Communication, Coordination, and Control in Neuromuscular Systems: Synergistic Interactions (IRG 1)

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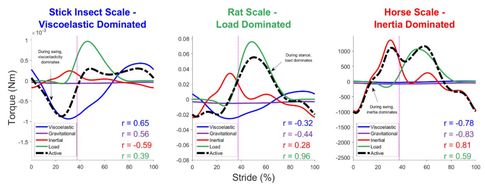
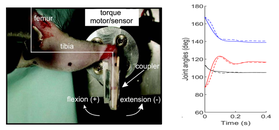
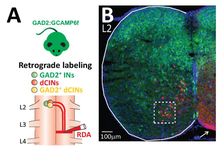
IRG1 collaborations with IRG4 to investigate the effects of changing size and joint parameters on dynamic control as inertia increases in importance

- Due to the size and speed of mammals, they operate in the inertial, or near inertial space, where most forces are dominated by momentum and gravitational load.



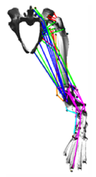


Kinematics of a leg released from a non-resting position show passive properties that are close to critically damped.

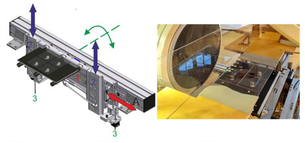


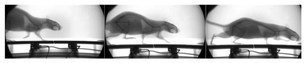
Commissural interneurons are being investigated for their role in reorganization during different dynamic-dependent behaviors

- Efforts are underway to develop models that capture the viscoelastic properties of the muscles and joints at different scales.



These properties are being translated into robot joint design for comparison in real environments



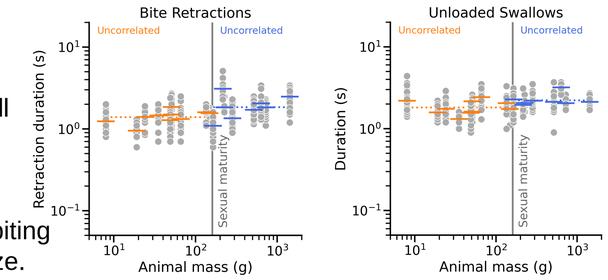


- Balance experiments are combined with x-ray and EMG recordings to elucidate neural control strategies.

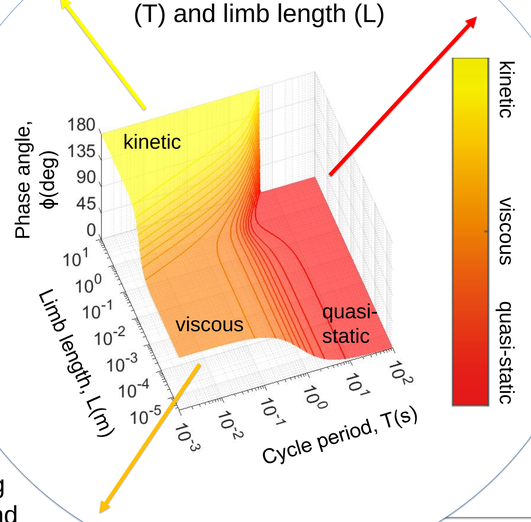
IRG1 collaborates with IRG3 to investigate quasi-static neuromuscular control

Understanding the role of scale in quasi-static neuromuscular systems

- Due to *Aplysia*'s slow movements and small size, it operates in the quasi-static regime.
- Consequently, the durations of many of its feeding behaviors are size invariant.
- Specifically, the durations of retractions in biting and swallowing do not scale with animal size.

