

Synthetic Aperture Imaging of Acoustic Nonlinearity (SAIAN)

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The ultrasonic imaging based on a pulse wave has difficulty visualizing the closing interface such as crack tip, delamination, and debonding. The imperfect contacts cause contact acoustic nonlinearity (CAN) which can be observable when using a tone-burst wave. However, the tone-burst wave degrades the image resolution because its wave length is relatively longer than the pulse wave. In order to visualize CAN with high resolution, a signal-processing technique, named Synthetic Aperture Imaging of Acoustic Nonlinearity (SAIAN), is proposed. SAIAN extract the fundamental and second-order harmonic frequency components from the tone-burst wave signals and then transform these components into pulse-like CAN parameter signals. The pulse-like signals can be used for synthetic aperture focusing method (SAFT), which can visualize the closing interfaces. To verify the effectiveness of SAIAN, the nonlinear ultrasonic measurement using tone-burst waves was carried out for closing interfaces in two acrylic blocks and an aluminum CT specimen. The results show that SAIAN visualize the CAN at the closing part; however, it was not observable in the image reconstructed by linear SAFT. This supports that SAIAN is an effective technique for acoustic nonlinearity visualization, which can increase the probability of detection of closing interfaces as well as the accuracy in crack sizing.