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This book is an introduction to holographic interferometry - a field of holography having a great number of important and practically useful ap pl ications. It is intended for special ists working in the field of optics and holography, and also for students of the relevant specialities. At present, a gr eater and greater number of mechanica 1 engi neers, tur bine designers, testers of diverse equipment, biologists, crystallographers, and so on have to do with holographic interferometry. To allow these spe cialists, who are comparatively far from optics, to master the subject too, the main content of the book is preceded by an introductory chapter treating the fundamental concepts of the interference of light, optical interferometry, holography and holographic interferometry. The following chapters deal with the fundamentals of the theory of ho lographic interferometry and of experimental equipment. The authors have set themselves the task of sharing their more than ten year of experience of work in the field of holographic interferometry with their readers. In this connection, the questions which they dealt with directly are con sidered in somewhat greater detail, as a rule, than those with which they have become acquainted only from publications on the subject. A sufficiently detailed (although far from complete) bibliography gives any interested reader an opportunity to improve his knowledge of this field. Holographic Interferometry provides a valuable and up-to-date source of information in the rapidly expanding field. The eight specialists` contributions cover the principles and methods currently in use. The scope of the book has been limited to the study of opaque object and ample space has been devoted to a comprehensive treatment of the phenomena of fringe formation, with a particular emphasis on the quantitative evaluation of the holographic interference fringe patterns. The emergence of computer-aided fringe analysis and phase-shifting techniques have simplified considerably the quantative real-time measurements of object shapes and deformations. The last two chapters provide a reasonably detailedoverview of full-field holographic methods for the measurement of shapes, displacements, dervatives, difference displacements and vibrations. Holographic interferometry was successfully applied to a large-scale wind tunnel (40-cm x 40-cm test section) experiment on a three-dimensional flow field. The laser interferometer was set up in a schlieren

bench with a pulsed-ruby laser as the light source. Both the object beam and the reference beam were collimated. The conventional double-exposure, off-axis operation was used to produce interferograms. A 15-degree half-angle opaque cone at zero and 16.5 degrees yaw in a M = 2 free stream provided the flow field for the investigation. The aerodynamic conditions were such that flow field was largely inviscid. 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. An application of optical holography known as 'Holographic Interferometry' has been developed which enables experimentalists either to measure deformations of a few microns in loaded mechanical systems or to examine relative displacements in sinusoidally-vibrating systems. The fundamental theory of holography and four techniques for holographic interferometry are described in this report. A system constructed to record interferograms of acoustic transducers operating either in air or submerged in water is discussed and some results of examining a sinusoidally-excited 7-inch permanent-magnet loudspeaker with interferograms are considered. (Author). The advent of holography and the laser as an extremely intense, coherent light source has opened new dimensions in interferometric techniques. Precision optics are not required, alignment is not a critical factor, and three-dimensional interferograms of a flow field are obtainable. These are only a few of the advantages that stand out over present day interferometers. A brief outline of the holographic interferometric process and its capabilities is presented here. A detailed exposition of the continuous reconstruction beam technique is given from experience gained with such a device in the Department of Aeronautics of the Naval Postgraduate School. (Author). HOLOGRAPHIC INTERFEROMETRY IS A NEW OPTICL METHOD FOR MEASURING DISPLACEMENT AND DEFORMATION FIELDS WHICH EXPLOITS UNIQUE PROPERTIES OF HOLOGRAPHY. SPECIFICALLY, HOLOGRAPHY PERMITS STORAGE OF A LIGHT WAVE FRONT AND ITS SUBSEQUENT RECONSTRUCTION AT ANY DESIRED TIME. AS SUCH, IT PROVIDES AN OPTICAL REPLICA OF A TEST PIECE IN A GIVEN STATE WHICH OPTICALLY INTERFERES WITH SUBSEQUENT IMAGES OF THE TEST PIECE. UNDER APPROPRIATE CONDITIONS, THE RESULTING INTERFERENCE PATTERN CAN THEN BE RELATED TO CHANGES IN POSITION AND DEFORMATION OF THE TEST PIECE. THE TECHNIQUE MAY BE ADAPTED TO THE USE OF EITHER TRANSPARENT OR OPAQUE TEST PIECES, AND WITH FAR GREATER FLEXIBILITY AND RANGE OF MEASUREMENT THAN CONVENTIONAL INTERFEROMETRY WHERE ALL SURFACES MUST BE OPTICALLY FLAT. BOTH REAL TIME AND STORED STATIC AND DYNAMIC TECHNIQUES HAVE NOW BEEN DEVELOPED AND ARE CONTINUOUSLY