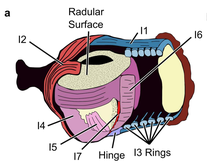


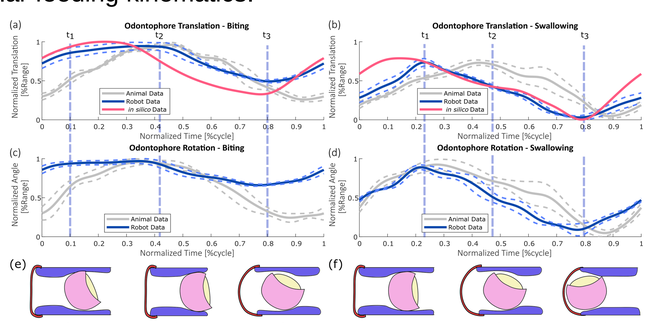
Phase angle (ϕ) dependence on cycle period (T) and limb length (L)



In silico and _in roboto_ biomechanical models have been developed to test scaling hypotheses

- *In roboto* models capture key muscles and kinematics.
- Using neural control models, *in roboto* models produce qualitatively similar feeding kinematics.

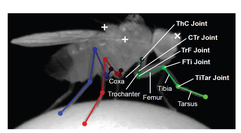


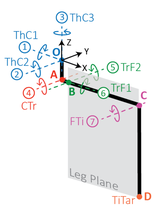


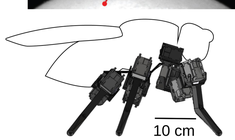
IRG1 collaborates with IRG2 to investigate viscous neuromuscular control

Understanding opportunities for sensing in viscous neuromuscular systems

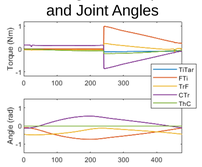
- 3D point tracking provides kinematics for use in inverse dynamics
- Viscous dynamics enable strain sensing without vibration in swing
- Dynamically scaling robot mechanics and movements enables implementation of insect neural controllers

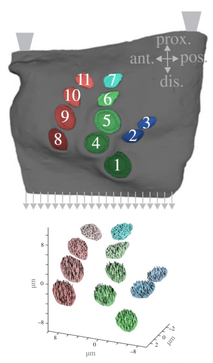




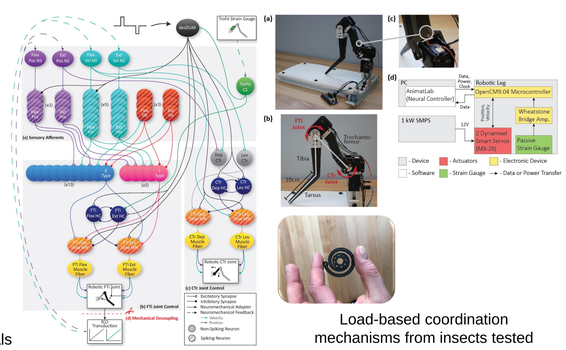


Robot platform under development based on *Drosophila* kinematics





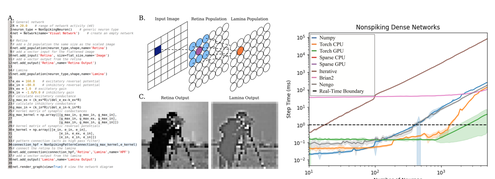
Finite Element model of campaniform sensilla reveals their sensitivity to applied load



Load-based coordination mechanisms from insects tested in robotic model of *Drosophila* leg

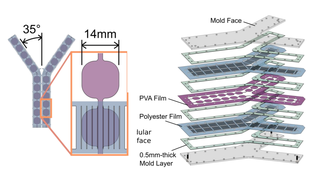
IRG1 is developing tools and technologies that are broadly applicable to neuromuscular modeling

SNS Toolbox



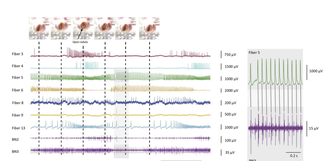
Directly assemble networks using functional subnetworks, compile for CPU or GPU implementation

Novel Actuators



Novel actuator configurations and materials allow more biomimetic actuation modes

Enabling Technologies



Carbon fiber electrode arrays for multi-neuronal recording in *Aplysia*