

The Robomechanics Lab



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Professor

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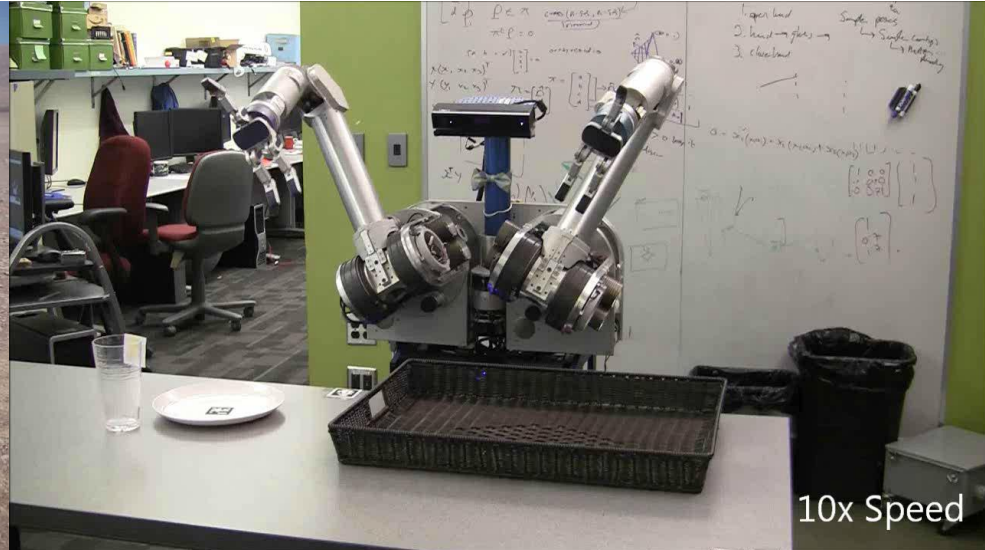
Carnegie Mellon University

