

COLLAB: Rumen Understanding through Millipede-Engineered Navigation and Sensing (RUMENS)

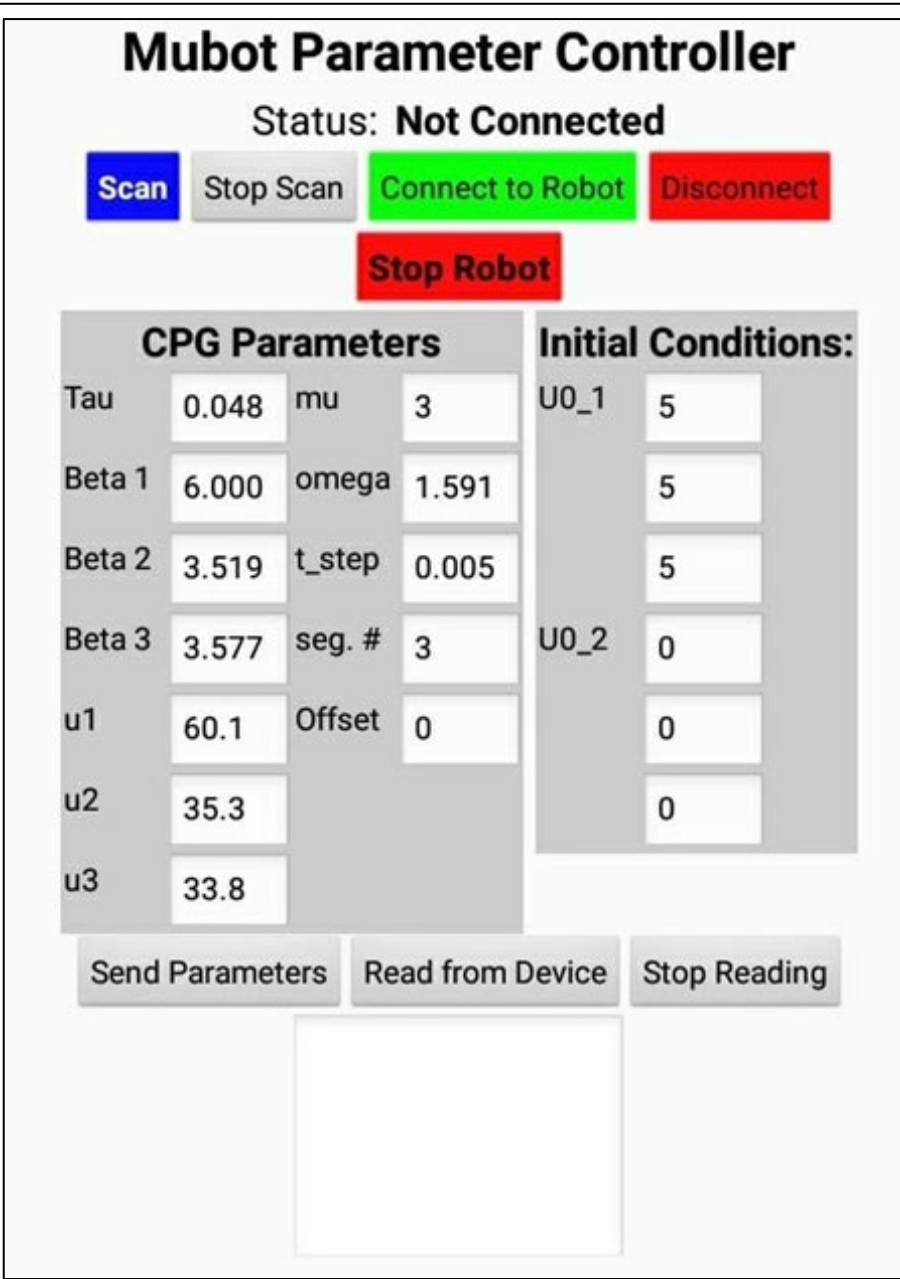
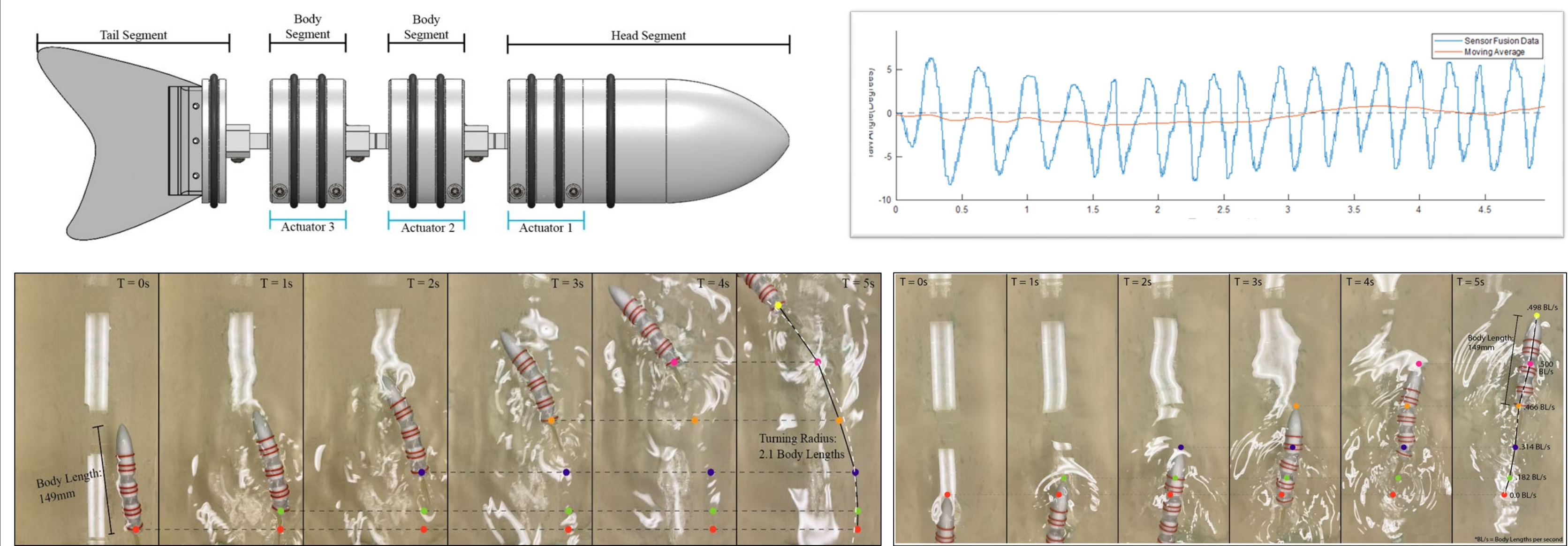
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Challenges: Developing multifunctional capability within rumen environment including: locomotion, localization, controlled measurements from desired location, long duration survival, sensing, wireless data transmission

