Optimal Design of Robust Compliant Actuators for Ubiquitous Co-Robots

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http://mysite.du.edu/~srezazad/SEA-Optimization.html

Key Problems to address:

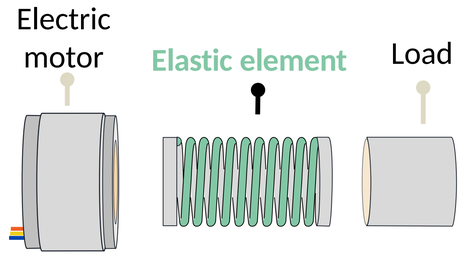
Framework for nonlinear springs acknowledging uncertainty

Achieve global solutions in polynomial-time

Solution independent of initial conditions

Avoid overdesign or underdesign resulting from safety factors

Challenge: Use series elasticity to minimize energy consumption and satisfy actuator constraints despite uncertainty



Series **E**lastic **A**ctuator (**SEA**)

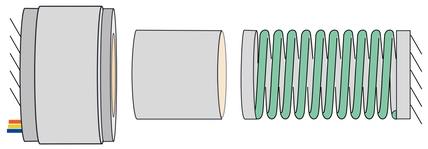
Scientific Impact:

Formulate spring design of SEAs as a convex program

Framework to guarantee performance in uncertain environments

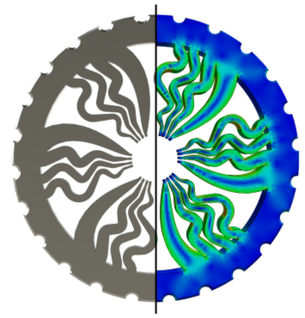
Bridge robust optimization and mechatronic design

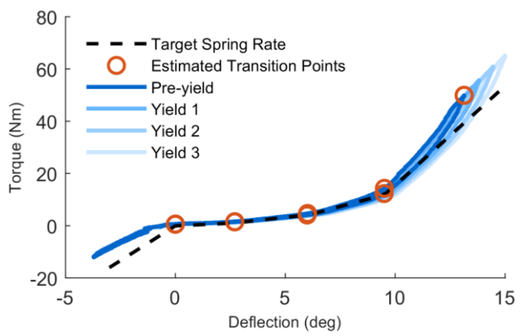
Extension: Parallel Elastic Element Optimization



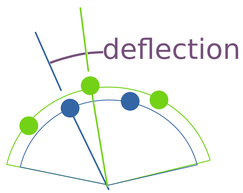
Outperforms SEA when Joule heating dominates, and is also convex (Bolivar et al. 2022)

Validation of Nonlinear Spring Design

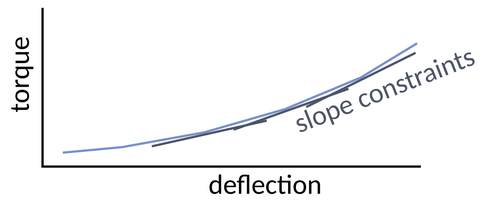




Optical Spring Deflection Sensor

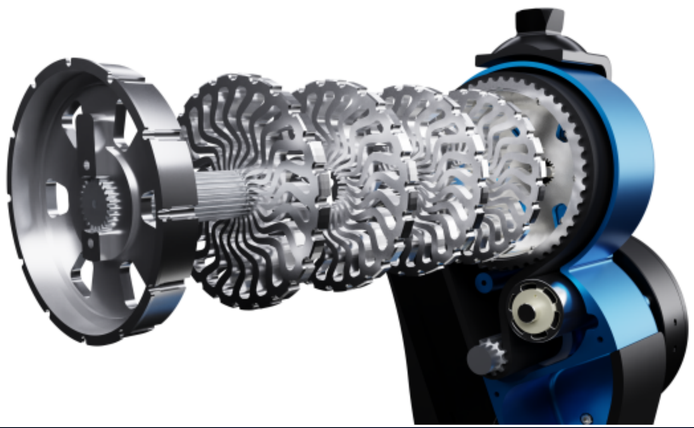


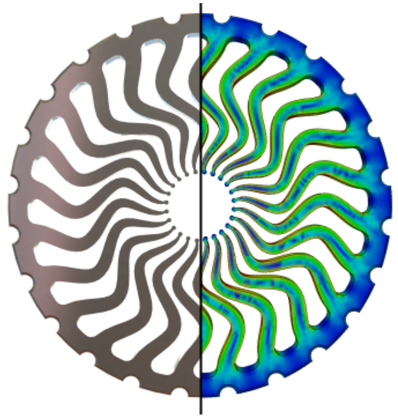
Optimization with Closed-Loop Impedance Targets



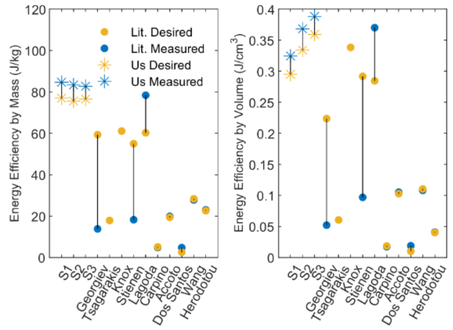
Minimum local stiffnesses resulting from noise limit on controllers that achieve biomimetic target closed-loop stiffness (Thomas et al. 2022 in prep.)

Springs Compatible with NSF's Open Source Leg





High Specific Energy



Outreach

2022 NRI & FRR Principal Investigators' Meeting
April 19-21, 2022

Award ID#: 1953908, 1830338