Evan Harber

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Objective

My research pursuits thus far have revolved around three key concepts: **tactile sensing**, **deformable object modeling**, and **motion planning**. The primary goal of my Ph.D. is to integrate these ideas to improve the dynamic control of deformable objects, particularly by incorporating feedback from tactile sensors to gain a more nuanced understanding of the internal state of these objects. Through this approach, my aim is to illustrate that **by leveraging both visual and force feedback, we can narrow the Sim2Real gap** in the manipulation of deformable objects.

Education

Ph.D. in Mechanical Engineering (Design Robotics and Manufacturing) Los Angeles, CA
University of California, Los Angeles, Samueli School of Engineering August 2021–Present
Advisor: Prof. Veronica Santos

Masters of Science in Robotics Pittsburgh, PA
Carnegie Mellon University, School of Computer Science May 2019–August 2021
Advisor: Prof. Howie Choset
Thesis: Stiffness Mapping of Deformable Objects Through Supervised Embedding and Gaussian Process Regression

Bachelor of Science in Physics (Applied Physics) Pittsburgh, PA
Carnegie Mellon University, Mellon College of Science August 2015–May 2019

Awards

Amazon 2024 Fellow: Awarded the Amazon Fellowship as part of the UCLA Science Hub for Humanity and Artificial Intelligence.
ICRA 2022 Outstanding Mechanisms and Design Paper: Award in recognition for work on "Design of a Biomimetic Tactile Sensor for Material Classification"
ISMR 2021 Nominated for Best Paper: Award in recognition for work on "Toward Robotically Automated Femoral Vascular Access"
CMU 2019 Senior Leadership Award: Awarded for founding and managing the Carnegie Mellon Physics steering committee
Mellon College of Science 2019 Graduation Honors: Recognition for a high undergraduate GPA and extended research beyond the curriculum's requirement.
CMU Summer 2016 Internship Experience Fund: Received grant to fund a summer of research with Prof. Dan Goldman at Georgia Tech.

Research Experience

University of California, Los Angeles Biomechatronics Lab — Los Angeles, CA

Research Assistant, Advisor Prof. Veronica Santos — *August 2021 - Current*

- **Deformable Object Motion Planning**: I designed a real2sim2real-based pipeline for dynamically controlling the tip of a rope, utilizing **both force and visual feedback**. The system follows a two-step process: (1) obtaining a probabilistic physics-based model of the rope and (2) using simulation to create a delta dynamics policy. This policy facilitates accurate control of the rope by discerning how modifications in the robot's actions influence the rope's dynamics. A key insight from this research is the policy's capacity to comprehend the effects of alterations in robotic actions on the rope, effectively addressing the sim2real gap.
- **Tactile Sensor Design**: Mentored a team of undergraduates and early PhD students in developing a robust, manufacturable optical tactile sensor that utilizes optical flow to measure elastomer deformation upon contact. Successfully adapted the design into multiple derivative projects, demonstrating its capabilities for underwater tactile sensing and integrating additional modalities to capture both high-frequency and high-spatial resolution data.

Human Fusions Institute (HFI): — Los Angeles, CA

Case Western Reserve University (CWRU), University of California, Los Angeles (UCLA), University of Washington (UW), and Cleveland State University (CSU)

Ground Robotics Team Lead, Supervisor Prof. Veronica Santos — *Jan 2024 – Sept 2024*

- **Teleoperation System**: Led a multidisciplinary team of approximately 10 graduate and undergraduate students, along with research staff, in designing, manufacturing, and testing a dual-arm teleoperated robotic system. Developed custom controllers and software interfaces to synchronize the Panda robotic arm, 3-finger Robotiq gripper, LEAP hand, UR5e robotic arm, and Digit tactile sensors to ultimately investigating the benefits of haptic feedback for enhancing robotic teleoperation.

Amazon Robotics — Boston, MA

Applied Scientist II Intern, Managers Vanessa Metcalf — *June 2023 - Sept 2023*

- **Uncertainty Propagation in Simulation**: Developed a probabilistic analysis tool that utilizes simulation to identify specific areas within a process where efforts to improve reliability should be concentrated. This tool enables a team to strategically enhance a system by directing their efforts toward sections that contribute the most variability to the outcome. Importantly, **I successfully applied this tool to uncover aspects of the physical system that were not accounted for in the simulation**, addressing approximately 15% of the error between simulation and reality.

Disney Research — Los Angeles, CA

Graduate Technology Intern, Managers Dr. Morgan Pope and Tony Dohi — *Jan 2023 - April 2023*

- **Stunt Robotic Dynamic Motion Planning**: I created an offline dynamics optimization tool designed for artists, allowing them to fine-tune animated motions that align closely with their creative vision while preserving dynamic stability. This innovation was implemented and showcased on a roller-skating robot named **Judy Hops, with the results revealed at SXSW**.

