Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
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Software Lab:

Structural optimization method for space structures under dynamic loading

Modeling:
Mathematics:
Programming:
Science:

Description

The Physikalisch-Meteorologisches Obersvatorium Davos (PMOD) has been developing optical instruments for space applications for decades. These products are designed, developed, and manufactured at the institute. These instruments must meet a wide range of requirements to fulfil the scientific objectives, to withstand harsh mechanical loading conditions during the satellite launch and to operate reliably once in orbit.

For that reason, their lightweight structural design must meet strict stiffness and dynamic performance requirements. Numerical structural optimization methods can enhance performance by analyzing the sensitivity of the design domain using techniques such as topology [1], topography, and size optimization while respecting specific manufacturing constraints. This project aims to explore advanced numerical methods utilizing the commercial FE software OptiStruct. A robust Python-based software framework will be developed to automate preprocessing, postprocessing, and analysis execution steps. The proposed methods will be demonstrated on housing components of a space instrument, evaluating their lightweight and load-bearing benefits as well as manufacturability aspects.
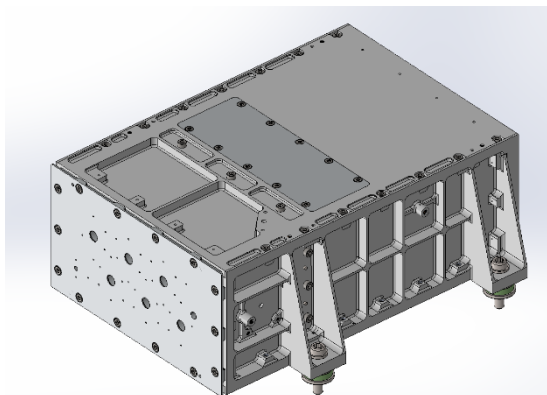

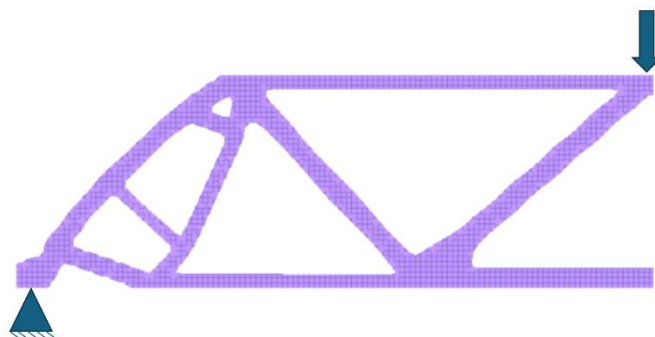Figure 1: Space Instrument for solarphysical measurments

Figure 2: Topology optimization through SIMP [1] approach

Task

- Formulate numerical design responses to enhance structural performance under random vibrations across a specified amplitude and frequency spectrum.
- Investigate various derivative-based structural optimization methods to achieve optimal thin-walled housing components reinforced with ribs.
- Implement a Python-based software tool to supervise the entire optimization loop for the design assembly.
- Demonstrate the structural improvements and benefits achieved through the optimized designs.

Supervisor

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References

[1]   Sigmund, Ole & Maute, Kurt. (2013). Topology optimization approaches A comparative review. Structural and Multidisciplinary Optimization. 48. 10.1007/s00158-013-0978-6.