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.

Steganography in Digital Media: Principles, Algorithms, and Applications by Jessica Fridrich, Cambridge University Press, ISBN 978-0-512-19019-0, 2010. *Reviewed by Mauro Barni (barni@dii.unisi.it), University of Siena, Italy.*

Data hiding is a general term pertaining to techniques for hiding a message into a hosting signal (the cover signal). Beginning in the first half of the 1990s, data hiding has received increasing attention since digital watermarking, a robust version of data hiding wherein the hidden message has the property of being recoverable even when the cover signal undergoes heavy manipulations, was seen a viable solution to the protection of copyrighted multimedia signals. In parallel to digital watermarking, other versions of the data-hiding problem, including steganography, have gained the attention of researchers. In steganography, rather than robustness, the ultimate goal is to hide a message into a cover signal in such a way that an adversary is not even able to understand if the signal contains a hidden message or not. Due to the possible malicious uses of steganography (e.g., as a mean used by terrorists to create a covert undetectable communication channel), and to the necessity of rigorously assessing the undetectability of the hidden message, steganography is always paralleled by steganalysis, i.e., the set of techniques that an adversary may use to discover the presence of the hidden signal.

Driven by the huge economical interest involved by copyright protection applications of data hiding, early research in the field was dominated by digital watermarking. As watermarking matured into an established discipline, the interest in steganography and steganalysis began to rise, driven by concerns that steganography might be used for terroristic or other criminal purposes. Nowadays, steganography is an established field attracting the interest of both researchers and practitioners in the field of signal, communication, and network security. Due to the initial focus on digital watermarking, most books (noticeably textbooks) fail to treat the steganographic problem properly, often (and erroneously) reducing it to a particular instantiation of watermarking and failing to recognize the peculiarities of steganography with respect to other branches of data hiding. *Steganography in Digital Media* by Jessica Fridrich excellently fills this gap, since it represents the first self-contained monograph dealing in depth with both steganography and steganalysis for multimedia signals.

The book is presented primarily as a textbook, with a pedagogical structure and exercises proposed throughout the text. The level of the book is for graduate students, since the breadth and depth of the topics addressed would make the book difficult to understand to an average undergraduate student. The book can also be a good starting point for anyone that wants to enter the field of steganography, however, readers must keep in mind that for taking full advantage of the richness of this book, a sequential reading is recommended including a serious attempt to solve at least part of the suggested exercises. On the other hand, the book can be conveniently used by readers that already know some basic notions of steganography and steganalysis and wish to deepen their understanding of a particular topic or algorithm.

The structure of the book is quite original, since it follows a bottom-up approach in which the basic concepts in steganography are introduced through simple and naive examples that are afterwards used to introduce the readers into a rigorous mathematical framework. Specifically, the book starts with a history of steganography through the centuries, then it continues with two preliminary chapters introducing some basic notions about image formats and image acquisition devices. A taxonomy of steganographic techniques according to channel selection is presented in Chapter 4. This chapter provides a very interesting point of view, since it permits to cast the popular steganography by cover modification approach into a wider framework, thus preventing possible, and rather common, misunderstandings. The rest of the book is split into two parts; Chapters 5–9 are dedicated to steganography, and Chapters 10–12 to steganalysis. The bottom-up approach of the book is particularly evident in the part dedicated to steganography, which starts with a presentation of some naive steganographic methods to gradually pass to more rigorous techniques, like matrix embedding and wet

