DANIEL RAKITA

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Assistant Professor
Yale University
Department of Computer Science
51 Prospect St., New Haven, CT 06511 USA
daniel.rakita@yale.edu, Personal website, Google Scholar

RESEARCH INTERESTS

My research primarily involves formulating **planning**, **optimization**, and **learning** algorithms that allow robot manipulation platforms to effectively complete tasks.

The goal of my work is to enable people to intuitively control or work alongside robot manipulation platforms to perform critical tasks deemed unsuitable, undesirable, understaffed, or unsafe for people, such as full-time homecare, home assistance, telenursing, robot surgery, disaster relief, large-scale manufacturing, nuclear materials handling, and space robotics. I use interdisciplinary techniques across robotics and computer science, including motion planning, motion optimization, shared autonomy, human-robot interaction, and machine learning to formulate and validate generalizable, end-to-end solutions within these problem spaces.

EDUCATION

Ph.D. in Computer Science, University of Wisconsin-Madison Advisors: Michael Gleicher and Bilge Mutlu	2015-2022
Masters of Computer Science, University of Wisconsin-Madison	2015-2017
Undergraduate work in computer science, University of Wisconsin-Madison	2013-2015
Bachelor of Music in Performance, Indiana University-Bloomington Jacobs School of Music	2008-2012

Academic Positions

Assistant Professor, Yale University, Department of Computer Science	2022 - Current
Graduate Researcher, University of Wisconsin-Madison Visual Computing Lab and Human-Computer Interaction Lab Advised by Michael Gleicher and Bilge Mutlu	2015-2022
NREIP Researcher, Naval Research Lab, Washington, D.C., Advised by Laura Hiatt	2018, 2019

AWARDS & HONORS

[A12]	Best Paper Award Winner, ACM/IEEE Conference on Human-Robot Interaction (HRI)	2023
[A11]	Outstanding Graduate-Student Research Award, UW-Madison	2022
[A10]	Outstanding Reviewer Award, Selected by IROS Conference Paper Review Board, Top 4 of 3,942	2021
[A9]	Cisco Graduate Student Fellowship Recipient, UW-Madison	2021
[A8]	Three Minute Thesis Competition Finalist, UW-Madison	2021
[A7]	Best Paper Award Finalist, ACM/IEEE Conference on Human-Robot Interaction (HRI)	2020
[A6]	Microsoft PhD Fellowship Recipient	2019
[A5]	Best Paper Award Winner, ACM/IEEE Conference on Human-Robot Interaction (HRI), Top 4 of 206 papers	2018
[A4]	NSF Graduate Research Fellowship Program Honorable Mention	2017
[A3]	HRI Pioneer, accepted to the selective workshop held at HRI 2017	2017
[A2]	Best Paper Award Nominee, IEEE Symposium on Robot and Human Interactive Communication (RO-MAN)	2017
[A1]	ACM SIGGRAPH Student Research Competition 1st Place	2015

JOURNAL ARTICLES

[J6] Chamzas, C., Quintero, C., Kingston, Z., Orthey, A., **Rakita, D.**, Gleicher, M., Toussaint, M., Kavraki, L. 2022. MOTIONBENCHMAKER: A Tool to Generate and Benchmark Motion Planning Datasets. *Robotics and Automation Letters* (RA-L). In *Proceedings International Conference on Robotics and Automation* (ICRA).

[J5] **Rakita, D.**, Mutlu, B., Gleicher, M. 2021. Single Query Path Planning using Sample Efficient Probability Informed Trees. *Robotics and Automation Letters* (RA-L). In *Proceedings International Conference on Robotics and Automation* (ICRA).

[J4] **Rakita, D.**, Mutlu, B., Gleicher, M. 2020. An Analysis of RelaxedIK: An Optimization-Based Framework for Generating Accurate and Feasible Robot Arm Motions. *Autonomous Robotics* (AURO).