Goal: Robots that can work in the real world

Wilderness &
Planetary
Exploration



Home
Assistance



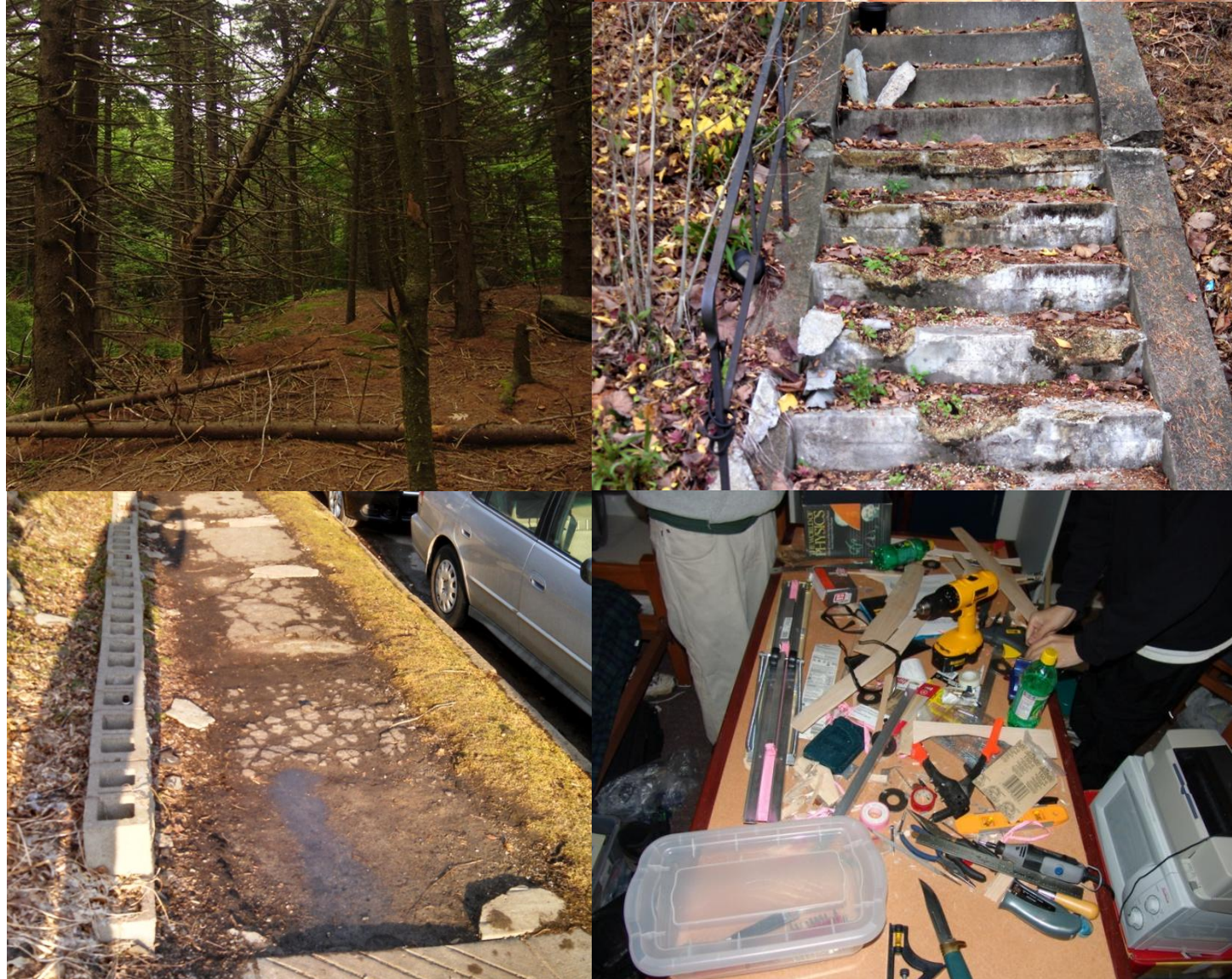
Environmental
Monitoring



Industrial
Inspection



Problem: The World is a Mess



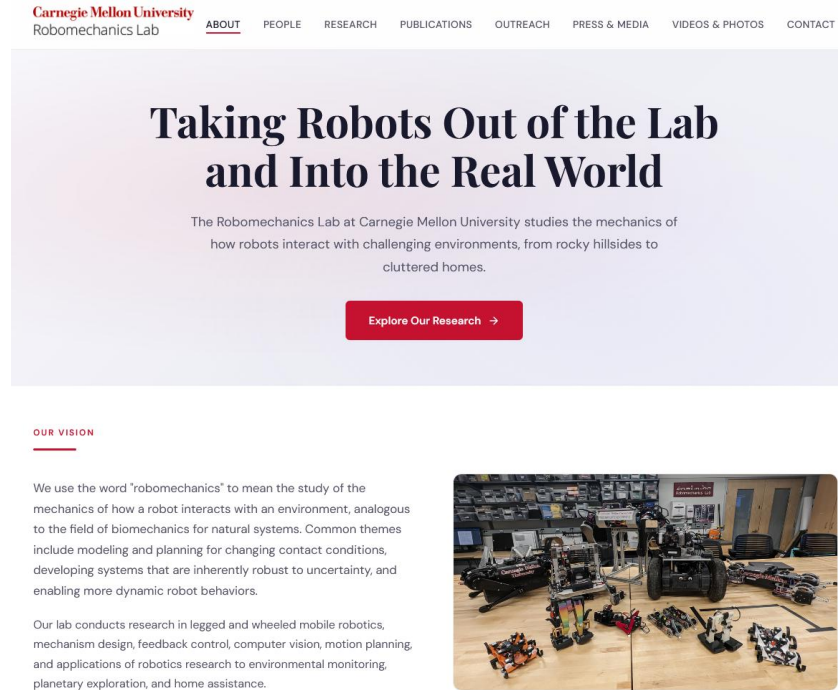
Robot Locomotion Challenges



Unexpected contact with the world

Lab Overview

Lab Website:



