Ultrasonic imaging of volumetric defect using diffuse signals acquired from a laser vibrometer

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Laser induced ultrasonic arrays have been used for defect detection and have advantages of being non-contact, and able to cope with complex geometry and harsh environments. However, the detection speed is limited by slow data acquisition, as the combinations of every transmitting and receiving sampling points are required to build up a full matrix capture (FMC) array data. This issue becomes even more challenging when detecting volumetric defect using a two-dimensional array. In this paper, a single conventional transducer is used to send ultrasound into a sample at an optimized location, while a laser vibrometer is used to acquire data at a prescribed set of 2D array element locations. The FMC array data for the 2D array is recovered from the acquired signals by cross-correlating pairs of acquired signals in their wave diffuse regimes. Compared to regular FMC using laser generation at each array element location, this approach results in a reduction in the number of acquired signals by a factor equal to the number of sampling points. The proposed method is demonstrated for imaging different types of defects, including sided-drilled-holes and flat bottom holes. The imaging performance is compared with the images obtained from conventional matrix ultrasonic arrays and laser induced ultrasonic arrays. It is shown that the proposed method can achieve the same image quality as conventional matrix ultrasonic arrays.