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Book Reviews

Optical Radiation Measurements Vol. 5: Visual Measurements

C. James Bartleson and Franc Grum, eds., 662 pp., illus., index, references. ISBN 0-12-304905-9. Academic Press, Inc., Orlando, FL 32887 (1984) \$110 hardbound.

Reviewed by F. Dow Smith, New England College of Optometry, Boston, MA 02115.

This book, the fifth in a series devoted to the measurement of optical radiation, describes the eye, or more properly the visual system, as a mechanism for the detection, processing, and measurement of light. It includes an in-depth discussion of the psychophysical methodology needed for visual measurements as well as a detailed discussion of photometric and colorimetric methods that can be applied to specifying the visual response to light. The book is comprehensive and should prove to be a valuable resource to a wide range of readers. The editors categorize their series as a treatise. This volume does seem to qualify as such, certainly so in that it provides reasonably comprehensive yet detailed coverage of the state of the art in those topics it addresses.

The first part of the book is titled Characteristics of the Visual Mechanism, with chapters on the eye as an optical system, the eye as a detector, visual pigments and sensitivity, and mechanisms of vision. The second part is titled Psychophysical Methods, with sections on psychophysics, thresholds and matching, measuring differences, direct-ratio scaling, and multidimensional scaling. The third and final section is titled Advanced Methods of Photometry and Colorimetry, with chapters on photometric measurements and colorimetric measurements.

For a multiply authored text the book is remarkably well organized and without serious redundancy. This is no doubt a tribute to good planning by the editors. The chapters are individually written by authors well qualified to speak with authority on their subject matter: Glen A. Fry, Robert M. Boynton, C. James Bartleson, and Peter M. Kaiser.

This 662-page book is in general well

illustrated with line drawings, graphs, and tables. There are virtually no photographs and, perhaps surprising for a book with some emphasis on color, no color illustrations.

Visual Measurements will not speak to any single audience but, in my opinion, is more likely to serve as a reference resource to a rather wide range of individuals. Researchers in vision will find in it a good basic introduction to many topics. Workers in other related fields will find in it a good road map to the literature in many fields of vision research. Clinicians interested in vision science will find it to be an excellent source book, or at least a refresher, on many aspects of the visual system. And perhaps most of all, students in programs that require a background in vision science should find this to be a highly readable and useful additional resource.

As one specific example, let me mention the burgeoning field of machine vision or computer vision, as it is variously called. New fields such as this tend to attract individuals who, although highly qualified, may have nontraditional prior work and educational experiences. This book would provide an excellent resource for such people to gain a needed perspective on the state of the art of classical and modern vision science as viewed by some of its best practitioners.

I found the book disappointing in some ways. In Bartleson's introduction he notes that the discussion is limited to information that has engineering utility for people who wish to make measurements indicating visual response to stimulation by light. That is fair enough. He then notes that the authors ask, "What should we expect the observer to see?" To some readers that statement may offer a promise that is not fulfilled. The text does explain what is seen within the limits of the psychophysical laboratory environment but does not discuss the limits that govern in applying many of these results to real-life situations.

Except for a passing reference to Mach bands and Southall's radiation, there is, for example, no discussion of illusions or of visual perception in the broad sense. If an

objective of the book was to give the engineering community a tool for predicting visual performance in carrying out practical tasks, then it largely fails, if only in not pointing out the limits that apply. It also would have been helpful to include more information on such topics as performance when abnormalities occur in the visual system and normal changes occur with age.

Each chapter is separately and completely documented with references. The index falls short in several areas I tested, but I did find that the relatively complete table of contents for each chapter usually helped me overcome those problems.

In summary, this book is a valuable contribution to the literature of vision. The editors assumed a herculean task in adding visual measurement to a series whose previous four volumes dealt with the more easily definable areas of radiometry, color measurement, measurement of photoluminescence, and physical detectors. They have carried out that task in a thoughtful and highly professional way that will serve their colleagues well.

Industrial Lasers and Their Applications

James T. Luxon and David E. Parker, viii + 248 pp., illus., index, references, problem sets. ISBN 0-13-461369-4. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632 (1985) \$32.95 hardbound.