[J3] **Rakita, D.**, Mutlu, B., Gleicher, M., and Hiatt, L. 2019. Shared-Control-Based Bimanual Robot Manipulation. *Science Robotics*.

[J2] Bodden, C., **Rakita, D.**, Mutlu, B., and Gleicher, M. 2018. A Flexible Optimization-Based Method for Synthesizing Intent-Expressive Robot Arm Motion. *The International Journal of Robotics Research* (IJRR). SAGE.

[J1] Pejsa, T., **Rakita, D.**, Mutlu, B., & Gleicher, M. 2016. Authoring directed gaze for full-body motion capture. ACM *Transactions on Graphics*, 35(6), 1–11. Proceedings *SIGGRAPH ASIA* 2016, December 2016.

REFEREED FULL CONFERENCE PAPERS

[C19] Patel, V., **Rakita, D.**, and Dollar, A. 2023. An Analysis of Unified Manipulation with Robot Arms and Dexterous Hands via Optimization-based Motion Synthesis. *International Conference on Robotics and Automation* (ICRA).

[C18] Wang, Y., Praveena, P., **Rakita, D.**, and Gleicher, M. 2023. RangedIK: An Optimization-Based Robot Motion Generation Method for Ranged-Goal Tasks. *International Conference on Robotics and Automation* (ICRA).

[C17]  Schoen, A., Sullivan, D., Zhang, Z., Rakita, D., and Mutlu, M. 2023. Lively: Enabling Multimodal, Lifelike, and Extensible Real-time Robot Motion. *International Conference on Human-Robot Interaction* (HRI). ACM/IEEE. *[Best Paper Award Winner]*

[C16] **Rakita, D.**, Mutlu, B., and Gleicher, M. 2022. Proxima: An Approach for Time or Accuracy Budgeted Collision Proximity Queries. *Robotics: Science and Systems* (RSS).

[C15] **Rakita, D.**, Shi, H., Mutlu, B., and Gleicher, M. 2021. CollisionIK: A Per-Instant Pose Optimization Method for Generating Robot Motions with Environment Collision Avoidance. *International Conference on Robotics and Automation* (ICRA).

[C14] **Rakita, D.**, Mutlu, B., and Gleicher, M. 2021. Strobe: An Acceleration Meta-algorithm for Optimizing Robot Paths using Concurrent Interleaved Sub-Epoch Pods. *International Conference on Robotics and Automation* (ICRA).

[C13] **Rakita, D.**, Mutlu, B., and Gleicher, M. 2020. Effects of Onset Latency and Robot Speed Delays on Mimicry-Control Teleoperation. *International Conference on Human-Robot Interaction* (HRI). ACM/IEEE (Acceptance rate 24%)

[C12]  Praveena, P., **Rakita, D.**, Mutlu, B., and Gleicher, M. 2020. Supporting Perception of Weight through Motion-induced Sensory Conflicts in Robot Teleoperation. *International Conference on Human-Robot Interaction* (HRI). ACM/IEEE. (Acceptance rate 24%) *[Best Paper Nominee]*

[C11] **Rakita, D.**, Mutlu, B., and Gleicher, M. 2019. Remote Telemanipulation with Adapting Viewpoints in Visually Complex Environments. *Robotics: Science and Systems* (RSS).

[C10] **Rakita, D.**, Mutlu, B., and Gleicher, M. 2019. Stampede: A Discrete-Optimization Method for Solving Pathwise-Inverse Kinematics. *International Conference on Robotics and Automation* (ICRA).

[C9] Praveena, P., **Rakita, D.**, Mutlu, B., and Gleicher, M. 2019. User-Guided Offline Synthesis of Robot Arm Motion from 6- DoF Paths. *International Conference on Robotics and Automation* (ICRA).

