

Adam Heins

University of Toronto
Institute for Aerospace Studies
4925 Dufferin Street, Toronto, Canada M3H 5T6

<https://adamheins.com>
mail@adamheins.com

RESEARCH

My research focuses on high-performance control of mobile manipulators. I am interested in combining classical control techniques with machine learning to enable the execution of complex, accurate, and safe autonomous interactive tasks.

EDUCATION

Ph.D. in Aerospace Science and Engineering¹ since 09/2018
Institute for Aerospace Studies, University of Toronto, Canada
Advisor: Prof. Angela P. Schoellig
Topic: High-performance control for mobile manipulators

B.A.Sc. in Mechatronics Engineering (with Dean's Honours²) 2012 – 2017
University of Waterloo, Canada

PUBLICATIONS

Peer-reviewed Journal Articles

- [J1] M. K. Helwa, **A. Heins**, and A. P. Schoellig, “Provably robust learning-based approach for high-accuracy tracking control of Lagrangian systems,” *IEEE Robotics and Automation Letters*, vol. 4, iss. 2, pp. 1587–1594, 2019. [\[pdf\]](#)

Peer-reviewed Conference Papers

- [C1] **A. Heins**, M. Jakob, and A. P. Schoellig, “How to Tame Your Manipulator: A Unified Optimization-based Approach for Force and Motion Control,” in *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2020, submitted.
- [C2] N. Kayhani, B. McCabe, **A. Heins**, W. Zhao, and A. P. Schoellig, “Tag-based indoor localization of UAVs in congested construction environments: opportunities and challenges in practice,” in *Proc. of the Construction Research Congress (CRC)*, 2020, accepted.
- [C3] N. Kayhani, **A. Heins**, W. Zhao, M. Nahangi, B. McCabe, and A. P. Schoellig, “An improved tag-based indoor localization of UAVs using an extended Kalman filter,” in *Proc. of the International Symposium on Automation and Robotics in Construction (ISARC)*, 2019, pp. 624–631. [\[pdf\]](#)
- [C4] M. Nahangi, **A. Heins**, B. McCabe, and A. P. Schoellig, “Automated localization of UAVs in GPS-denied indoor construction environments using fiducial markers,” in *Proc. of the International Symposium on Automation and Robotics in Construction (ISARC)*, 2018, pp. 88–94. [\[pdf\]](#)

¹Direct transfer from M.A.Sc. to Ph.D.

²Indicates a cumulative average of at least 80% and achievement of Dean's Honours list during at least two terms.

AWARDS

- International Experience Award**, University of Waterloo 2017
Award (\$1,500) given to students who participate in an international study or work experience.
- President's Scholarship of Distinction**, University of Waterloo 2012
Entrance award (\$2,000) for students with a high school average of at least 95%.

PROJECTS

- High-performance Control of Mobile Manipulators** 2018 – present
Optimization-based control of robotic mobile manipulators enabling high-accuracy trajectory tracking with obstacle avoidance and adaption to applied force (submitted to IROS [C1]).
- System redundancy is resolved by formulating the inverse kinematics as a quadratic program and solving it at each controller time step.
 - A novel force control method is formulated by incorporating force-based objectives directly into the optimization problem to achieve behaviours like force regulation and compliance.
 - Implemented and tested experimentally on a UR10 manipulator mounted on a Ridgeback omnidirectional base.
- Safe and Robust Learning for Lagrangian Systems** 2018 – 2019
Provably robust online learning approach for high-accuracy tracking control of Lagrangian systems using Gaussian processes (published in RA-L [J1]).
- Combines robust control with online learning of the model uncertainty to provide the least conservative control law while still maintaining robustness.
 - Tracking error is guaranteed to converge to ball, the radius of which can be selected in the control design, with high probability.
 - Implemented and tested in both simulation and experimentally on the UR10 industrial manipulator.
- Monitoring of Indoor Construction Sites using Quadrotors** 2017 – 2018
Autonomous inspection of indoor construction sites for progress monitoring using a quadrotor (presented in [C2-C4]).
- Implemented EKF-based localization on Parrot Bebop drone using odometry and AprilTag observations.

TEACHING EXPERIENCE

- University of Toronto**, Toronto, Canada 2019 – present
Teaching Assistant
- ROB 310: Mathematics for Robotics, instructed by Prof. A. P. Schoellig (1 term)
 - Substitute lecturer for 6 hours of lecture content including optimization techniques and singular value decomposition.
 - ROB 301: Introduction to Robotics, instructed by Prof. G. M. T. D'Eleuterio (1 term)
 - Supervised lab sessions in which students implement classic robotics algorithms on Turtlebots.
 - Marked final project reports on Bayesian localization.
 - AER 1514: Mobile Robotics, instructed by Prof. T. D. Barfoot (2 terms)
 - Provided consultation and assistance for student autonomous vehicle projects.
 - Marked term tests and project reports.

WORK EXPERIENCE

Nest, Palo Alto, USA

Summer 2016

Embedded Software Developer Intern

- Implemented in-store demo application for Nest Secure alarm system using C++.
- Wrote Python scripts to analyse and correlate log data stored on the device and in BigQuery.
- Rewrote timer implementation of Nest Secure on top of Linux timer API.

Pebble, Palo Alto, USA

Spring, Fall 2015

Embedded Firmware Developer Intern

- Developed the dialog window system for the Pebble Time smartwatch in C.
- Optimized performance and memory usage to increase frame rate by up to 20% and reduce critical path stack usage by 10% on the Pebble.
- Wrote default watch faces for Pebble Time Round; built Golf and Sports apps for Pebble Time.
- Implemented screenshot and power calibration tools for automated testing in Python.

BlackBerry, Mississauga, Canada

Summer 2014

Software Developer Intern

- Built BBM simulator in Java to automate tests and reduce testing time by a factor of five.
- Created a REST API with a Cassandra backend to validate user and message statistics.
- Wrote a tool in Java to automatically configure files deployed from Jenkins.

SKILLS

Languages: English (native)

Programming: C, C++, Python, Matlab, bash/zsh

Tools: Linux, git, ROS, vim