Reviewed by Phil Hemmer, Rome Air Development Center/ESO, Hanscom Air Force Base, MA 01731.

This book presents a concise, clearly written overview of conventional industrial laser applications that assumes little or no prior experience with lasers on the part of the reader. As a result of this assumption, however, nearly the entire first half of the book is devoted to a review of the fundamentals of lasers and optics, leaving only the second half to concentrate on actual industrial applications. A more descriptive title therefore might be *Introduction to Lasers and*

Their Industrial Applications. Nonetheless, it does contain a wealth of information that all but the most experienced laser user will find of interest.

The emphasis throughout is on presenting a physical understanding of the various properties and uses of lasers. Relevant equations are presented, though seldom derived from first principles, and the more important equations are illustrated using numerical examples. The problem sets presented at the end of each chapter are highly applications-oriented, and although not all of the topics in the book are covered in sufficient detail, each chapter is supplied with a separate bibliography and reference list for the convenience of the interested reader.

Industrial Lasers opens with reviews of fundamental optics, semiconductor theory, and radiometry in Chaps. 1 through 3. This is followed, in Chap. 4, by an informative overview of the various types and uses of commercially available light detectors. Next, Chaps. 5 through 7 cover laser and resonator theory in some detail, including a brief treatment of Gaussian beam properties. Chapter 8 is a comprehensive overview of the various types and most common uses of commercially available lasers. Special attention is paid to HeNe and CO₂ lasers.

Chapters 9 and 10 comprise the first overview of the industrial uses of lasers, concentrating on the uses of low power lasers. These lasers find applications primarily in measurement and sensing, for example, in velocity and displacement measuring devices or in alignment and surface inspection applications. The fundamentals of holography are also briefly reviewed here. Finally, Chaps. 11 and 12 are devoted to the industrial uses of high power lasers. These are primarily related to materials processing; for example, laser welding, drilling, cutting, marking, surface hardening, alloying, and cladding are all briefly discussed. In these chapters, considerable emphasis is placed on understanding the basic mechanics of laser heating, melting, and vaporization, which are at the root of most high power laser applications.

Luxon and Parker recommend that this text be used for a one-semester junior- or senior-level course or as a self-taught course for practicing engineers and scientists. As a course textbook, however, it may not cover enough material for an entire semester if the students have already studied laser and resonator theory. On the other hand, as a self-taught course for practicing engineers and scientists this book should be ideal, especially if the reader has had little or no prior experience with lasers. For example, a laser course taken several years ago, or less than a year of practical experience with lasers, should give the reader just enough background to easily follow the brief reviews of optics and laser theory.

In conclusion, this book is a well written, concise introduction to lasers and their

industrial applications that should be most useful for the novice or inexperienced laser user.

Robotics: A User-Friendly Introduction

Ernest L. Hall and Bettie C. Hall, xvi + 254 pp., illus., index, references, glossary. ISBN 0-03-069718-2. CBS College Publishing, Holt, Rinehart and Winston, 383 Madison Ave., New York, NY 10017 (1985).

Reviewed by John F. Gilmore, Georgia Tech Research Institute, Artificial Intelligence Branch, Atlanta, GA 30332.

Over the last several years, technology has evolved from science fiction to reality. Concepts along the lines of autonomous tanks and spacecraft with phasers have developed into funded research programs such as DARPA's Autonomous Land Vehicle Program and the Strategic Defense Initiative "Star Wars" project. In light of these developments, robotics has begun to gather widespread interest outside of university and industrial research environments. Thus, an introductory text on robotics becomes both timely and required in order to support growing user interest.

Robotics: A User-Friendly Introduction is such a book. Written as a text for undergraduate robotics courses, the book provides an overview of robotics without immersing the reader in the intensive analytic aspects discussed in more specialized works.¹⁻⁴ The text is free from mathematical equations and concentrates on examples of current robot technology drawn from a variety of application areas including the University of Australia's sheep-shearing robot, the Space Shuttle *Challenger's* remote manipulator, the Jet Propulsion Lab's robot rover, and Cincinnati Milacron's line of industrial robots.

