Nikhil Uday Shinde

858-261-8498

nshinde@ucsd.edu

Education

University of California San Diego — Expected Graduation: Dec 2025
Ph.D. Intelligent Systems, Robotics and Control: *GPA 3.95* — *NDSEG Fellow, Powell Fellowship*

University of California Berkeley — Graduated with Honors: May 2019
B.S. Electrical Engineering and Computer Science: *GPA: 3.855* — *Regents and Chancellor's Scholar*

Overview:

My research focus is to enable safe physical interactions while reasoning about uncertainty in unstructured, real world environments. In particular I am largely motivated by applications in the surgical and assistive spaces with the vision to bring consistent, accessible healthcare to all. Specifically my areas of research are:

- **Surgical Automation:** Developing algorithms for task automation specific to minimally invasive surgery
- **Adaptable Safety Guarantees via Online Learning:** My research uses non-parametric online learning methods to adapt safety assurances while maintaining probabilistic safety guarantees.
- **Uncertainty Aware Safe Automation:** My work focuses on leveraging uncertainty quantification and probabilistic estimation to give safety guarantees in unknown, unstructured environments.

Professional Experience:

- **UCSD Advanced Robotics and Controls Lab (ARCLab) and Safe Autonomous Systems Lab (SASLab)** *2020 - Present*
  - Conducting my Doctoral research with advisors Michael C. Yip and Sylvia L. Herbert at UC San Diego
  - Published and presented multiple papers on safe control, robotic manipulation and surgical automation in top robotics conferences including RSS, CoRL, ICRA, IROS, L4DC and CASE.
  - Conducted experiments on hardware platforms including a Manipulator, Intuitive Da Vinci Surgical Robot and UAVs.
  - Advised and mentored multiple undergraduate and masters students
  - Selected Projects:
    - *JIGGLE*: Published at RSS 2024. Developed an Extended Kalman Filter-based active sensing controller to probabilistically estimate tissue boundaries and uncover adhesions during surgery, with validation on real tissue images.
    - *From Space to Time*: Published at CoRL 2025. Designed a minimally invasive safety filter for drones in unknown wind environments by re-casting spatial disturbances as temporally increasing ones. Demonstrated on Crazyflie hardware.
    - *Learning to Nudge:* Submitted to ICRA 2025, Trained composable dense contact barrier functions in Isaac Lab to enable safe interactions for manipulators in cluttered settings, acting as an online safety filter to prevent knocking objects over.
    - *Interpretable Interventions*: Ongoing: This ongoing research uses Sparse Autoencoders and Transcoders to design interpretable features and interventions for Reinforcement Learning and Imitation Learning policies on robotic systems.
- **Engineering Intern at Intuitive Surgical: (Sunnyvale Office)** *Jan 2022 - May 2022*
  - Developed unsupervised and supervised learning based computer vision algorithms to improve navigation performance for robotic bronchoscopy procedures for Intuitive Surgical's Ion platform.
- **UCSD Wireless Communication, Sensing and Networking Lab (WCSNG)** *2019 - 2020*
  - Machine Learning and Communications research advised by Professor Dinesh Bharadia.
  - Conducted research on minimizing power amplifier nonlinearities using machine learning, training networks over the air on software defined radios and learning new communication schemes.
- **UC Berkeley ML4Wireless Center with Professor Anant Sahai (Undergraduate).** *2018 - 2019*
  - Research on Deep Learning for Equalization in communications and published on numerical results in the Witsenhausen Counterexample.
- **Engineering Intern at Qualcomm: (San Jose Office)** *June 2019 - Aug 2019*
  - Engineered a new feature in C for a DSP chip simulator, enabling the accurate simulation of hardware timers and significantly enhancing the tool's functionality.
- **Engineering Intern at Qualcomm: (San Diego Office)** *June 2018 - Aug 2018*
  - Engineered a suite of Python scripts that streamlined the modification, compilation, and decompilation of modem configuration binaries, improving workflow efficiency for the engineering team.
  - Earned a QualStar award for outstanding performance as an Intern
- **Development Engineer Intern at Epicor:** *June 2016 - Aug 2016*
  - Employed advanced linear modeling techniques in R to analyze extensive data logs, identifying and quantifying the primary factors influencing product performance

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Awards and Distinctions

- Best workshop paper at Reflections on Representations and Manipulating Deformable Objects ICRA 2025
- Department of Defense National Defense Science and Engineering Graduate (NDSEG) Fellowship.
- Powell Fellowship at UC San Diego.
- Competition winner at MRSS (Montreal Robotics Summer School) 2024: Attended a week long robotics course at MILA where my team won the competition to localize and navigate a course using a go-1 quadruped trained to walk using RL in IsaacGym.
- Regent's and Chancellor's Scholarship at UC Berkeley.
- Qualstar Award at Qualcomm