BEING REFINED. PROMISING AREAS FOR APPLICATION ARE IN ASSOCIATION WITH AND AS A COMPLEMENT TO PHOTO-ELASTICITY FOR STATIC AND DYNAMIC MODEL ANALYSIS, AND IN SUCH MATERIALS STUDIES AS FLAW GROWTH OR DAMAGE DETECTION IN FATIGUE AND FRACTURE MECHANICS. SPIE Milestones are collections of seminal papers from the world literature covering important discoveries and developments in optics and photonics. Laser holographic interferometry was applied to the measurement of density profiles of two-dimensional planar turbulent boundary layers on the wall of the Acoustic Research Tunnel (ART) at the Arnold Engineering Development Center (AEDC). Holograms were produced at Mach numbers 0.50 and 0.65 by the finite fringe, single-plate, dual-exposure method. The reconstructed image from this type of hologram contains fringes that are shifted relative to a reference fringe by an amount that is proportional to the difference in the densities at the two points. Therefore, it was possible to determine the density profiles by measuring the fringe shifts appearing in the reconstructed images. The results of two velocity-temperature relations are presented, and compared to data obtained by pitot, hot-wire, and split-film probes. A description of the experimental facility, hardware for data acquisition, data reduction methods, and a discussion of the problems encountered in the holographic interferometry technique are presented. Applications of holographic interferometry are so vast that they are limited only by the imagination of the researchers. This collection represents a variety of HI applications, from micro-crack detection in ancient paintings to holographic testing of nuclear technology. WE GIVE A METHOD OF PRODUCING COMPUTER GENERATED INTERFEROGRAMS OF SURFACE DEFORMATION FOR

COMPARISON WITH HOLOGRAPHIC INTERFEROGRAMS. THE PURPOSES ARE: TO VERIFY BOUNDARY CONDITIONS FOR BOTH STRESS ANALYSIS CODES AND HOLOGRAPHY EXPERIMENTS, TO DETERMINE THE THEORETICAL SENSITIVITY OF HOLOGRAPHY TO PROGRAMMED FLAWS, TO EXTRAPOLATE RESULTS OF HOLOGRAPHY TO INNER DEFORMATIONS FROM UNIFORM THERMAL STATES GIVEN BY STRESS CODES AND THE THERMAL GRADIENT STATE GIVEN BY TEMPERATURE CHANGE HOLOMETRY. THE METHOD CONSISTS OF REVERSING AN INTERFEROGRAM ANALYSIS CODE TO GENERATE OPTICAL PATH DIFFERENCES FROM THE OPTICAL ARRANGEMENT AND DEFORMATION AT EACH POINT ON THE SURFACE. THIS OPTICAL PATH DIFFERENCE IS THEN USED TO GENERATE FRACTIONAL ORDERS FOR DISPLAY OF AN INTERFEROGRAM. THE DERIVATION OF THE TECHNIQUE, ORIGINALLY USED TO VERIFY HOLOGRAPHIC INTERFEROMETRY ANALYSIS, IS GIVEN. DEFORMATION INPUTS TO PRODUCE THE INTERFEROGRAM CAN BE SIMPLE, SUCH AS DEFINING AN EQUATION FOR DEFORMATION ON A SURFACE, OR MORE USEFUL, SUCH AS USING THE OUTPUT OF A STRESS ANALYSIS CODE TO GENERATE SURFACE DEFORMATIONS. INTERFEROGRAM EXAMPLES FROM BOTH OF THESE INPUTS ARE GIVEN IN A COMBINATION OF SEVERAL DISPLAY MODES. THESE DISPLAY MODES ARE DISCUSSED AND COMPARED. An excellent introduction to holography for students and researchers in science and engineering. 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. Holographic and speckle interferometry are optical techniques which use lasers to make non-contracting field view measurements at a sensitivity of the wavelength of light on optically rough (i.e. non-mirrored) surfaces. They may be used to measure static or dynamic displacements, the shape of objects, and refractive index variations of transparent media. As such, these techniques have been applied to the solution of a wide range of problems in strain and vibrational analysis, non-destructive testing (NDT), component inspection and design analysis and fluid flow visualisation. This book provides a self-contained, unified, theoretical analysis of the basic principles and associated opto-electronic techniques (for example Electronic Speckle Pattern Interferometry). In addition, a detailed discussion of experimental design and practical application to the solution of physical problems is presented. In this new edition, the authors have taken the opportunity to include a much more coherent description of more than twenty individual case studies that are representative of the main uses to which the techniques are put. The Bibliography has also been brought up to date. A unified, comprehensive, self-contained treatment of theory, practice, and application, including related coherent optical techniques. Emphasizes quantitative evaluation of holographic interferograms of both opaque and transparent objects, explaining how tools such as the laser and holography are being applied to present-day measurement problems. Applies clear, simple, physical reasoning to present practical information and data; circumvents complicated mathematics wherever possible. Includes over 700 cited references, numerous line drawings and photographs, and several useful tables and equations relating optical data to physical properties. Holographic interferometry has reached a state of practical application wherein many different structural deformations have been recorded. Some of these recordings can be interpreted by casual observation while others require a detailed mathematical analysis