Laser ultrasonics for crack depth estimation using TOFD based delay and sum method

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This study introduces a technique for crack detph estimation through the TOFD(Time of Flight Difference) based delay and sum method using laser ultrasonic system. In the inspection process, two laser beams for excitation and measurement are aperture from the same interval and line scanning is performed perpendicular to the crack line on surface. The array signals are obtained by the scan and delay and sum method is carried out based on time of flight difference. Each signal is extracted considering location of excitation and measurement points, path of the wave according the assumed crack depth and wave velocity information. Signal amplification is then performed by using delay and sum method. Finally, the maximum value in the amplification result is searched to estimate the crack depth. Finite element modeling(FE-model)) is implemented before the experimental study. From the FE-model study, it was shown that in the case of an open crack, using S wave passing through the crack inner surface is the most effective for estimating depth of the crack. We conduct several experiments using both metallic and non-metallic specimen. As results of the experiments, it is confirmed that up to 10 mm of crack depth can be exactly estimated with an error of less than 0.1 mm.