

Alan Papalia

Curriculum Vitae

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Education

- 2019-Present** Massachusetts Institute of Technology / Woods Hole Oceanographic Institution
PhD Ocean Engineering, *Focus: Robotics*
Advisor: John Leonard
- 2015-2019** University of Illinois at Urbana-Champaign
BS Mechanical Engineering, *Focus: Computer Science*

Research Direction

My research focuses on developing autonomous systems that can efficiently and extensively monitor and explore the environment. Current observational capabilities limit our scientific understanding of the world, as capturing sufficient data to accurately model the dynamic and diverse phenomena of the natural world is technically challenging, time-consuming, and costly. Although modern robotic systems hold promise for enhancing our observational abilities, their unreliability and high cost make large-scale deployment impractical.

To address this challenge, I develop novel navigation algorithms that enhance the reliability, efficiency, and affordability of robotic systems. I demonstrate these algorithms on real-world robotic systems to validate their efficacy and ensure that they solve key problems.

Specifically, I specialize in developing navigation techniques for robots that operate in areas where traditional GPS is either unavailable or insufficient, such as underwater, subterranean, and extraterrestrial environments. These environments pose unique challenges for navigation due to environmental redundancy and limited perception.

Research Experience

Sep 2019 - [Massachusetts Institute of Technology](#)

Present Graduate Student
Advisor: John Leonard

- Algorithmic enhancements to range-aided state estimation via Riemannian geometry and optimization [1, 5]
- Preliminary demonstrations of navigation techniques allowing ~10x reduction in sensor costs (\$250k → \$30k)
- State estimation and low-level controller interfacing on proxy platforms for collaborative diver-AUV navigation [4]

Jun 2018 - [Oregon State University](#)

Sep 2018 Undergraduate Research Assistant
Advisors: Cindy Grimm and Ravi Balasubramanian

- Implemented and tested object pose-tracking systems for robotic grasping experiments
- Designed library for automated and synchronized RGB-D camera data collection

Sep 2016 - [University of Illinois at Urbana-Champaign](#)

Sep 2018 Undergraduate Research Assistant
Advisors: Placid Ferreira and Jorge Correa Panesso

- Developed cloud-based applications for distributed manufacturing; presented to DoD and Fortune 100 sponsors
- Integrated open-architecture microcontroller into consumer laser-cutter for direct machine control

Industry Experience

Sep 2021 - **Gaia AI**

Aug 2022 Lead Robotacist

- Early-stage startup developing robotics for improved forestry management and forest carbon sequestration
- Led robotics and computer vision efforts, leading to first product and [subsequent \\$3M funding round](#)

Jun 2017 - **Seurat Technologies**

Aug 2017 Mechanical Engineering Intern

- Cooling system for industrial 3D printer as part of team which achieved first-print milestone
- Designed cooling system via thermal-fluid analyses over range of expected operating conditions