[C8] **Rakita, D.**, Mutlu, B., and Gleicher, M. 2018. RelaxedIK: Real-time Synthesis of Accurate and Feasible Robot Arm Motion. *Robotics: Science and Systems* (RSS). *[Invited to Special Issue]*

[C7]  **Rakita, D.**, Mutlu, B., and Gleicher, M. 2018. An Autonomous Dynamic Camera Method for Effective Remote Teleoperation. *International Conference on Human-Robot Interaction* (HRI). ACM/IEEE. (Acceptance rate 23%) *[Best Paper Award Winner]*

[C6] **Rakita, D.**, Mutlu, B., Gleicher, M., and Hiatt, L. 2018. Shared Dynamic Curves: A Shared-Control Telemanipulation Method for Motor Task Training. *International Conference on Human-Robot Interaction* (HRI). ACM/IEEE. (Acceptance rate 23%)

[C5] **Rakita, D.**, Mutlu, B., and Gleicher, M. 2017. A Motion Retargeting Method for Effective Mimicry-based Teleoperation of Robot Arms. *International Conference on Human-Robot Interaction* (HRI). ACM/IEEE. (Acceptance rate 50/211)

[C4] Liu, O., **Rakita, D.**, Mutlu, B., and Gleicher, M. 2017. Understanding Human-Robot Interaction in Virtual Reality. *RO-MAN* 2017-The IEEE International Symposium on Robot and Human Interactive Communication. IEEE.

[C3] Subramani, G., **Rakita, D.**, Wang H., Zinn, M., Gleicher, M. 2017. Recognizing Actions during Tactile Manipulations through Force Sensing. *International Conference on Intelligent Robots and Systems* (IROS). IEEE/RSJ.

[C2] **Rakita, D**., Mutlu, B., and Gleicher, M. 2016. Motion Synopsis for Robot Arm Trajectories. *RO-MAN* 2016-The 25th IEEE International Symposium on Robot and Human Interactive Communication. IEEE. (Acceptance rate 44%)

[C1]  Bodden, C., **Rakita, D.**, Mutlu, B., and Gleicher, M. 2016. Evaluating Intent-Expressive Robot Arm Motion. RO-MAN 2016-The 25th IEEE International Symposium on Robot and Human Interactive Communication. IEEE. (Acceptance rate 44%) *[Best Paper Nominee]*

REFEREED SHORT CONFERENCE PAPERS

[S2] **Rakita, D.** 2017. Methods for Effective Mimicry-based Teleoperation of Robot Arms. *International Conference on Human-Robot Interaction* (HRI) Pioneers Workshop.

[S1]  **Rakita, D.**, Pejsa, T., Mutlu, B., and Gleicher, M. 2015. Inferring Gaze Shifts from Captured Body Motion. SIGGRAPH 2015 Poster Proceedings 77, 77:1. *[1st Place – ACM Student Research Competition]*

THESES

[T2] **Rakita, D.** 2022. On the Formulation, Characterization, and Application of Per-instant Pose Optimization as a Motion Generation Paradigm in Robotics. University of Wisconsin-Madison Department of Computer Sciences, PhD Dissertation.

[T1] **Rakita, D.**, Mutlu, B., and Gleicher, M. 2017. Relaxed-IK Solver: A Framework for Robot Arm Importance-based Inverse Kinematics. University of Wisconsin-Madison Department of Computer Sciences, Masters Tech Report.

FUNDING

Cisco Graduate Student Fellowship, one year PhD tuition and stipend 2021-2022

Microsoft PhD Fellowship, $84,000 for tuition, stipend, and travel funds 2019-2020

TEACHING

CPSC 485/585 Applied Planning and Optimization. Yale University. (course I designed) 2023 -

This course introduces students to concepts, algorithms, and programming techniques pertaining to planning and optimization. At a high level, the course teaches students how to break down a particular problem into a state-space or a state-action space, how to select an effective planning or optimization algorithm given the problem at hand, and how to ultimately apply the selected algorithm to achieve desired outputs. Concepts are solidified through grounded, real-world examples (particularly in robotics, but also including machine learning, graphics, biology, etc.). These examples come in the form of programming assignments, problem sets, and a final project. General topics will include discrete planning, sampling-based path planning, optimization via matrix methods, linear programming, computational differentiation, non-linear optimization, and mixed integer programming. After the course, students should be able to generalize their knowledge of planning and optimization to any problem domain.