Professional Events, Memberships and Services

- Reviewer for The International Journal of Robotics Research (IJRR), IEEE International Conference on Robotics and Automation (ICRA), IEEE Conference on Automation Science and Engineering (CASE), Learning for Dynamics and Controls (L4DC), Robotics Science and Systems (RSS), IEEE Transactions on Control Systems Technology (IEEE TCTS)
- Conference Presenter at RSS, CoRL, ICRA, IROS, CASE
- Consortium on Naval Enterprise Pathways 2024 Attendee
- Montreal Robotics Summer School 2024 Attendee
- Accepted into NSF I-Corp medtech accelerator
- IEEE Student Member
- Membership to Tau Beta Pi, Engineering Honors Society.
- Membership to Eta Kappa Nu, Mu chapter, Electrical Engineering and Computer Science Honors Society.

Technical Skills

- Linear Algebra, Statistical Modeling, Deep Learning, Reinforcement Learning, Imitation Learning, Gaussian Processes, Data Analytics, Simulation, Adaptive Learning
- Python, OpenCV, PyTorch, Multi threaded Programming. Very comfortable picking up new programming languages and packages.
- Basic skills: ROS, C++, C, MATLAB, R, Java

Mentorship

- **Research Mentorship at UCSD:** Research mentorship for undergraduate and masters students
- **Outreach Chair of RoboGrads at UCSD:** Outreach chair for Graduate Student organization at UC San Diego where I worked on organizing events to build a collaborative research community and inspire younger students through lab tours and events.
- **Undergraduate Student Instructor at UC Berkeley:** *Jan 2017 - May 2019:* I instructed students on electrical engineering concepts in discussion sections, and how to put these concepts to practice in labs via projects, such as creating a voice controlled car. I also created labs, homeworks, exams, course notes and other course content

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All Publications

1. Sander Tonkens*, **Nikhil Uday Shinde*,** Azra Begzadić, Michael C. Yip, Jorge Cortès, Sylvia L. Herbert, "From Space to Time: Enabling Adaptive Safety with Learned Value Functions via Disturbance Recasting", *In Conference on Robot Learning (CoRL) 2025, Workshop paper at Safe and Robust Robot Learning for Operation in the Real World at RSS 2025, Workshop paper at RSS 2025*
2. **Nikhil Uday Shinde***, Xiao Liang*, Fei Liu, Yutong Zhang, Florian Richter, Sylvia Herbert, Michael C. Yip, "JIGGLE: An Active Sensing Framework for Boundary Parameters Estimation in Deformable Surgical Environments", *In Robotics Science and Systems (RSS) 2024, Best workshop paper at Reflections on Representations and Manipulating Deformable Objects ICRA 2025*
3. Haixin Jin*, **Nikhil Uday Shinde*,** Soofiyan Atar, Hongzhan Yu, Dylan Hirsch, Sicun Gao, Michael C. Yip, Sylvia L. Herbert "Learning to Nudge: A Scalable Barrier Function Framework for Safe Robot Interaction in Dense Clutter", *In submission at ICRA 2026*
4. Will Sharpless*, Dylan Hirsch*, Sander Tonkens, **Nikhil Uday Shinde,** Sylvia L. Herbert "Dual-Objective Reinforcement Learning with Novel Hamilton-Jacobi-Bellman Formulations" *In submission at ICLR 2026, Workshop paper at Safe and Robust Robot Learning for Operation in the Real World at RSS 2025, Workshop paper at RSS 2025*
5. **Nikhil U. Shinde***, Zih-Yun Chiu*, Florian Richter, Jason Lim, Yuheng Zhi, Sylvia Herbert, Michael C. Yip, "SURESTEP: An Uncertainty-Aware Trajectory Optimization Framework to Enhance Visual Tool Tracking for Robust Surgical Automation", *In IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2024*
6. Azra Begzadić*, **Nikhil Uday Shinde***, Sander Tonkens*, Dylan Hirsch, Kaleb Ugalde, Michael C. Yip, Jorge Cortés, Sylvia Herbert, "Back to Base: Towards Hands-Off Learning via Safe Resets with Reach-Avoid Safety Filters", *Submitted to Learning*

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for Dynamics and Controls (L4DC), 2025, Workshop paper at Safe and Robust Robot Learning for Operation in the Real World at RSS 2025

