

Harel Biggie

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Education

- 2018 – 2024 (Expected) ● **Ph.D, University of Colorado Boulder** Computer Science focus in *Robotics Research Theme*: Designing exploration algorithms that leverage language models for context-aware robotic navigation in dynamic, unknown environments.
Advisor: *Christoffer Heckman*
GPA: 3.91/4.0.
- 2014 – 2018 ● **B.S University of Rochester** in Electrical and Computer Engineering
GPA: 3.71/4.0.
Cum laude with High Distinction
Study Abroad: Universidad Carlos III de Madrid Spring 2017

Research Experience

- 2019 – Present ● **Robotics Research Assistant**, Autonomous Robotics and Perception Group (ARPG), at The University of Colorado Boulder
- *Project Engineer*: Led the technical development and implementation of an autonomous solution for exploring underground caves as a part of the DARPA Subterranean Challenge (3rd place finish) for a team of 15 [2].
 - *Perception Lead*: Designed and led the development of low-light object detection systems as well as robust SLAM solutions for use in subterranean environments [5].
 - Developed an embodied framework for context-aware natural language-based navigation on mobile robots using foundational models and code generation. [7].
 - Designed global point cloud registration algorithms based on initialization using Bayesian optimization [6].
 - Built a mesh networking-based communication system for sharing environment data in multi-robot systems. [8].
- 2016 – 2018 ● **Robotics Research Assistant**, Robotics and Artificial Intelligence Lab (RAIL), at The University of Rochester
- Researched, developed, and tested state-lattice-based mobile robot planning algorithms; implemented on the ClearPath Husky A200 [9], [11].

Research Publications

Journal Articles

- 1 Z. Chen, **H. Biggie**, N. Ahmed, S. Julier, and C. Heckman, “Kalman Filter Auto-tuning through Enforcing Chi-Squared Normalized Error Distributions with Bayesian Optimization,” *IEEE Transactions on Aerospace and Electronic Systems*, Jan. 2024. 🔗 DOI: 10.1109/TAES.2024.3350587.
- 2 **H. Biggie**, E. Rush, D. Riley, S. Ahmad, M. Ohradzansky, K. Harlow, M. Miles, D. Torres, S. McGuire, E. Frew, C. Heckman, and J. Humbert, “Flexible Supervised Autonomy for Exploration in Subterranean Environments,” *Field Robotics*, vol. 3, pp. 125–189, 2023. 🔗 DOI: 10.55417/fr.2023004.
- 3 K. Ebadi, L. Bernreiter, **H. Biggie**, G. Catt, Y. Chang, A. Chatterjee, C. E. Denniston, S.-P. Deschênes, K. Harlow, S. Khattak, *et al.*, “Present and Future of SLAM in Extreme Underground Environments,” *IEEE Transactions on Robotics*, Oct. 2023. 🔗 DOI: 10.1109/TRO.2023.3323938.

- 4 M. J. Miles, **H. Biggie**, and C. Heckman, "Terrain-Aware Semantic Mapping for Cooperative Subterranean Exploration," *Frontiers in Robotics and AI*, vol. 10, 2023. [DOI: 10.3389/frobt.2023.1249586](https://doi.org/10.3389/frobt.2023.1249586).
- 5 M. Ohradzansky, E. Rush, D. Riley, A. Mills, S. Ahmad, S. McGuire, **H. Biggie**, K. Harlow, M. Miles, E. Frew, C. Heckman, and J. Humbert, "Multi-Agent Autonomy: Advancements and Challenges in Subterranean Exploration," *Field Robotics*, vol. 2, pp. 1068–1104, 2022. [DOI: 10.55417/fr.2022035](https://doi.org/10.55417/fr.2022035).

