

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

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**
 - * Developed an innovative path planning algorithm to enhance safety for autonomous vehicles under mission uncertainty.
 - * Formulated a multi-objective MPC with multi-horizon inputs, backed by rigorous stability guarantees and efficient real-time implementation using sampling based method MPPI.
 - * Demonstrated the algorithm's effectiveness through UAV emergency landing scenario, showing a 20% decrease in the energy consumption and 10% increase in safety margins compared to baseline methods.
- **Model Predictive Control against Dynamic Uncertainty**
 - * Developed a robust adaptive MPC controller to handle dynamic uncertainties and disturbances.
 - * Integrated L1 Adaptive Control for uncertainty estimation and compensation, and ensured robust constraints enforcement through constraints tightening.
 - * Improved tracking performance compared with exiting robust and tube MPC approaches through a flight control simulation.
- **Closed-loop Learning for Model Predictive Control**
 - * Developed an innovative closed-loop learning method to auto-tune MPC parameters.
 - * Extended differentiable programming to MPC, enabling gradient-based tuning for nonlinear systems.
 - * Improved tracking performance by 20% compared with hand-tuned parameters through quadrotor simulations in RotorPy and reduced tuning iterations for convergence compared with state-of-the-art methods.
- **Intelligent Crop Management System**
 - * Developed an intelligent crop management system integrating reinforcement learning, imitation learning, language models, and crop simulations.
 - * Achieved optimization of nitrogen fertilization and irrigation simultaneously, enhancing economic profit by over 45% while reducing environmental impact in crop simulation.
 - * Addressed the challenge of deploying trained policies in real-world settings, considering factors like sim-to-real gap and measurement noise impacts.

TECHNICAL SKILLS

Research Expertise: Adaptive Control, MPC, Optimization, State Estimation, Dynamics Modeling, Machine Learning

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

Technologies/Frameworks: git, PyTorch, LaTeX, MATLAB Simulink, OpenAI Gym for RL

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, 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.
- **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*. Pages 6228-6236.