Because robots have been glamorized in movies, the internationally accepted definition of the term industrial robot is radically different from the concept held by many individuals who have entered the field: "A reprogrammable, multifunctioned manipulator designed to move material, parts, tools or specialized devices through various programmed motions for the performance of a variety of tasks" (Robotics Industries Association, 1979).

With this definition in mind, *Robotics* proceeds to analyze the field in light of a number of application issues including

- a history of robotics,
- the components and operation of industrial robots,
- intelligent robot programming,
- sensors for intelligent robots,
- industrial robot applications,
- economic considerations and justification,
- the social impact of industrial robots, and
- future robot considerations.

Though the size of the book does not allow the authors to present issues in great detail, each topic is well covered and cross-referenced in an extensive bibliography.

Viewed as a purely technical work, *Robotics* would fall short of an acceptable text. However, this is not the book's aim. When complemented with a more detailed work, such as a text on artificial intelligence, computer vision, or kinematics, *Robotics* provides an overview that firmly ties these topics to a system concept. The text is recommended in this view for both graduate and undergraduate classes and as a stand-alone reference for managers involved in robotics applications.

REFERENCES

1. M. Brady, J. M. Hollerbach, T. L. Johnson, L. Tomas, and M. T. Mason, eds., *Robot Motion: Planning and Control*, The MIT Press, Cambridge, Mass. (1983).
2. R. P. Paul, *Robot Manipulators: Mathematics Programming and Control*, The MIT Press, Cambridge, Mass. (1981).
3. W. A. Wolovich, *Linear Multivariable Systems*, Springer-Verlag, New York (1974).
4. G. G. Dodd and L. Rossol, eds., *Computer Vision and Sensor-Based Robots*, Plenum Press, New York (1979).

Principles of Phase Conjugation

B. Ya. Zel'dovich, N. F. Pilipetsky, and V. V. Shkunov, 256 pp., illus., index, references. ISBN 0-387-13458-1. Springer-Verlag Publishing Co., Inc., 175 Fifth Ave., New York, NY 10010 (1985) \$49 cloth.

Reviewed by Duncan G. Steel, University of Michigan, Depts. of Physics and EE/CS, Randall Labs, Ann Arbor, MI 48109.

The application of linear or nonlinear optical methods to the reversal of wavefronts has led to a new area of optical physics called optical phase conjugation (OPC). The subject area has grown considerably in the last several years, and there have been hundreds of scientific publications in the journal literature. Interest in this area has been motivated by applications of OPC to the areas of aberration correction, beam propagation, optical computing, and the general use of phase conjugation as an optical probe of matter. Hence, the new book *Principles of Phase Conjugation* by Zel'dovich, Pilipetsky, and Shkunov is a welcome addition to the published literature on phase conjugation. The authors are recognized experts in the field. This book is pedagogical and unified in its approach, and there is no doubt that it will become a standard introductory reference book.

The authors show that there are two primary approaches to OPC: backward stimulated light scattering and four-wave mixing (FWM). The book is then divided into four general sections: (1) a description of phase

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conjugation, (2) OPC by stimulated scattering, (3) OPC by FWM, and (4) other approaches to phase conjugation and applications of phase conjugation.

The first part provides an excellent introduction to the concept of OPC, using simple pictures to compare a phase-conjugated wavefront with an ordinary wavefront. In this section, they also point out that the concept of a phase-reversed wavefront is not new, but is observed in conventional holography. What has made OPC the subject of so much interest in recent years is the demonstration that it is possible to achieve OPC in real time, without the need of film and intermediate processing steps. This new ability has led to numerous demonstrations of real-time aberration correction and has shown the possibility of eliminating the effects of atmospheric turbulence at bandwidths in excess of 100 MHz. In this first section, the authors also provide a brief summary of the two primary approaches to OPC without entering into the analytical detail that follows in later chapters. The approaches are compared, with a description given of the basic advantages and problems associated with each of the techniques. Finally, this section describes some of the better known applications of OPC such as for self-compensation of distortions, self-targeting of radiation, control of spatial-temporal-frequency structure of radiation, optical computing, and scientific applications such as spectroscopy and interferometry.

