CAREER: Mechanically Adaptive Energetically Passive Robotics

arcLab Robotics & Control

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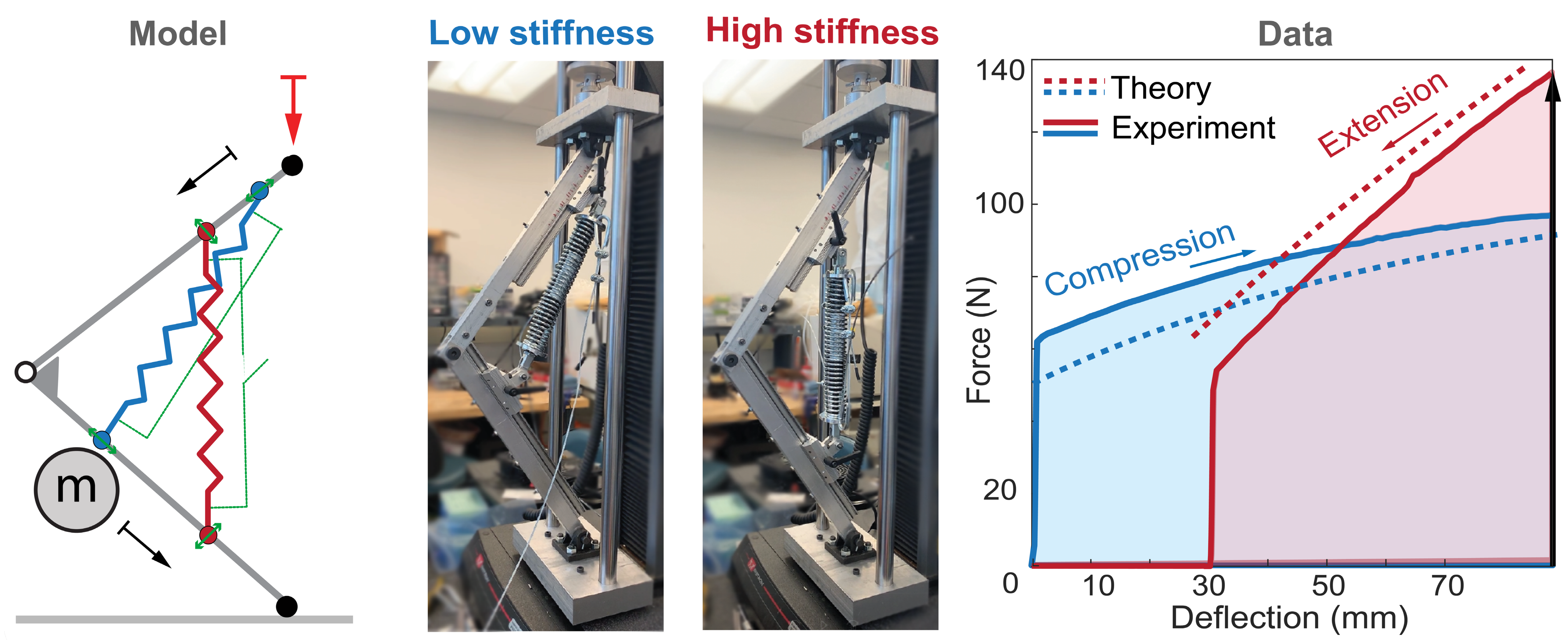
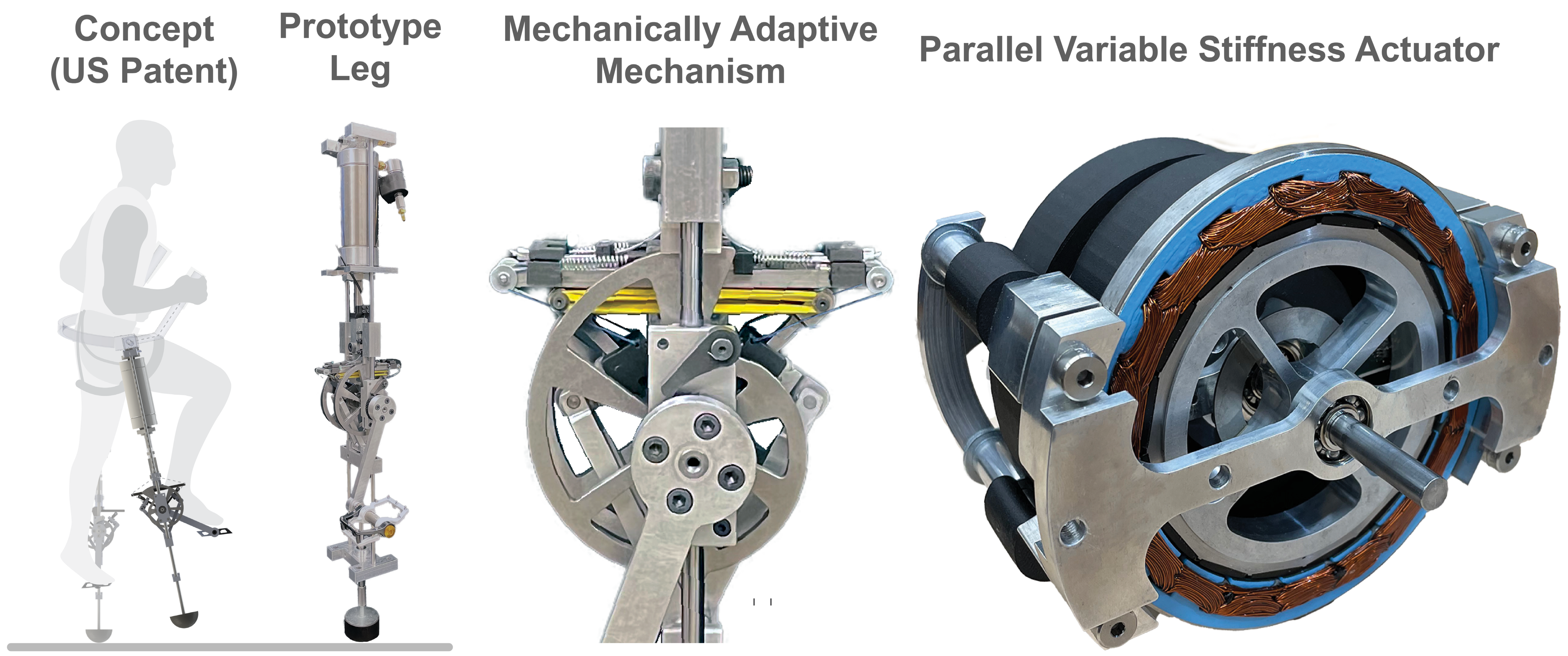
NSF | CMMI | Foundational Research in Robotics

