Adam Heins

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Research

I research high-performance control of mobile manipulators with a focus on *nonprehensile* manipulation, in which manipulated objects are not fully grasped. This includes behaviours like pushing objects across the floor and balancing objects on a tray.

Skills

Topics: robotics, control, numerical optimization, machine learning
Languages: C, C++, Python, bash/zsh

Education

Ph.D. in Aerospace Science and Engineering[1] since 09/2018
Institute for Aerospace Studies, University of Toronto, Canada
Advisor: Prof. Angela P. Schoellig
Topic: Control for nonprehensile mobile manipulation

B.A.Sc. in Mechatronics Engineering (with Dean's Honours[2]) 2012 – 2017
University of Waterloo, Canada

Publications

[1] **A. Heins** and A. P. Schoellig, "Force Push: Robust Single-Point Pushing with Force Feedback," *Under review, IEEE Robotics and Automation Letters*, 2024. [pdf] [video]

[2] **A. Heins** and A. P. Schoellig, "Keep it Upright: Model Predictive Control for Nonprehensile Object Transportation with Obstacle Avoidance on a Mobile Manipulator," *IEEE Robotics and Automation Letters*, vol. 8, iss. 12, pp. 7986–7993, 2023. [pdf] [video]

[3] **A. Heins** and A. P. Schoellig, "Robust Single-Point Pushing with Force Feedback," *Short paper, Embracing Contacts Workshop at the IEEE International Conference on Robotics and Automation*, 2023. [pdf]

[4] **A. Heins**, M. Jakob, and A. P. Schoellig, "Mobile manipulation in unknown environments with differential inverse kinematics control," in *Proc. of the Conference on Robots and Vision*, 2021, pp. 64–71. [pdf] [video]

[5] N. Kayhani, A. Abelaal, B. McCabe, **A. Heins**, 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*, 2020, pp. 226–235. [pdf]

[6] 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*, 2019, pp. 624–631. [pdf]

[1] Direct transfer from M.A.Sc. to Ph.D.
[2] Requires a cumulative average of at least 80% and achievement of Dean's Honours list during at least two terms.

[7] 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]

[8] 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*, 2018, pp. 88–94. [pdf]

Teaching

University of Toronto, Toronto, Canada 2019 – 2022
Teaching Assistant

- ROB 301: Introduction to Robotics, instructed by Prof. G. M. T. D'Eleuterio (4 terms)
  - Head lab TA supervising students implementing classic robotics algorithms on Turtlebots.
- ROB 310: Mathematics for Robotics, instructed by Prof. A. P. Schoellig (1 term)
  - Substitute lecturer for 6 hours of content including optimization and singular value decomposition.
- AER 1514: Mobile Robotics, instructed by Prof. T. D. Barfoot (2 terms)
  - Marking and assistance with student autonomous vehicle projects.

Work

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 firmware code to increase frame rate by up to 20% and reduce critical path stack usage by 10% on the Pebble.
- Built default watch faces for Pebble Time Round and 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.

Other

Robotics Leadership Program, University of Toronto 2022 – 2023

- Organized and led two robotics experience workshops for Grade 6 – 11 students.