radar. It includes three chapters (Chapters 1–3 of Volume 1) that are coedited by Ulrich Nickel, formerly associated with the Fraunhofer Institute for High Frequency Physics and Radar Techniques. In Chapter 1, the fundamentals of array radar are provided. It is a summary of radar array theory from an array-signal-processing point of view. Chapter 2 discusses space–time adaptive processing for detecting moving targets with airborne radar in the presence of stationary ground clutter or other interferers. An overview of radar resource management, including task management, priority assignment, and scheduling for an electronically steered array, are provided in Chapter 3.

**TOPIC 2**

Imaging radar is the next topic, which is treated in eight chapters (Chapters 4–11 of Volume 1). The coeditor is Christoph Gierull of Defence Research and Development Canada, Ottawa. Video-SAR is discussed in Chapter 4, which is a spotlight synthetic aperture radar (SAR) mode over an extended period to produce videolike high-resolution images for persistent surveillance and change detection. Next, Chapter 5 discusses the principle of high-resolution, wide-swath imaging through a displaced-phase-center antenna in the along-track direction. A review in Chapter 6 describes interferometric SAR for estimating the precise elevation of reflecting surfaces through the phase difference in SAR pixels from multiple elevation measurements. Chapter 7 asserts the latest advances and challenges in space-based SAR-ground moving target indication (GMTI). In Chapter 8, details are given for differential interferometric SAR to measure ground deformation over time from multipass SAR collection. Chapter 9 describes a new SAR-GMTI mode that combines monostatic and bistatic data collection using an airborne multichannel radar and a stationary transmitter. Chapter 10 considers inverse SAR imaging under the multiple distributed sensor scenario. Finally, Chapter 11 provides a description of the velocity SAR algorithm that aims to bring into focus moving targets that typically become smeared and displaced in a SAR image.

**TOPIC 3**

The third topic covers passive and multistatic radar in Chapters 12–19 of Volume 1. The coeditor is Pierfrancesco Lombardo of the University of Rome La Sapienza, Italy. Clutter modeling for bistatic scenarios is discussed in Chapter 12. Next, in Chapter 13, a description is given of the concept of and results obtained from forward-scattering radar systems, where the bistatic angle is close to 180°. Chapter 14 then details the through-wall imaging of building interior layouts by exploiting multistatic geometries, while Chapter 15 shows how short-range surveillance can be accomplished with passive radar by exploiting either digital video broadcasting-terrestrial (DVB-T) or Wi-Fi signals. An illustration of passive SAR imaging by using global navigation satellite signals is presented in Chapter 16. Chapter 17 discusses passive radar carried on an airborne platform for both SAR imaging and moving target detection, while using illuminators of opportunity, such as DVB-T on the ground. Chapter 18 considers hybrid passive radar utilizing multiple illuminators ranging from frequency-modulation broadcast to digital audio and digital TV signals to enhance target location. Then a characterization is given in Chapter 19 of the detection performance of passive multiple-input, multiple-output (MIMO) radar networks.

**TOPIC 4**

Waveform diversity and cognitive radar are treated under topic 4, which includes eight chapters (Chapters 1–8 of Volume 2) coedited by Hugh Griffiths of University College London, United Kingdom. Chapter 1 introduces the design and implementation of radar transmit waveforms to minimize spectral leakage that can interfere with other surrounding radio-frequency (RF) systems. The use of orthogonal-frequency division multiplexing signals as radar waveforms for adaptive clutter cancelation is explored in Chapter 2. Next, a cognitive radar waveform design is presented in Chapter 3 that optimizes radar performance while meeting spectral coexistence requirements with other RF systems. In Chapter 4, noise radar is discussed, with both its challenges for signal processing and its attractiveness (e.g., its low probability of interception and ideal thumbtack ambiguity function). Chapter 5 describes resource management and stochastic control techniques for cognitive radar to achieve the cognitive processes of attention and anticipation. An investigation is then presented in Chapter 6 that details how the bistatic properties of targets and clutter may be exploited to optimize detection and tracking under multistatic configurations. Afterward, Chapter 7 describes how bioinspired ideas from the echolocation system in bats can potentially be implemented in place of the traditional matched filter for radar receivers. Then Chapter 8 discusses the features and benefits of creating an intelligent, adaptive radar network as well as the challenges in resource management, communications, and synchronization.

