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Levi "Veevee" Cai

Education

Massachusetts Institute of Technology and Woods Hole Oceanographic Institution *2019 to Present*
Ph.D. Candidate in Applied Ocean Science and Engineering & Electrical Engineering and Computer Science
Advised by Dr. Yogesh Girdhar (WHOI), collaborated with Prof. Daniela Rus (MIT)

Massachusetts Institute of Technology *2016 to 2018*
M.S. in Media Arts and Sciences
Thesis, advised by Prof. Neri Oxman: "On-site Autonomous Fabrication at Architectural Scales"

University of Pennsylvania *2008 to 2012, 2015*
M.S.E. in Robotics, 2015
B.S.E. in Computer Science, Minor in Mathematics, 2012

Research Experience

Massachusetts Institute of Technology and Woods Hole Oceanographic Institution *2019 to Present*
Advised by Dr. Yogesh Girdhar (WHOI), collaborated with Prof. Daniela Rus (MIT)

- Created algorithms for efficient and active learning of visual detectors via core-set selection methods.
- Developed reinforcement learning algorithms for 6DOF controls of autonomous underwater vehicles, built in Isaac Labs; first known zero-shot sim-to-real deployment on physical AUV [ICRA 2025].
- Designed systems for real-time autonomous tracking of marine animals using semi-supervised learning approaches; first known system to track a barracuda in the wild, over 300m distance [IJCV 2023].
- Formulated controls and experiments for novel agile robotic platforms including buoyancy-driven and bio-inspired locomotion for minimally invasive animal monitoring tasks [IEEE AUV 2022; ICRA 2023; ICRA 2024].
- Collaborated closely with biologists studying biodiversity and animal behavior in coral reef environments.

University of Washington *2018 to 2019*
Advised by Prof. Kristi Morgansen (UW Aero&Astro) and Dr. Sarah Webster (UW APL), Graduate Researcher

- Designed automated tuning strategies for Kalman filters used on UW Seagliders [OCEANS 2019].

MIT Media Lab, Mediated Matter Group *2016 to 2018*
Advised by Prof. Neri Oxman, Graduate Research Assistant

- Designed controls, simulation, and software architecture for large-scale, mobile, autonomous robotic platform for construction. Performed real-world demonstration of system by printing 14.6m diameter half-dome. Supported by *Alphabet's X (formerly Google [x])* [CORO 2018; Sci. Rob. 2018].
- Developed electronics, software, and controls for swarm-based robots that fabricate tubular fiberglass structures; experimentally verified by creating 20 robots that each autonomously built a 4m tall structure [Sci. Rob. 2017, cover].

University 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.
- Built 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.**

Peer-Reviewed 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.*
- 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

University 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*

- Built a search engine for continuing education courses with Ruby on Rails and ElasticSearch

IBM *Software Engineer (Durham, NC)* *2012 to 2013*

- Developed mobile applications in Dojo for server management, as part of IBM Flex System Management

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 *IEEE RA-L, IEEE ICRA, IEEE IROS, IEEE CVPR, IEEE ICCV, ISER, Springer Construction Robotics, IEEE BioRob, Elsevier Automation in Construction, Wiley Ecology and Evolution*
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 Humanoid Soccer *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