Ultrasonic defect characterisation using the scattering matrix: A performance comparison study of Bayesian inversion and machine learning schemas

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Accurate defect characterisation is desirable in ultrasonic non-destructive evaluation as it can provide quantitative information about the defect type and geometry which can be used to evaluate the structural integrity of a component. For defect characterisation using ultrasonic arrays, high resolution images can provide the size and type information if a defect is relatively large. However, since the imaging resolution is limited by diffraction, the performance of image-based characterisation becomes poor for small defects whose sizes are comparable to the wavelength. An alternative approach is to extract the far-field scattering coefficient matrix of a defect from the array data and use it for characterisation. The scattering matrix was shown previously to have high sensitivity to defect parameters such as size and orientation angle. Defect characterisation can be performed based on a scattering matrix database that consists of the scattering matrices of idealised defects with varying parameters. In this paper, the characterisation problem is studied for an Aluminium sample containing 8 machined notches using two different approaches. The first approach is based on the introduction of the defect manifold and a general coherent noise model, and it performs characterisation within the Bayesian framework. The second approach relies to a supervised machine learning (ML) schema based on scattering matrix database which is used as training set to fit the ML model exploited for defect characterisation tasks. Experimental results obtained using both approaches are presented and the characterisation performance compared.