

Milad Azizkhani

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EDUCATION

Georgia Institute of Technology Ph.D. in Robotics, Minor in Optimization	Atlanta, GA, USA 2022–2026 est.
Amirkabir University of Technology (AUT) M.Sc. in Mechatronics Engineering, <i>Ranked 2nd in program</i>	Tehran, Iran 2017–2020
Bu Ali Sina University B.Sc. in Mechanical Engineering, <i>Ranked 3rd in program</i>	Hamedan, Iran 2013–2017

HONORS AND AWARDS

- **Flowers Family Topping Fellowship** *Spring 2026, Georgia Institute of Technology*
Awarded by the Woodruff School of Mechanical Engineering for achieving the highest number of first-author publications.
- **Herbert P. Haley Fellowship** *2025–2026, Georgia Institute of Technology*
Highly selective, merit-based fellowship awarded by the College of Engineering in recognition of academic excellence and research potential.
- **Ph.D. Research Excellence Award** *Spring 2025, Georgia Institute of Technology*
Awarded by the Mechanical Engineering Department for outstanding doctoral research.
- **Flowers Family Topping Fellowship** *Fall 2024, Georgia Institute of Technology*
Awarded by the Mechanical Engineering Department for a first-author paper with the highest citation count.

PROFESSIONAL SUMMARY

Robotics simulation and control engineer with nearly a decade of experience developing end-to-end robotic systems, from physics-based modeling and algorithm design to perception, hardware integration, and real-time deployment. My work focuses on **contact-rich simulation, control, optimization, and physical interaction under uncertainty**, with established contributions in **contact modeling, trajectory optimization / MPC, and adaptive and passivity-based control**. A key strength is combining **rigorous theoretical development** with **full-stack implementation in Python and C++**, including **physics engines, GPU-accelerated planning and perception, ROS-based systems, and kHz-rate control** on high-DoF soft and continuum robots.

My current work advances **learning, control, and decision-making under uncertainty**, with an emphasis on **sample-efficient, physically grounded methods** that transfer reliably from simulation to real robotic systems. Author of **12+ peer-reviewed publications** and recipient of multiple competitive **fellowships and research awards**.

Technical Focus: Robotics Simulation • Robot Learning • Reinforcement and Imitation Learning • Control Theory • Optimal Control • Trajectory Optimization • Model Predictive Control • Contact Modeling • Robot Perception • Adaptive and Passivity-Based Control • Decision-Making under Uncertainty • Contact-Rich Manipulation • Real-Time Robotic Systems

PUBLICATIONS

Journal Articles

- **[J9] M. Azizkhani** and Y. Chen, "A Complementarity-Based Framework for Soft-Robot Contact Modeling and Planning," *IEEE Robotics and Automation Letters*, vol. 11, no. 10, pp. 11291–11298, 2026. [DOI] [Source Code]
- **[J8] M. Azizkhani**, S. Kousik, and Y. Chen, "Dynamic Task Space Control of Redundant Pneumatically Actuated Soft Robot," *IEEE Robotics and Automation Letters*, vol. 10, no. 6, pp. 6408–6415, 2025. [DOI]
- **[J7] M. Azizkhani**, J. Ha, A. L. Gunderman, and Y. Chen, "Soft Robot Kinematic Control via Manipulability-Aware Redundancy Resolution," *ASME Journal of Mechanisms and Robotics*, vol. 17, no. 7, Art. no. 071013, 2025. [DOI]
- **[J6]** A. L. Gunderman, Y. Wang, B. O. Gunderman, A. Qiu, **M. Azizkhani**, J. Sommer, and Y. Chen, "Kinetostatics and Retention Force Analysis of Soft Robot Grippers with External Tendon Routing," *IEEE Robotics and Automation Letters*, vol. 10, no. 2, pp. 2064–2071, 2025. [DOI]
- **[J5]** A. L. Gunderman, **M. Azizkhani**, S. Sengupta, K. Cleary, and Y. Chen, "Modeling and Control of an MR-Safe Pneumatic Radial Inflow Motor and Encoder (PRIME)," *IEEE/ASME Transactions on Mechatronics*, vol. 29, no. 3, pp. 1714–1725, 2024. [DOI]
- **[J4]** J. Shen, Y. Wang, **M. Azizkhani**, D. Qiu, and Y. Chen, "Concentric Tube Robot Redundancy Resolution via Velocity/Compliance Manipulability Optimization," *IEEE Robotics and Automation Letters*, vol. 8, no. 11, pp. 7495–7502, 2023. [DOI]
- **[J3] M. Azizkhani**, A. L. Gunderman, I. S. Godage, and Y. Chen, "Dynamic Control of Soft Robotic Arm: An Experimental Study," *IEEE Robotics and Automation Letters*, vol. 8, no. 4, pp. 1897–1904, 2023. [DOI]
- **[J2] M. Azizkhani**, M. Zareinejad, and M. A. Khosravi, "Model Reference Adaptive Control of a Soft Bending Actuator with Input Constraints and Parametric Uncertainties," *Mechatronics*, vol. 84, Art. no. 102800, 2022. [DOI]

