

Alan Papalia

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I develop algorithms for long-duration autonomy in marine and field robots operating in harsh, dynamic environments. My work advances robust navigation and environmentally aware adaptation — responding to currents, terrain, and communication constraints — to enable environmental observation at unprecedented scales.

Education

2019-2025 Massachusetts Institute of Technology & Woods Hole Oceanographic Institution Joint Program
PhD Oceanographic Engineering
Advisor: John Leonard

2015-2019 University of Illinois at Urbana-Champaign
BS Mechanical Engineering, *Focus: Computer Science*

Research Interests

Algorithmic Autonomy; Environment-Aware Planning; Field & Marine Robotics

Current directions:

1. **Robust State Estimation and Navigation:** Certifiably correct localization and mapping methods that integrate multiple sensing modalities in GNSS-denied settings.
 2. **Information- and Environment-Aware Planning:** Long-horizon planning that accounts for environmental dynamics (currents, terrain) and operational limits (acoustic communication pathways).
 3. **Trustworthy Autonomy:** Verification of model- and learning-based components for safety-critical missions.
 4. **Real-World Validation:** Field trials in marine and coastal environments for environmental monitoring.
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Selected Awards & Honors

(2025) **Robotics: Science and Systems Pioneer:** Selected as 1 of 33 promising early-career researchers from 226 applicants (~14.6% acceptance rate).

(2024) **IEEE Transactions on Robotics King-Sun Fu Memorial Best Paper Award**

(2023) **MIT MathWorks Fellow:** Full tuition + stipend for fundamental research in robot navigation [8, 11].

(2023) **Undersea Technology Innovation Scholar:** 1 of 3 graduate recipients for this national award in marine technology.

(2019) **Woods Hole Next Wave Fellow:** Full tuition + stipend for research supporting oceanography and ocean engineering.

Additional Awards

(2020) **Best Poster**, ACM SIGCOMM N2W Workshop: Awarded for work on disease contact tracking [16].

(2019) **GM / Philip W. Leistra Jr. Society of Automotive Engineers Award**: Sole recipient out of 250+ Mechanical Engineering Seniors at UIUC for outstanding contributions to SAE.

(2018) **Illinois Engineering Achievement Scholar**

Research Funding

(2024, \$10,000 — PI) **WHOI Ocean Venture Fund**: Development of low-cost towed hydrophone arrays and underwater vehicles for environmental sensing and marine robotics research.

(2023, \$275,000 — Lead Author / Partner Institution PI Contribution) **NSF STTR Phase I (Gaia AI)**: Wrote and led the Gaia AI portion of a collaborative STTR Phase I proposal (with Carnegie Mellon University, PI: David Wettergreen) to develop robotic tools for forestry, enabling creation of forest digital twins for carbon accounting and forest management.

Experience

Jan 2026 - Present **University of Michigan**
Assistant Professor

Jan 2025 - Dec 2025 **Northeastern University**
Postdoctoral Researcher
Advisors: Hanu Singh and Michael Everett

Sep 2019 - Jan 2025 **Massachusetts Institute of Technology / Woods Hole Oceanographic Institution**
PhD in Ocean Engineering
Advisor: John Leonard

Sep 2021 - Aug 2022 **Gaia AI**
Lead Roboticist

- Led robotics/computer vision for first product (instrumented backpack for forest inventorying) used to support a **\$3M pre-seed** raise.
- Wrote and led NSF STTR Phase I proposal (**\$275K** award).