Scientific Impact: Outcomes from this program will have impact on livestock production, animal welfare, precision health monitoring, fermentation, reduction of greenhouse gas emissions, smart robotics, energy harvesting, machine learning, data analytics.

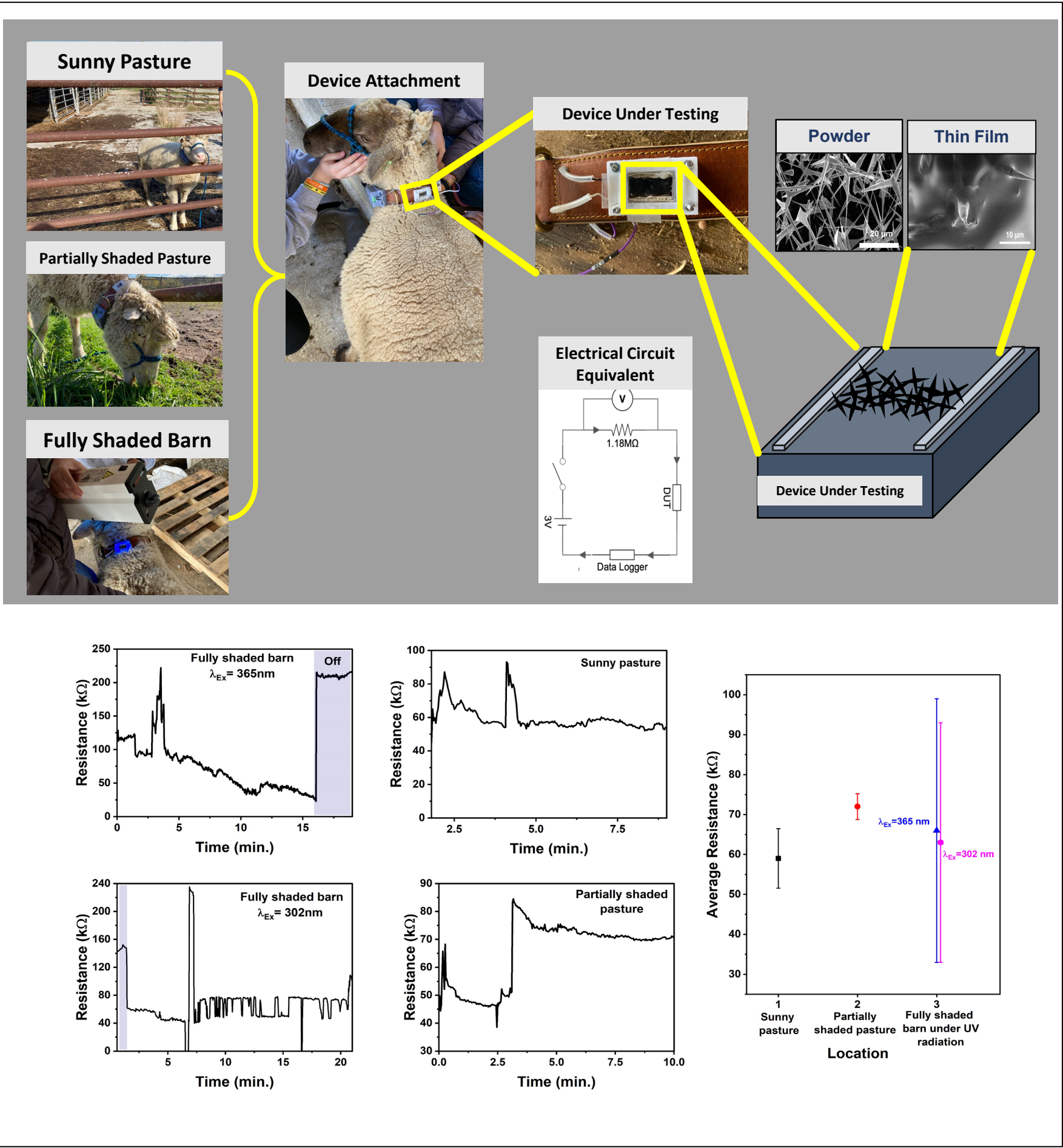
Research Approach:

- Bluetooth-operated biomimetic robotic fish is realized with onboard sensors
- Central Pattern Generators employed to achieve different swimming gaits
- Fundamental locomotion primitives developed: 0.5 BL/s speed achieved
- 9-DOF Inertial Measurement Unit to obtain absolute orientation



- Data from on-board sensor is transferred via BLE to Android App
- Future updates with include 3D swimming and autonomy

- Wireless zinc oxide tetrapod material based on-board sensors have been developed for ultraviolet light exposure monitoring to mitigate cases of photosensitization.
- Sensor was tested in sunny, partially shaded and fully shaded regions on ruminants.
- We are utilizing response to ultraviolet light to enhance signal from sensors to detect eructated gases and volatile fatty acids in rumen.
- Wireless power transfer schemes are being developed to charge the batteries onboard the robotic vehicle.



Societal Impact: Collaboration with farmers to integrate precision livestock farming for optimizing food production, and quality of life of animals. Advancement of biosensors to extend into the medical field.

Education and Outreach: Organize annual GO-FEST summer camps and interactive programming for high school students to spark their interest in pursuing careers in STEM.

Potential Impact: Quantification of biomarkers in rumen will improve understanding of livestock and improve farming monitoring and production. It will also assist with developing animal welfare practices.