# Michael Andres Lin

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I am a roboticist working at the intersection of robot perception and sensor development. I am interested in building robots that are more capable of effectively perceiving the environment through the sense of touch by using novel sensor designs and state estimation algorithms.

keywords: tactile sensing and perception, robotic manipulation and grasping

## Education

**PhD Mechanical Engineering - Robotics** 2019-2023 (Expected)
Stanford University (Stanford, CA)
- Thesis Committee: Mark Cutkosky (advisor), Jeannette Bohg, Monroe Kennedy III

**MS Mechanical Engineering - Robotics** 2015-2017
Stanford University (Stanford, CA)
- Focus: Dynamics & Controls, Robotics, Mechatronics

**BS Electrical Engineering and Computer Science** 2011-2015
University of California - Berkeley (Berkeley, CA)
- EECS Honors

## Professional Experience

**Research Intern** June 2022-Present
NVIDIA Seattle Robotics Lab (Seattle, WA)
Manager: Dieter Fox, Mentor: Yashraj Narang
- Investigating methods to improve transfer of robot skills learned in simulation to a real robot setting (sim2real) for contact-rich assembly tasks.
- Developed a framework for dynamics identification for an industrial robot arm (Franka Panda) which uses a differentiable manipulator dynamical model implemented in PyTorch to learn inertial and friction parameters. Through inverse dynamics loss, we successfully identified dynamics parameters from a hand-collected dataset of 100k datapoints.
- Investigating methods to transfer learned dynamics to robot simulator (NVIDIA Isaac Gym) to minimize forward dynamics loss. Ongoing work to improve simulation accuracy of real-world setting with the goal of facilitating sim2real transfer of robot skills for industrial assembly.

**Graduate Research Assistant** 2019-Present
Stanford University Biomimetics and Dexterous Manipulation Lab (Stanford, CA)
Advised by Mark Cutkosky, Ph.D.
- Investigating design of bio-inspired whisker sensor instrumented on robot manipulators to sense surroundings through very light contacts. Developing Bayesian filtering methods to combine robot proprioception and forces on the whisker to estimate contact locations. Aiming to use this sensing method to reach and navigate constrained spaces using haptic feedback.

- Developed a low-impedance robot gripper optimized for dynamic contact interactions with light objects. Leveraged the dynamics of the gripper to localize free-standing objects to sub-mm accuracy through contact measurements using Particle Filtering.
- Developed a pneumatic-based tactile sensing skin for large surface distributed pressure sensing and implemented reactive controllers to reach into constrained spaces while maintaining low forces.

**Graduate Teaching Assistant** Winter & Spring Qtr 2022

Advanced Dynamics & Computation Graduate-level (Stanford, CA)
Instructor: Paul Mitiguy

- Teaching efficient methods to formulate equations of motion for multi-body systems, as well as computational methods to model dynamical behavior.

**Robotics Systems Engineer** 2017-2019

Flexiv Robotics (Santa Clara, CA)

- Architected system design for a 7-DOF torque-controlled robot manipulator. Integrated joint sensors and actuators to enable robust, efficient, and ISO safety-compliant motion control.
- Designed and optimized a model-based Field Oriented controller for brushless DC Motor current control that outperformed competitive off-the-shelf motor controllers.
- Developed system testing procedures for problem solving through root-cause analysis and communicated findings to teammates effectively to drive design changes.
- Showcased the 7-DOF manipulator executing assembly and surface polishing tasks at automation trade fair Hannover Messe 2019.

**Graduate Research Assistant** 2015-2017

Stanford University - Biomimetics & Dexterous Manipulation Lab
Advised by Mark Cutkosky, Ph.D. and Bruce Daniel, M.D.

- Developed mixed-reality based navigation system for biopsy needle insertion to improve needle placement accuracy.
- Developed a shape-sensing needle (fiber optics sensing) to provide physicians with accurate real-time visualizations of the needle even under deflection.
- Conducted user studies on the guidance system that showed a 26% reduction in errors in when using needle shape information to assist in placing needle tip at a 2 mm target.

**Undergraduate Research Assistant** 2015-2017

Stanford University - CHARM Lab
Advised by Allison Okamura, Ph.D.

- Designed a hand-held variable stiffness haptic gripper used to teleoperate a laparoscopic surgical robot with the goal of reducing patient tissue damage during tissue handling.
- Demonstrated through user studies that rendering variable grip stiffness helps minimize the effective grip force users apply at the follower system (Raven II surgical robot system).

