1.3.65. FAST NUMERICAL CALCULATIONS OF TRANSIENT 3-D PHASED ARRAY WAVE FIELDS BASED ON SYMMETRY AND RECIPROCITY PRINCIPLES

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The increasing interest in ultrasonic phased array techniques for NDE and SHM applications is based on the fact that reasonably priced and easy-to-use transducers and multi-channel measuring systems become more and more available. As a consequence the need for fast and reliable modelling tools for the design and optimization of phased array wave fields is also increasing. While semi-analytical methods for wave field synthesis are very fast but often suffer from several approximations like neglect of near-field effects, multiple scattering, and mode conversions, purely numerical methods include all relevant wave phenomena but are characterized by significantly larger computation times and memory requirements, especially in 3-D. In the present paper a new hybrid method is presented which combines the Elastodynamic Finite Integration Technique (EFIT) with easy but powerful symmetry and reciprocity principles. As a result transient 3-D ultrasonic wave fields generated by arrays of connected and distributed transducers can be calculated in quasi-real-time. We present various examples of application including low-frequency guided wave arrays for SHM applications and high-frequency phased arrays for volume inspection. We also discuss how the proposed technique can be expanded to multi-layers, anisotropic media and to wave-defect interactions so that efficient simulation-supported probability of detection (PoD) studies can be performed.