DEPARTMENTS

BOOK REVIEWS

Optical Document Security

Rudolf L. van Renesse, Ed., 370 pages, references, illus., index, and appendix with samples. ISBN 0-89006-619-1. Artech House, Inc., 685 Canton Street, Norwood, MA 02062 (1994) $89 hardbound.

Reviewed by Steve McGrew, New Light Industries, Ltd., 9713 West Sunset Highway, Spokane, WA 99204.

Optical document security has been used throughout history for good reason: the first line of defense against fraudulent documents is the clerk, whose eyes and brain are usually the most powerful pattern recognition system available. There has been a recent upsurge of interest in optical security technology, partly as a result of the new tools available to the counterfeiter (image scanners and color printers), partly as a result of flashy new optically variable devices for security, and partly as a result of increasing global security risks.

Rudolf van Renesse has created a book that is timely and valuable. In the preface, he begins with a question that comes right to the point: *"Is document security a subject that should not be discussed in public?"* Some of those he invited to contribute declined: "After mature reflection and consultation with various interested parties, we think that the result of such a publication could be counterproductive." Others saw the issue from the opposite standpoint: "The major strategic mistake one can make is underestimating the enemy. In the development of securities, one should take into account that possible counterfeiters can get information about the security elements with or without a book."

While the book naturally contains only contributions from the latter group, it does not fail to provide a broad and detailed overview of optical security technologies including photography, handwritten signatures, watermarks, microprinting, intaglio printing, colored fibers in currency paper, fluorescent inks, multilayer interference coatings, iridescent inks, retroreflective printing, embossing, diffusion transfer printing, luminescence, special chemistries, tamper sensitivity, liquid crystals, transparent overlays, serial numbering, modulated gratings, volume holograms, embossed holograms, kinoforms, grating dots, and zero-order gratings.

One of the most important chapters in the book is Chap. 2 by Dr. Ralph Tadema Wielandt, entitled "The evaluation of document fraud resistance." He gives an excellent answer to those who were invited but declined to contribute to the book: "In our opinion, only those security systems that still function adequately, even after all information and documentation is disclosed, are reliable." This sentiment is supported by a quote from K. J. Schell in the preface: "We would compare our strategy with that of computer security, where the security of encrypting algorithms is based on keys, and not on the secrecy of the algorithms."

Dr. Wielandt presents a lucid analysis of document security systems as *systems,* as opposed to technologies. In his analysis the counterfeiter is as much a part of the security system as the security printer. Though the security printer and the counterfeiter are in different businesses, they are interdependent in all respects. They both have a systematic approach to reaching their goals. They are both powerfully motivated, and they both have substantial financial and technical resources. They are in a technology race constrained by risk, cost, time, and the capabilities of their opponents.

Though the cover of the book is decorated by a hologram and four of the seven samples included in the Appendix are holograms, there is not an undue emphasis on holography in the chapters. A novice to the field, and even some of the contributors themselves, would be well advised to read *every* chapter in this book. As van Renesse says, "The reader of this book will find that, almost invariably, the producers of one device tend to maintain that their device is superior to any other existing device and produce more or less convincing evidence of it. This can cause the reader some bewilderment." Reading only one selected chapter will give a reader a clear but almost certainly wrong impression of the value of a particular technology. However, van Renesse has done an admirable job of allowing the contributors to present their arguments without setting up a debate. A careful reader can sort through the information and opinions presented in this book and acquire a valuable overview of the challenge, process, and promise of optical document security.

One word of caution: most of the security devices presented *can* be counterfeited or effectively simulated. As pointed out by Dr. Wielandt, "It is generally agreed that a one hundred percent secure system does not exist and will never exist." None of the technologies alone can provide a high level of security against a determined and well-funded criminal organization. Only an intelligently designed and carefully tested security *system,* complete with constant re-evaluation and possibly including several of the available technologies, can reliably limit fraud to an acceptably low level. My personal hope is that the many users of optical document security will read this book and develop a new awareness of security as a dynamic system. A discerning reader will read the entire book, think about the wealth of methods described in the chapters, then go back and read Chap. 2 again.

Coherent Optical System Design

Pieter W. Hooijmans, 417 pages, illus., index, references, and four appendixes. ISBN 0-471-94836-5. John Wiley & Sons, Ltd., Baffins Lane, Chichester, West Sussex PO19 1UD, United Kingdom(1994) $79.95 hardbound.

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A monumental effort is currently being made by researchers worldwide to push optical communication transmission rates and distances to their limits. In most work the emphasis is on optical system technologies, such as advanced lasers, fiber amplifiers, and soliton propagation, all the while using relatively simple and straightforward direct-detection techniques. An alternate approach is to concentrate on the detection process, utilizing coherent detection. Coherent detection in optical communication systems can enhance detection sensitivity while also making possible a variety of novel modulation techniques that may contribute additional bandwidth enhancement. *Coherent Optical System Design* by Pieter W. Hooijmans provides, to the best of my knowledge, the first detailed review of this subject in a single volume.

