DEPARTMENTS

BOOK REVIEWS

Optical Communications: Second Edition

Robert M. Gagliardi and Sherman Karp, 347 pages, illus., index, references, and problems following each chapter. ISBN 0-471-54287-3. John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158 (1995) $59.95 hardbound.

Reviewed by Robert J. Feldmann, USAF Wright Laboratory, System Avionics, Information Transmission Group, WL/AAAI, Wright-Patterson AFB, OH 45433-7301.

Students and engineers have, until now, been unable to use a single reference that provides a comprehensive treatment of optical communications. Robert Gagliardi and Sherman Karp have attempted to fill this void with an updated version of their first edition text published in 1976. Notably they present aspects of both fiber optic and free-space optical communications in a single volume. This separates it from the predominance of books that concentrate solely on fiber communications. In addition to fiber optics, new material in the areas of digital communications, fiber networks, and atmospheric and space channels have been included as well.

Readers familiar with the first edition will notice that the extensive mathematical modeling and statistical analyses have been significantly reduced in this edition. To make up for this reduction in theoretical rigor, the authors have added sections on optical hardware and device descriptions so as to emphasize the more applied nature of this edition. However, the treatment of the material allows the reader to gain an appreciation for the system aspects of optical communications, while not getting bogged down with learning the details of devices and hardware. In addition, the remaining analytical procedures have been streamlined to be compatible with modern analysis and design.

Chapter 1 provides a general introduction to optical communication systems for both guided and nonguided media. As would be expected, terminology is established and system applications are defined so as to provide the framework and motivation for the remainder of the book. A cursory review of optical fields, sources, channels, field expansions, and random fields is also given in preparation for the in-depth discussions of the following chapters.

Chapter 2 begins in earnest with an exploration of optical field reception. This chapter covers field focusing for rectangular and circular apertures, the relation between power detection and receiver field of view, and the need for optical filtering in the presence of background noise. In keeping with the discussion of received optical fields, Chap. 3 then covers the photodetection process and the conversion of light signals to useful electrical current. This chapter discusses general photodetection concepts, photodetectors, and the statistics of photodetection. While not as lengthy or inclusive as the first edition, it provides the essential statistical models to perform system evaluations.

The material covered in Chaps. 4 and 5 addresses various signal detection methods as preliminary steps in system application and design. Specifically, Chap. 4 covers direct detection (noncoherent) systems, while heterodyne (coherent) systems are discussed in Chap. 5. These two chapters represent the crossover point from optical engineering to communications engineering in that the discussions emphasize modulation/demodulation of signals, signal to noise ratios, and performance evaluation. Chapter 6 then extends the discussion of imposing information on an optical signal by presenting digital modulation. This chapter is distinct from the analog formats presented in the previous chapters and covers binary and block encoding techniques as well as timing and clocking issues of digital communication systems. Chapters 7 and 8 are confined to fiber optic communications, an area that was minimally covered in the first edition. Chapter 7 addresses the characteristics of fibers when used as the guiding medium, including power flow, dispersion, and modulation. Chapter 8 then broadens the material from single fiber applications to fiber networks, including interconnection, architectures, and multiplexing issues.

Chapters 9 and 10 take up the system performance issues associated with unguided optical communications. Chapter 9 outlines the effects on an optical signal when it is propagated through the atmosphere and discusses atmospheric effects for both direct and heterodyne detection systems. In all, this chapter conveys a modicum of practical knowledge for assessing the performance of an optical system using an atmospheric channel. Chapter 10 is the final chapter and addresses the pointing, acquisition, and tracking of an optical system. This chapter outlines the pointing problem and discusses both spatial acquisition and tracking of an optical beam. Tracking performance is related to overall communication link performance because beam tracking is in many cases an integral part of the communication link. The interrelationship between the two is developed at the end of the chapter.

Optical Communications is well written and the topics covered flow in a logical manner. The format is consistent with a textbook in that the type is easily readable, equations are centered in each page, and there are abundant illustrations. There are problems at the end of each chapter, though no worked examples. In addition, many equations are given without derivation. This is consistent with the authors attempt to provide

a tractable presentation of the material. This will undoubtedly cause some consternation among those individuals desiring a more detailed approach.

Practicing optical communications engineers may find the text to be redundant and of limited value. However, I believe that Gagliardi and Karp have successfully written a very good introductory text on optical communications for senior or graduate level electrical engineering or electro-optics students and nonoptical communication engineers. Each chapter serves as an introduction to the components and underlying concepts of optical communications. Readers desiring a greater understanding of these concepts, though, will need to study the referenced texts.

Adapted Wavelet Analysis from Theory to Software

Mladen Victor Wickerhauser, 494 pages, illus., index, bibliography, and three appendices. ISBN 1-56881-041-5. A. K. Peters, Ltd., 289 Linden Street, Wellesley, MA 02181 (1994) $59.95 hardbound.

Reviewed by T. A. Tuthill, Electrical Engineering Department, University of Dayton, 300 College Park, Dayton, OH 45469-0226.

