Digital Holographic Microscopy Principles
Techniques And Applications Springer Series In
Optical Sciences

Edited and authored by leading experts from top institutions in Europe, the US and Asia, this comprehensive overview of micro- and nanophotonics covers the physical and chemical fundamentals, while clearly focusing on the technologies and applications in industrial R&D. As such, the book reports on the four main areas of telecommunications and display technologies; light conversion and energy generation; light-based fabrication of materials; and micro- and nanophotonic devices in metrology and control.

Building up from the basic principles of optics, this straightforward introduction to digital holography, aimed at graduate students, engineers and researchers, describes modern techniques and applications, plus all the necessary underlying theory. Supporting Matlab code is available for download online, and homework problems are accompanied by an instructor solution manual.

This book presents a substantial description of the principles and applications of digital holography. The first part of the book deals with mathematical basics and the linear filtering theory necessary to approach the topic. The next part describes the fundamentals of diffraction theory and exhaustively details the numerical computation of diffracted fields using FFT algorithms. A thorough presentation of the principles of holography and digital holography, including digital color holography, is proposed in the third part. A special section is devoted to the algorithms and methods for the numerical reconstruction of holograms. There is also a chapter devoted to digital holographic interferometry with applications in holographic microscopy, quantitative phase contrast imaging, multidimensional deformation investigations, surface shape measurements, fluid mechanics, refractive index investigations, synthetic aperture imaging and information encrypting. Keys so as to understand the differences between digital holography and speckle interferometry and examples of software for hologram reconstructions are also treated in brief.

Contents
1. Mathematical Prerequisites
2. The Scalar Theory of Diffraction
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Appendix. Examples of Digital Hologram Reconstruction Programs

The book presents a clear and comprehensive review of the current status of the holographic microscopy with discussion of the positive and negative features of classical and holographic methods for solving the problem of three-dimensional (3D) imaging of phase microscopic objects. Classical and holographic methods of phase, interference and polarization contrast are discussed. Combination of the developed holographic methods with the methods of digital image processing allowed creating the digital holographic interference microscope (DHIM). The first 3D images of native phase microscopic objects such as blood cells were obtained using the DHIM. The results of DHIM application for study of blood erythrocytes, thin films, micro-crystals are presented.
The measurement and characterisation of surface topography is crucial to modern manufacturing industry. The control of areal surface structure allows a manufacturer to radically alter the functionality of a part. Examples include structuring to effect fluidics, optics, tribology, aerodynamics and biology. To control such manufacturing methods requires measurement strategies. There is now a large range of new optical techniques on the market, or being developed in academia, that can measure areal surface topography. Each method has its strong points and limitations. The book starts with introductory chapters on optical instruments, their common language, generic features and limitations, and their calibration. Each type of modern optical instrument is described (in a common format) by an expert in the field. The book is intended for both industrial and academic scientists and engineers, and will be useful for undergraduate and postgraduate studies.

Digital holography is an emerging field of new paradigm in general imaging applications. The book presents an introduction to the theoretical and numerical principles and reviews the research and development activities in digital holography, with emphasis on the microscopy techniques and applications. Topics covered include the general theory of diffraction and holography formations, and practical instrumentation and experimentation of digital holography. Various numerical techniques are described that give rise to the unique and versatile capabilities of digital holography. Representative special techniques and applications of digital holography are discussed. The book is intended for researchers interested in developing new techniques and exploring new applications of digital holography.

What is a hologram? -- Important optical principles and their occurrence in nature -- Conventional holography and lasers -- Digital image holograms -- Recording materials for holography -- Processing techniques -- Infrastructure of a holography studio and its principle components -- Making conventional denisyuk, transmission, and reflection holograms in the studio -- Sources of holographic imagery -- A personal view of the history of holography -- Epilogue : an overview of the impact of holography in the world of imaging

Advancement of Optical Methods & Digital Image Correlation in Experimental Mechanics, Volume 3 of the Proceedings of the 2018 SEM Annual Conference & Exposition on Experimental and Applied Mechanics, the third volume of eight from the Conference, brings together contributions to this important area of research and engineering. The collection presents early findings and case studies on a wide range of optical methods ranging from traditional photoelasticity and interferometry to more recent DIC and DVC techniques, and includes papers in the following general technical research areas: New Developments in Optical Methods & Fringe Pattern Analysis; DIC Applications for Challenging Environments; Optical Methods in SEM: History & Perspective; Mechanical Characterization of Materials & Structures with Optical Methods; Bioengineering.

