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Multi-site Delamination Detection and Quantification in Composites through Guided Wave Based Global-local Sensing

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Advanced composite materials are contributing to a revolution in aerospace applications. Rapid inspection techniques for detecting and quantifying damage in large composites are critical for ensuring operability and safety of composite structures. Moreover, in the development and manufacturing of next-generation composite materials, rapid inspection techniques are imperative for evaluating and certifying the materials.

This paper presents a guided wave based global-local sensing method for rapid detection and quantification of delamination damage in large composite panels. The global-local approach uses a hybrid system consisting of a piezoelectric transducer (PZT) for generating guided waves and a non-contact scanning laser Doppler vibrometer (SLDV) for acquiring guided wave data. The global-local inspection is performed in two steps. First, a phased array configured of a small number of SLDV scan points (for example 10×10 points in a rectangular grid array) performs inspection over the entire plate to detect and locate damage (Figure 1a). Local areas are identified as potential damage regions for the second step. Then high density wavefield measurements are taken over the target damage areas and wavefield analysis is performed to quantitatively evaluate the damage (Figure 1b). For the proof of concept, the global-local approach is demonstrated on a carbon fiber reinforced polymer (CFRP) composite plate with two sites of impact-induced delamination damage. In the first step, the locations of two delamination sites are detected by the phased array method. In the second step, the delamination size and shape are evaluated through the wavefield analysis. The detected delamination location, size and shape agree well with those of ultrasonic C-scan.

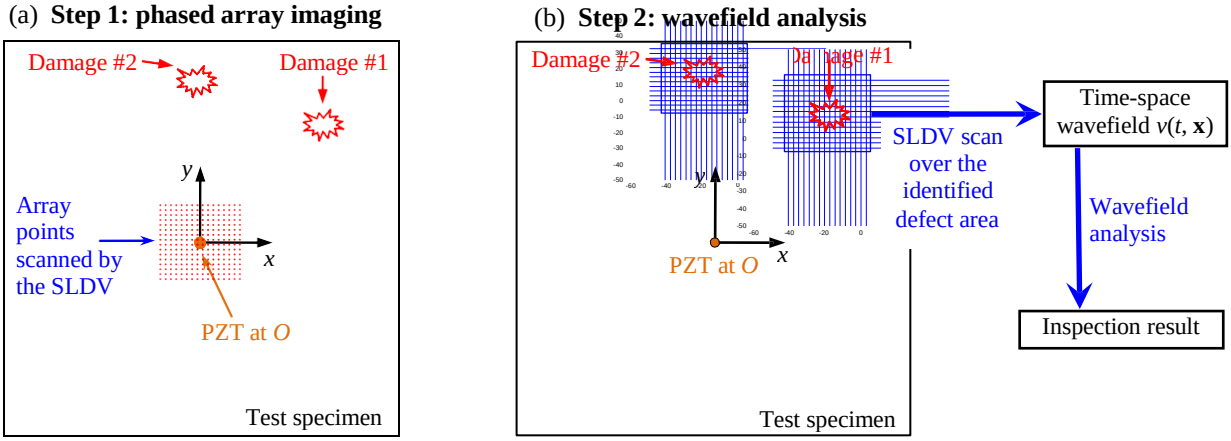

Figure 1. The global local sensing strategy. Step 1: a phased array configured by a small number of SLDV scan points is used to detect and locate the damage. Step 2: high density wavefield measurements are taken over the identified damage area to quantitatively evaluate the damage.