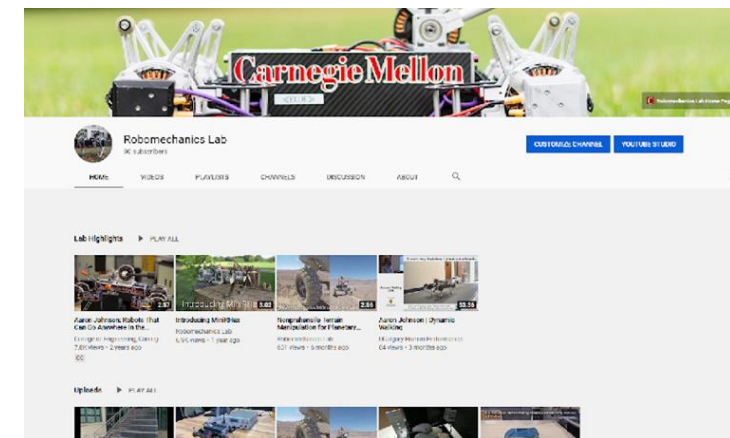
With research overview, recent publications, etc
<https://robomechanics.net>

YouTube Channel w/more talks & research videos:
<https://www.youtube.com/@robomechanicslab>

Recent Seminars:



https://www.youtube.com/watch?v=PF30Sg_C0c4
<https://www.youtube.com/watch?v=KVjeNPxD0DE>
<https://www.youtube.com/watch?v=GHXko5-CorQ>



Fall 2026 Projects

robomechanics.net
amj1@cmu.edu

- I am an MS-R or CIT-H student. How do I work with you?
 - Look through this document at the advertised projects.
 - Read the recommended paper.
 - After that, email Prof. Johnson with:
 - Your resume
 - Which project you are interested in
 - Why you want to work on that project (~2 sentences)
- Can I work on a different project in the lab or propose a new project?
 - Maybe, send an email. Most new students will work on one of these projects.
- Do you advise MS-C, MS-AS, or other non MS-R students?
 - Yes, but priority is for MS-R slots first.
- If I don't join your lab, can we still work together?
 - Yes! I teach Robot Dynamics & Analysis in the fall (next slide)
- Do you fund MS-R students?
 - No. I wish I could!

Fall: 24-760 Robot Dynamics and Analysis

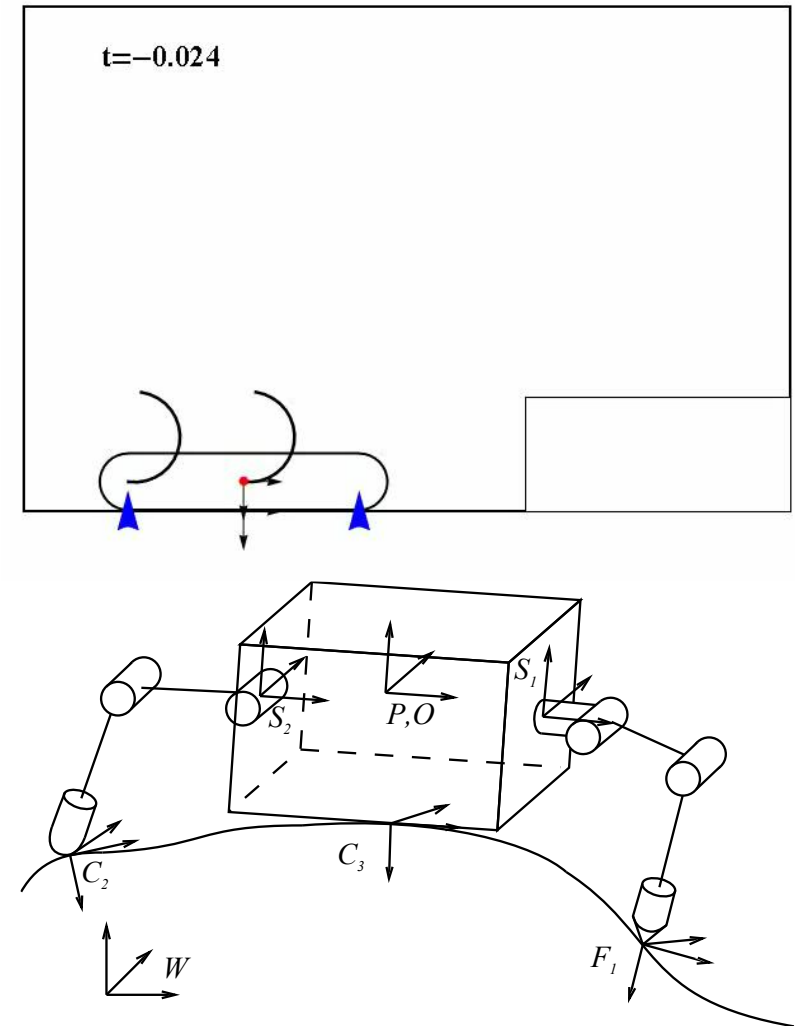
Format: Lecture based, weekly assignments

