Computational Mechanics Group
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Master's thesis / Semester project

Optimisation of the specimen geometry for one-shot discovery of material models

Introduction

Mechanical characterisation of materials play an important role in science and industry. The more efficient and robust the characterisation process, the more reliable the engineering products. Within this context, researchers in our group have developed an approach for Efficient Unsupervised Constitutive Law Identification and Discovery (*EUCLID*) (Flaschel et al., 2021), which exploits machine learning tools to automatically discover material laws based on full-field displacement and global force data only (no stress data) obtained from a single mechanical test. The displacement field can be measured on the surface of a target specimen via the digital image correlation (DIC) technique. In principle, discovery of the material law with EUCLID can be performed in a one-shot fashion, i.e. using only one experiment. However, this capability heavily relies upon the richness and self-sufficiency of the measured displacement data, which in turn is dictated by the specimen geometry.

Goal

In the present project, we aim to optimally design the geometry of the target specimen in order to maximise the robustness of material identification against the noise in the experimental displacement data. To this aim, we utilise density-based topology optimisation (Andreassen et al., 2011) driven by an objective function specifically tailored to trigger stability in the identified parameters. Possible extensions in this project include the exploration of different classes of material models, topology optimisation approaches and enhancements in the optimisation engine itself.

Prerequisites

Prior knowledge in continuum mechanics and the finite element method as well as programming skills in Matlab are desirable.

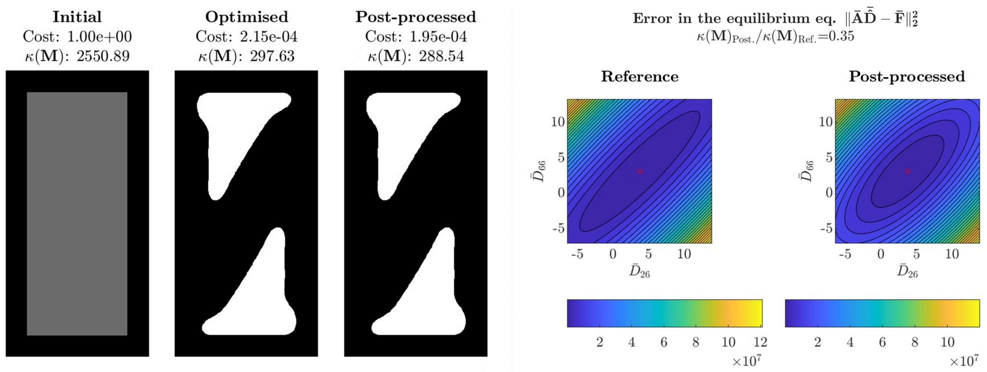

Figure: An example of topology optimisation of a rectangular sheet

References

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E. Andreassen, A. Clausen, M. Schevenels, B. S. Lazarov, and O. Sigmund, "Efficient topology optimization in MATLAB using 88 lines of code," *Structural and Multidisciplinary Optimization*, vol. 43, no. 1, pp. 1–16, jan 2011.

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