- **[J1] M. Azizkhani**, I. S. Godage, and Y. Chen, "Dynamic Control of Soft Robotic Arm: A Simulation Study," *IEEE Robotics and Automation Letters*, vol. 7, no. 2, pp. 3584–3591, 2022. [DOI]

Conference Proceedings

- **[C3]** A. L. Gunderman, **M. Azizkhani**, S. Sengupta, K. Cleary, and Y. Chen, "Open Source MR-Safe Pneumatic Radial Inflow Motor and Encoder (PRIME): Design and Manufacturing Guidelines," in *Proc. International Symposium on Medical Robotics (ISMR)*, pp. 1–7, 2023. [DOI]
- **[C2]** A. Qiu, C. Young, A. L. Gunderman, **M. Azizkhani**, Y. Chen, and A.-P. Hu, "Tendon-Driven Soft Robotic Gripper with Integrated Ripeness Sensing for Blackberry Harvesting," in *Proc. IEEE International Conference on Robotics and Automation (ICRA)*, pp. 11831–11837, 2023. [DOI]
- **[C1]** **M. Azizkhani** and Y. Chen, "Supervised Adaptive Fuzzy Control of LVAD with Pulsatility Ratio Modulation," in *Proc. IEEE 18th International Conference on Automation Science and Engineering (CASE)*, pp. 2429–2434, 2022. [DOI]

Ongoing Research Directions

- **GPU-Accelerated MPPI-Family Control for Contact-Rich Soft-Robot Manipulation**
- **Learning from Demonstration and Learning-Integrated Control for Soft Robot Interaction**
- **Vision-Guided and Manipulability-Aware Control for Soft Robotic Harvesting**
- **Hybrid Soft-Rigid Dexterous Manipulation with RL, MPPI, World-Action Models, and VLA Policies**

SKILLS

Programming: Python, C++, MATLAB, Julia, C, Git/GitHub, Linux, LaTeX

Robot Learning & Control: Reinforcement learning (RL), MPPI, SAC, TRPO, DDPG, behavior cloning, DAgger, policy distillation, offline RL / IQL, probabilistic ensemble dynamics, MPC, world-action models, VLA policies

Frameworks & Systems: PyTorch, TensorFlow, JAX, Gymnasium, Isaac Gym, MuJoCo, PyBullet, Drake, ROS, OpenCV, CasADi, ACADOS, Gurobi, NVIDIA Jetson, TensorRT, Teensy, Arduino, UDP, WebSockets, I2C

