The Power of High-speed Finite Element Simulations for Ultrasonic NDT

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Modelling of ultrasound is becoming increasingly important for NDT applications. This has applications in generating data for training humans as well as machine learning models, inversion schemes where model output is matched to physical measurements, development and verification of new inspection approaches as well as understanding physical phenomena. The finite element (FE) method is very powerful for ultrasound simulations in these areas: it is accurate (no assumptions are made beyond the fundamental discretisation used) and it is flexible (the method allows arbitrary meshes to be used, which can fully conform to geometry of the component and defects). This power does come with a computational burden, but modern computing hardware provides an avenue to address this. The architecture of the graphics card is well suited to performing the lightweight parallel calculations which occur when solving the finite element method with explicit time steps. We have developed the Pogo FE software package (www.pogo.software) to exploit this capability, which has demonstrated speed-ups of around two orders of magnitude compared to equivalent CPU packages. This talk will discuss the recent developments incorporated into Pogo which have enabled faster, more accurate simulations. These developments have also enabled some of the largest ultrasonic models to be run, which have provided some important steps forward in understanding of ultrasound propagation. The talk will also present some other findings which have been enabled by these advances.