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Validating the use of Gaussian Process Regression for Adaptive Mapping of Residual Stress Fields

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Neutron residual stress mapping is a valuable tool for determining the bulk residual stress state of large-scale engineering components. Probing the stress state using a high density of measurement points is time intensive and presents a limitation for what is experimentally feasible. These data are traditionally obtained using a brute force approach where data are measured for a discreet grid of locations. An active learning approach such as, Gaussian process regression (GPR), can incorporate information about previous measurements to achieve higher fidelity stress/strain maps by reconstructing individual fields from a subset of measurement locations. Results presented in this paper evidence that determining stresses from reconstruction strain fields is a viable approach for reducing the number of measurements needed to fully sample a component's stress state. Effects of errors in individual GP reconstructed strain maps and how these errors propagate to the final stress maps were assessed. Implications of the initial sampling approach and how localized strains affect convergence are explored to give guidance on how best to implement a dynamic sampling experiment.

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