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Synthetic Aperture Imaging of Contact Acoustic Nonlinearity at Closed Interfaces

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Ultrasonic imaging has been widely used as an intuitive recognition method for the detection of defects [1]. To enhance the resolution in ultrasound imaging, various kinds of techniques have been developed. Synthetic aperture focusing technique (SAFT) is one of effective post-processing techniques for the resolution improvement. Many studies have shown that SAFT has high resolution as well as high signal to noise ratio for identifying the characteristics of defects accurately [2]. However, most of the imaging techniques based on linear characteristics of ultrasound could underestimate the size of flaws. In particular, the defects in initial state so called micro cracks or closed interfaces are very difficult to be visualized. In order to visualize these micro defects, it is necessary to adopt novel imaging technique using nonlinear ultrasonic characteristics such as contact acoustic nonlinearity (CAN) effect.

This study proposed a nonlinear SAFT based on CAN effect and verified its effectiveness. The experiments with array probe for imaging closed interfaces were carried out. The pressure of the interfaces was increased by a hydraulic press, which resulted in the change of the contact state at the interfaces from open interfaces to closed interfaces. When a fundamental ultrasonic wave is incident at closed interfaces, the CAN effect leads the harmonic generation [3]. The proposed synthetic aperture imaging based on CAN effect was applied to visualize the closed interfaces with respect to the change of the contact interface condition.

The results showed that SAFT based on CAN effect was effective for the detection of closed interface. This supports that synthetic aperture imaging techniques based on acoustic nonlinearity had advantages for the diagnosis of structural integrity.

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