Taylor A. **Howell**

Optimization · Control · Robotics

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Summary

Currently, I am a Ph.D. candidate at Stanford University. I work on optimization-based tools for simulation, planning, and control for robotic systems. My expertise include: numerical optimization, technical computing, automatic control, and modeling of dynamical systems.

Education

Stanford University — *Stanford, CA, USA*

Ph.D. in Mechanical Engineering — *Sept. 2017 - Dec. 2022 (expected)*

- Optimization, Control, Robotics
- Advisors: Zachary Manchester, Allison Okamura

Stanford University — *Stanford, CA, USA*

M.S. in Mechanical Engineering — *Sept. 2017 - June. 2019*

- Automatic Controls, Robotics

University of Utah — *Salt Lake City, UT, USA*

B.S. in Mechanical Engineering — *May 2013 - Dec. 2016*

- Summa Cum Laude
- Capstone Project: Wireless Power for Aerial Robots

Research

Robotic Exploration Lab, Stanford University — *Stanford, CA, USA*

Research Assistant — *May 2018 - present*

My research is focused on developing optimization-based tools for simulation, planning, and control of robotic systems. Currently, I am working on algorithms for fast model-predictive control, solvers for non-convex planning problems, and differentiable physics engines.

Telerobotics Laboratory, University of Utah — *Salt Lake City, UT, USA*

Research Assistant — *Oct. 2015 - Dec. 2016*

I devised and implemented a control scheme to sort swarms of microrobots using rotating uniform magnetic fields for minimally invasive medical applications. This work included: applied physics, simulation, nonlinear optimization, fabrication of a scaled microrobot swarm, and writing C++ code to control a tri-axial Helmholtz-coil system.

Utah Center of Excellence for Biomedical Microfluidics, University of Utah — *Salt Lake City, UT, USA*

Research Assistant — *Sept. 2014 - Oct. 2015*

I designed and built a forty-eight-syringe pump for a medical microfluidic system, developed standard operating procedures for a high-throughput drug screening and cytotoxicity evaluation system, and performed statistical analysis for ovarian-cancer cell experiments.

Experience

DeepMind — *London, United Kingdom*

Research Scientist Intern — *June. 2022 - Sept. 2022*

- MuJoCo simulation team

Google Brain — *San Francisco, CA, USA (remote)*

Research Intern — *June. 2021 - Sept. 2021*

- differentiable optimization-based dynamics for trajectory optimization
- contributed to open-source JAX project: trajax

Department of Aeronautics and Astronautics, Stanford University — *Stanford, CA, USA*

Course Assistant - Dynamics and Control of Aircraft (AA271A) — *Apr. 2021 - Jun. 2021*

- held office hours four times per week
- graded assignments and exams

Department of Computer Science, University of Utah — *Salt Lake City, UT, USA*

Instructor - GREAT Summer Camp — *Jun. 2017 - Jul. 2017*

- led a teaching team of three
- taught practical robotics and programming skills to elementary school students using the LEGO Mindstorm platform
- developed projects and challenges for FLL skills, telerobotics, and kinetic-art themed weeks

Cornaby-Howell LLC — *Salt Lake City, UT, USA*

Co-founder, Engineer — *Apr. 2015 - Oct. 2015*

- prototyped systems: touch-display module with GUI, Arduino C code, a lead-screw system, and syringe attachment modules for precision high-throughput syringe pumps
- designed hardware schematics for patent application

Ramada Limited Draper — *Draper, UT, USA*

Front Desk Clerk — *Apr. 2013 - Aug. 2013*

- manager on duty: checked in and out guests, made reservations, and ran breakfast
- developed communication and practical problem solving skills

Designer — *Draper, UT, USA*

Twisty Puzzles — *Aug. 2007 - Jan. 2011*

- designed and built twisty puzzles with selling prices ranging from $25 - $850
- exhibited my work at the community's premier international event: Dutch Cube Day 2008

Publications

2022 **CALIPSO: A Differentiable Solver for Trajectory Optimization with Conic and Complementarity Constraints**, T. Howell, K. Tracy, S. Le Cleac'h. ISRR 2022.

Dojo: A Differentiable Physics Engine for Robotics, T. Howell*, S. Le Cleac'h*, Z. Kolter, M. Schwager, Z. Manchester. *(arXiv)*.

2021 **Trajectory Optimization with Optimization-Based Dynamics**, T. Howell, S. Le Cleac'h, S. Singh, P. Florence, Z. Manchester, V. Sindhwani. ICRA 2022.

Fast Contact-Implicit Model-Predictive Control, S. Le Cleac'h*, T. Howell*, M. Schwager, Z. Manchester. *(arXiv)*.

Direct Policy Optimization using Deterministic Sampling and Collocation, T. Howell, C. Fu, Z. Manchester. Robotics and Automation Letters.

2020 **Scalable Cooperative Transport of Cable-Suspended Loads with UAVs using Distributed Trajectory Optimization**, B. Jackson*, T. Howell*, K. Shah, M. Schwager, Z. Manchester. Robotics and Automation Letters.

2019 **ALTRO: A Fast Solver for Constrained Trajectory Optimization**, T. Howell*, B. Jackson*, Z. Manchester. International Conference on Intelligent Robots and Systems. Macao, China.

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

2017 **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.

Skills

Programming	Julia, C/C++, Python
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

Community Outreach

2019 **Co-organizer**, of Social Impact Night event at Stanford University to connect social-impact focused students and entrepreneurs

2016 **Mentor**, to 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

2015 **Science-fair Judge**, for local elementary school to provide feedback to students about their projects

Fellowships & Scholarships

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)

Coursework

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