

Modern trends in ultrasonic inspection and imaging

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Since the 1970s more and more ultrasonic inspection has been performed using array transducers rather than monolithic single-element probes. At first array systems performed physical beam-forming to mimic monolithic transducer operation. With the advent of fully digital systems in the early 2000s and the capability to deal with large data volumes it has been possible to acquire all possible raw data from an array in near real time. This is so-called Full Matrix Capture (FMC) and enables the acquisition and processing operations to be decoupled. Most commercial array controllers now provide FMC capability and increasingly research is focusing on how to extract more information from FMC data. This paper will look at examples, including: high resolution imaging algorithms based on the Total Focusing Method (TFM); adaptive imaging that accounts for unknown component geometry; multi-view imaging; scattering matrices for defect characterisation. Array inspection speed is ultimately limited by the number of transmission cycles and for FMC this is equal to the number of elements in an array. The paper will consider different strategies for accelerating acquisition in time-constrained inspections, including both changes to the physical design of arrays and the mode of acquisition (e.g. plane wave and virtual source imaging). Finally, some new ultrasonic inspection methods including nonlinear imaging and laser-based acquisition of FMC data will be discussed.