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Laser ultrasonic propagation visualization in plates with liquid boundaries

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Existing NDT techniques based on Lamb wave obtained by contact method were difficult to perform inspection for the target structure in water. So, this study presents a non-contact NDT/E technique (such as laser-based ultrasonic generator/sensor) with ultrasonic wave propagation imaging algorithm for damage visualization in submerged aluminum plate. The experimental case studies were performed to predict the size and shape of the damage for test specimen with three different cases; free plate and immersed plate in water and glycerin. An aluminum plate specimen (400mm 400mm 3mm) with a 12 mm long and 2-mm deep artificial crack was immersed in water and glycerin. A 532 nm Q-switched pulses wave laser with a wavelength of 532 nm and energy of 1.2 mJ was used to scan an area of 100 mm with slit damage. A laser Doppler vibrometer based on the Doppler shift of the laser light was used as the non-contact ultrasonic sensor which measures displacement of guided wave. The time domain ultrasonic wave measured by the LDV sensor was amplified and band-pass filtered in (40 – 140) kHz range. Then, the propagation of ultrasonic wave in the submersed specimen was visualized using the basic ultrasonic wave propagation imaging (UWPI) technique. The visualized Lamb waves in the immersed plates with water and glycerin showed delay of propagation time and reduction of amplitude in A0 mode compared to the free plate. SNR was deteriorated due to leaky Lamb wave in the submerged plate. Therefore, the repeat scanning technique was incorporated in the original UWPI system to solve low SNR problem in real world application. Lamb wave dispersion curves at each case are calculated to investigate the velocity-frequency relationship by DISPERSE software, and propagation time for the respective cases obtained by the dispersion curve are compared with the experimental results. This study shows the dispersion and attenuation of Lamb wave in an Al plate in contact with different liquids on two surfaces. In addition, it is demonstrated that the developed fully non-contact ultrasonic propagation imaging system is capable of damage sizing in the submerged structures.

Biography

Jae-kyeong Jang has completed his master's degree at the age of 28 years from Chonbuk National University and Ph.D. studies from Chonbuk National University. He is associated with Los Alamos National Laboratory-Chonbuk National University Engineering Institute Korea.

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