This highly practical and self-contained guidebook explains the principles and major applications of digital hologram recording and numerical reconstruction (Digital Holography). A special chapter is designated to digital holographic interferometry with applications in deformation and shape measurement and
refractive index determination. Applications in imaging and microscopy are also described. Special techniques such as digital light-in-flight holography, holographic endoscopy, information encrypting, comparative holography, and related techniques of speckle metrology are also treated.

This volume includes 16 papers from the National Academy of Engineering's 2005 U.S. Frontiers of Engineering (USFOE) Symposium held in September 2005. USFOE meetings bring together 100 outstanding engineers (ages 30 to 45) to exchange information about leading-edge technologies in a range of engineering fields. The 2005 symposium covered four topic areas: ID and verification technologies, engineering for developing communities, engineering complex systems, and energy resources for the future. A paper by dinner speaker Dr. Shirley Ann Jackson, president of Rensselaer Polytechnic Institute, is also included. The papers describe leading-edge research on face and human activity recognition, challenges in implementing appropriate technology projects in developing countries, complex networks, engineering bacteria for drug production, organic-based solar cells, and current status and future challenges in fuel cells, among other topics. Appendixes include information about contributors, the symposium program, and a list of meeting participants. This is the eleventh volume in the USFOE series.

Cutting-edge quantitative phase imaging techniques and their applications. Filled with unique, full-color images taken by advanced quantitative phase imaging (QPI), Quantitative Phase Imaging of Cells and Tissues thoroughly explores this innovative technology and its biomedical applications. An introductory background on optical imaging and traditional optical microscopy is included to illustrate concept development. The book explains how various visualization modalities can be obtained by numerical calculations. This authoritative resource reveals how to take full advantage of the unprecedented capabilities of QPI, such as rendering scattering properties of minute subcellular structures and nanoscale fluctuations in live cells. Coverage includes: Groundwork Spatiotemporal field correlations Image characteristics Light microscopy Holography Point scanning QPI methods Principles of full-field QPI Off-axis full-field methods Phase-shifting techniques Common-path methods White light techniques Fourier transform light scattering (FTLS) Current trends in QPI.

Digital holography and its application to 3-D display is one of the formidable problems of evolving areas of high technology to receive great attention in recent years. This book offers a collection of key chapters that covers digital holography and 3-D display techniques to provide the state-of-the-art developments in these important areas. The book contains research material as well as reviews, new ideas and fresh insights.

This book deals with the latest achievements in the field of optical coherent microscopy. While many other books exist on microscopy and imaging, this book...
provides a unique resource dedicated solely to this subject. Similarly, many books describe applications of holography, interferometry and speckle to metrology but do not focus on their use for microscopy. The coherent light microscopy reference provided here does not focus on the experimental mechanics of such techniques but instead is meant to provide a users manual to illustrate the strengths and capabilities of developing techniques. The areas of application of this technique are in biomedicine, medicine, life sciences, nanotechnology and materials sciences.

Handbook of Optical Metrology: Principles and Applications begins by discussing key principles and techniques before exploring practical applications of optical metrology. Designed to provide beginners with an introduction to optical metrology without sacrificing academic rigor, this comprehensive text: Covers fundamentals of light sources, lenses, prisms, and mirrors, as well as optoelectronic sensors, optical devices, and optomechanical elements Addresses interferometry, holography, and speckle methods and applications Explains Moiré metrology and the optical heterodyne measurement method Delves into the specifics of diffraction, scattering, polarization, and near-field optics Considers applications for measuring length and size, displacement, straightness and parallelism, flatness, and three-dimensional shapes

This new Second Edition is fully revised to reflect the latest developments. It also includes four new chapters—nearly 100 pages—on optical coherence tomography for industrial applications, interference microscopy for surface structure analysis, noncontact dimensional and profile metrology by video measurement, and optical metrology in manufacturing technology.

