Ran Tao

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EDUCATION

University of Illinois Urbana-Champaign

Ph.D. Candidate, M.Sc., B.Sc. in Mechanical Engineering — *Expected May 2026*
- Highest Honor: University Honor

TECHNICAL SKILLS

Research Expertise: Robotics, Motion Planning, Adaptive Control, Model Predictive Control, Optimization, Reinforcement Learning, Machine Learning

Programming Languages: C++, Python, MATLAB, Linux Shell

RESEARCH EXPERIENCE

Advanced Controls Research Lab (PI: Naira Hovakimyan) — Fall 2021 – Present

Graduate Student Researcher — *Urbana, IL*

- **Safe Planning for Autonomous Vehicles under Mission Uncertainty**
  * Designed a multi-objective MPC path planning framework to address long-horizon emergency response and mission uncertainty scenarios.
  * Ensured rigorous closed-loop stability and real-time feasibility using a sampling-based MPPI approach.
  * Validated in UAV emergency landing simulations, reducing energy consumption by 20% and increasing safety margins by 10% compared to baseline controllers.
- **Model Predictive Control against Dynamic Uncertainty**
  * Designed and implemented a robust adaptive MPC controller that compensated for uncertainties and disturbances in real time by integrating L1 Adaptive Control.
  * Ensured guaranteed constraint satisfaction and system stability through automated constraint tightening.
  * Achieved superior tracking performance over existing robust and tube MPC methods, demonstrated through simulations including aircraft trajectory tracking and autonomous spacecraft landing.
- **Closed-loop Learning for Model Predictive Control**
  * Developed a closed-loop learning framework to automatically tune MPC parameters using auto-differentiation.
  * Extended differentiable programming to implicitly differentiable MPC controllers, enabling gradient-based tuning for nonlinear systems in real time.
  * Improved quadrotor tracking accuracy by 20% and reduced tuning iterations compared to state-of-the-art methods, validated through RotorPy simulations.
- **Intelligent Crop Management System**
  * Developed an intelligent crop management system integrating reinforcement learning, imitation learning, language models, and crop simulations using DSSAT and addressed the sim-to-real gap using feature masking.
  * Achieved optimization of nitrogen fertilization and irrigation simultaneously, enhancing economic profit by over 45% while reducing environmental impact in crop simulation.

INTERN EXPERIENCE

Zoox — May 2025 – August 2025

Planner Motion Intern — *Foster City, CA*

- Developed a context-aware stopping framework within the motion planning stack for autonomous driving, enhancing passenger comfort and optimizing traffic flow.
- Analyzed large-scale human driving data to extract stopping behavior patterns, using the insights to guide design decisions, and refined the framework through public road vehicle testing in San Francisco.

SELECTED PUBLICATIONS

- **Ran Tao**, Sheng Cheng, Xiaofeng Wang, Shenlong Wang, and Naira Hovakimyan. "DiffTune-MPC: Closed-loop learning for model predictive control." IEEE Robotics and Automation Letters (2024).
- **Ran Tao**, Pan Zhao, Jing Wu, Nicolas F. Martin, Matthew T. Harrison, Carla Ferreira, Zahra Kalantari, and Naira Hovakimyan. "Optimizing Crop Management with Reinforcement Learning and Imitation Learning." In Proceedings of the Thirty-Second International Joint Conference on Artificial Intelligence, IJCAI-23, AI for Good.
- **Ran Tao**, Pan Zhao, Ilya Kolmanovsky, and Naira Hovakimyan. "Robust Adaptive MPC Using Uncertainty Compensation." In 2024 American Control Conference (ACC), pp. 1873-1878. IEEE, 2024.
- **Ran Tao**, Hunmin Kim, Hyung-Jin Yoon, Wenbin Wan, Naira Hovakimyan, Lui Sha, and Petros Voulgaris. "Backup Plan Constrained Model Predictive Control with Guaranteed Stability." AIAA Journal of Guidance, Control, and Dynamics, 47(2), 233-246.