to convert fringe patterns into displacement data. A few investigators have proposed different mathematical models for fringe formation resulting from surface displacements. Most of these models, however, do not adequately represent realistic structures. The report is concerned with examining these approaches and devising a systematic plan of investigating displacement determination for complex structures. Holographic interferometry has gained wide acceptance as a nondestructive testing and vibration analysis technique since its introduction in 1965. The report outlines the history of holographic interferometry, describes the holography process, and describes several applications representative of the present state of the art of holographic interferometry that are particularly relevant to underwater acoustics work. Potential future applications are presented for consideration. (Author). The application of holographic interferometry to displacement and strain determination has been reviewed. A brief introduction to the theoretical

basis of holography and holographic interferometry, and a summary of recent developments is given. It is concluded that with continued development, holographic interferometry has the potential to become a routine tool for whole field displacement and strain measurement, and non-destructive testing of aircraft structures. Transparent in the visible range, phase objects can be studied in the optical range using holographic interferometry. Typically, the holograms are recorded on high-resolving-power holographic photo materials, but a lower spatial resolution is sufficient for successful research in many scientific applications. Holographic Interferometry: A Mach–Zehnder Approach offers practical guidance to research scientists and engineers using Mach–Zehnder holographic interferometry methods to study phase objects in the laboratory. The Mach–Zehnder approach allows the use of standard photographic film and electronic CCD/CMOS sensors with low resolving power, making it a simpler and more affordable option for testing many types of phase objects. This book demonstrates how to use standard photographic film for the optical recording and reconstruction of Mach–Zehnder holograms. It also illustrates techniques for using CCD/CMOS cameras to digitally record Mach–Zehnder holograms/interferograms of transparent objects. Bringing together original research and information scattered throughout existing literature, this book focuses on the holographic reference beam and shearing interferometry methods. In particular, it looks at how these methods and optical schemes can be directly applied to testing aerodynamic flows, as well as to plasmas, shocks, and waves in noncoherent laser–matter interactions. Numerous reconstructed and classic interferograms, deflectograms, and Schlierengrams illustrate the material, helping readers develop and design their own optimal optical scheme and choose applicable details to apply the approach. Describing methods in a mathematically simple and accessible way, this book is also suitable for graduate students in the fields of aerospace engineering and optics, as well as those in laser, thermal, and plasma physics. Holographic interferometry was successfully applied to a large-scale wind tunel (40-cm x 40-cm test section) experiment on a three-dimensional flow field. The laser interferometer was set up in a schlieren bench with a pulsed-ruby laser as the light source. Both the object beam and the reference beam were collimated. The conventional double-exposure, off-axis operation was used to produce interferograms... This monograph deals with diverse applications of holographic interferome try in experimental solid mechanics. Holographic interferometry has experienced a development of twenty years. It has enjoyed success and suffered some disappointments mainly due to early overestimation of its potential. At present, development of holo graphic interferometry is progressing primarily as a technique for quantita tive measurements. This is what motivated us to write this book - to ana lyze the quantitative methods of holographic interferometry. The fringe patterns obtained in holographic interferometry are graphi cally descriptive. In the general case, however, because they contain infor mation on the total vectors of displacement for points on the surface of a stressed body, the interpretation of these interferograms is much more complicated than in typical conventional interferometry. In addition, the high sensitivity of the method imposes new requirements on the loading of the objects under study. New approaches to designing loading fixtures are needed in many cases to ensure the desired loading conditions. The wealth of information obtained in holographic interferometry necessitates the use of modern computational mathematics. Therefore, practical implementation of the various methods of holographic interferometry must overcome sub stantial difficulties requiring adequate knowledge in diverse areas of science such as coherent optics, laser technology, mechanics, and applied mathe matics. Experimental methods play a significant role in solid mechanics.