This NSF project promotes **foundational research in the dynamics and control of mechanically adaptive but energetically passive robots**. Examples of these robots are artificial limbs and exoskeletons, that use mechanical adaptation to reduce the need for external energy by providing optimal leverage for the human to supply more energy or enabling a robot actuator to supply energy more efficiently.

Mechanically adaptive energetically passive spring



Mechanically adaptive energetically passive robotics



Scientific Impact:

Programmable springs that

- combine the benefit of levers and springs
- enable near-zero energy cost mechanical adaptation

Impact on Society:

Mechanically adaptive robot limbs that

- help rescue and law enforcement
- provide a new device for recreation and sports
- facilitate the physical activity of the elderly

Education and Outreach:

- Integration with undergraduate Dynamics and graduate Optimal Control courses
- Provide opportunities for 'Prototype and Break Things' discovery projects
- Promote knowledge-based journalism about robots used for human augmentation

Related works:

- C.W. Mathews and D.J. Braun, Parallel Variable Stiffness Actuators, *IEEE T-RO*, 39(1), 768-782, 2023
- C.W. Mathews and D.J. Braun, Design of a Variable Stiffness Spring with Human-Selectable Stiffness, *IEEE ICRA*, 2023
- S. Kim and D.J. Braun, Controllable Mechanical-domain Energy Accumulators, *IEEE ICRA*, 2023
- C. Dempsey and D.J. Braun, Novel Spring Mechanism Enables Iterative Energy Accumulation under Force and Deformation Constraints, *IEEE ICRA*, 2023
- T. Zhang, D.J. Braun, Theory of Fast Walking with Human-Driven Load-Carrying Robot Exoskeletons, *IEEE TNSRE*, 30, 1971-1981, 2022

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