Ultrasonic simulation with FEM in 3D for machine learning

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Ultrasonic inspection is used for the in-service inspection of nuclear power plant (NPP) primary circuit components. Due to limited accessibility and lack of real defects, artificial defects are used for training and qualification of personnel and inspection methods. However, artificial flaws such as EDM notches lack in flaw representatives and are costly and time consuming to manufacture. Simulation opens an affordable alternative for data heavy processes like training of machine learning (ML) models and probability of detection (POD). In previous work (Koskinen et al. 2018) simple cracks were modelled to be augmented as eFlaws for POD estimation with real inspectors. The inspectors could not distinguish the simulated flaws from the real flaws, but the simulated flaws were detected more easily. Thus, more representative flaws are needed for evaluation of inspector performance and to train ML models. The goal of this work is to produce representative input data for ML models. Vast amount of training data combined with the requirement for small element size to allow accurate propagation simulation makes the simulations computationally heavy. Alternative solvers in Elmer are explored in addition to the previously used Abaqus solver. The acquired results from previous 2D FEM simulations and simple CIVA simulations are compared with the carried out 3D FEM simulations.