The term "coherent" relates to all forms of detection that involve the mixing of a signal field with a reference local oscillator (LO) field. Hooijmans uses the term "IF detection" to cover all variations of this basic design, referring to the intermediate frequency (IF) produced as the difference between signal and LO frequencies. He further divides IF detection into incoherent and coherent detection; incoherent referring to IF detection with only frequency lock between signal and LO, and coherent referring to systems with phase and frequency lock. He discusses the additional subdivision of differential coherent detection, in which phase lock is only required for the duration of two successive bits.

While Hooijmans' emphasis is on practical systems, the book provides a very nice balance of theory and technique and should appeal to both audiences. The level of writing and the format should make the book useful for both graduate students and researchers familiar with optical communications but new to coherent systems. This book would also make a useful reference for those experienced in the field, as it provides a fairly complete review of a substantial amount of literature in a single volume. In addition, researchers in other fields of optics that employ coherent detection, such as laser radar, may find the book useful, as many of the same concepts are applicable and few practical discussions of any kind of coherent detection exist.

The first two chapters cover general material. Chapter 1 is a review of some of the general concepts of optical fiber communication and coherent detection. It includes a brief review of the different components involved as well as some special component issues such as fiber nonlinearities. It also includes a fairly lengthy section describing possible examples of real-world communication systems where coherent detection could be beneficial. This section is perhaps a bit too detailed, because it doesn't really contribute to the understanding of any subsequent material, but merely serves as justification for the research.

Chapter 2 gives a more detailed analysis of the physical characteristics of the components that make up a coherent optical communication system, including sources, detectors, and modulation. Again I was a little disappointed that more detail was given to modulation techniques than some of the fundamental characteristics of detectors and lasers. Important equations describing noise and bandwidth performance were quoted without proof and with very little explanation. While I acknowledge that the scope and purpose of the book do not call for detailed theory, some more detailed explanation as well as references to more fundamental works on these issues would have been useful.

The majority of the remainder of the book deals strictly with the detection process from the generation of an IF signal back. Chapter 3 addresses general incoherent IF detection, while Chaps. 4 through 7 address specific implementations of the various detection schemes as well as some simple coherent IF detection systems. Each chapter is organized very systematically with an overview of device issues, followed by a detailed statistical analysis, and concluding with a review of experimental results using the system in question. This is the heart of the book, and I feel it is quite well done.

Chapter 8 is entitled "Practical system experiments," and had the potential of being the single most valuable aspect of this book. I was hoping this would be a tutorial-like overview of the design of a real coherent optical communication system, addressing all of the key practical design issues, and I believe this was also Hooijmans' intent. However, the discussion of the design of a system is intermingled among descriptions of several existing systems. The large volume of references and experimental results tended to clutter the chapter to the point that it did not read smoothly and was not as useful as a design tool as I would have hoped. Nonetheless, addressing practical design issues is an interesting idea that I wish more authors would consider.

The book ends with a concise yet detailed chapter-by-chapter summary in Chap. 9 that could serve as a useful quick reference guide. The appendixes show the more complicated calculations from Chaps. 3 through 7. Appendix A is an especially good reference for anyone working in areas of signal detection and estimation, as it provides a detailed review of statistical analysis.

In conclusion, Hooijmans' book, by giving a thorough review of coherent detection, fills a very important need in the optics community previously not addressed in such detail. At times the writing is a little difficult to follow and the organization seems slightly disjointed. There are some scattered typographical errors and some of the illustrations are not entirely clear. Nonetheless, despite these minor reservations, I can recommend it as a solid reference for a broad audience.

BOOKS RECIEVED

Elements of Signal Detection & Estimation, by Carl W. Helstrom. xvi + 586 pp., illus., subject index, bibliography, problems following each chapter, and ten appendixes. ISBN 0-13-808940-X. Prentice Hall, Inc, Englewood Cliffs, NJ 07632 (1995) $63.00 hardbound. Content highlights include: detecting a signal of known form in Gaussian noise; complex-envelope representation of narrowband signals and their detection; statistical estimation theory; constant-false-alarm-rate and nonparametric receivers; sequential processing; design of detectors of Gaussian stochastic signals and the calculation of their error probabilities.

Wavelength Division Multiplexing, by Jean-Pierre Laude. xvii + 209 pp., illus., subject index, bibliography, and list of symbols. From the Prentice Hall International Series in Optoelectronics. ISBN 0-13-489865-6. Prentice Hall Inc., Englewood Cliffs, NJ 07632 (1993) $65.00 hardbound. Explains the basic theory of optical multiplexing, explores the practical applications, and reviews the current research, summarizing the latest developments in the field.

Rydberg Atoms, by Thomas F. Gallagher. xiv + 495 pp., illus., subject index, and references following each chapter. From the Cambridge Monographs on Atomic, Molecular, and Chemical Physics Series. ISBN 0-521-38531-8. Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211 (1994) $100 hardbound. Provides a comprehensive description of the physics of Rydberg atoms, highlighting their remarkable properties by reference to their behavior in a wide range of physical situations.