CPSC 685 Topics on Robot Motion Generation. Yale University. (course I designed) Fall 2022

This course focuses on concepts, approaches, and algorithms related to robot motion generation. Students will read, summarize, present on, and discuss papers and textbook chapters related to search-based path planning, sampling-based path planning, inverse kinematics, and trajectory optimization. These readings span the full range between historical context to current trends on the above topics. Further, some lecturing is interspersed throughout the course such that students can gain background on foundational topics in robotics (e.g., kinematics, dynamics, rotations, non-linear optimization, etc.) in order to more fully grasp the assigned papers and chapters. The course involves a semester-long project where students (optionally working in small groups) can

choose between an implementation-based project or a writing-based project.

Guest Lectures

CPSC 472 Intelligent Robotics. Yale University.	Fall 2022
CS/ Psych 770 Human-Computer Interaction. University of Wisconsin-Madison.	Spring 2020
CS 559 Introduction to Computer Graphics, University of Wisconsin-Madison.	Spring 2019

Student Supervision

Ph.D. Students

- Liam Merz Hoffmeister (2023 -)
- Xiatao Sun (2023 -)

Undergraduate Students

- Francis Fan (2023 -)
- Jack Chen (2023 -)
- Ryan Tsai (2023 -)
- Sem Asmelash (2022 - 2024)
- Sohpie Usherwood (2022 - 2023)

ACADEMIC SERVICE

Session Chair, ICRA session Optimization-Based Motion Planning	2021
Review Editor, Frontiers in Robotics and AI	2021-Current
Reviewer (>100 papers), ICRA, IROS, RSS, RA-L, TRO, HRI, CHI, SIGGRAPH, Transactions on Mechatronics, Frontiers, Humanoids	2017-Current

INVITED TALKS

Cornell University. *Intuitive Robot Shared-Control Interfaces via Real-time Motion Planning and Optimization*	2022
Workshop on Bimanual Manipulation, ICRA 2022. *Generating Accurate, Feasible, and Coordinated Bimanual Robot Motions in Real-time*	2022
KavrakiLab, Rice University. *Methods and Applications for Generating Accurate and Feasible Robot-arm Motions in Real-time*.	2021
Talking-Robotics Series, *Methods and Applications for Generating Accurate and*	2021

Feasible Robot-arm Motions in Real-time. [video link]

Northwestern University. *Methods and Applications for Generating Accurate and Feasible Robot-arm Motions in Real-time* 2020

AI and Its Alternatives for Shared Autonomy in Assistive and Collaborative Robotics Workshop, RSS 2019. *Robust Human-Arm to Robot-Arm Motion Remapping in Real-time for Effective Shared-Control Telemanipulation Methods* 2019

UW-Madison Computer Science Student Symposium. *Effective Methods for Robot Telemanipulation*. 2019

Naval Research Lab. *Effective Methods for Robot Teleoperation.* 2017

SELECTED MEDIA COVERAGE

Techcrunch, This robot learns its two-handed moves from human dexterity

Tech Xplore, Shared control allows a robot to use two hands working together to complete tasks

Cosmos, The Science of Everything, Breaking: robot makes breakfast

Milwaukee Journal Sentinel, UW team designs robot hands that work together

TECHNICAL SKILLS

Programming: Rust, Python, C++, C, C#, Java, OpenGL, ROS, MATLAB, JavaScript, HTML, CSS, WebGL

Software: Blender, 3dsMax, Unity, MotionBuilder, Photoshop, Illustrator, Premier Pro, After Effects, Maya, MudBox, Office