Optimisation of speed in ultrasonic array imaging for non-destructive testing

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Phased Array Ultrasound Testing (PAUT) is now a widely used method in industry for non-destructive testing. Arrays offer an intuitive view of the interior of a component from which geometric features and defects can be observed. Arrays also offer unprecedented information about the nature and extent of any defects. In recent years, Full Matrix capture (FMC) and Total Focusing Method (TFM) have attracted significant interest due to the high resolution of the images possible throughout an inspection volume. However, due to the requirement of transmitting on each element separately, a major drawback with any FMC-based imaging technique is the speed of acquisition. These speed limitations restrict the range of industrial applications on which FMC can be utilised. The motivation of this project is to find methods to increase speed of data acquisition and imaging whilst maintaining acceptable image quality. Firstly, the relative performance of various algorithms, such as Plane-Wave Imaging (PWI) and Virtual Source Aperture (VSA) is explored in terms of both speed and quality, covering a range of materials and defect types. This extensive comparison is achieved with simulation models and then validated on side-drilled hole defects, with the TFM as a benchmarks. The use of coded sequences, in combination with these imaging algorithms to further reduce the number of firings is then explored and the limitations quantified. The results of the comparison show that there is not a single optimal solution, but rather an understanding of the inspection challenge is needed in order to find the best imaging approach for a given circumstance. For example, on materials such as aluminium with low grain scattering, excellent images can be achieved with a very low number of firings. However, highly scattering materials require significantly more firings to achieve acceptable imaging results.