EXPERIENCE

Georgia Institute of Technology, Atlanta, GA, USA

2022 – Present

Senior Graduate Research Assistant, BioMedical Mechatronics (BM²) Lab

- **Contact-Rich Modeling, Planning, and Control under Uncertainty**
 - Derived and implemented a custom **physics-based dynamics model** for underactuated soft robots with unilateral contact, combining **complementarity-based (LCP) contact dynamics** with trajectory optimization [J9].
 - Built a custom **real-time physics engine** for forward simulation and contact-aware planning, and analyzed model and interaction uncertainty through **reachability-based forward rollouts**.
 - Developed and evaluated **GPU-accelerated MPPI-family controllers in simulation**; ongoing work extends the framework toward **uncertainty-aware trajectory optimization** and **hardware validation** for contact-rich soft-robot manipulation.
- **Adaptive and Passivity-Based Control with Experimental Validation on Soft Robots**
 - Developed and experimentally validated **σ -modified adaptive passivity-based controllers** with a **high-gain observer** for high-speed tracking and disturbance rejection in soft robotic systems.
 - Demonstrated these methods on **high-DoF pneumatic soft robotic platforms** with **1 kHz control implementations**, improving tracking accuracy, robustness, and stability; designed and instrumented custom hardware including a **rotary encoder with 0.03 mm resolution** [J1, J3, J8].
- **Task-Space Control and Redundancy Resolution**
 - Developed **manipulability-aware redundancy resolution** methods for simultaneous position–orientation control under joint limits, and extended them to **dynamic task-space control** through acceleration-level formulations and adaptive/passivity-based methods [J4, J7, J8].
- **Full-Stack Learning-Enabled Robotic Systems**
 - Architected and field-deployed the onboard stack for a **9-DoF pneumatic soft-robot harvester**, integrating edge computing, embedded control, stereo and eye-in-hand vision, a robotic gripper, and networked pneumatic actuation.
 - Derived a family of **constrained QP planners** for redundant robots, incorporating joint-limit avoidance, centering objectives, actuator bounds, and multiple task and solver modes.
 - Developed **multimode kinematic learning and adaptation** using physical-parameter estimation, RBF machine learning, offline system identification, and online EKF correction; integrated YOLO/TensorRT perception and timestamp-aligned sensor fusion.
 - Deployed a multi-rate autonomy stack spanning **20 Hz planning**, **100 Hz trajectory streaming**, and **1 kHz adaptive control**, with a mobile web interface, data logging, E-STOP, and command-loss failsafes for laptop-free field operation.

- **Algorithm Development for Robot Learning and Stochastic Control**

- Derived and implemented **robot-learning and stochastic-control algorithms from first principles**, translating mathematical formulations into training, GPU-parallel sampling, and rollout pipelines; representative implementations include **SAC, DDPG, behavior cloning, IQL, and MPPI**.
- Formulated complete learning problems for robotic systems, including **nonlinear dynamics, numerical integration, custom environments, state/action spaces, reward design, expert-data generation**, and curriculum learning; applied these methods to continuous control of a nine-actuator soft manipulator.
- Co-developed a **PyBullet** benchmark for a 7-DoF KUKA arm, integrating depth-camera point clouds, a **PointNet-style autoencoder**, learned collision prediction, reward shaping, and **SAC/TRPO** training.

- **Teaching and Research Supervision**

- Mentored **15+ ECE, ME, BME, and CS students** as a VIP course TA, supporting experimental design, control, and system development for soft rehabilitation robots.
- Supervised projects in **reinforcement learning for control, SMA-driven underwater robots, tendon-driven grippers [C2], dVRK bimanual surgery control**, and **learning-based kinematics**.

University of Arkansas, Fayetteville, AR, USA

2021 – 2022

Graduate Research Assistant, Medical Robotics Lab

- Initiated foundational research in dynamic control and redundancy resolution for soft robotic arms, which was subsequently expanded upon at Georgia Tech.
- Developed core adaptive and fuzzy control algorithms for left-ventricular assist devices (LVADs), forming the basis for later publications.

New Technologies Research Center, Amirkabir University of Technology, Tehran, Iran

2017 – 2020

Research Assistant, Soft Robotics Lab

- Implemented control for soft bending/longitudinal actuators using MPC-NN and adaptive-RISE methods.
- Designed and built experimental setups for actuator fabrication and validation.
- Robust Model Reference Adaptive Control of soft actuators with input constraints and parametric uncertainties [J2].

Amirkabir University of Technology, Tehran, Iran

2018 – 2019

Mechatronics Engineer — MotoGP Simulator Project

- Developed and controlled a real-time motorcycle simulator using Arduino and AVR microcontrollers.

Bu-Ali Sina University, Hamedan, Iran

2016

Instructor

- Taught SolidWorks and design to 60+ students in industrial engineering.

PROFESSIONAL SERVICE

Technical Reviews:

IEEE Transaction on Robotics (TRO), IEEE Robotics and Automation Letters (RA-L), IEEE Access, IEEE Transaction on Haptics, IEEE Transaction on Automation Science and Engineering, The International Journal of Robotics Research (IJRR), Nonlinear Dynamics, Journal of Field Robotics, Scientific Reports, Multibody System Dynamics, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), IEEE International Conference on Robotics and Automation (ICRA), Robotics: Science and Systems (RSS), IEEE International Symposium on Medical Robotics (ISMR).