Rachel Holladay

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Research Overview

My goal is to enable **robots to perform long-horizon, contact-rich manipulation tasks** in everyday environments. I propose **models and algorithms** that exploit the physics and geometry of the world in order to tackle the dual challenges of long-horizon decision-making and acting under uncertainty. My research is motivated by and grounded in deploying these methods on real robots.

Education

Ph.D. EECS 2017-2024	Massachusetts Institute of Technology (MIT) Advisors: Alberto Rodriguez and Tomás Lozano-Pérez Committee Members: Leslie Pack Kaelbling, Dmitry Berenson Thesis: *Leveraging Mechanics for Multi-step Robotic Manipulation Planning*
M.S. EECS 2017-2019	Massachusetts Institute of Technology (MIT) Advisors: Alberto Rodriguez and Tomás Lozano-Pérez Thesis: *Force-and-Motion Constrained Planning for Tool Use*
B.S. CS+Robotics 2013-2017	Carnegie Mellon University (CMU) Advisor: Siddhartha Srinivasa Thesis: *Following Paths in Task Space: Distance Metrics & Planning Algorithms*

Employment

University of Pennsylvania 2025-	Asness Family Foundation Assistant Professor of Mechanical Engineering, Department of Mechanical Engineering and Applied Mechanics (MEAM)
University of Pennsylvania 2024-2025	Postdoctoral Researcher, MEAM Mentors: Cynthia Sung, Daniel Koditschek
Naval Research Lab Summers 2012-2014	Research Intern Mentor: Sergio deRada

Selected Awards and Honors

Robotics: Science and Systems (RSS) Pioneers	2023
MIT EECS Seth J. Teller Award for Excellence, Inclusion and Diversity	2022
Robotics: Science and Systems (RSS) Best Student Paper Award	2018
Amazon Robotics Best Systems Paper Award in Manipulation	2018
National Science Foundation (NSF) Graduate Research Fellowship	2018-2021

Publications

Peer-Reviewed Journal Articles

J7 Gregory Xie, **Rachel Holladay**, Lillian Chin, Daniela Rus. "In-Hand Manipulation with a Simple Belted Parallel-Jaw Gripper" *IEEE Robotics and Automation Letters* 9.2 (2024): 1334-1341.

J6 **Rachel Holladay**, Tomás Lozano-Pérez, Alberto Rodriguez. "Robust Planning for Multi-stage Forceful Manipulation" *International Journal of Robotics Research (IJRR)*, 2023. Editor's Choice in Science Robotics.

J5 Caelan Reed Garrett, Rohan Chitnis, **Rachel Holladay**, Beomjoon Kim, Tom Silver, Leslie Pack Kaelbling, Tomás Lozano-Pérez. "Integrated Task and Motion Planning". *Annual Review of Control, Robotics, and Autonomous Systems* 4 (2021): 265-293.

J4 Nikhil Chavan-Dafle, **Rachel Holladay**, Alberto Rodriguez. "Planar In-Hand Manipulation via Motion Cones". *International Journal of Robotics Research (IJRR)* 39.2-3 (2020): 163-182.

J3 Andy Zeng, Shuran Song, Kuan-Ting Yu, Elliott Donlon, Francois Hogan, Maria Bauza, Daolin Ma, Orion Taylor, Melody Liu, Eudald Romo, Nima Fazeli, Ferran Alet, Nikhil Chavan-Dafle, **Rachel Holladay**, Isabella Morona, Prem Qu Nair, Druck Green, Ian Taylor, Weber Liu, Thomas Funkhouser, Alberto Rodriguez. "Robotic Pick-and-Place of Novel Objects in Clutter with Multi-Affordance Grasping and Cross-Domain Image Matching". *International Journal of Robotics Research (IJRR)* 41.7 (2022): 690-705.

J2 **Rachel Holladay**, Oren Salzman, Siddhartha Srinivasa. "Minimizing Task Space Fréchet Error via Efficient Incremental Graph Search." *IEEE Robotics and Automation Letters* 4.2 (2019): 1999-2006.

J1 Anca Dragan, **Rachel Holladay**, Siddhartha Srinivasa. "Deceptive robot motion: synthesis, analysis and experiments." *Autonomous Robots* 39 (2015): 331-345.

