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Quantitative nondestructive tests of defects with optical methods

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Summary

The quantitatively assessment of defect characteristic parameters (DCP), such as coordinates, size, embedding depth and type of defects in structures or materials, is becoming increasingly important. One reason is for economy and safety, and the other for a defect in structures may lead to failure while it is growing to a critical size. Therefore, it is possible to estimate both remaining life of structures and extent of the degradation by knowing the dimensions of defects presenting in structures. In this paper, several research topics on quantitative detection of the DCP in our group are reviewed as follows:

1)Nondestructive testing methods, holographic interferometry (HI), shearing speckle interferometry (SSI), and simple mechanical models are combined to quantitatively estimate of the coordinates, size, embedding depth, and type of defects of a thin-walled pressure vessel. Experimental tests are conducted to demonstrate the efficiency and the accuracy of this combined technique for thin-walled spherical vessels that contain cavities or cracks.

2)Laser diffraction technique (LDT) is used to investigate the crack opening and propagation of a single slit crack and a cavity subjected to uniaxial tensile load. Moreover, this technique is also combined with the power spectrum autocorrelation method and spectral iterative technique, respectively, to retrieve the complex shapes of microcracks and cavity apertures on the surface of the tested samples.

3)Optical methods, such as electronic speckle pattern interferometry (ESPI) and SSI, design optimization and FEM are combined to accomplish quantitative nondestructive tests (QNDT). Three types of defects are inspected and their DCP values are obtained quantitatively.

Finally, the paper briefly introduces the research on automatic detection of the defect characteristics with the wavelet transform (WT). The signal changes corresponding to the partial fringe patterns caused by the local defects in HI and ESPI nondestructive testing are analyzed. We demonstrate how the Morlet wavelet is used to detect the defect-induced partial fringe patterns from the global fringe pattern in HI and the ESPI nondestructive testing.