CAREER: Morphological Computation for Resilient Dynamic Locomotion of Compliant Legged Robots with Application to Precision Agriculture

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Motivation

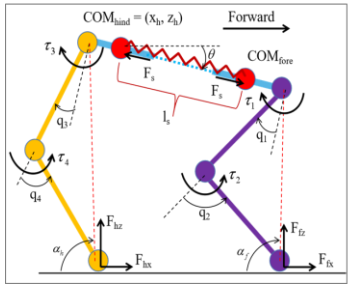
- Legged robots' mobility and adaptability may create new avenues to interact with crops

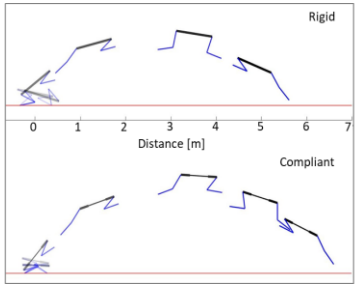
Goal and Objectives

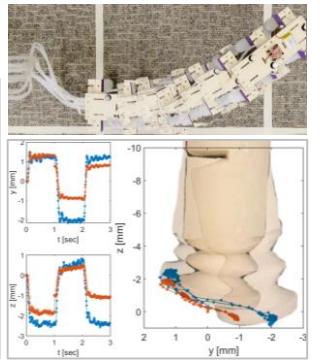
- Investigate how compliance embedded in legged robots can be harnessed to facilitate control and computation for efficient and resilient agricultural field navigation
  - Hardware design and dynamic modeling • Locomotion control • Non-holonomic motion planning and autonomous navigation

Key Technical Innovations

- Modeling and trajectory optimization for quadrupeds with spinal compliance to improve standing jump performance [1]
- Closed-loop pneumatic trajectory tracking control for soft legged robots [2]
- Pneumatic circuits with memory to reduce number of valves [3]
- Learning-based models via Koopman operator theory for soft robotics [4]







Educational Activities

- College/UCR-wide robotics makerspace
- Robotics middle-school summer camp (first in 7/21)

[1] K. Ye and K. Karydis, "Modeling and Trajectory Optimization for Standing Long Jumping of a Quadruped with A Preloaded Elastic Prismatic Spine," IEEE/RSJ IROS 2021.
[2] Z. Liu and K. Karydis, "Position Control and Variable-Height Trajectory Tracking of a Soft Pneumatic Legged Robot," IEEE/RSJ IROS 2021.
[3] S. Hoang, K. Karydis, P. Brisk, and W. H Grover, "A Pneumatic Random-access Memory for Controlling Soft Robots," PloS one 2021.
[4] L. Shi and K. Karydis, "ACD-EDMD: Analytical Construction for Dictionaries of Lifting Functions in Koopman Operator-based Nonlinear Robotic Systems," IEEE RAL + ICRA 2021.