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Ultrasonic Time of Flight Estimation Using Wavelet Transforms

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Abstract : The accurate estimation of the time-of-flight (TOF)of the ultrasonic echoes is important in non-destructive testing (NDT). The main interest of the TOF estimation is the flaw detection, localization and coating thickness evaluation. Usually, the backscattered echoes from a thin coating or a flaw located close to the interface overlap in the time domain, so TOF estimation becomes more complicated and requires advanced signal processing methods. In this paper, the wavelet transform was investigated in order to evaluate the TOF. The two applied methods are the continuous wavelet transform based on the scale-averaged power (SAP) and the discrete stationary wavelet transform (DSWT). These methods were applied, firstly, on simulated Gaussian echoes for two practical cases: without andwith partially overlapping echoes. Several numerical tests have been carried out to select a suitable mother wavelet for each method and for each case. The performance was evaluated through the mean square error (MSE) between the estimated and the reference value of the TOF. The numerical tests showed that both methods give a low error for non-overlapping echoes, while a reasonable error was obtained in case of partially overlapping echoes. An experimental validation was performed on a real signal taken from a thermally coated sample in order to evaluate the coating thickness. An overall agreement was observed between simulation and experiment.

Keywords : Time of Flight estimation, ultrasonic echo, SAP, DSWT