Peer-Reviewed Conference Papers

C9 Gregory Xie, Lillian Chin, Byungchul Kim, **Rachel Holladay**, Daniela Rus. "Strong Compliant Grasps Using a Cable-Driven Soft Gripper." *IEEE/RSJ Interational Conference on Intelligent Robots and Systems (IROS)*, 2024.

C8 **Rachel Holladay**, Tomás Lozano-Pérez, Alberto Rodriguez. "Planning for Multi-stage Forceful Manipulation." *IEEE Interational Conference on Robotics and Automation (ICRA)*, 2021.

C7 **Rachel Holladay**, Tomás Lozano-Pérez, Alberto Rodriguez. "Force-and-Motion Constrained Planning for Tool Use." *IEEE/RSJ Interational Conference on Intelligent Robots and Systems (IROS)*, 2019.

C6 Nikhil Chavan-Dafle, **Rachel Holladay**, Alberto Rodriguez. "In-Hand Manipulation via Motion Cones." *Robotics: Science and Systems (RSS)*, 2018. Best Student Paper Award.

C5 Andy Zeng, Shuran Song, Kuan-Ting Yu, Elliott Donlon, Francois Hogan, Maria Bauza, Daolin Ma, Orion Taylor, Melody Liu, Eudald Romo, Nima Fazeli, Ferran Alet, Nikhil Chavan Dafle, **Rachel Holladay**, Isabella Morona, Prem Qu Nair, Druck Green, Ian Taylor, Weber Liu, Thomas Funkhouser, Alberto Rodriguez. "Robotic Pick-and-Place of Novel Objects in Clutter with Multi-Affordance Grasping and Cross-Domain Image Matching." *International Conference of Robotics and Automation (ICRA)*, 2018. Amazon Robotics Best Systems Paper Award in Manipulation.

C4 **Rachel Holladay**, Siddhartha Srinivasa. "Distance Metrics and Algorithms for Task Space Path Optimization." *IEEE/RSJ Interational Conference on Intelligent Robots and Systems (IROS)*, 2016.

C3 Laura Herlant, **Rachel Holladay**, Siddhartha Srinivasa. "Assistive Teleoperation of Robot Arms via Automatic Time-Optimal Mode Switching." *Human Robot Interaction (HRI)*, 2016.

C2 **Rachel Holladay**, Anca Dragan, Siddhartha Srinivasa. "Legible Robot Pointing." *IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 2014.

C1 Anca Dragan, **Rachel Holladay**, Siddhartha Srinivasa. "An Analysis of Deceptive Robot Motion." *Robotics: Science and Systems* (RSS), 2014.

Peer-Reviewed Workshop Papers

W6 **Rachel Holladay**. "Developing Multi-Step Robotic Dexterity". *Robotics: Science and Systems (RSS) Pioneers Workshop*, 2023.

W5 **Rachel Holladay**, Tomás Lozano-Pérez, Alberto Rodriguez. "Force-and-Motion Grasp Planning for Tool Use." *Robotics: Science and Systems (RSS) Workshop on "Task-Informed Grasping (TIG-II): From Perception to Physical Interaction"*, 2019.

W4 Oren Salzman, **Rachel Holladay**, Sherdil Niyaz, Alan Kuntz, Ron Alterovitz, Siddhartha Srinivasa. "Minimizing the Fréchet Error of Task-Space Paths for Manipulators and Surgical Robots". *Robotics: Science and Systems (RSS) Pioneers Workshop*, 2018.

W3 **Rachel Holladay**, Laura Herlant, Henny Admoni, Siddhartha Srinivasa. "Visibility Optimization in Robot Manipulation Tasks." *IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN) "Workshop on Human-Oriented Approaches for Assistive and Rehabilitation Robotics (HUMORARR)"*, 2016.

W2 **Rachel Holladay**, Shervin Javdani, Anca Dragan, Siddhartha Srinivasa. "Active Comparison Based Learning Incorporating User Uncertainity and Noise." *Robotics: Science and Systems (RSS) Workshop on "Model Learning for Human-Robot Communication"*, 2016.

W1 **Rachel Holladay**, Siddhartha Srinivasa. "RoGuE: Robot Gesture Engine." *AAAI Spring Symposium: "Enabling Computing Research in Socially Intelligent Human-Robot Interaction: A Community-Driven Modular Research Platform"*, 2016.