The next section of the text is given to a detailed analytical description of the physics of OPC by stimulated scattering. These four chapters represent an important contribution to the new scientific literature of OPC by stimulated scattering because of the introductory approach taken by the authors. This is in contrast to much of the literature. Starting with the basic equations, they provide a reasonable outline of the fundamental origin of the phase-reversed wavefront in stimulated scattering. This is very helpful because the physical origin of OPC by stimulated scattering is much more difficult to understand than that by FWM. Also, in contrast to FWM, nearly all of the published analytical work describing this problem has been in the Soviet literature. Indeed, the authors of this book were significant contributors to developing the fundamental understanding. Unfortunately, researchers encountering this area for the first time will still have quite a job understanding the details. The description, though complete, is still basically an outline of the details. Initial equations are stated without a complete justification, and the interested researcher will probably return to the original literature for further discussions. While numerous mathematical steps are omitted in the calculations, enough detail is given so as to be able to fill in the details in most cases. Because the

very origin of OPC by stimulated scattering lies in the noise properties of the field, the calculations are very detailed, and insight comes with considerable effort. Fortunately, the authors provide comparison with experimental results, which assists in understanding the conclusions of the analytical work. In this section, they introduce a new term in optical physics, the specklon, for stimulated scattering by a speckle inhomogeneous pump. The specklon is basically the phase-conjugated backscattered component, which they show is remarkably stable despite the inhomogeneity in the backscatter gain. An entire chapter is devoted to the theory of the specklon including the effects of saturation, pump depletion, polarization, and non-monochromatic pumps. It should be noted, however, that the discussions in this part of the book concentrate on the origin of the stimulated wave and the properties of that wave, given an interaction that gives rise to a stimulated process. There is little discussion of the microscopic origin of stimulated waves.

In the third section of the book, the authors describe OPC by FWM. Unlike OPC by stimulated scattering, the physical origin of the phase-reversed wave by FWM is much more transparent. The authors briefly describe some of the important issues in FWM such as polarization behavior, effects of absorption, filter characteristics, coupled waves, and the failure of the Born approximation. Another important issue they discuss is that the same optical nonlinearity that gives rise to OPC by FWM also gives rise to self-focusing. This can lead to optical instability in the pump waves, which can reduce or eliminate the fidelity of the phase-reversed wavefront.

There are many nonlinear optical interactions that give rise to FWM, and Chap. 7 is devoted to a summary of the primary nonlinearities such as molecular orientation, saturation, photorefraction in ferroelectrics and semiconductors, and nonparabolicity of the conduction band in semiconductors. The description here is more phenomenological, but does provide a nice physical picture to parallel more detailed descriptions to be found in the references. It is interesting to observe that there was greater attention to mathematical detail in the section on OPC by stimulated scattering than in the section on OPC by FWM.

The last section of the book describes other methods of producing phase-reversed wavefronts such as by three-wave mixing, nonlinear mixing at a reflecting surface, and a linear approach based on corner cube type arrays. There is even a discussion of acoustic wave phase conjugation. There is also a description of the basic behavior of a laser cavity when one of the mirrors is replaced with a phase conjugate mirror.

Most of the basic issues in OPC are described in this book, but the primary text is 228 pages, and hence, in many places the descriptions are more brief than the reader

would desire. There are many points in the text at which the serious researcher will need to spend considerable time on his own, filling in the details. This is particularly true in the chapters describing OPC by stimulated scattering. Over 400 references are given to assist the reader; however, some of the important references to subject matter in the text are to untranslated Russian citations, and numerous references to Western literature are missing. It is also unfortunate that in a monograph of this magnitude, the subject index is very brief and incomplete, covering only one and a half pages. For instance, despite the fact that Sec. 4.3 is titled "The Specklon" and Sec. 5.1 is called "Theory of the Specklon," there is no reference to the specklon in the index.

Finally, it should be noted that in contrast to the book *Optical Phase Conjugation* (R. Fisher, ed., Academic Press, New York, 1983), *Principles of Phase Conjugation* considers in detail only stimulated scattering and FWM. *Optical Phase Conjugation* presents a far more detailed treatment of many other subjects in OPC such as resonator analysis with an OPC mirror and OPC in resonant FWM. These two texts are basically complementary in their approach to OPC.

