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Shearography and its Applications

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KEYNOTE SPEAKER

A grainy pattern formed in space when a laser beam strikes an object is called a speckle pattern. It was considered a bane of holographers because the reconstructed images from the holograms were grainy. A number of methods were investigated to reduce this delirious effect. During the late sixties, it was discovered that the speckle pattern carries information about the object and hence could be used for measurement. Initially both speckle photography and speckle interferometry was investigated to measure displacement and deformation of the objects. It was realized that speckle interferometry could be configured to measure components of the deformation vector unlike the holographic interferometry. In the beginning, the recordings were made on photoemulsions (photographic plates or films) and the technique came to be known as speckle pattern interferometry. Since it was possible to control the size of the speckles in the pattern, electronic recording using vidicon tube was successfully attempted and the technique took a new name, that is, electronic speckle pattern interferometry (ESPI). When recording is done on a CCD or a CMOS and digital manipulations are carried out, the technique is known as digital speckle pattern interferometry (DSPI). Using ESPI/DSPI along with phase-shifting, the deformation map of the object subjected to an external agency is obtained almost in real-time. The technique is wholefield, extremely sensitive and can be configured to obtain either in-plane components or out-ofplane component or all the three components of the deformation vector simultaneously. It has also been applied to the study of vibrating object either in a time-average or a stroboscopic mode. Material scientists, stress analysts, quality assurance personnel, product developers and many others are interested not only in deformation but in strain values. Strain measurements are the basis for predicting how long an object will perform without failure when subjected to certain external influences. There are several techniques for strain measurement: some are point-wise, and some are whole-field techniques. Shearography is one of the optical techniques that has evolved both for qualitative and quantitative strain (difference quotient) measurements. When shear interferometry features are included in speckle pattern interferometry, it becomes speckle pattern shear interferometry (SPSI) or speckle shear interferometry (SSI) or simply shearography.

Shearography is a displacement gradient sensitive full-field optical technique that is resilient to the environmental disturbances and vibrations. It does not respond to rigid body translations. Being almost common-path technique, temporal coherence requirement is considerably relaxed. The experimental set-up is simple and offers reduced sensitivity to fill the gap between DSPI and moiré techniques. Initially various methods of shearing were investigated and shearography was used for visualization of slope and strain fringes. The recordings were mostly on photo-emulsions and slope and strain fringes were obtained by Fourier filtering. It was also used to visualize vibration modes. Later recording on CCD/CMOS along with phase shifting provided phase maps from which quantitative values of strain and slope could be obtained. Information. It has, however, found applications in non-destructive testing of components and structures used in aircraft and automobiles. It is finding applications for NDT of wooden and canvas paintings.