Terradynamics Lab

Prof. Chen Li

Movement Science at the Interface of Biology, Robotics, & Physics

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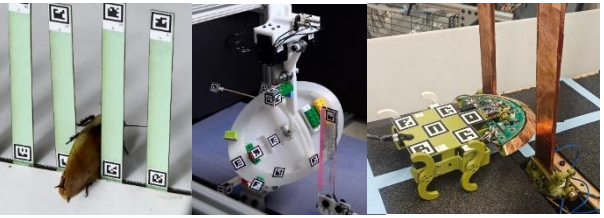
JOHNS HOPKINS WHITING SCHOOL of ENGINEERING

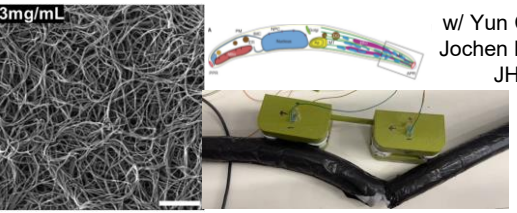
We study how the mechanics and dynamics of interaction with complex terrain shape animals' movement, morphology, sensing, control, planning, and predator-prey interaction strategies, and how to use principled understanding of this "terradynamics" to improve the performance and functions of bio-inspired robots in the complex, 3-D, real world.

Insects and legged robot sensing force to traverse cluttered terrain



Fishes and fish robot crawling on mud

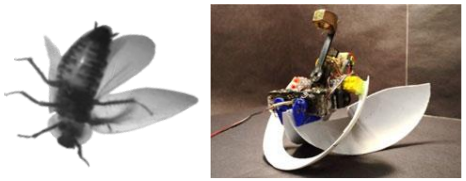
Cell robot going through model tissue to understand how to treat disease

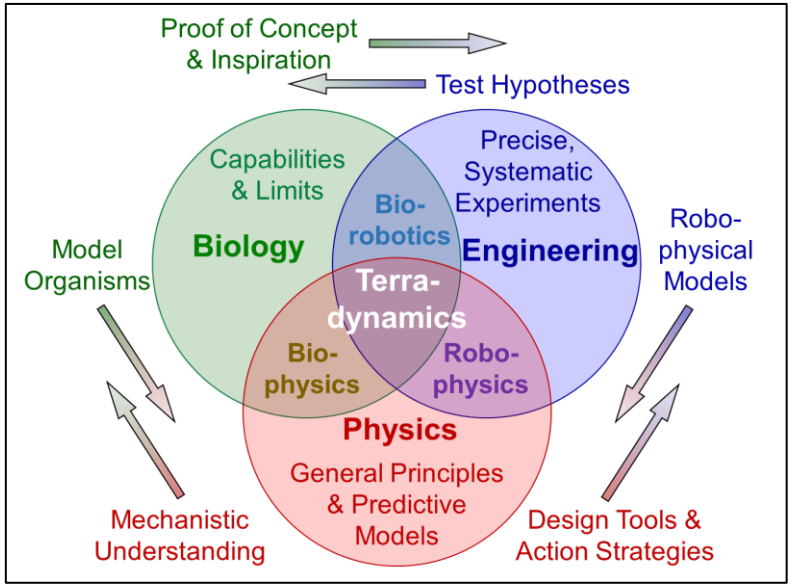


w/ Yun Chen & Jochen Mueller, JHU

Vine robot growing into packed rubble

Animal and robot self-righting after flipping over

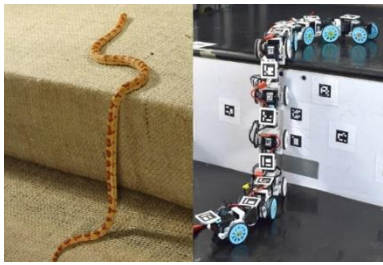




Jumping spider stalking web spider in forest environment

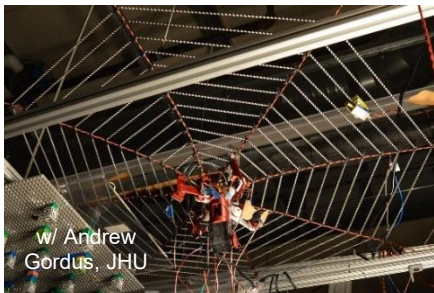
w/ Malcolm MacIver at Northwestern, Ximena Nelson at Canterbury, Daiqin Li at Hubei

Snake and snake robot traversing uneven terrain



Animals and robots climbing on steep terrain

Robotic modeling of web spider sensing prey via web vibrations



Projects

Animal

1. Cockroaches traversing cluttered obstacles
2. Snakes traversing uneven terrain
3. Animals self-righting (recovering from flipping over) on complex substrates
4. Amphibious fishes crawling on mud of various wetness
5. Jumping spiders visually navigating arboreal environments to hunt prey
6. Humans and mountain goats climbing steep rocks
7. Squirrels and cats parkouring in arboreal and artificial 3-D environments

Robot

8. Cockroach robots using sensing force to traverse cluttered obstacles
9. Snake robots sensing force to traverse uneven terrain
10. Amphibious fish robots sensing force to traverse mud of various wetness
11. Quadrupedal robots using new foot design to traverse wet sand and mud
12. Mountain goat robots sensing force to climb on steep rocks
13. Web spider robot using vibration sensing to detect prey robot on webs
14. Vine robot growing into dense rubble terrain for search and rescue
15. Cell-like robot crawling through tissue-like substrates to understand and cure diseases

Student Mentee Achievements

Prof. Li is committed to cultivating the next-generation researchers

- Have mentored 130+ students at JHU (from PhD to high-school levels)
  - 30% female and under-represented
- ~40% master, undergraduate, and high school students have earned co-authorship on conference abstracts, ~20% on peer-reviewed papers
- ~50% have continued onto top PhD, master, or undergraduate programs
  - MIT, Caltech, Stanford, Princeton, UC Berkeley, Johns Hopkins, Carnegie Mellon, Northwestern, Georgia Tech, U Michigan Ann Arbor, UIUC, Columbia, U Washington, Virginia Tech, Penn State, U Southern California, etc.
- ~20% have continued on to top tech companies
  - Google, Facebook, SpaceX, Agility Robotics, Northrop Grumman, etc.
- ~10% mentees have won competitive research awards in the department, at local events, and from other universities
- All 5 graduated doctoral and postdoctoral mentees have gone onto research positions at leading research labs
  - US Army Research Laboratory, Janelia Research Campus, Georgia Tech, Harvard, EPFL, Intuitive Surgical

Learn more: https://li.me.jhu.edu/, https://www.youtube.com/@terradynamicslab

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