Over the past decade, wavelets have been used as a panacea to a wide variety of signal and image processing problems. In this short time span there has been an enormous proliferation of wavelet research in image compression, noise reduction, speech analysis, and feature extraction. Yet for many practicing engineers, wavelet theory is a tough field to break into. The definitive works in wavelet analysis are written by mathematicians and extrapolation to practical problems is often esoteric. There are few texts on the subject that nonmathematicians can read without their eyes glazing over at the mention of function spaces and Lebesgue measures. Wickerhauser has put together a comprehensive book that provides all the necessary theory for discrete wavelet analysis (and, yes, function spaces and Lebesgue measures are all there) along with detailed pseudocode for actually implementing algorithms on the computer.

The reader should be cautioned that this is not an introductory text on the concept of wavelets. In fact, excluding the preface, wavelets are not even mentioned until halfway through the book. Yet the overall scope, the decomposition of signals using a library of generalized wavelet packets and windowed trigonometric waveforms, is elegantly and rigorously laid out. All of the background information is carefully detailed from Fourier series to localized transforms. More wavelet specific topics of quadrature filters, wavelet packets, and best basis algorithms are then thoroughly examined. The result is a stand- alone text that will serve as an invaluable resource for both engineers and applied mathematicians.

The necessary mathematical definitions and properties, complete with theorems and proofs, are covered in the first chapter. Standard signal analysis topics such as the discrete Fourier transform, convolution, and approximations are presented along with clear and concise explanations of duals and frames. Some of the proofs are fairly abstract and should be skimmed over in their first reading. However, the material presented here is a useful reference for subsequent chapters.

Chapter 2 lays the foundation for the computer programs. Common programming pitfalls in adapting mathematical algorithms are discussed along with the necessary data structures for wavelet analysis. Even the nonprogrammer should be able to follow these straightforward descriptions of binary trees and hedges. The pseudocodes sprinkled throughout the chapter and the remainder of the text are Standard C-based and are readily translated into other languages.

Algorithms and implementation codes for the discrete Fourier transform are then given along with other fast orthogonal transforms such as the Hartley, discrete sine, and discrete cosine. These transforms are adapted into localized transforms in Chap. 4. The author does an excellent job in covering all the subtle nuances of indexing and presenting the different techniques for folding the data.

The crux of the discrete wavelet transform is in the convolution-decimation procedure. Chapter 5 is devoted to the types of quadrature filters used in the convolution and carefully differentiates between the periodic and aperiodic cases. Thorough treatment is given to both the phase (or shift) and frequency responses. Filter coefficients for many of the standard wavelet filters such as Haar-Walsh, Daubechies, and Coifman are provided in the appendix.

The heart of the text is found in the next three chapters. The discrete wavelet transform, the wavelet packet, and the search algorithm for determining the best basis from the wavelet packet are detailed with generous examples and illustrations. Further extension to multidimensional signals using library trees and a comprehensive treatment of the time-frequency plane are also provided. Finally, Chap. 11 offers some specific applications, including principle component analysis and image compression using two-dimensional wavelets.

This book provides a unique combination of in-depth theoretical background and practical programming code. It would serve as a useful supplementary text for a graduate course on wavelets. At the end of each chapter is a set of exercises, many involving computer algorithms. Partial solutions are included in the appendix. There is also a program diskette with Standard C source programs to accompany the book available for purchase from the publisher. With this text, the practicing engineer can obtain all the necessary tools to implement adapted wavelets.

BOOKS RECEIVED

Field Theory of Acousto-Optic Signal Processing Devices, by Craig Scott. Subject index, references, five appendixes, and problems following each chapter. ISBN 0-89006-593-4. Artech House, Inc., 685 Canton Street, Norwood, MA 02062 (1992) $88 hardbound. Provides a thorough introduction to acousto-optic theory, which is equally rigorous from both acoustic and electromagnetic viewpoints. Written for a senior-level undergraduate or first-year graduate level course on acousto-optic theory and technology, it may also be used in senior-level electrical engineering courses on transmission line and waveguide theory as well as senior-level mechanical engineering courses in acoustical wave theory.

Semiconductor Raman Lasers, by Ken Suto and Jun-ichi Nishizawa. Subject index and references following each chapter. ISBN 0-89006-667-1. Artech House, Inc., 685 Canton Street, Norwood, MA 02062 (1994) $79 hardbound. This book is devoted to the fundamentals and practical technologies for the semiconductor Raman laser. This includes comparative discussions of rare-earth doped optical fiber amplifiers and laser diode amplifiers. These discussions will give a perspective view for future very wideband optical communication, which can be called terahertz-band optical communication.

Optical Engineering *is currently seeking reviewers for the books listed in the "Books Received" section. In exchange for a publication-worthy critique, reviewers will receive a complimentary copy of the book they review. Interested individuals should contact Dr. Bradley D. Duncan, Book Reviews Editor, The University of Dayton, Center for Electro-Optics, 300 College Park, Dayton, OH 45469-0245. E-mail: bduncan@engr.udayton.edu. Phone: 513/229-2796.*