Carnegie Mellon University's Biorobotics Lab — Pittsburgh, PA

Research Assistant, Advisor Prof. Howie Choset — *December 2016 - August 2021*

- **Palpation and Stiffness Mapping of Deformable Objects**: Developed a supervised machine learning strategy based on Gaussian Process Regression for fitting and sampling data that maps between the surface of an object to a property about that surface, for example, local stiffness of a thin-walled deformable object. This methodology showed a **33% decrease in testing error** as compared to traditional methods for fitting real-world object stiffness data.

- **Generalized Tactile Sensing Framework**: Managed a group of 6+ graduate and undergraduate students in designing a generalizable force sensor framework that relies on measuring elastomer deformation to estimate and localize external forces. Deployed these sensors on various applications, such as for tumor localization on a Da Vinci robotic surgical system and ground contact detection for legged robotics. Applied this generalized elastomer platform to show how the addition of fingerprint ridges on the surface of the sensor allows a K-NN model to **classify materials with more than 7.7% increased accuracy** over smooth sensors. This research **won ICRA's best paper award** for Outstanding Mechanism Design.
- **Medical Robotics: TRAuma Care In a Rucksack (TRACIR)**: Managed a team of 8+ graduate students to develop software and hardware systems for robotic ultrasound scanning and needle insertion. Integrated each graduate student's custom code into one cohesive system. Field tested our custom medical system in surgery as a part of the **first robotically assisted femoral guidewire insertion in-vivo**.

Bito Robotics Inc. Pittsburgh, PA and Shanghai, China
Software Engineer Intern *Summer 2018*

- **Path Planning**: Designed experimental real-time dynamic multiagent robotic path planners that relied on a decentralized approach to obstacle avoidance and a priority system for handling robotic interactions. Tested custom decentralized planning algorithms in a factory on a combination of physical and simulated robots.

Georgia Institute of Technology's Complex Rheology and Biomechanics Lab Atlanta, GA
Research Assistant, Advisor Prof. Daniel Goldman *Summer 2016*

- **Biology and Swarm Robotics**: Designed and manufactured robots for testing biologically inspired algorithms for use in decentralized planning. Studied the interaction of groups of fire ants to understand how biological systems self-organize to accomplish tasks more efficiently. Compared group interactions of a collection of robotics inspired by biological systems to better design decentralized swarm robotic algorithms.

Teaching Experience

University of California, Los Angeles Los Angeles, CA
Teaching Assistant, Dynamics of Particle and Rigid Bodies *Fall 2022*

Carnegie Mellon University Pittsburgh, PA
Teaching Assistant, Robotic Kinematics and Dynamics *Fall 2018, Fall 2019, Fall 2020*

Professional Service

IEEE Haptics Technical Committee Los Angeles, CA
Student Member *Spring 2025-Spring 2026*

Samuelli School of Engineering, Faculty Executive Committee Los Angeles, CA
Graduate Committee Member *Spring 2024*

Mechanical and Aerospace Engineering Graduate Interest Council Los Angeles, CA
Co-President *Spring 2022 - Present*

- **Community Building**: Lead a team of 10+ graduate students to host accessible events for the 300+ graduate students in the UCLA Department of Mechanical and Aerospace Engineering. Mediate communication between department faculty, staff and graduate students.

Robotics Institute Summer Scholars Pittsburgh, PA
Mentor *Summer 2021*

Physics Outreach Program Pittsburgh, PA
Mentor *Fall 2016 - Spring 2017*

Physics Steering Committee Pittsburgh, PA
Co-Founder and Co-President *Fall 2018 – Spring 2019*

- **Community Engagement**: Co-founded and led a student committee dedicated to enhancing the undergraduate experience within the physics department, with a particular emphasis on supporting underrepresented groups. This initiative fostered a more inclusive and supportive community, contributing to a positive departmental culture.
- **Advocacy for Diversity and Inclusion**: Spearheaded the implementation of diversity and bias training programs for both faculty and students, aiming to improve interpersonal dynamics and strengthen student-advisor relationships. **These efforts were recognized with Carnegie Mellon University's Senior Leadership Recognition award.**

Fringe Pittsburgh, PA
Social Chair *Fall 2017 - Spring 2018*

In Preparation

[1] E. Harber, A. Liebman, B. Forbes, J. Winefeld, J. Chen, C. P. Johnson, J. Peñaloza, and V. J. Santos, "Design and fabrication of opti: An open source optical tactile sensor," *IEEE Sensors*, 2025, In Preparation.

[2] B. Forbes, E. Harber, J. Penaloza, H. Yared, P. Kasmalkar, and V. J. Santos, "H2Opti: A vision-based underwater tactile sensor," 2025, In Preparation.

