AARON JAMES WILHELM

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RESEARCH PROFILE

Robotics Ph.D. candidate specializing in geometry-aware visual localization and SLAM for mobile robots. Develops lightweight algorithms and integrated robotic systems, with experience spanning geometric computer vision, machine learning, hardware development, and real-world experimental validation.

EDUCATION

- PhD Candidate, Electrical Engineering — Cornell University (GPA: 4.09/4.30, Spring/Summer 2027)
- MS, Electrical Engineering — Cornell University (December 2023)
- BS, Electrical Engineering, Summa Cum Laude — University of California, Los Angeles (GPA: 3.92/4.00, June 2020)

HONORS AND AWARDS

- Fulbright U.S. Scholar Program Semi-Finalist, Australia, 2026
- ICRA 2025 PhD Consortium Participant, May 2025
- McMullen Fellowship, Fall 2025
- Lester Eastman Fellowship, Fall 2023
- Cornell ECE Outstanding TA Award, 2021–2022
- Best Research Poster, UCLA Electrical Engineering Annual Research Review, 2019
- Best Undergraduate Research Poster, UCLA Electrical Engineering Annual Research Review, 2018

EXPERIENCE

PhD Research — Napp Lab at Cornell University **Fall 2020-present**

- Deterministic GAN-Based Ground Texture Simulator for SLAM, *Ongoing Research*
  - Creating a controllable simulator that generates spatially consistent ground-texture imagery for localization and SLAM research
- Micro-Localization: High-Precision Mobile Robot Localization Using Microscopic Ground Texture, *Submitted to ICRA 2027*
  - Built a low-cost, markerless localization system that uses microscopic surface texture to achieve global localization accuracy in the tens of micrometers
  - Designed a custom mobile robot and high-magnification sensing module costing under $600, adapting the localization pipeline to a scaled-orthographic camera model
  - Validated localization accuracy against a precision CNC gantry across multiple surface types and demonstrated reuse of the same map across gantry and mobile-robot platforms
  - Measured thermal expansion of an aluminum rod using the localization system and demonstrated agreement with temperature-based predictions
- HyGround: A Hybrid Loop Closure Architecture for Scalable Ground Texture SLAM, *Manuscript in Preparation*
  - Designed a scalable ground-texture SLAM system that outperformed both ground-texture SLAM baselines on most trajectories while reducing per-keyframe memory by up to 55× relative to a direct-method baseline.
- “Improved Bag-of-Words Image Retrieval with Geometric Constraints for Ground Texture Localization”, *ICRA 2025*
  - Created a geometry-aware Bag-of-Words retrieval system for ground texture global localization and loop-closure detection

    - Exploited the fixed scale and consistent orientation of downward-facing imagery through scale-binned vocabularies and integrated geometric verification
    - Improved retrieval mean average precision from 0.026 to 0.559 and detected nearly 3× as many loop closures as a standard DBoW baseline
- "Lightweight Ground Texture Localization", *ICRA 2024*
    - Built a lightweight global-localization system using natural ground texture for deployment on resource-constrained robots
    - Introduced improved feature selection, locality-preserving dimensionality reduction, and KD-tree spatial voting
    - The high-accuracy version improved state-of-the-art localization performance, while the lightweight version roughly halved runtime and achieved over 4 Hz on a Raspberry Pi 4
- "Inexpensive, Automated Pruning Weight Estimation in Vineyards", *ICRA 2024*
    - Contributed to a low-cost smartphone and structured-light vision system for automated grapevine pruning-weight estimation, achieving R^2 = 0.80 on vertical-shoot-positioned vines and demonstrating initial results on high-cordon vines
- "Frozen Assets: Leveraging Ice, Water, and Phase Transitions in Robots", *IROS 2024*
    - Co-developed robotic systems that exploit melting, freezing, and fracturing of ice for structural reconfiguration, actuation, and environmental adaptation, supported by a scaling analysis of ice structural elements

Artificial Intelligence/Computer Vision Intern — EpiSys Science Inc. Fall 2019–2020

- Proposed a novel reinforcement learning algorithm for an agent to exploit partial environment information while learning POMDP environments
- Decreased sPOMDP model generation times by 31–63% while improving robustness

Research Assistant — Interconnected and Integrated Bioelectronics Lab Fall 2016–2020

- Designed and manufactured a skin health monitor and a bladder monitor
- Collaborated on a device that uses photoplethysmography (PPG) to detect blood clots after surgery
- Engineered a device that non-invasively extracts sweat to determine blood glucose levels for diabetics

Capstone Project — UCLA ECE 183DB Design of Robotic Systems Spring 2019

- Worked as a team to build a multi-robot system that used RFID tags for spatial communication
- Observed a 3× mapping speed increase for robots using the spatial communication method vs. without

PUBLICATIONS

Manuscripts Under Review

- **Aaron Wilhelm**, Marina De Albuquerque Marcon, Emith Uyanwatte, and Nils Napp, "Micro-Localization: High-Precision Mobile Robot Localization Using Microscopic Ground Texture," submitted to ICRA 2027.

Manuscripts in Preparation

- **Aaron Wilhelm** and Nils Napp, "HyGround: A Hybrid Loop Closure Architecture for Scalable Ground Texture SLAM."

Peer-Reviewed Publications

- **Aaron Wilhelm** and Nils Napp, "Improved Bag-of-Words Image Retrieval with Geometric Constraints for Ground Texture Localization", ICRA, 2025.
- **Aaron Wilhelm** and Nils Napp, "Lightweight Ground Texture Localization", ICRA, 2024.

- **Aaron Wilhelm***, Andrew Wilhelm*, Lydia Isabela Calderon-Aceituno*, Nils Napp, Kirstin Petersen, E. Farrell Helbling, “Frozen Assets: Leveraging Ice, Water, and Phase Transitions in Robots”, IROS, 2024. *Equal Contribution
- Jonathan Jaramillo, **Aaron Wilhelm**, Nils Napp, Justine Vanden Heuvel, and Kirstin Petersen, “Inexpensive, Automated Pruning Weight Estimation in Vineyards”, ICRA, 2024.
- Sanaz Pilehvar, **Aaron Wilhelm**, Andrew Wilhelm, Kimber King, Sam Emaminejad, “Emerging wearable technologies for personalized health and performance monitoring”, SPIE Defense and Commercial Sensing Conference, 2018.

Book Chapters

- Bo Wang, Andrew Wilhelm, **Aaron Wilhelm**, Sanaz Pilehvar, Sina Moshfeghi, Phoenix Stout, Kamyar Salahi, Sam Emaminejad, “Wearable Chemical Sensors” in *Wearable Bioelectronics*, 2020.

TEACHING EXPERIENCE

Teaching Assistant — ECE 3140 Embedded Systems Spring Semesters **2021–2024**

- Led a team of teaching assistants in the delivery of weekly discussion sections for a lower-level undergraduate embedded systems course
- Developed novel course content, including live hardware demonstrations, to provide students with hands-on learning experiences
- Achieved consistently high ratings on mid-semester and end-of-semester student evaluations

SERVICE

- Peer Reviewer: IEEE Robotics and Automation Letters (RA-L); IEEE International Conference on Robotics and Automation (ICRA); IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- Volunteer Firefighter at Cayuga Heights Fire Department, Spring 2022 – Fall 2023
- “Write A Researcher” Mentor, Fall 2021 – Summer 2023

SKILLS

- Localization, Mapping, SLAM, Visual Place Recognition, Computer Vision, Machine Learning, AI, ROS, Python, C++, C, Linux, Git