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Rapid Localization and Ultrasonic Imaging of Multiple Damages in Structural Panel with Piezoelectric Sensor-Actuator Network

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Rapid localization of multiple damages and non-intrusive imaging of these damages can greatly help in reducing the inspection time for guided wave based NDE and in integrated SHM. A circular array of sensor-actuator network was employed for scanning a panel type structure for quantitative damage detection besides non-intrusive imaging with the help of the available reduced number of measurements and a mathematical model. This method employs Lamb waves with a narrow frequency band of excitation. What is advantageous in the proposed method is that, a circular array of sensor-actuator network with a very small physical area of coverage is sufficient to construct the virtual image of an entire panel without physically scanning using the actuators or the sensors. By employing this technique, surface breaking cracks on either inaccessible or accessible face and of size as small as 3 mm in a typical aircraft structural panel are detected with a relatively low frequency band of 100-250 kHz. The coordinates of the damages are estimated from the experimentally obtained signals using triangulation technique. Change in the wavelet coefficient with respect to a baseline signal is used to construct a quantitative relationship with damage size parameters. A damage index is then estimated by integrating the corresponding wavelet coefficient over the frequency scales of interest and over the time window of interest according to the group velocity dispersion. The magnitude of the damage index shows the severity of damage. Further correlation of these quantities with failure mechanisms and prognosis remain an open area of research.

Ключевые слова:

Structural health monitoring, circular array, multiple damages, damage detection, imaging, wavelet, damage index, Lamb wave.

Содержание.

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