Publications

- [1] Zihao Dong, **Alan Papalia**, Leonard Jung, Alenna Spiro, Philip R. Osteen, Christa S. Robison, and Michael Everett. “Learning Smooth State-Dependent Traversability from Dense Point Clouds”. *Conference on Robot Learning (CoRL)*. 2025.
- [2] Leonard Jung, **Alan Papalia**, Kevin Doherty, and Michael Everett. “Practical and Performant Enhancements for Maximization of Algebraic Connectivity”. *arXiv preprint arXiv:2511.08694* (2025).
- [3] **Alan Papalia**, Charles Dawson, Laurentiu L Anton, Norhan Magdy Bayomi, Bianca Champenois, Jung-Hoon Cho, Levi Cai, Joseph DelPreto, Kristen Edwards, Bilha-Catherine Githinji, et al. “A Roadmap for Climate-Relevant Robotics Research”. *arXiv preprint arXiv:2507.11623* (2025).
- [4] **Alan Papalia**, Frederike Dümbgen, Connor Holmes, and Timothy D Barfoot. “A Field Guide to Certifiably Correct Optimization for Robotics” (2025). *In Preparation*.
- [5] **Alan Papalia**, Nikolas Sanderson, Haoyu Han, Heng Yang, Hanumant Singh, and Michael Everett. “Sparse Variable Projection in Robotic Perception: Exploiting Separable Structure for Efficient Nonlinear Optimization”. under review. 2025.
- [6] Alexander Thoms, **Alan Papalia**, Jared Velasquez, David M. Rosen, and Sriram Narasimhan. “Distributed Certifiably Correct Range-Aided SLAM”. *IEEE Intl. Conf. on Robotics and Automation (ICRA)*. IEEE. 2025.
- [7] Kevin J. Doherty, **Alan Papalia**, Yewei Huang, David M. Rosen, Brendan Englot, and John J. Leonard. “MAC: Maximizing Algebraic Connectivity for Graph Sparsification”. *Under Review*. 2024.
- [8] **Alan Papalia**, Andrew Fishberg, Brendan W. O’Neill, Jonathan P. How, David M. Rosen, and John J. Leonard. “Certifiably Correct Range-Aided SLAM”. *IEEE Transactions on Robotics* 40 (2024). **IEEE T-RO King-Sun Fu Memorial Best Paper Award**, pp. 4265–4283. doi: [10.1109/TR0.2024.3454430](https://doi.org/10.1109/TR0.2024.3454430).
- [9] **Alan Papalia**, Yulun Tian, David M Rosen, Jonathan P How, and John J Leonard. “An Overview of the Burer-Monteiro Method for Certifiable Robot Perception”. *arXiv preprint arXiv:2410.00117* (2024).
- [10] Raymond Turrisi, Haojing Huang, Filip Strømstad, John Morrison, **Alan Papalia**, John Leonard, and Michael Benjamin. “The Spurdog AUV: A Field Configurable and Optionally A-Sized Low-Cost AUV”. *2024 IEEE/OES Autonomous Underwater Vehicles Symposium (AUV)*. IEEE. 2024.
- [11] **Alan Papalia**, Joseph Morales, Kevin J. Doherty, David M. Rosen, and John J. Leonard. “SCORE: A Second-Order Conic Initialization for Range-Aided SLAM”. *IEEE Intl. Conf. on Robotics and Automation (ICRA)*. 2023.
- [12] Qiangqiang Huang, **Alan Papalia**, and John J. Leonard. “Nested Sampling for Non-Gaussian Inference in SLAM Factor Graphs”. Vol. 7. 4. IEEE, 2022, pp. 9232–9239.
- [13] Brendan W. O’Neill, Jesse R. Pelletier, Samuel Calvert, **Alan Papalia**, John J. Leonard, Lee Freitag, and Eric Galimore. “Loosely-Coupled Human-Robot Teams for Enhanced Undersea Operations”. *Proc. of the IEEE/MTS OCEANS Conf. and Exhibition*. IEEE. 2022.
- [14] **Alan Papalia**, Nicole Thumma, and John Leonard. “Prioritized Planning for Cooperative Range-Only Localization in Multi-Robot Networks”. *IEEE Intl. Conf. on Robotics and Automation (ICRA)*. IEEE. 2022, pp. 10753–10759.
- [15] Marcos Tieppo, ..., **Alan Papalia**, Douglas Hart, John Leonard, Maha Haji, Olivier de Weck, Peter Godart, and Pierre Lermusiaux. “Submarine Cables as Precursors of Persistent Systems for Large Scale Oceans Monitoring and Autonomous Underwater Vehicles Operation”. *OCEANS 2022, Hampton Roads*. 2022, pp. 1–7. doi: [10.1109/OCEANS47191.2022.9977360](https://doi.org/10.1109/OCEANS47191.2022.9977360).
- [16] Lillian Clark, **Alan Papalia**, Jônata Tyska Carvalho, Luca Mastrostefano, and Bhaskar Krishnamachari. “Inter-mobile-device distance estimation using network localization algorithms for digital contact logging applications”. *Smart Health* 19 (2021), p. 100168.
- [17] **Alan Papalia** and John Leonard. “Network Localization Based Planning for Autonomous Underwater Vehicles with Inter-Vehicle Ranging”. *IEEE/OES Autonomous Underwater Vehicles Symposium*. IEEE. 2020.

