Guest Editorial

Coherent Optical Techniques in Experimental Mechanics

F. P. Chiang
State University of New York
Department of Mechanical Engineering
Stony Brook, New York 11794

This is the first of two special issues of *Optical Engineering* on optical techniques in experimental mechanics, which I have been kindly asked by Dr. Caulfield to organize. The first issue deals with coherent optical methods, and the second with incoherent optical methods. The division is somewhat arbitrary because many light sources are partially coherent and some methods require the use of both coherent and incoherent light sources. In essence, I have called a method a coherent optical technique if a laser is used as the primary information gathering device and if, in the process, some sort of the coherent property of the light is utilized. Otherwise, it is classified as an incoherent optical technique.

In the past fifteen or so years, many new optical measurement techniques have been developed in the general field of experimental stress analysis. Among the most important is the group of laser speckle methods whereby the random dots (i.e., the speckles) created by the multiple interference of scattered or reflected wavelets are utilized as displacement gauging elements. There are many different ways of utilizing this speckle pattern. The first paper by F. P. Chiang, J. Adachi, et al. describes a family of techniques in which the laser speckles are recorded through a lens by direct photography. A different approach is offered by Y. Y. Hung's paper wherein speckle shearing interferometry is introduced. T. D. Dudderar and P. G. Simpkins review the development of the scattered light speckle technique, which is one of the very few methods that is capable of measuring interior displacement and strain. Originally developed for solids, it has now found wider application in fluid mechanics. The technique of electronic speckle pattern interferometry (ESPI) (as reviewed by C. Wykes) combines speckle interferometry and electronic processing, thereby offering the capability of viewing structural response in real time. The objective speckle methods in which speckles are directly recorded on film without the use of a lens give rise to some special possibilities. The close range objective speckle method is described by P. M. Boone whereas a far-field objective speckle method is offered by F. P. Chiang and C. C. Kin. While one might be led to believe that all these methods are mutually independent, P. K. Rastogi and P. Jacquot present to us an analytical net that ties the underlying principles of all these techniques together. When one is confronted with the need to analyze numerous fringe patterns, it is imperative that some sort of automation be constructed. T. Yatagai, et al. offer a semiautomatic processing technique in this regard. A big step forward in the art of collecting and analyzing experimental data is to forego photographic film altogether. The papers by W. H. Peters and W. F. Ranson, and by I. Yamaguchi show ways to use digital computers to calculate the speckle correlation directly. This is a direction of research which shows great promise.

Other important coherent optical techniques were also developed during this period. C. A. Sciammarella describes a family of holographic-moire methods whereby two important classical methods are married to yield new results. The ingenious application of coherent optics to the classical moire method by D. Post has pushed the sensitivity to the near theoretical limit, thus greatly widening the application range of the moire method. The paper by D. C. Holloway describes one of the more important applications of holographic

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interferometry: the study of stress wave and crack propagation in solids. A new development in holographic interferometry in recent years is the adaptation of an image derotator to study rapidly rotating structures. An application of this device is described by J. C. MacBain, et al. The paper by A. E. Ennos, to whom the development of many of the speckle and holographic techniques can be traced, gives a comparison between the two methods in their application to out-of-plane deformation measurement. The paper by W. N. Sharpe, Jr. shows how a simple diffraction phenomenon can be utilized to yield useful information in solid mechanics. And, the paper by R. J. Sanford presents another happy marriage between two classical methods: holography and photoelasticity.

While I cannot claim exhaustiveness, I do believe that most of the important coherent optical techniques of displacement and strain measurement have been comprised within this special issue. The applications included are mostly in solid mechanics, some in fluid mechanics, and others in nondestructive testing. I am quite certain that the domain of application of these powerful tools will widen in the years to come. And, I am equally certain that newer and even more powerful optical techniques will emerge from the horizon in the near future. It is a fascinating field. I thank the authors for their excellent contributions and invite new members to join our community.