White Papers

V1 **Rachel Holladay**. "Graduate Women in Robotics Community: Creation and Early Years." 2023.

Patents

P2 Nikhil Chavan-Dafle, **Rachel Holladay**, Alberto Rodriguez. "Robotic Manipulation of Objects for Grip Adjustment." Patent 11396431. July 2022.

P1 Nikhil Chavan-Dafle, **Rachel Holladay**, Alberto Rodriguez. "Robotic Manipulation of Objects using External Contacts." Patent 11396072. July 2022.

Theses

T3 **Rachel Holladay** 2024. "Leveraging Mechanics for Multi-step Robotic Manipulation Planning". Doctoral Thesis, Massachusetts Institute of Technology.

T2 **Rachel Holladay** 2019. "Force-and-Motion Constrained Planning for Tool Use". Master's Thesis, Massachusetts Institute of Technology.

T1 **Rachel Holladay** 2017. "Following Paths in Task Space: Distance Metrics and Planning Algorithms". Undergraduate Honors Thesis, Carnegie Mellon University. <u>Allen Newell Award for Excellence in Undergraduate Research.</u>

Teaching

Experience

6.800/6.834 Robotic Manipulation (Undergraduate/Graduate)   Fall 2021
Teaching Assistant, Massachusetts Institute of Technology (MIT)
Instructor: Russ Tedrake, 80+ students

Robotics Essentials   2020-2021
Subject Matter Expert (SME), MIT xPro Online Course
Program Faculty: Alberto Rodriguez, Julie Shah, 380+ learners (as of 2023)

15-300 Research and Innovation in Computer Science (Undergraduate)   Fall 2016
Teaching Assistant, Carnegie Mellon University (CMU)
Instructors: Todd Mowry, Jonathan Aldrich, 25+ students

Pedagogical Training

Grad Teaching Development Tracks (MIT Teaching+Learning Lab)   2021-2022
Four multi-session workshop tracks on: Lesson Planning, Microteaching, Inclusive Teaching
and Subject Design. Earned the MIT Graduate Teaching Certificate

TA Days Training (MIT Teaching+Learning Lab)   Summer 2021
Workshop Series introducing evidence-based teaching practices for TAs

Invited Talks

Dexterous Decision-Making for Real-World Robotic Manipulation

Massachusetts Institute of Technology, Department Seminar	April 2024
Duke University, Department Seminar	March 2024
University of Colorado Boulder, Department Seminar	March 2024
University of Southern California, Department Seminar	March 2024
University of Michigan, Department Seminar	March 2024
University of Pennsylvania, Department Seminar	March 2024
Columbia University, Department Seminar (virtual)	Feb 2024
Princeton University, Department Seminar	Feb 2024
Northeastern University, Department Seminar	Feb 2024
Worcester Polytechnic Institute, Department Seminar	Feb 2024

Long-Horizon, Contact-Rich Robotic Manipulation

Yale University, Robotics Lunch	Nov 2023
University of Michigan, Manipulation Reading Group	Oct 2023
Northeastern University, Robotics/RL Reading Group	Oct 2023

Constraints and Planning for Forceful Robotic Manipulation

Cornell University, Robotics Seminar (virtual)	May 2023
University of Pennsylvania, DAIR Lab Meeting (virtual)	Oct 2022
University of Washington, Robotics Colloquium	May 2022
Tel Aviv University, Computational Geometry Seminar (virtual)	Nov 2021
Brown University, Robotics Groups Meeting	Oct 2021

Force-and-Motion Constrained Manipulation Planning

MIT CSAIL and Schlumberger-Doll Research Workshop	Oct 2019

Mentoring

Research Mentoring

Anika Cheerla	2022-2024, MIT Master's Student → Kodiak Robotics *Thesis: Task and Motion Planning in Uncertain Dynamic Environments*
Gregory Xie	2022-2023, MIT Master's Student → Boston Dynamics AI Institute *Thesis: Don't Over Think It: Mechanically Intelligent Manipulation*
Daniella White	2021-2022, MIT Master's Student → SpaceX *Thesis: Nonprehensile Manipulation of Multi-Link Hinges*
Tarang Lunawat	2022-2024, MIT Undergraduate *Project: Robot Cutting as a Process*
Rachel Lu	2022-2024, MIT Undergraduate *Project: Handling Uncertainty in Articulated Object Manipulation*
Ashwin Krishna	2020-2021, Harvard Undergraduate → Aurora Innovation *Project: Combining Planning and Learning for Robust Manipulation*