Open-Source Software

Selected libraries I have developed or led, adopted by researchers and practitioners in robotics, state estimation, and optimization.

- **CORA** — Certifiably Correct Range-Aided SLAM: first certifiably correct backend for range-aided SLAM; provides global optimality certificates. <https://github.com/MarineRoboticsGroup/cora>

- **SCORE** — Second-Order Conic Relaxation for Range-Aided SLAM: convex-relaxation-based initialization for robust range-aided state estimation. <https://github.com/MarineRoboticsGroup/score>
- **MAC** — Maximizing Algebraic Connectivity: convex-optimization-based graph sparsification for efficient state estimation and model compression. <https://github.com/MarineRoboticsGroup/mac>

Invited Talks and Guest Lectures

1. University of Michigan, Advanced Topics in Computer Vision (December 2025)
 2. Harvard University Computational Robotics Lab (August 2025)
 3. Scripps Institution of Oceanography, Meyer Group (July 2025)
 4. University of California, San Diego (June 2025)
 5. Harvey Mudd College, Computer Science Department (June 2025)
 6. University of Michigan, Mobile Robotics Course (April 2024)
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Advising

PhD Students

1. Hanna Zhang, Northeastern University (2025); *Verification of Learned Models for Robotics*
2. Zihao Dong, Northeastern University (2025); *Terrain-Aware Navigation in Offroad Autonomy*
3. Leonard Jung, Northeastern University (2025); *Contingency-Aware Planning for Autonomous Systems*

Master's Students

1. JP Morrison, MIT-WHOI (2022-2025); *Cooperative Navigation of a Team of Low-Cost AUVs*
2. Tim Magoun, MIT (2022-2024); *Open-Set SLAM with Foundation Models*
3. Elizabeth Pedlow, MIT (2020-2021); *UWB Error Modeling for Improved Localization*
4. Nicole Thumma, MIT (2020-2021); *Multi-Robot Planning for Collaborative Navigation*

Undergraduate Students

1. Nikolas Sanderson, Northeastern University (2025); *Terrain-Aware Navigation in Offroad Autonomy*
 2. Christian Tavera, MIT (2024); *Design of a Low-Cost Acoustic Hydrophone Array*
 3. Abigail Greenough, MIT (2023); *Visualization in Manifold Optimization*
 4. Calvin Cigna, MIT (2023); *Visualization in Manifold Optimization*
 5. Wells Crosby, MIT (2023); *Simulation for Marine Robotics*
 6. Keiji Imai, MIT (2023); *Learned Inertial Navigation*
 7. Joseph Morales, MIT (2022); *Convex Relaxations for Multi-Robot Navigation*
 8. Omoruyi Atekha, MIT (2021-2022); *Visual SLAM*
 9. Sophia Franklin, MIT (2020-2021); *Low-cost Swarm Robot for Collaborative Mapping*
 10. Hunter Celio, MIT (2020); *3-DOF Robot Arm for Mobile Manipulation*
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Teaching

- Instructor, *Introduction to Tool Design*, MIT Mechanical Engineering (Full-Semester, 2024)
 - Instructor/Workshop Leader, robotics, makerspace operations, and marine robotics topics for MIT EHS staff, MIT MakerWorkshop, and MIT-Portugal Marine Robotics Summer School (2022-2023)
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Outreach and Community Involvement

- President/Executive Board, MIT MakerWorkshop (2020-2023)
 - Admitted Student Representative, MIT-WHOI Joint Program Marine Robotics Group (2020-2025)
 - Volunteer, MIT-WHOI Applicant Support & Knowledgebase (2020-2025)
 - Robotics Outreach Volunteer, Takeoff Space (2019-2021)
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Reviewer Service

- **Journals:** IEEE RA-L, IEEE T-RO, IJRR
- **Conferences:** RSS, ICRA, IROS, L4DC, AAMAS