Conference Proceedings

- 6 **H. Biggie**, A. Beathard, and C. Heckman, "BO-ICP: Initialization of Iterative Closest Point Based on Bayesian Optimization," in *2023 IEEE International Conference on Robotics and Automation (ICRA)*, IEEE, Jun. 2023. [DOI: 10.1109/ICRA48891.2023.10160570](https://doi.org/10.1109/ICRA48891.2023.10160570).
- 7 **H. Biggie**, A. N. Mopidevi, D. Woods, and C. Heckman, "Tell Me Where to Go: A Composable Framework for Context-Aware Embodied Robot Navigation," in *Conference on Robot Learning*, PMLR, Nov. 2023. [URL: https://proceedings.mlr.press/v229/biggie23a/biggie23a.pdf](https://proceedings.mlr.press/v229/biggie23a/biggie23a.pdf).
- 8 **H. Biggie** and S. McGuire, "Heterogeneous Ground-Air Autonomous Vehicle Networking in Austere Environments: Practical Implementation of a Mesh Network in the DARPA Subterranean Challenge," in *2022 18th International Conference on Distributed Computing in Sensor Systems (DCOSS)*, IEEE, Oct. 2022, pp. 261–268. [DOI: 10.1109/DCOSS54816.2022.00051](https://doi.org/10.1109/DCOSS54816.2022.00051).
- 9 M. E. Napoli, **H. Biggie**, and T. M. Howard, "Learning Models for Predictive Adaptation in State Lattices," in *Field and Service Robotics: Results of the 11th International Conference*, Springer, Nov. 2018, pp. 285–300. [DOI: 10.1007/978-3-319-67361-5_19](https://doi.org/10.1007/978-3-319-67361-5_19).
- 10 J. Arkin, M. R. Walter, A. Boteanu, M. E. Napoli, **H. Biggie**, H. Kress-Gazit, and T. M. Howard, "Contextual Awareness: Understanding Monologic Natural Language Instructions for Autonomous Robots," in *2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, IEEE, 2017, pp. 502–509. [DOI: 10.1109/ROMAN.2017.8172349](https://doi.org/10.1109/ROMAN.2017.8172349).
- 11 M. E. Napoli, **H. Biggie**, and T. M. Howard, "On the Performance of Selective Adaptation in State Lattices for Mobile Robot Motion Planning in Cluttered Environments," in *2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, IEEE, Sep. 2017, pp. 4436–4443. [DOI: 10.1109/IROS.2017.8206309](https://doi.org/10.1109/IROS.2017.8206309).

Service

Invited Talks

- June 2023 ● **University College London**, From Challenges to Breakthroughs: A Deep Look into Fielded Robotic Systems
- September 2023 ● **Rocky Mountain Artificial Interest Group**, Embodied Navigation for Robotics using Large Language Models

Leadership Roles

- 2022 ● **Co-Chair, Workshop on Practical Mesh Networking in Field Robotics** at *IEEE/RSJ International Conference on Intelligent Robots and Systems*

Professional Reviewing Experience

- IEEE International Conference on Robotics and Automation (ICRA) Referee
- IEEE International Conference on Robotics and Intelligent Systems (IROS) Referee
- IEEE Robotics and Automation Letters (RAL) Referee

Service (continued)

- Robotics: Science and Systems (RSS) Referee
- Journal of Field Robotics Referee

Industry Experience

- 2022 – 2022 ● **Robotics Engineering Intern** Pattern Labs, Erie, Colorado
 - Designed and implemented camera to lidar calibration systems.
 - Developed a hardware sensor synchronization system for gig-e vision cameras, and lidars
 - Researched relative navigation techniques for mobile robots
- 2018 – 2019 ● **Robotics Software Engineer** Protodyne, Windsor, Connecticut
 - Designed and implemented containerized solutions for software deployment
 - Implemented control software in java for automated processing of blood samples
- 2017 – 2017 ● **Robotics Engineering Intern** Leidos, Huntsville, Alabama
 - Developed algorithms for GPS-denied localization for UAVs and ground vehicles in MATLAB and C++
 - Compared Kalman Filter-based localization methods to Factor Graph-based localization methods

Awards and Achievements

- 2024 ● **Top Poster**, *CU Boulder* Annual Research Expo.
- 2023 ● **Top Poster**, *CU Boulder* Annual Research Expo.
- 2021 ● **3rd Place**, \$500K *DARPA* Subterranean Challenge (Team).
- 2019 ● **Honorable Mention**, NSF GRFP.

Mentorship and Outreach

Outreach

- 2023 ● Robotics demonstration at CU Boulder women's basketball game for 4th and 5th graders
- St. Vrain Valley introduction to robotics lab tour for 7th and 8th graders
- 2020 ● Innovation Center for St. Vrain Valley robotic presentation for middle schoolers

Mentored Students

- Current ● **Patrick Cooper** Masters Student, **Ajay Narasimha Mopidevi** Masters Student
- 2022 ● **Andrew Beathard** Masters Student at Texas A&M
- 2021 ● **Greg Lund** Masters Student at Stanford

Professional Skills

- Programming Languages/Frameworks ● C/C++, Python, Matlab, CMake, CUDA, Pytorch, ROS \LaTeX .
- Languages ● English, Hebrew
- Mechanical Design ● Solidworks, PTC Creo