7. **Nikhil U. Shinde**, Jacob Johnson, Sylvia Herbert, Michael C. Yip, "Object-Centric Representations for Interactive Online Learning with Non-Parametric Methods", *In IEEE 19th International Conference on Automation Science and Engineering (CASE), 2023*
8. **Nikhil U. Shinde**, Xiao Liang, Florian Richter, Michael C. Yip, "Investigating Low Data, Confidence Aware Image Prediction on Smooth Repetitive Videos using Gaussian Processes", *In IEEE 19th International Conference on Automation Science and Engineering (CASE), 2024*
9. Will Sharpless, **Nikhil Shinde**, Matthew Kim, Yat Tin Chow, Sylvia Herbert, "Koopman-Hopf Hamilton-Jacobi Reachability and Control", *Arxiv pre-print*
10. Xiao Liang, Chung-Pang Wang, **Nikhil Uday Shinde**, Fei Liu, Florian Richter, Michael Yip, "MEDiC: Autonomous Surgical Robotic Assistance to Maximizing Exposure for Dissection and Cautery", *Accepted to IEEE International Conference on Robotics and Automation (ICRA), 2025*
11. Christopher D'Ambrosia, Florian Richter, Zih-Yun Chiu, **Nikhil Shinde**, Fei Liu, Henrik I. Christensen, Michael C. Yip, "Robust Surgical Tool Tracking with Pixel-based Probabilities for Projected Geometric Primitives", *In IEEE International Conference on Robotics and Automation (ICRA), 2024*
12. Elizabeth Peiros, Zih-Yun Chiu, Yuheng Zhi, **Nikhil Shinde**, Michael C. Yip, "Finding biomechanically safe trajectories for robot manipulation of the human body in a search and rescue scenario", *In IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2023*
13. Vignesh Subramanian, Laura Brink, Nikunj Jain, Kailas Vodrahalli, Akhil Jalan, **Nikhil Shinde**, Anant Sahai, "Some new numeric results concerning the Witsenhausen Counterexample", *In 56th Annual Allerton Conference on Communication, Control, and Computing (Allerton)*, 2018

Ongoing Work and Relevant Projects:

- **Adaptive Safety Filters using Neural Operators for spatially varying wind maps:** Trained a Neural Operator to learn an environment's safety value function by solving the HJ PDE from wind disturbance maps, enabling a GP-based approach for online disturbance mapping and adaptive safety filter creation.
- **Safe Deformable Manipulation with Vision Language Models:** Using vision language models to enable safe manipulation strategies while manipulating complex deformable objects and scenes where safety can be difficult to quantify.
- **Meta Learning for Safe Deformable Manipulation:** Training a policy to safely manipulate deformable objects, such as cloth and rope. Use Meta learning techniques to enable policy generalization across a wide array of deformable objects.
- **Explainable Learned Control Policies:** Developing a framework leveraging Sparse Autoencoders and Transcoders to extract interpretable features from learned control policies (RL and Imitation Learning). The approach facilitates transparent and targeted interventions to enable online policy performance improvements.
- **Safe Exploration and Manipulation in Unknown Environments with Stochastic Transitions:** Using Gaussian Processes for safe goal driven exploration and object manipulation in unknown environments subject to a stochastic transition function.
- **Learned Koopman Operators for Robotic Systems:** Ongoing work to use neural network lifting functions to linearize the dynamics of complex robotic systems for control and analysis.
- **Shared modular policies for collaborative robot manipulation:** I trained modular single link level policies to generalize across multi link arms, in pybullet, for reach and manipulation tasks.
- **Toy Surgical Environment for Safe Navigation through Unknown Environments:** Developed a toy deformable environment to mimic an exploratory surgical scenario. Compared using Partially Observable Markov Decision Processes with value function based exploration methods to safely explore, plan in and navigate through unknown settings in this toy environment.
- **Learned Wireless communication:** I developed neural network based, robust communication systems, trained end to end over the air with software defined radios.
- **Deep Network Defined Radios**: I utilized neural networks to learn wireless communication protocols. In particular I focused on estimation and correction of carrier frequency offset and channel estimation and equalization over wireless
- **Image to Image translation**: I explored using Image to Image translation between different visual domains to enable learned policies trained on one domain to generalize to domains with similar dynamics, action spaces and reward structures.
- **Computational photography projects:** I used classical computational photography techniques to implement projects in image alignment, gradient domain blending, face morphing, image refocusing, creating panorama and eulerian video magnification.