This book presents peer-reviewed articles from the 20th International Symposium on Optomechatronic Technologies (ISOT 2019), held in Goa, India. The symposium brought together students, researchers, professionals, and academicians in the field of optomechatronics and related areas on a common platform conducive to academic interaction with business professionals. Presents a fully updated, self-contained textbook covering the core theory and practice of both classical and modern optical microscopy techniques.

Where conventional testing and inspection techniques fail at the micro-scale, optical techniques provide a fast, robust, and relatively inexpensive alternative for investigating the properties and quality of microsystems. Speed, reliability, and cost are critical factors in the continued scale-up of microsystems technology across many industries, and optical techniques are in a unique position to satisfy modern commercial and industrial demands. Optical Inspection of Microsystems is the first comprehensive, up-to-date survey of the most important and widely used full-field optical metrology and inspection technologies. Under the guidance of accomplished researcher Wolfgang Osten, expert contributors from industrial and academic institutions around the world share their expertise and experience with techniques such as image correlation, light scattering, scanning probe microscopy, confocal microscopy, fringe projection, grid and moiré techniques,
interference microscopy, laser Doppler vibrometry, holography, speckle metrology, and spectroscopy. They also examine modern approaches to data acquisition and processing. The book emphasizes the evaluation of various properties to increase reliability and promote a consistent approach to optical testing. Numerous practical examples and illustrations reinforce the concepts. Supplying advanced tools for microsystem manufacturing and characterization, Optical Inspection of Microsystems enables you to reach toward a higher level of quality and reliability in modern micro-scale applications.

This 1996 book is an expanded edition of one of the best known introductions to optical holography.

"This eBook is a collection of comprehensive and cutting edge book articles written by leading experts on digital signal and image processing in general, and specifically book written by one of pioneers of digital holography, one of the foremost branches o"

Cell Volume Regulation and Fluid Secretion, Volume 81, the latest release in the Current Topics in Membranes series highlights new advances in the field, with this new volume presenting interesting chapters on General principles of cell volume regulation, Cell volume maintenance: water and salt homeostasis, The search for ubiquitous cell volume sensor: the role of plasma membrane and cytoplasmic hydrogel, More than membranes, Cellular and membrane biomechanics of CVR response, Molecular identities of volume-regulatory anion channels, Molecular biology and physiology of volume-regulated anion channel (VRAC), the Role of WNKs in the modulation of intracellular chloride, amongst other topics. Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in the Current Topics in Membranes series Includes the latest information on Cell Volume Regulation

Written by leading optical phase microscopy experts, this book is a comprehensive reference to phase microscopy and nanoscopy techniques for biomedical applications, including differential interference contrast (DIC) microscopy, phase contrast microscopy, digital holographic microscopy, optical coherence tomography, tomographic phase microscopy, spectral-domain phase detection, and nanoparticle usage for phase nanoscopy The Editors show biomedical and optical engineers how to use phase microscopy for visualizing unstained specimens, and support the theoretical coverage with applied content and examples on designing systems and interpreting results in bio- and nanoscience applications. Provides a comprehensive overview of the principles and techniques of optical phase microscopy and nanoscopy with biomedical applications. Tips/advice on building systems and working with advanced imaging biomedical techniques, including interpretation of phase images, and techniques for quantitative analysis based on phase microscopy. Interdisciplinary approach that combines optical engineering, nanotechnology, biology and medical aspects of this topic. Each chapter includes practical implementations and worked examples.

Holography - Basic Principles and Contemporary Applications is a collection of fifteen chapters, describing the basic principles of holography and some recent innovative developments in the field. The book is divided into three sections. The first, Understanding Holography, presents the principles of hologram recording illustrated with practical examples. A comprehensive review of diffraction in volume gratings and holograms is also presented. The second section, Contemporary Holographic Applications, is concerned with advanced
applications of holography including sensors, holographic gratings, white-light viewable holographic stereograms. The third section of the book Digital Holography is devoted to digital hologram coding and digital holographic microscopy.