[3] M. Whidby, S.-M. Kang, E. Harber, J. Penaloza, A. T. Bender, J. D. Posner, and V. J. Santos, "Towards texture classification in diverse medium: Leveraging liquid metal strain gauge tactile sensors," 2025, In Preparation.

Publications

[1] E. Harber and V. J. Santos, "Robotic Grappling: The Advantage of Force Feedback in Dynamic Rope-Tip Manipulation," *IEEE Transactions on Robotics*, 2025, In Review.

[2] E. Harber, C. P. Johnson, A. Liebman, A. Psychoyos, M. Whidby, S.-M. Kang, J. Peñaloza, A. T. Bender, J. D. Posner, and V. J. Santos, "Optistrain: A vision- and microfluidics-based tactile sensor with high spatial and temporal resolution," in *IEEE World Haptics Conference*, 2025, Work in Progress.

[3] S. Asjad, E. Harber, V. Santos, and D. Tyler, "Neuroreality™ : A data distribution service-based inter-process communication middleware," in *2024 IEEE Conference on Telepresence*, 2024, pp. 168–171. [Online]. Available: https://ieeexplore.ieee.org/document/10841742

[4] E. Harber, "Stiffness mapping of deformable objects through supervised embedding and gaussian process regression," Master's thesis, Carnegie Mellon University, Pittsburgh, PA, May 2022. [Online]. Available: https://www.ri.cmu.edu/publications/stiffness-mapping-of-deformable-objects-through-supervised-embedding-and-gaussian-process-regression/

[5] K. Dai, X. Wang, A. M. Rojas, E. Harber, Y. Tian, N. Paiva, J. Gnehm, E. Schindewolf, H. Choset, V. A. Webster-Wood, and L. Li, "Design of a biomimetic tactile sensor for material classification," in *2022 International Conference on Robotics and Automation (ICRA)*, 2022, pp. 10 774–10 780. [Online]. Available: https://ieeexplore.ieee.org/document/9811543

[6] N. Zevallos*, E. Harber*, Abhimanyu, K. Patel, Y. Gu, K. Sladick, F. Guyette, L. Weiss, M. R. Pinsky, H. Gomez, J. Galeotti, and H. Choset, "Toward robotically automated femoral vascular access," in *2021 International Symposium on Medical Robotics (ISMR)*, 2021, pp. 1–7. [Online]. Available: https://ieeexplore.ieee.org/document/9661560

[7] A. Rojas, K. Dai, E. Harber, E. Schindewolf, J. Gnehm, W. Wang, H. Choset, L. Li, and V. Webster-Wood, "Design of low-cost tactile sensor inspired by human skin," in *BMES*, 2021, abstract.

[8] W. Chen, E. Harber, N. Zevallos, K. Patel, Y. Gu, K. Sladick, R. Goel, H. Choset, and J. Galeotti, "Real-time needle tracking in ultrasound for robotic needle insertion," in *MHSRS*, 2021, abstract.

[9] L. Li, E. Schindewolf, E. Harber, and H. Choset, "Sensing device," May 3 2022, patent number WO2022093771A1. [Online]. Available: https://patents.google.com/patent/WO2022093771A1

[10] E. Harber, E. Schindewolf, V. Webster-Wood, H. Choset, and L. Li, "A tunable magnet-based tactile sensor framework," in *2020 IEEE SENSORS*, 2020, pp. 1–4. [Online]. Available: https://ieeexplore.ieee.org/document/9278634

Presentations

[1] E. Harber, "Optistrain: A vision- and microfluidics-based tactile sensor with high spatial and temporal resolution," in *IEEE World Haptics Conference*, 2025, Poster.

[2] E. Harber, "Precision in Dynamic Rope Manipulation: The Advantage of Force Feedback," University of California, Los Angeles Mechanical and Aerospace Engineering Industrial Advisory Board Symposium, Los Angeles, CA, USA, March 2025, Poster.

[3] E. Harber, "Precision in Dynamic Rope Manipulation: The Advantage of Force Feedback," Amazon Fellows Lightning Talks, Los Angeles, CA, USA, December 2024, Podium.

[4] E. Harber, "Stiffness Mapping of Deformable Objects Through Supervised Embedding and Gaussian Process Regression," Carnegie Mellon University, Robotics Institute, Pittsburgh, PA, USA, Tech. Rep., May 2022, Podium.

[5] E. Harber, "A tunable magnet-based tactile sensor framework," in *2020 IEEE SENSORS Conference*, 2020, Podium. [Online]. Available: https://www.youtube.com/watch?v=eKHvWxwSocM&list=PLk0Ch0igcxBCfiIWUVpWeh-VV8cALejPJ&index=87