Milad Azizkhani

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Education

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

Theory-driven robotics researcher with 7+ years of experience building end-to-end robotic systems, from mathematical formulation and algorithm design to sensing, hardware integration, and real-time control. My work focuses on **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 of my research is combining **deep theoretical development** with **full-stack robotic implementation**, validated on **high-DoF soft and continuum robotic platforms** with **kHz-rate control pipelines**.

My current direction is toward **deeper foundations for learning, control, and decision-making under uncertainty**, aiming to develop **sample-efficient, physically grounded, and robust methods**. Author of **11+ peer-reviewed publications** and recipient of multiple competitive **fellowships and research awards**.

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

Publications

Journal Articles

- **[J8] M. Azizkhani**, S. Kousik, and Y. Chen, "Dynamic Task Space Control of a Redundant Pneumatically Actuated Soft Robot," *IEEE Robotics and Automation Letters*, 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*, 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*, 2024. [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*, 2023. [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*, 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*, 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*, 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*, 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," *2023 International Symposium on Medical Robotics (ISMR)* [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," *2023 IEEE International Conference on Robotics and Automation (ICRA)* [DOI]
- **[C1] M. Azizkhani** and Y. Chen, "Supervised Adaptive Fuzzy Control of LVAD with Pulsatility Ratio Modulation," *2022 IEEE 18th International Conference on Automation Science and Engineering (CASE)* [DOI]

Under Review / Preprints

- **M. Azizkhani** and Y. Chen, "Unified Complementarity-Based Contact Modeling and Planning for Soft Robots," *Under Review / Preprint*. [arXiv] [Project Website]

Ongoing Research Directions

- **Contact-Rich Planning and Control under Uncertainty**
- **Learning from Demonstration and Learning-Integrated Control for Soft Robot Interaction**
- **Vision-Guided and Manipulability-Aware Control for Soft Robotic Harvesting**

SKILLS

Programming:

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

Technologies & Tools:

ROS, Simulink, CasADi, ACADOS, YALMIP, Gurobi, Drake, MuJoCo, PyBullet, Isaac Gym, SurRoL, PyTorch, TensorFlow, Stable-Baselines3, OpenCV, Arduino/Teensy, LabVIEW, Flowcode, motion capture, SolidWorks, ABAQUS, ANSYS, Maple, Mathematica

EXPERIENCE

Georgia Institute of Technology, Atlanta, GA, USA 2022 – Present

Senior Graduate Research Assistant, BioMedical Mechatronics (BM^2) Lab

- **Contact-Rich Modeling, Planning, and Control under Uncertainty**
  - Developed unified **modeling, planning, and control frameworks** for nonlinear and underactuated robots in contact-rich environments, combining **complementarity-based (LCP) contact formulations**, **trajectory optimization**, and real-time simulation.
  - Built a **real-time physics engine** for forward simulation and planning through contact, and incorporated **reachability-based uncertainty analysis** for decision-making under interaction uncertainty.
  - Current research directions include **sampling-based stochastic optimal control** for contact-rich planning and control, including **MPPI-style methods**, with the goal of improving robustness and computational efficiency under uncertainty.
- **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]*.
- **Learning-Integrated and Vision-Guided Robotic Systems**
  - Led end-to-end development of a **vision-guided robotic harvesting platform**, integrating **ZED2 + ArUco + YOLO + Depth Anything**, teleoperation, and real-time control through **UDP-based communication** across MATLAB, Python, and WSL with **CasADi**/**ACADOS**-based motion generation.
  - Ongoing work explores **learning from demonstration**, **policy learning for robot interaction**, and **learning-augmented control** for developing more **sample-efficient and physically grounded** robot behaviors under uncertainty.
- **Teaching and Research Supervision**
  - Served as **TA for the VIP course** on soft elbow rehabilitation devices, mentoring **15+ students** from ECE, ME, BME, and CS in experimental design, control, and team-based system development.
  - Supervised graduate and undergraduate projects in **reinforcement learning for control**, **SMA-driven underwater robots**, **tendon-driven grippers** *[C2]*, **dVRK bimanual surgery control**, and **learning-based kinematic**

modeling.

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, 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).

Invited Talks

Soft Robot Control *April 2023*
Lidar Group Seminars, Georgia Institute of Technology, Atlanta, GA

Flash Talk: Adaptive Control for Soft Robot *August 2023*
CS 7785 (Introduction to Robotics), Georgia Institute of Technology, Atlanta, GA

From Soft to Smart: Enhancing Robot Control with Intelligence, Speed, and Accuracy *Oct 2023*
Coulter BME Seminar Series, Georgia Institute of Technology, Atlanta, GA

Bio-inspired Continuum Robot (joint lecture with Y. Chen and Y. Cai) *Nov 2024*
Guest Lecture for Prof. Dong's class, Vanderbilt University — Nashville, TN (Virtual)