

Levi “Veevee” Cai

Education

- Massachusetts Institute of Technology and Woods Hole Oceanographic Institution** *June 2019 to Present*
Graduate Student in Applied Ocean Science and Engineering & Electrical Engineering and Computer Science
Advised by Dr. Yogesh Girdhar (WHOI), collaborate with Prof. Daniela Rus (MIT)
- University of Washington** *Sept. 2018 to June 2019*
Research Assistant in Aeronautics and Astronautics
Co-advised by Prof. Kristi Morgansen and Dr. Sarah Webster (UW APL)
- Massachusetts Institute of Technology** *May 2016 to May 2018*
Master of Science in Media Arts and Sciences, GPA: 5.0/5.0
Thesis, advised by Prof. Neri Oxman: “On-site Autonomous Fabrication at Architectural Scales”
- University of Pennsylvania** *Sept. 2008 to Dec. 2015*
Master of Science in Engineering in Robotics, 2015, GPA: 3.94/4.0
Bachelor of Science in Engineering in Computer Science, Minor in Mathematics, 2012, GPA: 3.35/4.0

Research

- Massachusetts Institute of Technology and Woods Hole Oceanographic Institution** *2019 to Present*
Advised by Dr. Yogesh Girdhar (WHOI), collaborate with Prof. Daniela Rus (MIT)
- Researching semi-supervised machine learning, controls, and vision-based methods for marine animal tracking using autonomous underwater vehicles, with a particular focus on scenarios with little or no labelled data. Extensive field work and diving.
 - Reinforcement learning-based 6DOF controls for thruster-driven autonomous underwater vehicles.
 - Developing algorithms for vision-based control of multi-robot systems on soft robotic fish.
 - Collaborate closely with biologists to develop various vision and machine learning models and hardware to assist in understanding biodiversity and animal behavior in coral reef and coastal environments.
- University of Washington** *Fall 2018 to 2019*
Advised by Prof. Kristi Morgansen (UW Aero&Astro) and Dr. Sarah Webster (UW APL), Graduate Researcher
- Studied automated tuning strategies for Kalman filters used on UW Seaglidors.
- MIT Media Lab, Mediated Matter Group** *May 2016 to 2018*
Advised by Prof. Neri Oxman, Graduate Research Assistant
- Designed controls, simulation, and software architecture for large-scale, mobile, autonomous robotic platform used for construction. Performed real-world demonstration of system by printing 14.6m diameter half-dome. Supported by *Alphabet’s X (formerly Google [x])*.
 - Developed electronics, software, and controls for swarm-based robots that fabricate tubular fiberglass structures, experimentally verified by creating 20 robots, each autonomously built structures that were 4-meters tall.
- Univ. of Pennsylvania, GRASP Lab** *2009 to 2015*
Advised by Prof. Daniel Lee and Prof. Mark Yim, Graduate Research Assistant
- Developed a provably optimal algorithm for any-angle path planning by applying a novel overestimate heuristic to the Fast Marching Method. Additionally investigated heuristic strategies for multi-robot settings.
 - Developed software for user control of modular robots (CKBots) based on Robotics Bus Protocol.

Publications and Presentations

* Co-first author

Journal Articles

- **L. Cai**, N. E. McGuire, R. Hanlon, T. A. Mooney. “Semi-supervised Visual Tracking of Marine Animals using Autonomous Underwater Vehicles.” *International Journal of Computer Vision (IJCV)*, 2023.
- M. Kayser*, **L. Cai***, S. Falcone, C. Bader, N. Inglessis, B. Darweesh, J. Costa, N. Oxman. “FIBERBOTS: An Autonomous Swarm-based Robotics System for Digital Fabrication of Fiber-based Composites.” *Springer Construction Robotics (CORO)*, Dec. 2018.

- M. Kayser*, **L. Cai***, S. Falcone, C. Bader, N. Inglessis, B. Darweesh, N. Oxman. "Design of a multi-agent, fiber composite digital fabrication system." *Science Robotics*, Sept. 2018.
- S. J. Keating, J. C. Leland, **L. Cai**, and N. Oxman. "Toward site-specific and self-sufficient robotic fabrication on architectural scales." *Science Robotics*, Apr. 2017. **Cover article.**

Refereed Conference Papers

- **L. Cai***, K. Chang*, Y. Girdhar. "Learning to swim: reinforcement learning for 6DOF control of thruster-driven autonomous underwater vehicles." *IEEE International Conference on Robotics and Automation (ICRA)*, 2025. (submitted for review)
- K. Macauley, **L. Cai**, P. Adamczyk, Y. Girdhar. "ReefGlider: A highly maneuverable vectored buoyancy engine based underwater robot." *ICRA*, 2024.
- Y. Girdhar, N. McGuire, **L. Cai**, S. Jamieson, S. McCammon, B. Claus, J. E. San Soucie, J. E. Todd, T. A. Mooney. "CUREE: A Curious Underwater Robot for Ecosystem Exploration." *ICRA*, 2023.
- J. Salazar, **L. Cai**, B. Cook, D. Rus. "Multi-Robot Visual Control of Autonomous Soft Robotic Fish." *IEEE/OES Autonomous Underwater Vehicles Symposium (IEEE AUV)*, 2022.
- **L. Cai***, B. Boyacıoğlu*, S. E. Webster, K. Morgansen. "Towards Auto-tuning of Kalman Filters for Underwater Gliders based on Consistency Metrics." *MTS/IEEE OCEANS*, 2019.
- Y. Girdhar, **L. Cai**, S. Jamieson, N. McGuire, G. Flaspohler, S. Suman, B. Claus. "Enabling Co-Robotic Scientific Exploration of Unknown Environments over a Low Bandwidth Communication Channel." *ICRA*, 2019.
- M. Kayser, **L. Cai**, C. Bader, S. Falcone, N. Inglessis, B. Darweesh, J. Costa, N. Oxman. "FIBERBOTS: Design and Digital Fabrication of Tubular Structures Using Robot Swarms." *ROBARCH*, Aug. 2018. **KUKA Young Potential Best Paper Award.**

