

# Levi “Veevee” Cai

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## 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.
  - Developing algorithms for vision-based control of multi-robot systems on soft robotic fish.
  - Working with biologists to develop various vision and machine learning models 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.

### Refereed Conference Papers

- K. Macauley, **L. Cai**, P. Adamczyk, Y. Girdhar. "ReefGlider: A highly maneuverable vectored buoyancy engine based underwater robot." *IEEE International Conference on Robotics and Automation (ICRA)*, 2024. [in review]
- 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. X. Yang, Y. Jezequel, T. A. Mooney, Y. Girdhar. "Reducing Impact of Autonomous Underwater Vehicles on Marine Animals when Sampling Abundance and Biodiversity Metrics." *ASLO Ocean Sciences Meeting (OSM)*, 2024. (to appear)
- **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

### Massachusetts Institute of Technology, 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

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

**NDSEG Fellow 2019**

**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)  
IBM

Software Engineer (New York, NY)  
Software Engineer (Durham, NC)

2013 to 2014  
2012 to 2013

## Service and Outreach

ICRA'24 Organizer for Workshop on Robotics for Understanding Natural Environments (to appear)

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

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