Ravi Teja Bollineni - 3D Topology Optimization Portfolio

Project Title

Topology Optimization of 3D Structures using MATLAB

Research Overview

This research investigates the optimization of 3D material layouts under mechanical load conditions using a compact and efficient MATLAB code (top3d). The objective is to minimize structural compliance while maintaining material constraints, leveraging SIMP and FEA techniques.

Research Objective

To develop high-performance and lightweight structures for 3D printing by minimizing deformation (compliance) through intelligent material distribution in complex 3D domains using topology optimization.

Implementation Strategy

- Used a 169-line MATLAB code including FEA, sensitivity filtering, and optimization logic
- Customized boundary conditions and multiple loading scenarios
- Applied continuation and density filtering to enforce convergence
- Focused on minimum compliance as primary objective
- Added support for compliant mechanisms and heat transfer problems

Academic Foundation

This project is based on the educational work by Liu and Tovar (2014), which outlines the entire process of 3D topology optimization using SIMP in MATLAB. The code handles FEA, material penalization, and optimization strategies including Optimality Criteria (OC), SQP, and MMA.

Applications

- Biomedical Implants and Structural Supports
- Lightweight Vehicle Brackets and Components
- Custom Mechanical Connectors in Robotics
- Thermal-Mechanical Design in Multi-functional Materials

Visual Results (Placeholder)

This section will contain screenshots of:

- Initial domain vs optimized domain

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- Cantilevered beam with material evolution
- 3D force inverter mechanism
- Compliant mechanism sample

(Visuals to be inserted manually in the final version.)

Conclusion and Future Work

This project successfully demonstrates a compact, modifiable MATLAB implementation of 3D topology optimization. Next steps involve applying optimization to multi-objective problems, especially heat-structural interactions in medical device design. Integration with AI-driven material prediction is also a future direction.