Praise for the First Edition “essential reading for any physical scientist who is interested in performing biological research.” —Contemporary Physics "an ambitious text.... Each chapter contains protocols and the conceptual reasoning behind them, which is often useful to physicists performing biological experiments for the first time." —Physics Today This fully updated and expanded text is the best starting point for any student or researcher in the physical sciences to gain firm grounding in the techniques employed in molecular biophysics and quantitative biology. It includes brand new chapters on gene expression techniques, advanced techniques in biological light microscopy (super-resolution, two-photon, and fluorescence lifetime imaging), holography, and gold nanoparticles used in medicine. The author shares invaluable practical tips and insider’s knowledge to simplify potentially confusing techniques. The reader is guided through easy-to-follow examples carried out from start to finish with practical tips and insider’s knowledge. The emphasis is on building comfort with getting hands "wet" with basic methods and finally understanding when and how to apply or adapt them to address different questions. Jay L. Nadeau is a scientific researcher and head of the Biomedical Engineering in Advanced Applications of Quantum, Oscillatory, and Nanotechnological Systems (BEAAQONS) lab at Caltech and was previously associate professor of biomedical engineering and physics at McGill University.

Choice Recommended Title, March 2020 Optical microscopy is used in a vast range of applications ranging from materials engineering to in vivo observations and clinical diagnosis, and thanks to the latest advances in technology, there has been a rapid growth in the number of methods available. This book is aimed at providing users with a practical guide to help them select, and then use, the most suitable method for their application. It explores the principles behind the different forms of optical microscopy, without the use of complex maths, to provide an understanding to help the reader utilise a specific method and then interpret the results. Detailed physics is provided in boxed sections, which can be bypassed by the non-specialist. It is an invaluable tool for use within research groups and laboratories in the life and physical sciences, acting as a first source for practical information to guide less experienced users (or those new to a particular methodology) on the range of techniques available. Features: The first book to cover all current optical microscopy methods for practical applications Written to be understood by a non-optical expert with inserts to provide the physical science background Brings together conventional widefield and confocal microscopy, with advanced non-linear and super resolution methods, in one book To learn more about the author please visit here.

Optical Holography: Materials, Theory and Applications provides researchers the fundamentals of holography through diffraction optics and an overview of the most relevant materials and applications, ranging from computer holograms to holographic data storage. Dr. Pierre Blanche leads a team of thought leaders in academia and industry in this practical reference for researchers and engineers in the field of holography. This book presents all the information readers need in order to understand how holographic techniques can be applied to a variety of applications, the benefits of those techniques, and the materials that enable these technologies. Researchers and engineers will gain comprehensive knowledge on how to select the best holographic techniques for their needs. Covers current applications of holographic techniques in areas such as 3D television, solar concentration, non-destructive testing and data storage Describes holographic recording materials and their most relevant applications Provides the fundamentals of holography and diffraction optics This book presents not only the simultaneous combination of optical methods based on holographic principles for marker-free imaging, real-time trapping, identification and tracking of micro objects, but also the application of substantial low coherent light sources and non-
diffractive beams. It first provides an overview of digital holographic microscopy (DHM) and holographic optical tweezers as well as non-diffracting beam types for minimal-invasive, real-time and marker-free imaging as well as manipulation of micro and nano objects. It then investigates the design concepts for the optical layout of holographic optical tweezers (HOTs) and their optimization using optical simulations and experimental methods. In a further part, the book characterizes the corresponding system modules that allow the addition of HOTs to commercial microscopes with regard to stability and diffraction efficiency. Further, based on experiments and microfluidic applications, it demonstrates the functionality of the combined setup, and discusses several types of non-diffracting beams and their application in optical manipulation. The book shows that holographic optical tweezers, including several non-diffracting beam types like Mathieu beams, combined parabolic and Airy beams, not only open up the possibility of generating efficient multiple dynamic traps for micro and nano particles with forces in the pico and nano newton range, but also the opportunity to exert optical torque with special beams like Bessel beams, which can facilitate the movement and rotation of particles by generating microfluidic flows. The last part discusses the potential use of a slightly modified DHM-HOT-system to explore the functionality of direct laser writing based on a two photon absorption process in a negative photoresist with a continuous wave laser.

