

# Taylor A. Howell

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## Summary

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

## 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](https://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:**  $\text{\LaTeX}$ , 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]

*ALTR0: 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 Mindstormm 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

<b>Reviewer</b> ICRA, IROS, RAL	2018 - 2022
<b>Social Impact Night co-organizer</b> Helped plan and run event at Stanford University to connect social-impact focused students and entrepreneurs.	2019
<b>Research mentor</b> 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
<b>Science-fair judge</b> 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