DEPARTMENTS

BOOK REVIEWS

Speckle Metrology

Rajpal S. Sirohi, Ed., 551 pages, illus., index, references. ISBN 0-8247-8932-6. Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016 (1993) $175 hardbound.

Reviewed by Y. Y. Hung, Oakland University, Rochester, Michigan.

The grainy appearance of an object when illuminated by coherent light is known as the speckle effect. A speckle pattern is a random interference pattern resulting from the interference of light scattered from various depths of an optically rough surface. In the early days, speckle was considered to be a nuisance by the coherent optics community. Lendertz and Butter were the first to realize the usefulness of the speckle effect. They demonstrated that speckle patterns acted as information carriers about the object surface and served as fingerprints for object points. They used the speckle effect to measure surface displacement. Inspired by their work, numerous techniques and applications of speckle patterns have been reported. *Speckle Metrology* (edited by R. K. Erf), the first monograph summarizing research work on the use of speckle, was published in 1978. Since then the area of speckle metrology has advanced tremendously due to the advent of microcomputers and digital image processing hardware. An updated book on the subject has been long overdue. This book, which provides an overview of the state of the art of speckle metrology, will be of great value to the optical metrology community. The book consists of 11 chapters, each dealing with a different aspect of speckle metrology. Each chapter was contributed by prominent researchers in the field.

Chapter 1, "Theory and Applications of Speckle Displacement and Decorrelation" by I. Yamaguchi, gives a lucid review of the theory of speckle correlation/decorrelation and its applications to the measurement of displacement, strain, and velocity. Chapter 2, "Techniques of Displacement and Deformation Measurement in Speckle Metrology" by Pramod K. Rastogi, deals primarily with photographic-film-based speckle techniques. Chapter 3, "Speckle Methods in Experimental Mechanics" by Rajpal S. Sirohi, provides a review of the various photographic-based speckle interferometric techniques and their applications to deformation measurement and nondestructive testing. Chapter 4, "Recent Developments in Video Speckle Interferometry" by Ole J. Lokberg, reviews the state of the art in video speckle recording and processing. This digital imaging technique is also known as ESPI, or TV, holography. Chapter 5, "Novel Applications of Speckle Metrology" by Chandra S. Vikram, covers some unique applications. Chapter 6, "Particle Image Velocimetry" by K. D. Hinsch, deals with the applications of speckle patterns in full-field flow measurement. This relatively new application (not covered in the previous book on speckle metrology) has had a significant impact on the area of flow studies. Chapter 7, "White Light Speckle Metrology" by Anand K. Asundi, deals with speckle patterns that are not produced by coherent light. Chapter 8, "Surface Roughness Evaluation" by J. D. Briers, summarizes three previous reviews on the application of laser speckle to surface roughness measurement. Chapter 9, "Automatic Fringe Analysis Procedures in Speckle Metrology" by G. H. Kaufmann, deals with the analysis of Young's fringes and phase extraction in speckle fringe patterns. Chapter 10, "Speckle Metrology Using Hololenses" by Chandra Shakher, deals with the use of holographic lenses in speckle metrology. One advantage of holographic lenses is that they provide large lens apertures not achievable with conventional lenses. Chapter 11, "Correlation Speckle Interferometry in the Mechanics of Contact Interaction" by Yuri I. Ostrovsky and V. P.

Shchepinov, reviews the application of speckle decorrelation to studies of contact mechanics.

Overall, this is a good book that covers most of the important aspects of speckle metrology. The book would be more valuable if it included a chapter on shearography. Among various speckle techniques, shearography is probably the most practical, and it has received wide industrial acceptance for nondestructive evaluation.

BOOKS RECEIVED

Vision, by Pierre Buser and Michel Imbert. 571 pp., illus., subject index, references. ISBN 1-262-02336-9. The MIT Press, 55 Hayward Street, Cambridge, MA 02142 (1992). Covers structure and organization of the retina, distribution of the optic nerve fibers, visual field, binocular vision, phylogenetic aspects, intermediate cellular layers, the physical characteristics of visual stimuli, radiant energy, the fundamental radiometric units, light energy, fundamental photometric units, colorimetric units and quantities, the psychophysical laws of visual sensation, problems concerned with absolute thresholds, adaptation in the retina, simultaneous contrast, visual acuity, and spatial frequency resolution, movement perception, real color vision, genesis and elaboration of signals in the retina, retinal photochemistry, the electroretinogram, the neuronal network in the retina, mechanisms in the central visual pathways, the midbrain visual centers, the lateral geniculate body, the visual areas of the cortex, and the developing visual system.

Introduction to Electro-optical Imaging and Tracking Systems, by Khalil Seyrafi and S.A. Hovanessian. 272 pp., illus., index, references following each chapter. ISBN 0-

89006-672-8. Artech House, 685 Canton Street, Norwood, MA 02062 (1993). Covers invention of the telescope and microscope, particle theory and wave theory of light, the line spectra of atoms, optical detectors, holography, electro-optical sensors, astronomy and the development of large optical sensors, quantities of radiation and units, blackbody radiation, surface irradiance, target radiation signature, atmospheric transmission, optical properties of the atmosphere, Rayleigh scattering, numerical calculation, adaptive optics and signal processing, spectral, spatial, and temporal variations in infrared backgrounds, background statistics, spectral bands, sensor noise, signal amplitude, analog processing approach, signal processing and staring mosaic, illustration of probability of detection and probability of false alarm, multiple channel detection, sequential detection, electro-optical system design and performance equations, noise equivalent flux density, minimum resolvable temprature, electro-optical systems applications, spaceborne imaging systems, high-resolution imaging spectrometer, laser radar systems, laser beam larger than target, speckled targets, laser radar measurements, signal-to-noise ratio computation, and numerical example of a spaceborne laser radar system.