Holography is the only truly three-dimensional imaging method available, and MATLAB has become the programming language of choice for engineering and physics students. Whereas most books solely address the theory behind these 3D imaging techniques, this monograph concentrates on the exact code needed to perform complex mathematical and physical operations. The text and the included CD-ROM spare students and researchers from the tedium of programming complex equations so that they can focus on their experiments instead. Topics include a brief introduction to the history, types, and materials of holography; the basic principles of analog and digital holography; a detailed explanation of famous fringe-deciphering techniques for holographic interferometry; holographic and non-holographic 3D display technologies; and cutting-edge concepts such as compressive, coherence, nonlinear, and polarization holography.

Holographic Materials and Optical Systems covers recent research achievements in the areas of volume holographic optical elements and systems, development of functionalized holographic recording materials, and applications in holographic imaging and metrology. Designs of single and multiplexed volume holographic optical elements for laser beam shaping, combining, and redirection are covered, and their properties are studied theoretically and experimentally. The high impact of holography in imaging and metrology is demonstrated by applications spreading from thickness and surface measurements, through antenna metrology and analyzing high-density gradients in fluid mechanics to characterization of live objects in clinical diagnostics. Novel functionalized materials used in dynamic or permanent holographic recording cover photopolymers, photochromics, photo-thermo-refractive glasses, and hybrid organic-inorganic media.

Modern holographic techniques have been successfully applied in many important areas, such as 3-D inspection, 3-D microscopy, metrology, and profilometry, augmented reality, and industrial informatics. This Special Issue covers selected pieces of cutting-edge research works, ranging from low-level acquisition, to high-level analysis, processing, and manipulation of holographic information. The Special Issue also serves as a comprehensive review of existing state-of-the-art techniques in 3-D imaging and 3-D display, as well as broad insights into the future development of these disciplines. The Special Issue contains 25 papers in the field of holography, 3-D imaging, and 3-D display. All the papers underwent substantial peer review under the guidelines of Applied Sciences.

In the 50 years since the first volume of Progress in Optics was published, optics has become one of the most dynamic fields of science. The volumes in this series that have appeared up to
now contain more than 300 review articles by distinguished research workers, which have become permanent records for many important developments, helping optical scientists and optical engineers stay abreast of their fields. Comprehensive, in-depth reviews Edited by the leading authority in the field

Encyclopedia of Biomedical Engineering is a unique source for rapidly evolving updates on topics that are at the interface of the biological sciences and engineering. Biomaterials, biomedical devices and techniques play a significant role in improving the quality of health care in the developed world. The book covers an extensive range of topics related to biomedical engineering, including biomaterials, sensors, medical devices, imaging modalities and imaging processing. In addition, applications of biomedical engineering, advances in cardiology, drug delivery, gene therapy, orthopedics, ophthalmology, sensing and tissue engineering are explored. This important reference work serves many groups working at the interface of the biological sciences and engineering, including engineering students, biological science students, clinicians, and industrial researchers. Provides students with a concise description of the technologies at the interface of the biological sciences and engineering Covers all aspects of biomedical engineering, also incorporating perspectives from experts working within the domains of biomedicine, medical engineering, biology, chemistry, physics, electrical engineering, and more Contains reputable, multidisciplinary content from domain experts Presents a ‘one-stop’ resource for access to information written by world-leading scholars in the field

The various techniques and applications of holography are covered in this profound book. It is an elucidative account on the fundamental principles of holography and current innovative advancement in this area. Topics covered in the book include a discussion on the standards of hologram recording, an extensive review of diffraction in volume gratings and holograms, advanced functions of holography in sensors, holographic gratings and white-light viewable holographic stereograms, digital hologram coding and digital holographic microscopy. The book presents the principles and methods of holographic interferometry - a coherent-optical measurement technique for deformation and stress analysis, for the determination of refractive-index distributions, or applied to non-destructive testing. Emphasis of the book is on the quantitative computer-aided evaluation of the holographic interferograms. Based upon wave-optics the evaluation methods, their implementation in computer-algorithms, and their applications in engineering are described.

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