Collaborative Research: FRR: Adaptive mechanics, learning and intelligent control improve soft robotic grasping

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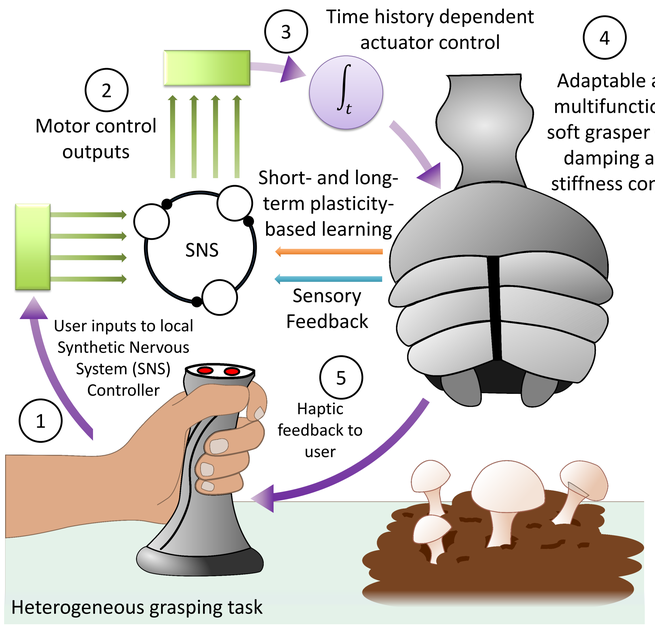
Research Approach

Challenge: Controlling soft robots, onboard learning, and manipulating complex objects remain ongoing robotics challenges

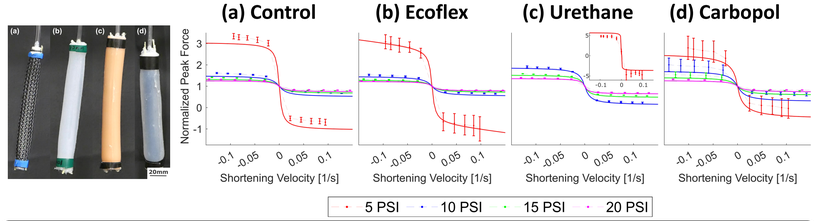
Solution:

1. Implement actuator adaptability over short timescales
2. Implement local control adaptability through short-term learning in a synthetic nervous system (SNS)
3. Implement longer-term synaptic weight changes in an SNS, mimicking learning from experience.

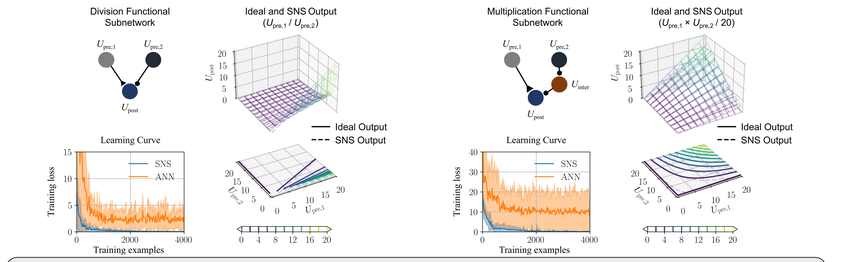


Tuning materials makes pneumatic muscles more biomimetic

- Force-velocity properties of viscoelastic McKibben actuators can be tuned with an external sheath

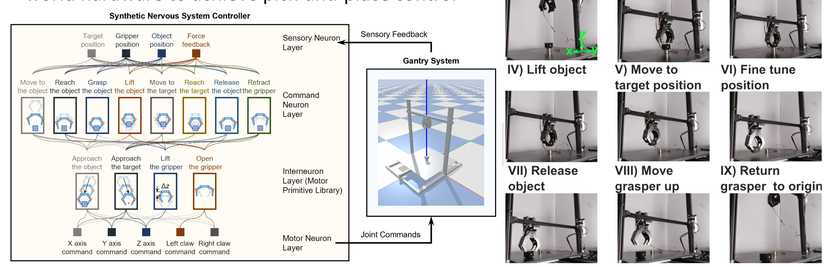


SNS discretization allows backprop and parameter learning



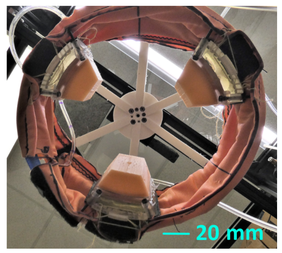
SNS control translates from sim-to-real with minimal tuning

