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Estimation and Application of 2-D Scattering Matrices for Sparse Array Imaging of Impact Damage in Composite Panels

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Reliable detection of hidden damage in composites is important for failure prevention in the aerospace industry since these materials are being more frequently used in high stress applications. Structural health monitoring (SHM) via guided wave sensors mounted on or embedded within a composite structure can help detect and localize damage in real-time while also reducing overall maintenance costs. One approach to guided wave SHM is sparse array imaging via the minimum variance algorithm, and it has been shown in prior work that incorporating estimated scattering from expected defects can improve the quality of damage localization and characterization [1]. For this study, impacts were applied to induce delaminations within a composite panel. Wavefield data were recorded on a circle centered at the damage location from multiple incident directions before and after the impacts. Baseline subtraction [2] is used to estimate scattering patterns for each incident direction, and these patterns are combined and interpolated to form a full 2-D scattering matrix. This matrix is then incorporated into the minimum variance imaging algorithm, and imaging efficacy is evaluated for both these impacts and impact damage in other similar composite plates. Results are compared to images generated using simpler scattering assumptions.

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References:

1. J. S. Hall, P. Fromme, and J. E. Michaels, "Guided wave damage characterization using a distributed array of ultrasonic sensors," *Journal of Nondestructive Evaluation*, **33**, pp. 299- 308, 2014.
2. A. J. Dawson, J. E. Michaels, and T. E. Michaels, "Isolation of ultrasonic scattering by wavefield baseline subtraction," *Mechanical Systems and Signal Processing*, **70–71**, pp. 891- 903, 2015.