Digital Object Identifier 10.1109/MSP.2011.941841
Date of publication: 22 August 2011

paper coding. For its very nature, the part dedicated to steganalysis is a bit more empirical, however, all of the concepts are always treated in a very deep way. Having treated steganalysis, the last chapter of the book goes back to a theoretical view of steganography addressing the problem of the capacity of a perfectly secure stegosystem and introduces the so-called square root law of steganography, providing a powerful and synthetic view of the tradeoffs intrinsic to any stegosystem. The necessary mathematical background to fully understand the text is confined to a series of appendices (there are six of them) with the intent to preserve the clarity of the flow of ideas throughout the main body of the book. As an expert reader, I very much appreciated this choice, since it allowed me to focus on the main concepts without being distracted by auxiliary notions. However, for a primer in the field, going back and forth from the text to the appendices may be a difficult exercise. In addition, the material contained in the appendices might not be enough to fully comprehend the many subtleties involved in the mathematical parts of the book. The book features a large number of very instructive exercises, I am sure that a diligent reader will obtain a great advantage by solving them. I fear, though, that a good part of them will be too difficult for an average reader, thus letting him/her regret the lack of some detailed hints on the solutions.

The overall quality of the book is outstanding. Its coverage of the current state of the art is nearly total, going from well-known methods to the very latest developments. The technical depth is also impressive; the author has the ability to switch from examples to mathematical models, even the more complicated ones, with extreme facility and in a very effective way. The language is also very good, despite the difficulty of the addressed topics the text is always easy to read, and in the less technical parts, the reading is absolutely enjoyable. A drawback I see in the book is its full dedication to image steganography. While it is true that most of the concepts remain the same for different cover media, and while image steganography is significantly more advanced than steganography in any other domain, a comprehensive book like this should have dedicated at least one or two chapters to highlight the differences between various media, the challenges that hiding a message in media other than images present, and briefly review the state of the art of at least audio and video steganography.

As I said, there is no really competing book on this subject, the closest one being *Digital Watermarking and Steganography*, by I. J. Cox, M. L. Miller, J. A. Bloom, J. Fridrich and T. Kalker, that devotes to steganography a good amount of attention. Indeed, the book by J. Fridrich can be seen as an evolution of the steganography chapters of Cox et al.'s book into a unique textbook entirely devoted to steganography. For a reader interested in a general coverage of data-hiding technology without focusing on a particular application scenario, Cox et al.'s book would clearly be preferable, however, such a book does not obviously cover steganography and steganalysis with a depth that is even comparable to that of Fridrich's book. For this reason, the two books are directed to quite different audiences and do not really compete with each other.

In summary, I believe that J. Fridrich did an excellent job in providing the steganography community with a thorough reference textbook that will surely have a lasting impact in this challenging and stimulating research and engineering area.

Sparse Image and Signal Processing: Wavelets, Curvelets, Morphological Diversity by Jean-Luc Starck, Fionn Murtagh, and Jalal M. Fadili, Cambridge University Press, ISBN: 978-0-521-11913-9, 2010. *Reviewed by Michael B. Wakin (mwakin@mines.edu), Colorado School of Mines.*

A number of modern techniques in signal processing are rooted in the powerful concept of sparsity. Generalizing the idea of a bandlimited signal (one that can be represented as a compact sum of low-frequency sinusoids), a sparse signal is one that can be represented using a small set of properly chosen elements from some specialized basis or dictionary. Sparse representations lead naturally to efficient techniques for data compression and dimensionality reduction; they also allow many signals to be recovered from incomplete or corrupted observations. Consequently, over the past few decades, research in sparsity-based signal and image processing has become quite broad, ranging from the mathematical design of optimized sparse bases such as wavelets to the practical implementation of sparsity-based algorithms for tasks such as noise removal and compressive sensing. As such, although there have been many books published in this field, few of these arm the reader with both an understanding of the many sparse transforms available and an appreciation of the algorithmic considerations important for practical applications. The recently published *Sparse Image and Signal Processing: Wavelets, Curvelets, Morphological Diversity* by Jean-Luc Starck, Fionn Murtagh, and Jalal M. Fadili helps to fill this void, providing an intensive, implementation-focused exposition of sparse representations and their applications.

Although it has fewer than 300 pages, *Sparse Image and Signal Processing: Wavelets, Curvelets, Morphological Diversity* covers an impressive variety of topics. The first half of the book is

Digital Object Identifier 10.1109/MSP.2011.941842
Date of publication: 22 August 2011

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