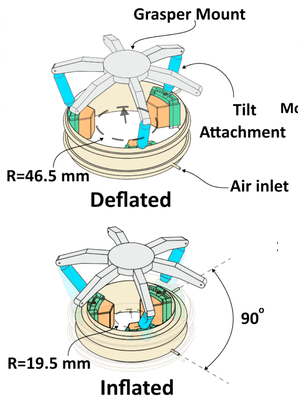
- SNS trained in simulation can be transferred to real-world hardware to achieve pick-and-place control

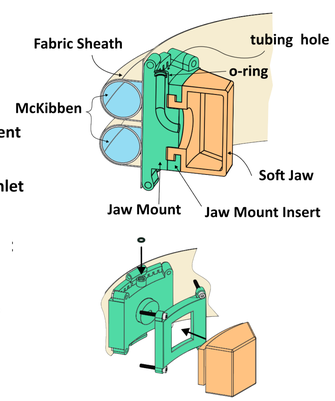


SNS control and tunable stiffness in soft grasping allows a range of objects to be pick-and-placed

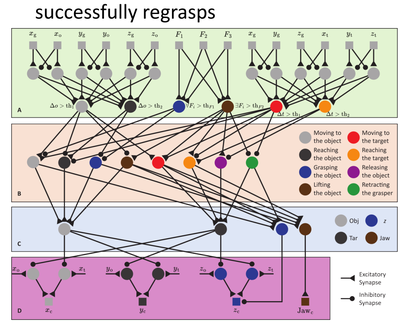
- A novel soft grasper abstracted from general principles of sea slug grasping has been created
- Jaw closure and stiffness can be controlled independently

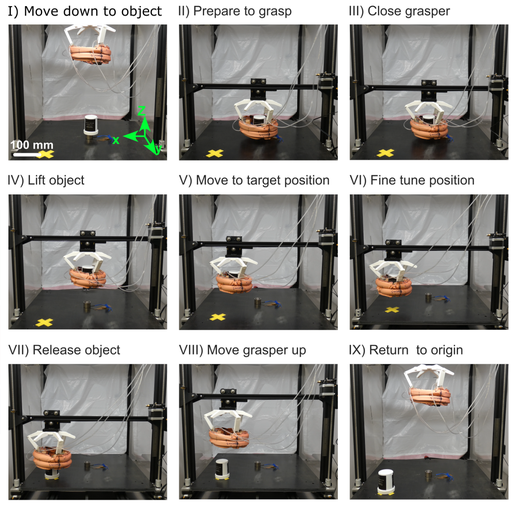




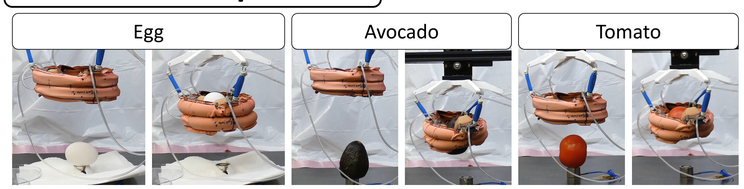


- An SNS controller was developed in simulation and transferred to the physical system with minimal tuning
- The soft grasper can handle a wide variety of objects
- Emergent adaptability observed when the grasper fails to grasp an object and successfully regrasps

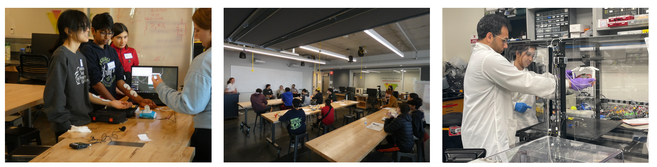




Broader Impacts



Soft grasper safely picks up a wide variety of objects



Research team trains next-generation of students

- IRB Protocol for summer human-in-the-loop studies has been approved
- Gantry enclosure completed to ensure participant safety
- User surveys under development

Protocols and surveys for human user studies in progress

Would you like to learn more? Scan here to learn about project outcomes

2023 FRR & NRI Principal Investigators' Meeting
May 2-3, 2023

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