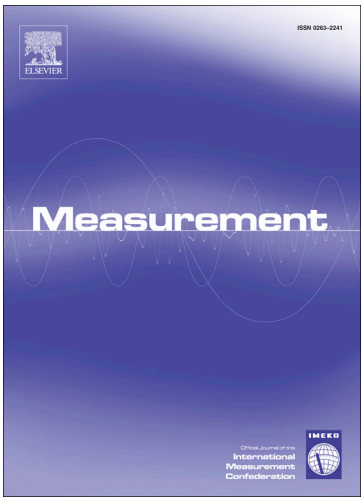

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Aircraft Integrated Structural Health Monitoring Using Lasers, Piezoelectricity, and Fiber Optics

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Abstract

Various structural health monitoring (SHM) systems that have been developed based on laser ultrasonics and fiber optics are introduced in this paper. The systems are used to realize the new SHM paradigm for ground SHM, called the Smart Hangar. Guided wave ultrasonic propagation imaging (G-UPI) technology is implemented in the Smart Hangar in the form of built-in and mobile G-UPI systems. The laser-induced guided waves generated by pulsed beam scanning in the wings and fuselage of an aircraft are captured by a fiber optic, piezoelectric, or laser ultrasonic sensor, and their propagation is visualized. The wave propagation video is further processed to visualize damage in the presence of multiple sources using a multi-time-frame ultrasonic energy mapping (mUEM) method. For in-flight SHM, laser scanning-based smartification of the structure with sensors is presented, and an event localization method based on fiber optics and piezoelectric sensing is also introduced. Optic sensors are also utilized to reconstruct the wing deformation from the measured strain. The wing deformation and impact localization information is transferred to a ground pilot in the case of unmanned aerial vehicles (UAV), and the ground pilot can feel the wing deformation and impact by using a pilot arm-wearable haptic interface, which makes it possible to achieve human-UAV interactive decision making.

Keywords: Integrated structural Health Monitoring, Laser Ultrasonic, Fiber Bragg Grating, Piezoelectric