Basics of Optics of Multilayer Systems, by S. A. Furman and A.V. Tikhonravov, edited by J. Tran and Thanh Van. 248 pp., illus., index. Part of the "Basic of" series. ISBN 2-86332-110-2. Editions Frontières, B.P. 33 91192 Gif/Yvette Cedex, France (1992). Covers electromagnetic field in layered media; spectral characteristics of layered media, the Fresnel formulas, transmittance, reflectance and absorptance, matrix calculating method, approximate formulas, relations between spectral characteristics for the direct and reverse waves, the multilayer coatings optical properties: impact of variations in the layer parameters, characteristic matrix of a periodic multilayer system, merit function selection, base matrices, industrial methods of thin-film optical coating deposition, optical film thickness monitoring, time stabilization of coating optical properties, selective antireflection coatings, achromatic antireflection coatings, achromatic antireflection coatings, dielectric cutoff filters, polarizers, method of interference bands displacement, ellipsometric method, investigation of thin-film coating composition by electron spectroscopy methods.

Stochastic Electromagnetic Image Propagation (and Adaptive Compensation), by Robert M. Manning, edited by Robert E. Fischer and Warren J. Smith. 240 pp., illus.,

index, references following each chapter, appendixes at back. ISBN 0-07-039929-8. McGraw Hill, 11 West 19th Street, New York, NY 10011 (1992). Covers the fundamental equations for analysis of electromagnetic wave propagation in the turbulent and turbid atmosphere, the application of the Maxwell equations to the random atmospheric propagation environment-the Vector stochastic wave equation, the stochastic parabolic wave equation and the spatial moments of the propagating wave field, the extended Huygens-Fresnel principle and its phase approximation, the statistical modeling of the atmospheric permittivity field, fluctuations and statistics of the gaseous refractivity field, a unified statistical model of the atmospheric electromagnetic propagation environment, the formation and characterization of images viewed through random media, the analysis of diffraction image formation by a lens of an object in a random medium, image resolution and its assessment, the analysis of image propagation in the atmosphere, application of the Rytov method, analysis of the temporal spectrum of wavefront tilt and astigmatism, methods of compensation for image degradation due to the atmosphere, object intensity distribution reconstruction via speckle imaging and interferometry, application of the maximum likelihood method to the analysis and subsequent reconstruction of speckle images.

Progress in Optics, Volume XXX, edited by Emil Wolf. 399 pp., illus., index, cumulative index of volumes I-XXX, references following each chapter. ISBN 0-444-89544-2. Elsevier Science Publishers, P.O. Box 882, Madison Square Station, New York, NY 10159 (1992). Covers quantum fluctuations in optical systems, techniques for quantum noise reduction, applications of squeezed light, theory of quantum noise in noise reduction, theory of quantum noise in optics, squeezed-state generation by parametric interaction, semiclassical representations of the field, correlation holographic speckle interferometry, fringe contrast in holographic interferometry and speckle photography as related to a change in surface microrelief, mechanics of contact interaction, localization of waves in media with one-dimensional disorder, one-dimensional localization, waves in randomly layered media, theoretical foundation of optical-soliton concept in fibers, solitons in optics, guiding center soliton, cavity quantum optics and the quantum measurement process, cavity QED, the micromaser, quantum measurements, quantum non-demolition measurements, macroscopic superpositions, separated fields, and outlook: mechanical effects.

Chaos in Dynamical Systems, by Edward Ott. xii + 385 pp., subject index, problems and notes following each chapter, references, some chapters have appendixes. ISBN 0-521-43215-4. Press Syndicate of the University of Cambridge, 40 West 20th Street, New York, NY 10011-4211 (1993) $69.95 hardbound, $29.95 softbound. Covers one-dimensional maps; strange attractors and fractal dimension; dynamical properties of chaotic systems; nonattracting chaotic sets; quasiperiodicity; chaos in Hamiltonian systems; chaotic transitions; multifractals; and quantum chaos.

Non Destructive Evaluation of Materials by Infrared Thermography, by Xavier P.V. Maldague. xxxii + 207 pp., illus., subject index, references. Color section of figures, appendixes at end of book, figure credits. ISBN 0-387-19769-9. Springer Verlag, 175 Fifth Avenue, New York, NY 10010 (1993) $198.00 hardbound. Covers theoretical aspects, experimental apparatus, nondestructive evaluation (NDE) using infrared thermography, external and internal thermal stimulation, quantitative analysis of delaminations, inspection of materials with low emissivity by thermal transfer imaging, thermal diffusivity measurements of materials, thermal tomography, thermal NDE of nonplanar surfaces and applications of infrared thermography to high temperatures.

Pauper and Prince: Ritchey, Hale, and Big American Telescopes, by Donald E. Osterbrock. xv + 359 pp., illus., subject index, bibliography, appendix, preface to notes and bibliography, notes. ISBN 0-8165-1199-3. The University of Arizona Press, 1230 N. Park Avenue, Suite 102, Tucson, Arizona 85719-4140 (1993) $45.00 hardbound. Focuses on the career of George Willis Ritchey, who perfected the methods of making large parabolic mirrors for reflecting telescopes, and the telescope-building aspects of George Ellery Hale's life at Yerkes, Mount Wilson, and Palomar observatories and shows how the relationship between these men helped the United States take the lead in developing major astronomical facilities.

Fiber Optics, Second Edition, by Robert J. Hoss and Edward A. Lacy. xiv + 290 pp., illus., index, references, glossary. ISBN 0-13-321241-6. Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632 (1993) $45.00 hardbound. Covers fiber optics: lightwave communications; fundamentals of light; light sources and transmitters; optical fibers; splices, connectors, and couplers; detectors and receivers; system design and architecture; and installation and measurements.