In summary, this book should definitely be studied and referred to by all those involved in the study or application of optical phase conjugation. It will be especially interesting to people working on one specific approach to OPC who want to understand or compare their work to other approaches.

Videodisc and Optical Memory Systems

Jordan Isailović, 355 pp., illus., indexes, references, appendixes. ISBN 0-13-942053-3. Prentice-Hall Inc., Englewood Cliffs, NJ 07632 (1985) \$32.95 hardbound.

Reviewed by Albert A. Jamberdino, Rome Air Development Center, Griffiss Air Force Base, NY 13441-5700.

For both the novice and the experienced developer, this book is an extremely well-written, well-organized treatise on videodisc technology. It concentrates primarily on the basic theory and principles of videodisc and compact audio disc, with one chapter devoted to digital optical memories. Refreshingly, the author was able to reduce complex theoretical concepts to their simplest form, thus making the book easily read.

This is the first of two books published on the subject. The first chapter of the book compares the videodisc concept with its magnetic tape counterpart. In Chap. 2, a more detailed summary of basic disc recording materials and their characteristics is presented. The author then discusses the stages of disc production, i.e., mastering,

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replication, molding, metallization, and coating. Chapter 3 contains the principles and descriptions of the optical disc playback system. Chapter 4 contains the principles and a description of the basic capacitive playback system for both pregrooved and flat disc systems. Chapter 5 consists of theoretical descriptions of basic optics, optical modulations, and Fourier transform theory. Chapter 6 delves into the fundamentals of the total videodisc system and includes a discussion of such issues as noise, dropouts, photodetection, optical readout, etc. Chapter 7 includes a summary of the various aspects of optical digital disc storage—both archival and erasable.

All in all, this first book is an excellent summarization of optical disc technology, its theory, and its application. It certainly could be used as an auxiliary textbook for a course in optoelectronics.

BOOKS RECEIVED

Special Functions for Engineers and Applied Mathematicians, by Larry C. Andrews. MacMillan Co., \$32.50 hardbound. ISBN 0-02-948650-5, 357 pages including bibliography and references. Intended as a reference or course book for graduate students.

Sparsity and Its Applications, edited by David J. Evans. Cambridge University Press, \$39.50 hardbound. ISBN 0-521-26272-0, 338 pages. Based on lectures from a topical meeting of the same title at the University of Technology, Loughborough, England, April 1983.

Understanding Laser Technology, by C. Breck Hitz. PennWell Publishing Co., Tulsa, Oklahoma, hardbound. ISBN 0-87814-262-2, 226 pages including photos, figures, and index. Intended for the general reader or technologists in other fields wishing a quick introduction to lasers.

Advanced Ceramic Materials: Technological and Economic Assessment. Noyes Publications, Park Ridge, N.J. Based on studies by Charles River Assoc. Inc. (Boston, Mass.), International Trade Administration (U.S. Dept. of Commerce), and National Materials Advisory Board (National Research Council). \$64 hardbound. ISBN 0-8155-1037-3, 651 pages including references; no index. Divided into six parts, one of which is Integrated Optical Devices (56 pages). Includes industry surveys, and addenda on Competitive Assessment of Japanese Advanced Ceramics Industry.

Oils, Lubricants, and Petroleum Products: Characterization by Infrared Spectra, compiled by J. P. Coates and L. C. Setti. Marcel Dekker, Inc., \$145 hardbound. 294 pages including indexes and references. ISBN 0-8247-7412-4. A compilation of the IR spectra (direct copies of IR spectrometer strip charts) of hundreds of commercial petrochemical products. ☺

Meetings

FEBRUARY 1986

Feb. 2-7 Application of Optical Instrumentation in Medicine XIV: Medical Imaging, Processing, and Display, and Picture Archiving and Communications Systems (PACS IV) for Medical Applications, Newport Beach, CA. Includes exhibit. Chairmen: Roger H. Schneider, Center for Devices and Radiological Health, FDA, and Samuel J. Dwyer III, Univ. of Kansas, College of Health Sciences and Hospital. SPIE, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290.

Feb. 3-4 Automated Manufacturing, St. Petersburg, FL. Frost & Sullivan, Inc., 106 Fulton St., New York NY 10038. 212/233-1080.