Publications

- [1] **Alan Papalia**, Andrew Fishberg, Brendan W. O’Neill, Jonathan P. How, David M. Rosen, and John J. Leonard. “Certifiably Correct Range-Aided SLAM”. In: *arXiv:2302.11614* (2023). URL: <http://arxiv.org/abs/2302.11614>.
- [2] **Alan Papalia**, Joseph Morales, Kevin J. Doherty, David M. Rosen, and John J. Leonard. “SCORE: A Second-Order Conic Initialization for Range-Aided SLAM”. In: *IEEE Intl. Conf. on Robotics and Automation (ICRA)*. 2023. URL: <http://arxiv.org/abs/2210.03177>.
- [3] Qiangqiang Huang, **Alan Papalia**, and John J. Leonard. “Nested Sampling for Non-Gaussian Inference in SLAM Factor Graphs”. In: *IEEE Robotics and Automation Letters* 7.4 (2022), pp. 9232–9239.
- [4] 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”. In: *Proc. of the IEEE/MTS OCEANS Conf. and Exhibition*. IEEE. 2022.
- [5] **Alan Papalia**, Nicole Thumma, and John Leonard. “Prioritized Planning for Cooperative Range-Only Localization in Multi-Robot Networks”. In: *IEEE Intl. Conf. on Robotics and Automation (ICRA)*. IEEE. 2022, pp. 10753–10759. URL: <http://arxiv.org/abs/2109.05132>.
- [6] Marcos Tieppo, Eduardo Pereira, Laura González García, Margarida Rolim, Emanuel Castanho, Aníbal Matos, António Silva, Bruno Ferreira, Maria Pascoal, Eduardo Almeida, Filipe Costa, Fred Zabel, João Faria, José Azevedo, José Alves, José Moutinho, Luís Gonçalves, Marcos Martins, Nuno Cruz, Nuno Abreu, Pedro Silva, Rúben Viegas, Sérgio Jesus, Tânia Chen, Tiago Miranda, **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”. In: *Proc. of the IEEE/MTS OCEANS Conf. and Exhibition*. IEEE. 2022.
- [7] 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”. In: *Smart Health* 19 (2021), p. 100168.
- [8] **Alan Papalia** and John Leonard. “Network Localization Based Planning for Autonomous Underwater Vehicles with Inter-Vehicle Ranging”. In: *IEEE/OES Autonomous Underwater Vehicles Symposium*. IEEE. 2020.

Open-Source Software

Open-source libraries to promote adoption of these works and assist the scientific community.

- Certifiably Correct Range-Aided SLAM (CORA): a novel approach to performing range-aided state estimation, a key technological capability to enabling low-cost autonomous navigation.
URL: <https://github.com/MarineRoboticsGroup/cora>
- PyFactorGraph: a general format for working with state estimation problems, allowing portability and ease-of-comparison between projects.
URL: <https://github.com/MarineRoboticsGroup/PyFactorGraph>
- Second-Order Conic Relaxation for Range-Aided SLAM (SCORE): reliably improve the initialization of range-aided state-estimation problems, providing theoretical insights and enhanced navigational robustness.
URL: <https://github.com/MarineRoboticsGroup/score>

Awards

Best Poster (2020 ACM SIGCOMM N2Women)

Woods Hole Next Wave Fellow (2019) 1 year full tuition & stipend

General Motors / Philip W. Leistra Jr. Society of Automotive Engineers Award (2019)

Illinois Engineering Achievement Scholar (2018)

Eagle Scout

Mentorship

Summary: 3 Masters theses and 4 undergraduate research experiences

- Master of Engineering, MIT (2022-Present), Tim Magoun; *Diver-AUV Collaborative Navigation*
- Undergraduate Research, MIT (2023-Present), Keiji Imai; *Learned Inertial Navigation*
- Undergraduate Research, MIT (2021-2022), Omoruyi Atekha; *Visual SLAM*
- Master of Science, MIT (2020-2021), Elizabeth Pedlow; *UWB Error Modeling for Improved Localization*
- Master of Engineering, MIT (2020-2021), Nicole Thumma; *Multi-Robot Planning for Collaborative Navigation*
- Undergraduate Research, MIT (2020-2021), Sophia Franklin; *Low-cost Swarm Robot for Collaborative Mapping*
- Undergraduate Research, MIT (2020), Hunter Celio; *3-DOF Robot Arm for Mobile Manipulation*

Outreach and Community Involvement

- President/Executive Board, [MIT MakerWorkshop](#) (2020-Present)
- Instructor, [MIT-Portugal Marine Robotics Summer School](#) (2022)
- Admitted Student Representative, [Marine Robotics Group](#) (2020-Present)
- Mentor, [MIT MakerWorkshop](#) (2019-Present)
- Volunteer, [MIT-WHOI Applicant Support & Knowledgebase](#) (2020-Present)
- Volunteer, [MakeMIT](#) (2019)
- Robotics Outreach Volunteer, [Takeoff Space](#) (2019-2021)
- Volunteer, Orpheum Children's Science Museum Robot Day (2018)
- Curriculum Designer, UIUC - ME270, Design for Manufacturing (2018)