**TOPIC 5**

Topic 5 encompasses target tracking and data fusion. It includes seven chapters (Chapters 9–15 of Volume 2). The coeditor is Wolfgang Koch of the Fraunhofer Institute for Communication, Information Processing, and Ergonomics, Wachtberg, Germany. A review is provided in Chapter 9 about the developments in the estimation of posterior Cramer–Rao performance bounds for target tracking. Chapter 10 discusses tracking and data fusion in a log-spherical coordinate system, which is particularly useful when range information is missing from a sensor. The target-tracking task for multistatic passive radar systems is discussed in Chapter 11, while Chapter 12 provides an overview of techniques used to achieve ground surveillance using radar in combination with environmental models.
and other types of sensors. Chapter 13 then reviews multiplatform radar systems with platforms connected via a high data-rate network to share sensor data and achieve performance gains over single-platform systems. Chapter 14 discusses indoor human localization and tracking using a network of ultrawideband radars. Finally, Chapter 15 describes resource management techniques to optimize the performance of radar networks.

**FINAL THOUGHTS**

I was excited to review this book, as it gave me an opportunity to test my ability to understand radar research from a systems perspective. After reading it, I would say that it gave me an overall snapshot of the active research directions in radar. It should be noted that the chapters are not written as an introductory book for students but intended for seasoned radar researchers, at approximately the level of articles in *IEEE Transactions on Aerospace and Electronic Systems, IEEE Transactions on Geoscience and Remote Sensing, or IET Radar, Sonar, and Navigation*. In comparison to the classic *Radar Handbook* edited by M.I. Skolnik (first edition, 1970; second edition, 1990; third edition, 2008), the present book is not an overview of existing radar technologies. Instead, it tries to capture the active radar research areas of the past decade. I believe it has achieved its intended goal quite well.

For readers in the AP community, this book presents an opportunity to identify potential research topics in the physical layer (e.g., antennas, propagation, and scattering) that can impact radar system design and signal processing. A good example is the discussion found in Chapter 13 on forward scattering in connection with the design of a forward-scattering radar. AP readers will find plenty of familiar terminology and scattering concepts in this chapter. This topic will be crucial for next-generation radar nets and MIMO sensors. Another example is the use of multichannel, displaced-phase-center antennas for ground moving target detection and high-resolution imaging discussed in Chapters 5, 7, 9, and 11 of the book. Meeting the challenging system requirements of these new radar concepts would require a holistic consideration of both antenna hardware and digital processing.

There are a few things I wish had been included in the book. First, its focus is on defense applications. I wish there would have been some coverage of emerging commercial sensors, such as automotive radar or short-range wearable radar for gesture recognition. I was also surprised to find little coverage of compressive sensing, considering that there has been such a large body of work on the topic in the past decade. Perhaps these could be incorporated into future editions of the book. Second, I found that the writing styles across chapters varied quite a bit. While some chapters are comprehensive in reviewing the state of the art, others read like research papers. The introduction at the beginning of each part of the book by the coeditors alleviated this problem to some extent, but only partially. Last, almost 75% of the chapter authors are from Europe (with the remainder from North America and Australia). I would have liked to have seen more participation from non-European authors.

A colleague of mine, who was the editor-in-chief of a prominent communications journal, once said to me, “Radar research used to be more advanced than communications research, but not anymore.” This book dispels that notion by documenting the state of the art in radar research. It will be a valuable addition to one’s library.

**ABOUT THE REVIEWER**

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