Feb. 4-6 Second International Conference on Data Engineering, Los Angeles, CA. Sponsored by IEEE Computer Society, P.O. Box 639, Silver Spring MD 20901. 301/598-8142.

Feb. 4-6 Fourth Working Symposium on Oceanographic Data Systems—1986, La Jolla, CA. Sponsored by IEEE Computer Society Technical Committee on Oceanic Engineering and Technology and Scripps Institution of Oceanography. Daniel Steiger, Naval Research Lab., Code 5103, 4555 Overlook Ave., SW, Washington DC 20375-5000. 202/767-3265.

Feb. 11-13 Fourth National Symposium on Optical Fibres and Their Applications, Warsaw, Poland. Instytut Zaoznosoi, Samodzielna Pracownia Telekomunikacji Optycznych, ul. Szaohowa 1, 04-894 Warszawa. Poland.

Feb. 19-21 1986 IEEE International Solid-State Circuits Conference, Anaheim, CA. Sponsored by IEEE's Solid-State Circuits Council, Los Angeles

Council, and Orange County Section and Univ. of Pennsylvania. Lewis Winner, 301 Almeria Ave., Coral Gables FL 33134. 305/446-8193.

Feb. 24-26 OFC '86, Conference on Optical Fiber Communication, Atlanta, GA. Cosponsored by IEEE Lasers and Electro-Optics Society and OSA, 1816 Jefferson Place NW, Washington DC 20036. 202/223-8130.

Feb. 24-28 Seminar on Industrial Robotics '86—International Experience, Developments and Applications, Brno, Czechoslovakia. Hosted by U.N. Economic Commission for Europe, Working Party on Engineering Industries and Automation. Contact U.N. ECE, Industry and Technology Division, Palais des Nations, CH-1211 Geneva 10, Switzerland. Telephone (022) 34 60 11, ext. 3254. Telex 28 96 96.

Feb. 25-27 NEPCON WEST 86, Anaheim, CA. Cahners Exposition Group, P.O. Box 5060, Des Plaines IL 60017-5060. 312/299-9311.

Feb. 26-28 IGWO '86, Topical Meeting on Integrated and Guided Wave Optics, Atlanta, GA. Cosponsored by IEEE Lasers and Electro-Optics Society and OSA, 1816 Jefferson Place NW, Washington DC 20036. 202/223-8130.

Feb. 26-28 Fifth Annual Phoenix Conference on Computers and Communications, Phoenix, AZ. Sponsored by IEEE in conjunction with its Computer Society, Communications Society, and Phoenix Section and Arizona State Univ. William Lewis, Arizona State Univ., Computer Science Dept., Tempe AZ 85287.

MARCH 1986

March 1 IEEE National Radar Conference,

Los Angeles, CA. Sponsored by IEEE, 345 E. 47th St., New York NY 10017. 212/705-7895.

March 2-7 Two Conferences on Astronomical Instrumentation, Tucson, AZ. Program includes topical conferences listed below and instrument exhibits. SPIE, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290.

Advanced Technology Optical Telescopes III. Chairman: Larry D. Barr, National Optical Astronomy Observatories, Advanced Development Program.

Instrumentation in Astronomy VI. Chairman: David L. Crawford, National Optical Astronomy Observatories, Kitt Peak National Observatory.

March 3-6 Compcon Spring 86, Thirty-first IEEE Computer Society International Conference, San Francisco, CA. Alan Bell, Xerox Palo Alto Research Ctr., 3333 Coyote Hill Road, Palo Alto CA 94304. 415/494-4326.

March 9-14 Santa Clara Symposium on Microlithography, Santa Clara, CA. Program includes topical conferences listed below, tutorials, and instrument exhibits. SPIE, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290.

Advances in Resist Technology and Processing III. Chairman: C. Grant Willson, IBM San Jose Research Ctr.

Optical Microlithography V. Chairman: Harry L. Stover, ASM Lithography.

Electron-Beam, X-Ray, and Ion-Beam Techniques for Submicrometer Lithographies V. Chairman: Phillip D. Blais, Westinghouse R&D Ctr.

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