

Taylor A. Howell

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Summary

I am an engineer and researcher working on high-performance robotics with expertise in machine learning, numerical optimization, physics simulation control, and state estimation.

Education

PhD / MS in Mechanical Engineering **September 2017 - December 2022**
Dissertation: *Numerical Optimization For Things That Move: Simulation, Planning, and Control*
Advisors: Zachary Manchester, Allison Okamura
Stanford University

BS summa cum laude in Mechanical Engineering **May 2013 - December 2016**
Senior Project: Wireless Power for Aerial Robots
University of Utah

Professional Experience

DeepMind, London, United Kingdom **June - October 2022**
Research Scientist Intern: Mentor: Yuval Tassa

- MuJoCo MPC (project lead) is a tool for real-time robot behavior generation using prediction control algorithms.
github.com/google-deepmind/mujoco_mpc
- C/C++, MuJoCo, Git, numerical optimization, parallel computing, motion planning
- First author: *Predictive Sampling: Real-time Behaviour Synthesis with MuJoCo*

Google Brain, San Francisco, CA (remote) **June - September 2021**
Research Intern: Mentor: Vikas Sindhwani

- Python, JAX, differentiable optimization, planning algorithms
- First author: *Trajectory Optimization with Optimization-Based Dynamics*

Research Experience

Robotic Exploration Lab, Stanford University **May 2018 - December 2022**
Research Assistant: Advisor: Prof. Zachary Manchester

- Motion planning for drone coordination, legged locomotion, and robotic manipulation.
- Differentiable physics simulation for contact dynamics.
- Open-source software development in Julia.
- Hardware: quadrotors, quadrupeds (Stanford Doggo, Unitree A1)

Telerobotics Laboratory, University of Utah **October 2015 - December 2016**
Undergraduate Researcher: Mentor: Prof. Jake Abbott

- Algorithm design for control of magnetically actuated microrobot swarms.
- Fabrication of scaled magnetic microrobot swimmers and experimentation with rotating magnetic fields.

Utah Center for Excellence in Biomedical Microfluidics, University of Utah **September 2014 - October 2015**
Undergraduate Researcher: Mentor: Prof. Bruce Gale

- Design and fabrication of mechatronics device for experimental high-throughput system for testing ovarian cancer treatments.
- Assisted in experiments evaluating efficacy of cancer treatments: cell passaging, treatment preparation, tumor harvesting

Skills

Programming: C/C++, Python, Julia

Computational: \LaTeX , Git, Linux, SNOPT, Ipopt, CVX/Convex.jl, MeshCat, MuJoCo, JAX, Solidworks, VSCode, Arduino

Fabrication: Mill, Lathe, Vacuum Forming, Laser Cutting, Mold Making and Casting, Metal Sheet Fabrication

Publications

Lead | Co-Lead

Numerical Optimization For Things That Move: Simulation, Planning, and Control. **T. Howell.** Stanford University. 2022. [dissertation] [slides]

Predictive Sampling: Real-time Behaviour Synthesis with MuJoCo. **T. Howell,** N. Gileadi, S. Tunyasuvunakool, K. Zakka, T. Erez, Y. Tassa. arXiv. 2022. [paper] [code]

CALIPSO: A Differentiable Solver for Trajectory Optimization with Conic and Complementarity Constraints. **T. Howell,** K. Tracy, S. Le Cleac'h. Z. Manchester. ISRR. 2022. [paper] [code] [slides]

Dojo: A Differentiable Physics Engine for Robotics. **T. Howell** & S. Le Cleac'h, Z. Kolter, M. Schwager, Z. Manchester. arXiv. 2022. [paper] [code]

Trajectory Optimization with Optimization-Based Dynamics. **T. Howell,** S. Le Cleac'h, S. Singh, P. Florence, Z. Manchester, V. Sindhwani. RAL. 2022. [paper] [code] [poster]

Fast Contact-Implicit Model Predictive Control. S. Le Cleac'h & **T. Howell,** M. Schwager, Z. Manchester. (submitted to TR0). 2021. [paper] [code]

Direct Policy Optimization using Deterministic Sampling and Collocation. **T. Howell,** C. Fu, Z. Manchester. RAL. 2020. [paper] [code]

