CAREER: Adaptive Actuation and Control in Embodied Biohybrid Robots

Victoria A. Webster-Wood, Carnegie Mellon University
https://engineering.cmu.edu/borg Twitter: @The_CMU_BORG

Carnegie Mellon University
The Biohybrid and Organic Robotics Group

Research Approach

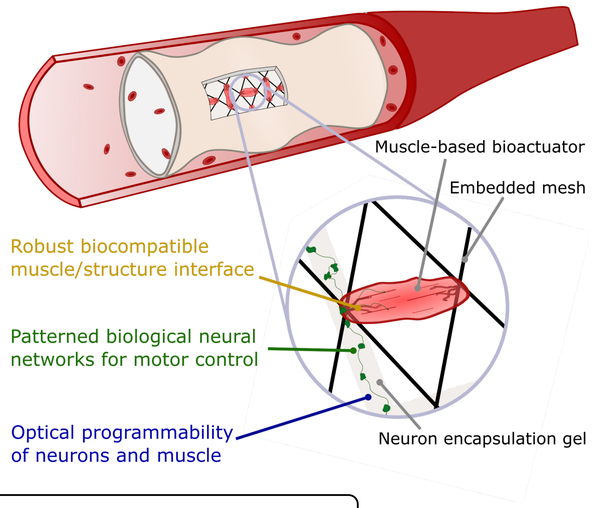
Challenges:

(1) Current bioactuators are limited to interfacing with soft or small-scale substrates

(2) Bioactuator stimulation often result in low actuation forces and muscle fatigue

Solutions:

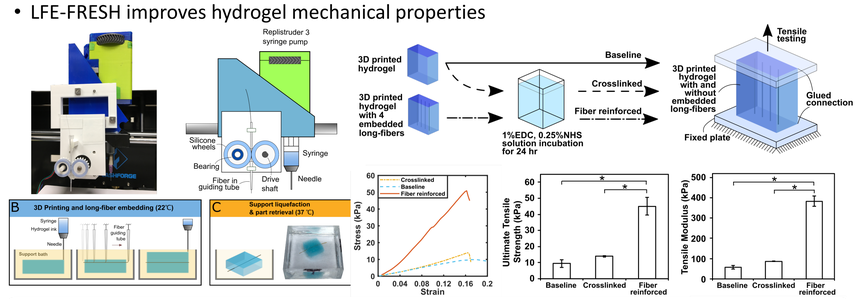
- Adaptive bioactuation with embedded fiber-based interfaces
- Bioinspired biological neural networks for motor control
- 'Programed' bioactuators and biological neural networks for robotic applications



Experimental Highlights

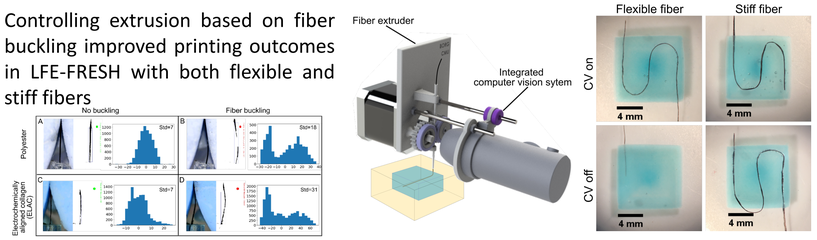
Long-fiber embedded FRESH (LFE-FRESH) printing improves hydrogel interfaces

- LFE-FRESH improves hydrogel mechanical properties



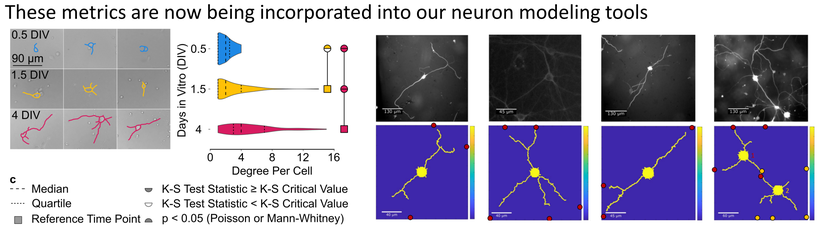
Closed-loop computer vision improves print fidelity in LFE-FRESH printing

