Graduate Student Research Seminar

Fall 2022

Residual Stress Reduction in Metal Additive Manufacturing Through Support Structure Design

Lucas Morand (PhD student)

Advisor: Dr. Garrett Pataky

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3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

While metal additive manufacturing enables complex geometries and broadens the design space, it is challenged by residual stress and end-part distortion. Laser powder bed fusion simulations have allowed for faster, more economical development of the AM method, but part-scale finite element analysis of the thermo-mechanical process remains computationally costly. The inherent strain approach simplifies the simulation, with only a meso-scale thermo-mechanical simulation that yields a representative eigenstrain. This strain is then applied to the macro-scale part in a less computationally expensive mechanical simulation. The approach allows iterative learning on the part scale, without having to simulate laser-level physics for each attempt. The inherent strain method is utilized to understand the evolution of residual stress during the build process. However, instead of a single eigenstrain that represents the entire part, unique eigenstrains are extracted for key features in order to improve the accuracy of eigenstrain simulations while retaining their low computational cost. Support structures are then applied to the features on a part in order to reduce end-part deformation. Moving residual strains to more favorable sacrificial areas allows for an end-use part within tolerance, reducing expensive scrap rates and improving the accuracy of metal AM parts.

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