

Taylor Howell

EMBODIED INTELLIGENCE: OPTIMIZATION · CONTROL · SIMULATION

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Summary

My research is focused on embodied intelligence and the development of 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

PH.D. IN MECHANICAL ENGINEERING

- Advisors: Zachary Manchester, Allison Okamura
- Dissertation: *Numerical Optimization For Things That Move: Simulation, Planning, and Control*

Stanford, CA, USA

Sept. 2017 - Dec. 2022

Stanford University

M.S. IN MECHANICAL ENGINEERING

- Automatic Controls, Robotics

Stanford, CA, USA

Sept. 2017 - June. 2019

University of Utah

B.S. IN MECHANICAL ENGINEERING

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

Salt Lake City, UT, USA

May 2013 - Dec. 2016

Research

Robotic Exploration Lab, Stanford University

RESEARCH ASSISTANT

My research is focused on embodied intelligence and 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.

Stanford, CA, USA

May 2018 - Dec. 2022

Telerobotics Laboratory, University of Utah

RESEARCH ASSISTANT

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.

Salt Lake City, UT, USA

Oct. 2015 - Dec. 2016

Utah Center of Excellence for Biomedical Microfluidics, University of Utah

RESEARCH ASSISTANT

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.

Salt Lake City, UT, USA

Sept. 2014 - Oct. 2015

Experience

DeepMind

RESEARCH SCIENTIST INTERN

- MuJoCo robotics simulation team
- Project: MuJoCo MPC

London, United Kingdom

June. 2022 - Sept. 2022

Google Brain

RESEARCH INTERN

- Project: Planning with differentiable optimization-based dynamics

San Francisco, CA, USA (remote)

June. 2021 - Sept. 2021

Department of Aeronautics and Astronautics, Stanford University

COURSE ASSISTANT - DYNAMICS AND CONTROL OF AIRCRAFT (AA271A)

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

Stanford, CA, USA

Apr. 2021 - Jun. 2021

Department of Computer Science, University of Utah

INSTRUCTOR - GREAT SUMMER CAMP

- 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

Salt Lake City, UT, USA

Jun. 2017 - Jul. 2017

Designer

TWISTY PUZZLES

- 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

Draper, UT, USA

Aug. 2007 - Jan. 2011

Publications

Lead / Co-Lead

- 2022 **Predictive Sampling: Real-time Behaviour Synthesis with MuJoCo**, T. Howell, N. Gileadi, S. Tunyasuvunakool, K. Zakka, T. Erez, Y. Tassa. (*arXiv*).
- CALIPSO: A Differentiable Solver for Trajectory Optimization with Conic and Complementarity Constraints**, T. Howell, K. Tracy, S. Le Cleac'h. ISRR.
- 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. RAL.
- 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. RAL.
- 2020 **Scalable Cooperative Transport of Cable-Suspended Loads with UAVs using Distributed Trajectory Optimization**, B. Jackson*, T. Howell*, K. Shah, M. Schwager, Z. Manchester. RAL.
- 2019 **ALTRO: A Fast Solver for Constrained Trajectory Optimization**, T. Howell*, B. Jackson*, Z. Manchester. ICRA.
- 2018 **Sorting Rotating Micromachines By Variations in Their Magnetic Properties**, T. Howell, B. Osting, J. Abbott. Physical Review Applied.

Contributions

- 2023 **Differentiable Collision Detection for a Set of Convex Primitives**, K. Tracy, T. Howell, Z. Manchester. ICRA.
- 2022 **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. (*arXiv*)
- 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	TeX, 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
- 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
- 2016
- 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