Prerequisites:

- Undergrad dynamics (should know: $f=ma$, inertia, torque, potential energy, etc)
- Matlab (ode45, syms, fmincon)
- Linear algebra, multivariable calculus, differential equations

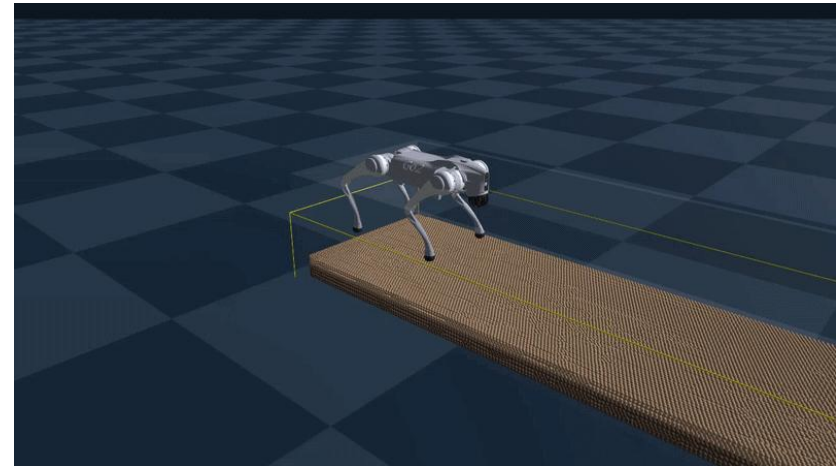
Topics:

- **Math Fundamentals:** Topological spaces, maps, implicit & inverse function thm, constraints
- **Kinematics:** Frames, rotations, velocities, twists, adjoint, forward & inverse kinematics, Jacobians
- **Dynamics:** Lagrangian dynamics, constrained dynamics
- **Contact:** Contact dynamics, impact, friction complementarity, hybrid systems
- **Simulation & Optimization:** Timestepping & hybrid simulation, shooting & direct colocation



Project 1: Legged Robot Adaptive Learning Control

- Improving adaptability of learned controls
- Navigate challenging environments like entanglements and mud
- Skills: Strong Python, C/C++, RL
- Talk to George & Thomas
- Paper to read:



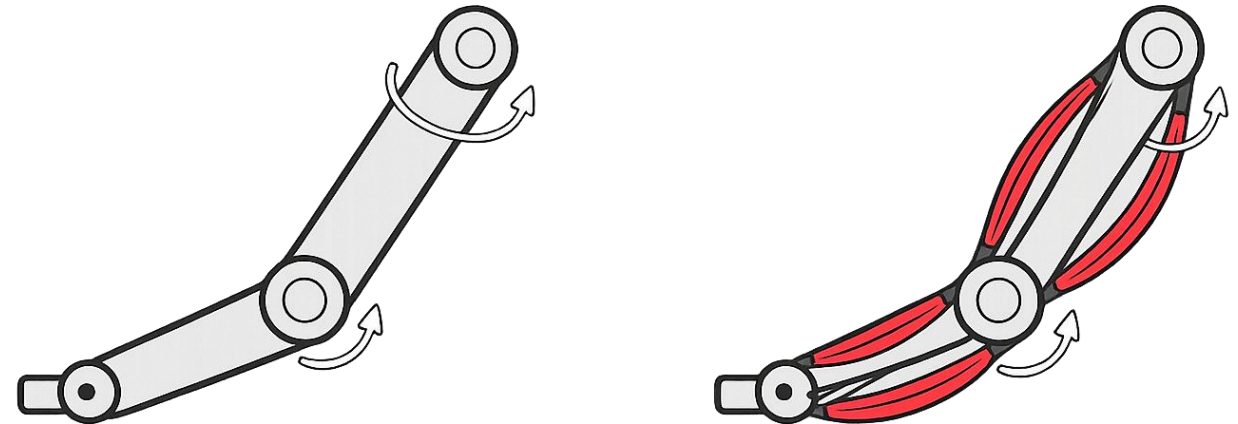
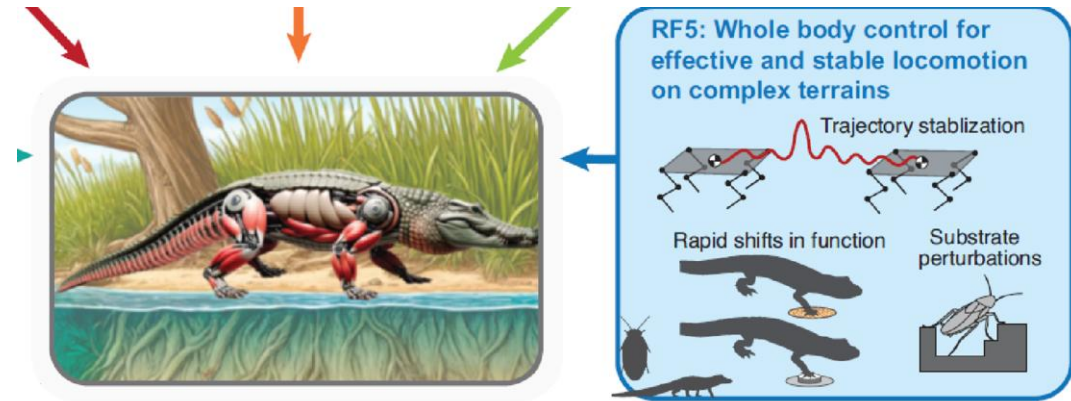
Sean J. Wang; Honghao Zhu; and Aaron M. Johnson. "Pay Attention to How You Drive: Safe and Adaptive Model-Based Reinforcement Learning for Off-Road Driving." In *IEEE Intl. Conference on Robotics and Automation*, 2024.

<https://arxiv.org/pdf/2310.08674.pdf>

https://youtu.be/5WgZQ_ALNHg

Project 2: Muscle-Inspired Control

- Study muscles to understand the low-level reflex control and mechanics
- Create simulated model to look at muscle response. Compare stability loop of muscles to PID control.
- Learn controllers for muscle-based robots
- Skills: Controls and reinforcement learning
- Talk to Diana
- Paper to read:

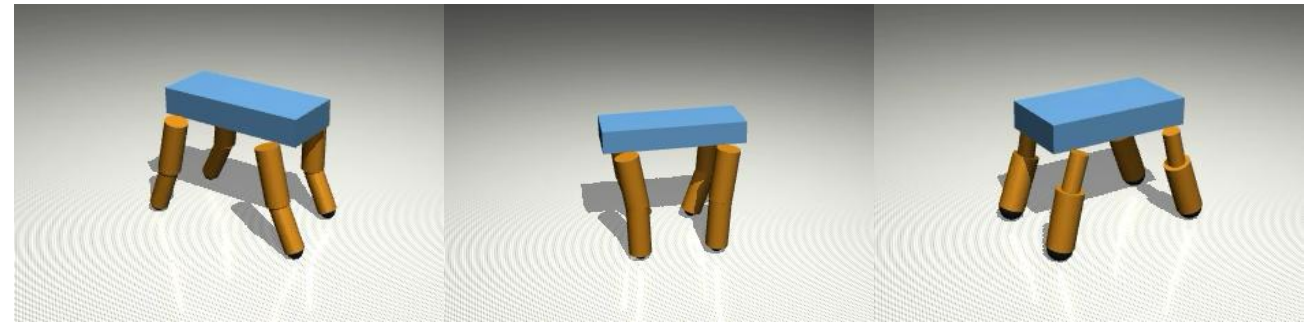
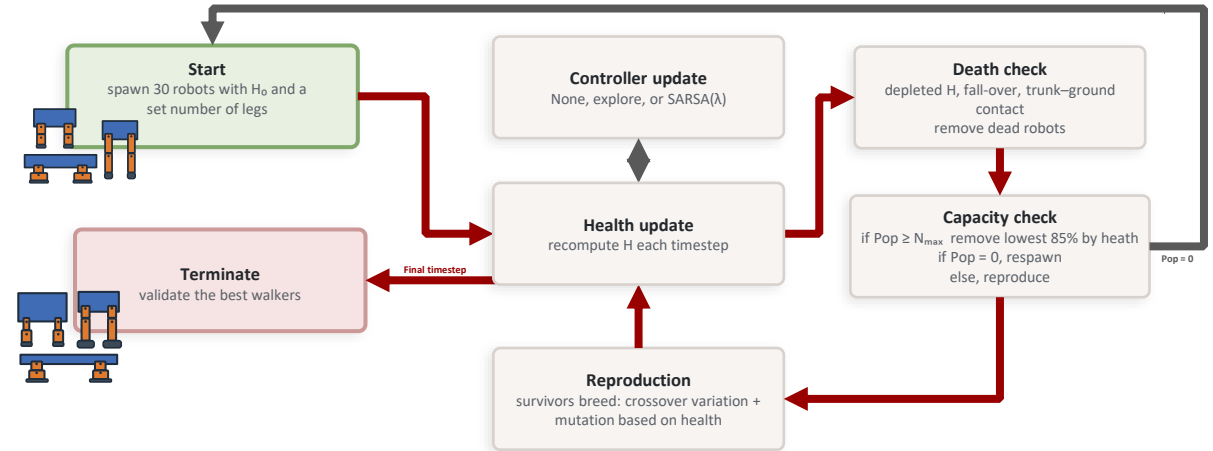


Wochner, Isabell, et al. "Learning with muscles: Benefits for data-efficiency and robustness in anthropomorphic tasks." *Conference on Robot Learning*. PMLR, 2023.

<https://proceedings.mlr.press/v205/wochner23a/wochner23a.pdf>

Project 3: Co-design framework

- Computational approach to designing the robot body and control simultaneously
- Based on evolution of populations of designs
- Algorithm development + on-robot testing
- Skills: Algorithm design, rapid prototyping
- Talk to Naomi
- Paper to read:



Wang, Yuxing, et al. "Embodied co-design for rapidly evolving agents: Taxonomy, frontiers, and challenges." *arXiv:2512.04770* (2025).

<https://arxiv.org/abs/2512.04770>

Thank you!

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This work was
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