Workshops, Talks, and Presentations

- **L. Cai**, D. Yang, Y. Jezequel, T. A. Mooney, Y. Girdhar. "Quantifying Marine Animal Response to Surveys Using Underwater Vehicles." *ICRA Robotics and Sustainability Workshop*, 2024. **Best Poster 3rd Place Award.**
- **L. Cai**, D. X. Yang, S. Jamieson, Y. Girdhar. "Robot Goes Fish: Rapid, High-Resolution Biological Hotspot Mapping in Coral Reefs with Vision-Guided Autonomous Underwater Vehicles." *IEEE Computer Vision and Pattern Recognition (CVPR) CV4Animals Workshop*, 2023.
- **L. Cai**, N. E. McGuire, R. Hanlon, T. A. Mooney, Y. Girdhar. "Semi-supervised Visual Tracking of Marine Animals in the Wild." *CVPR CV4Animals Workshop*, 2022.
- **L. Cai**, R. Hanlon, Y. Girdhar. "Evaluation of Semi-supervised Visual Object Tracking Methods for Fully Autonomous In-situ, Tagless Tracking of Marine Animals." *CVPR CV4Animals Workshop*, 2021.
- "WARPAUV: A low-cost, vision-guided AUV for robotics research." Northeast Robotics Colloquium 2019.
- "Digital Construction Platform." Northeast Robotics Colloquium 2017.

Patents

- M. Kayser, L. Cai, S. Falcone, N. Oxman. "Methods and apparatus for tube fabrication." Patent application, Appl. No. US16/260,149.

Teaching and Mentoring

Supervised Master's or Undergraduate Projects

- Juan Salazar (MIT Aero, MEng.), Jadorian Paul (MIT EECS, undergrad), Braden Cook (MIT EECS, undergrad), Robert Williamson (MIT MechE undergrad), Maaya Prasad (WHOI, EECS undergrad), Charles Xu (WHOI, Physics undergrad), Kevin Macauley (WHOI, MechE undergrad), Kevin Chang (WHOI, CS undergrad)

Massachusetts Institute of Technology, Electrical Engineering and Computer Science Dept.

- 6.S898, Deep Learning, grad-level, Fall 2023

Univ. of Pennsylvania, Computer Science Dept.

- CIS520, Intro. to Machine Learning, grad-level, Fall 2015
- CIS521, Intro. to AI, grad-level, Fall 2012

Fellowships and Awards

3rd Place Best Poster Award – ICRA Robotics and Sustainability Workshop, 2024

Nvidia Hardware Grant Recipient – Awarded an A6000 GPU for research purposes

NDSEG Fellow 2019 – 3 years full funding towards PhD

Link Ocean Engineering Fellowship 2019 – Declined for NDSEG (4 awarded annually)

UW GSFEI Top Scholar Program - Fellowship awarded to 1 student per department at Univ. of Wash.

KUKA Young Potential Best Paper Award – RobArch 2018 Conference paper

UPenn Rachleff Scholar – Highly-selective undergraduate research program

Professional

MasterStreet (startup)

Software Engineer (New York, NY)

2013 to 2014

IBM

Software Engineer (Durham, NC)

2012 to 2013

Service and Outreach

ICRA'24 Lead Organizer for Workshop on Robotics for Understanding Natural Environments – Workshop to bring together roboticists and ecologists (<https://sites.google.com/view/icra-2024-rune-workshop>)

Reviewer for RA-L, ICRA, IROS, CVPR CV4Animals, ISER, CORO, BioRob, Autocon

Robotics: Science and Systems Conference (RSS) 2017 Volunteer

MIT RoboCon Organizer – Helped organize an MIT/Boston-area robotics conference (<http://robocon.mit.edu/>)

IBM Extreme Blue Technical Mentor – Mentored team of engineering undergraduates and an MBA student

FIRST Robotics Mentor – NCSSM Team 900 in Durham, NC

UPenn Summer Mentorship Program – Full-time instructor for 6-week, high-school summer technology course

FIRST Lego League Coach – FACTS Middle School, afterschool robotics team coach

Leadership and Extracurriculars

UPenn RoboCup SPL Vision

Vision Team Lead

2009 to 2012

UPenn FSAE Race Car

Electrical Team Lead

2010 to 2012

Additional Skills

Programming

Python, C/C++, ROS, CUDA, MATLAB/MEX, Full Web Stack

Software

Eagle PCB CAD, SolidWorks, Adobe Illustrator

Other

Certified Scientific Diver