- Controlling extrusion based on fiber buckling improved printing outcomes in LFE-FRESH with both flexible and stiff fibers



Quantitative metrics can be used to identify neuron growth stages

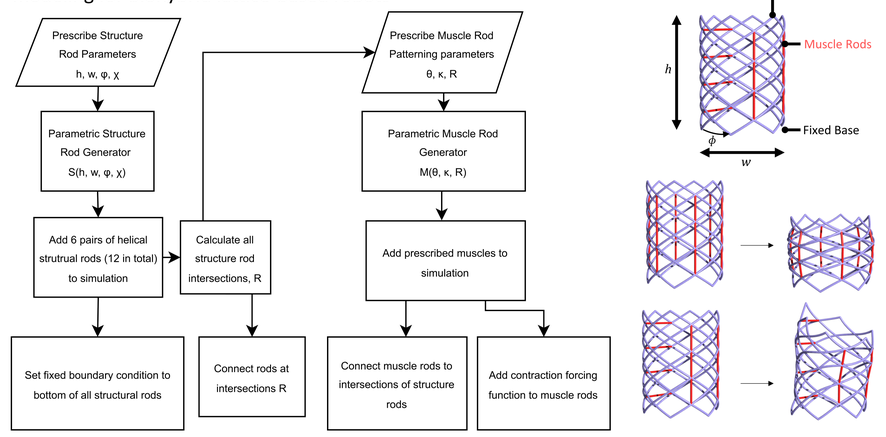
- We developed and disseminated a dataset of neuron growth *in vitro*
- Metrics were identified to automatically identify growth stages
- These metrics are now being incorporated into our neuron modeling tools



Modeling Highlights

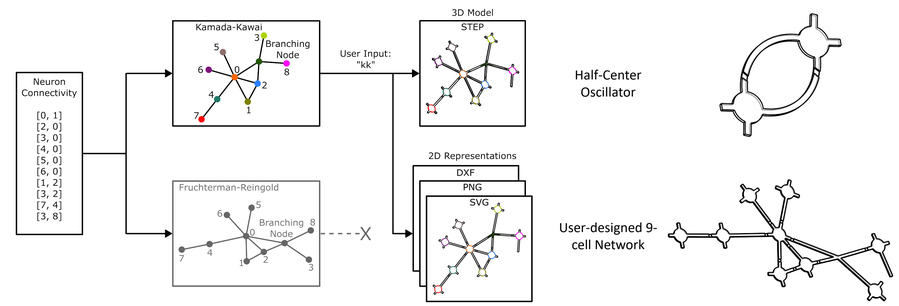
Developed parametric modeling pipeline for biohybrid lattice structures in PyElastica

- Parametric model definition reduces barriers of entry to PyElastica modeling for biohybrid lattice-based robots



GANGLIA: A tool for designing customized neuron circuit patterns

- Our Generation of Automatic Neuron Graph-Like Interconnected Arrangements (GANGLIA) tool, allows micropatterns to be automatically created in a variety of common manufacturing file types



Education and Outreach

Incorporate neuromuscular modeling in educational curriculum

- Reducing barriers of entry in biohybrid modeling
- Designed and ran a summer workshop for middle school students on bioinspired and biohybrid robotics in partnership with the CMU Gelfand center.
- Created new summer mini course titled "Introduction to Bioinspired and Biohybrid Research"

Improve recruitment of young women to robotics

- Scaling up undergraduate research opportunities
- New Canvas based onboarding and training tools
- Supported 5 female or URM undergraduate researchers this year
- Two prior undergrad women now admitted to PhD programs

Build and assess community tools for women faculty in robotics

- Created web-based landing page and search feature for the CMU Women Faculty in Robotics list
- Tracking new additions to the list

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

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

Award ID#: 2044785