Scalable Cooperative Transport of Cable-Suspended Loads with UAVs using Distributed Trajectory Optimization. B. Jackson & **T. Howell,** K. Shah, M. Schwager, Z. Manchester. RAL. 2020. [paper]

ALTRO: A Fast Solver for Constrained Trajectory Optimization. **T. Howell** & B. Jackson, Z. Manchester. IROS. 2019. [paper] [code]

Sorting Rotating Micromachines By Variations in Their Magnetic Properties. **T. Howell,** B. Osting, J. Abbott. Physical Review Applied. 2018. [paper]

Contributions

RoboPianist: A Benchmark for High-Dimensional Robot Control. K. Zakka, L. Smith, N. Gileadi, **T. Howell** , X. B. Peng, S. Singh, Y. Tassa, P. Florence, A. Zeng, P. Abbeel. arXiv. 2023. [paper]

Differentiable Physics Simulation of Dynamics-Augmented Neural Objects. S. Le Cleac'h, HX Yu, M. Guo, **T. Howell,** R. Gao, J. Wu, Z. Manchester, M. Schwager. RAL. 2022. [paper]

Differentiable Collision Detection for a Set of Convex Primitives. K. Tracy, **T. Howell,** Z. Manchester. ICRA. 2023. [paper]

Use of a highly parallel Microfluidic Flow Cell Array to determine therapeutic drug dose response curves. J. Arellano, **T. Howell,** J. Gammon, S. Cho, M. Janat Amsbury, B. Gale. Biomedical Microdevices. 2017. [paper]

Open Source

[MuJoCo MPC] (lead w/ MuJoCo team @ DeepMind)

- tool for interactive robot behavior synthesis (C++)
- paid consulting work (DeepMind) for state estimation tools (C++, Python) June - September 2023

[CALIPSO.jl] (lead)

- solver for non-convex optimization problems with conic and complementarity constraints (Julia)

[Dojo.jl] (co-lead w/ S. Le Cleac'h & J. Brüdigam)

- differentiable physics engine for rigid-body dynamics with contact (Julia)

[TrajectoryOptimization.jl] (co-lead w/ B. Jackson)

- tool for fast trajectory optimization

[github.com/thowell]

Teaching Experience

Course Assistant, Department of Aeronautics and Astronautics, Stanford University Spring 2021
Dynamics and Control of Aircraft (AA271a) Prof. Stephen Rock

- held multiple office hours each week (virtually) and graded assignments

Robotics Instructor, GREAT Summer Camp, School of Computing, University of Utah Summer 2017

- taught basic robotics and programming skills to elementary school students with LEGO Mindstorm platform

Awards and Honors

Stanford Graduate Fellowship	2017 - 2018
University of Utah Undergraduate Research Opportunities Program Fellowship	2016
The Boeing Company Scholarship	2016
Shirley L. & Kathelyne O. Evans Endowed Scholarship	2016
Big Ten+ Grad Expo Travel Scholarship	2016
University of Utah Presidential Scholarship	2013 - 2016

Community

Reviewer ICRA, IROS, RAL	2018 - 2022
Social Impact Night co-organizer Helped plan and run event at Stanford University to connect social-impact focused students and entrepreneurs.	2019
Research mentor Mentored three summer interns at the Telerobotics Laboratory and developed soft robots with potential as catheter tips that will increase insertion distance deep in the brain and other hard-to-reach locations in the body.	2016
Science-fair judge Surveyed projects and provided feedback to students at local elementary school in Salt Lake City.	2015

Coursework

Machine Learning · Decision Making Under Uncertainty · Deep Learning · Convex Optimization · Advanced Software Development · Optimal Control · Nonlinear Control · Engineering Design Optimization · State Estimation · Principles of Robotic Autonomy · Introduction to Mechatronics · Linear Dynamical Systems · Introduction to Robotics · Control Design Techniques · Advanced Robotic Manipulation · Advanced Feedback Control · Introduction to Optimization · Experimental Robotics · Multi-robot Systems · RL for Stochastic Control in Finance · State Space Control · Design of Experiments · Introduction to Finite Element Method · Programming for Engineers