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Invited Paper

Full Field Inference of Stress, Strain, and Displacement with Local Spatial Observations using Physics-Informed Neural Networks: Applications in Solid Mechanics

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ABSTRACT

Accurately estimating stress, strain, and displacement fields is crucial in solid mechanics problems. Traditional methods often rely on limited and sparse measurements, resulting in an incomplete understanding of the underlying physical behavior of solids. In this study, we propose a novel approach that leverages physics-informed neural networks (PINNs) to achieve full field inference of stress, strain, and displacement by incorporating local spatially observed data. By harnessing the power of deep learning and integrating physics-based constraints, our method enables the reconstruction of the complete field, surpassing the limitations of traditional techniques. We validate the effectiveness of our approach through extensive simulations and experiments on diverse solid mechanics problems, including open hole tension, cantilever under a tip load, and a tension-loaded plate with multiple and varied defects.

The results demonstrate significant improvements in the accuracy and efficiency of stress, strain, and displacement estimation, opening up possibilities for advanced analysis and design in solid mechanics applications. Furthermore, we briefly introduce future promising applications in solid mechanics and provide a survey of the state-of-the-art research in the field.

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