## Academic Publications

Google Scholar: https://scholar.google.com/citations?user=n20ytXgAAAAJ

**Refereed Journal & Conference Articles**

1. **Michael A. Lin**, Emilio Reyes, Jeannette Bohg and Mark R. Cutkosky. Whisker-Inspired Tactile Sensing for Contact Localization on Robot Manipulators. 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2022.
2. Hojung Choi, Dane Brouwer, **Michael A. Lin**, Kyle Yoshida, Carine Rognon, Benjamin Stephens-Fripp, Allison M. Okamura, Mark Cutkosky. Deep Learning Classification of Touch Gestures Using Distributed Normal and Shear Force. 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2022.
3. **Michael A. Lin**, Rachel Thomasson, Gabriela Uribe, Hojung Choi, and Mark R. Cutkosky. Exploratory Hand: Leveraging Safe Contact to Facilitate Manipulation in Cluttered Spaces. IEEE Robotics and Automation Letters 6, no. 3 (2021): 5159-5166.
4. Alexander M. Gruebele, **Michael A. Lin**, Dane Brouwer, Shenli Yuan, Andrew C. Zerbe, and Mark R. Cutkosky. A Stretchable Tactile Sleeve for Reaching Into Cluttered Spaces. IEEE Robotics and Automation Letters 6, no. 3 (2021): 5308-5315.
5. **Michael A. Lin**, Alexa F. Siu, Jung Hwa Bae, Mark R. Cutkosky, and Bruce L. Daniel. Holoneedle: augmented reality guidance system for needle placement investigating the advantages of three-dimensional needle shape reconstruction. IEEE Robotics and Automation Letters 3, no. 4 (2018): 4156-4162.
6. Stephanie L. Perkins, **Michael A. Lin**, Subashini Srinivasan, Amanda J. Wheeler, Brian A. Hargreaves, and Bruce L. Daniel. A mixed-reality system for breast surgical planning. In 2017 IEEE International Symposium on Mixed and Augmented Reality (ISMAR-Adjunct), pp. 269-274. IEEE, 2017.
7. Jung Hwa Bae, Christopher J. Ploch, **Michael A. Lin**, Bruce L. Daniel, and Mark R. Cutkosky. Display of needle tip contact forces for steering guidance. In 2016 IEEE haptics symposium (HAPTICS), pp. 332-337. IEEE, 2016.
8. **Michael A. Lin**, Samuel B. Schorr, Iris Yan, and Allison M. Okamura. The effect of manipulator gripper stiffness on teleoperated task performance. In 2015 IEEE World Haptics Conference (WHC), pp. 494-499. IEEE, 2015.

## Patent Applications

1. Bruce L. Daniel, Brian A. Hargreaves, **Michael A. Lin**, Christoph Leuze, Stephanie Liu Perkins, Serena Zhang. Novel system for in situ visualization of solid tumors and sentinel nodes within the patient's body [*submitted December 2021*].
2. Alexander Gruebele, **Michael A. Lin,** Daniel Brower, Mark R. Cutkosky. A Stretchable Tactile Sleeve for Reaching into Cluttered Spaces. U.S. Patent Application 63/168091, filed March 30, 2021.
3. Stephanie Liu Perkins, Bruce L. Daniel, Brian A. Hargreaves, **Michael A. Lin**, Christoph Leuze. System for visualizing tumor location and extent within opaque tissues. U.S. Patent Application 63/162408, filed March 17, 2021.
4. **Michael A. Lin**, Jung Hwa Bae, Subashini Srinivasan, Mark R. Cutkosky, Brian A. Hargreaves, and Bruce L. Daniel. Real-time Three Dimensional Display of Flexible Needles Using Augmented Reality. U.S. Patent Application 15/786,952, filed May 3, 2018.

## Skills

**Coding** - Python, C++, C (Low level), MATLAB, C#
**Libraries & Toolkits** - PyBullet, MuJoCo, ROS, PyTorch, Unity, OpenCV, Qt-5, Gazebo
**Embedded Systems** - State machines, SPI, I2C, UART, EtherCAT, BLE
**Hardware** - Motor control, circuit design & testing, CAD modeling, rapid prototyping

## Honors & Awards

- Best Poster Award (of 113 posters) at Stanford Bio-X IIP Symposium, 2017
- National Science Foundation Graduate Research Fellowship (NSF GRFP), 2015
- Stanford School of Engineering Fellowship, 2015
- 1st place NATCAR competition (autonomous RC car racing)