Other Mentoring

MIT EECS Thriving Stars Buddy Program	2022-2023
MIT EECS AI Mentorship Program	2020-2022
MIT WiEECS Mentorship Program	2018
FIRST Tech Challenge (FTC) Team 13620 and 20409	2018-2024
FIRST Robotics Competition (FRC) Team 3504	2013-2017

Awards and Grants

Graduate Awards and Grants	
NextProf Nexus Workshop Participant	2023
MIT Graduate Women of Excellence Award	2023
Outstanding MIT UROP Mentor Awards (Nominated)	2023
MIT Graduate Student Council (GSC) Travel Grant Winner	2019
Computing Research Association (CRA-WP) Grad Cohort for Women Workshop Participant	2018
MIT Merrill Lynch Fellowship	2017-2018
Science, Mathematics And Research for Transformation Scholarship (declined)	2017-2020

Undergraduate Awards and Grants	
Allen Newell Award for Excellence in Undergraduate Research	2017
CMU Women's Association's Outstanding SCS Senior Student	2017
Mark Stehlik SCS Alumni Undergraduate Impact Scholarship	2016
Human Robot Interaction (HRI) Pioneer	2016
National Center for Women & Information Technology (NCWIT) Collegiate Award	2016
Collaborative Research Experience for Undergraduates (CREU) Grant Winner	2015
SRC Undergraduate Research Program (URO) Grant Winner	2014-2017
NASA College Scholarship	2013-2017

Service

Service: Conferences

Area Chair for Conference on Robot Learning (CoRL)	2024
Program Committee Chair for Robotics: Science and Systems (RSS) Pioneers Workshop	2024
Student Volunteer at the Robotics: Science and Systems (RSS)	2020

Co-Organizer of MCube Lab-MLab Manipulation Workshop	2018
Photographer for Robotics: Science and Systems (RSS)	2017
Local Arrangements Committee for Intel International Science and Engineering Fair (ISEF)	2016
Student Volunteer at the Human Robot Interaction (HRI)	2016

Service: MIT EECS Department

Co-Creator of MIT EECS "Building Healthy Happy Labs" Workshop for New Faculty	2021-2024
MIT EECS Graduate Student Advisory Group for Faculty Search	2021
Executive Committee for MIT EECS Graduate Application Assistance Program (GAAP)	2020-2022
Member of MIT EECS Resources for Easing Friction and Stress (REFS)	2019-2023
Graduate Women at MIT (GW@MIT) EECS Department Representative	2018
Graduate Women in MIT Course 6 (GW6) Co-President	2018

Service: Other

Webmaster and Student Volunteer for Robotics Today Seminar Series	2020-2021
Webmaster for Embodied Intelligence Community of Research at CSAIL	2020-2024
Student Leader and Co-Founder of Graduate Women in Robotics Community (GWiRC)	2019-2024
Interest Groups Manager for MIT Sidney Pacific Graduate Dorm	2018-2020
Student Leader in CMU SCS Day, SCS4ALL, Women@SCS	2013-2017

Refereeing: Conferences and Journals

AAAI Symposium
Autonomous Robotics (AURO)
Conference on Robot Learning (CoRL)
ACM/IEEE International Conference on Human-Robot Interaction (HRI)
IEEE Conference on Decision and Control (CDC)
IEEE International Conference on Robotics and Automation (ICRA)
IEEE Robotics and Automation Letters (RA-L)
IEEE Symposium on Robot and Human Interactive Communication (RO-MAN)
IEEE Transactions on Automation Science and Engineering (T-ASE)
IEEE Transactions on Neural Networks and Learning Systems (TNNLS)
IEEE Transactions on Robotics (T-RO)
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
International Conference on Automated Planning and Scheduling (ICAPS)
International Journal of Robotics Research (IJRR)
International Journal of Social Robotics (IJSR)
International Symposium on Robotics Research (ISRR)
Robotics: Science and Systems (RSS)