

Ran Tao

217-904-5083 | rant3@illinois.edu

EDUCATION

University of Illinois Urbana-Champaign

Ph.D. Student in Mechanical Engineering

Expected May 2026

University of Illinois Urbana-Champaign

M.Sc. in Mechanical Engineering

Fall 2021 - December 2022

University of Illinois Urbana-Champaign

B.Sc. in Mechanical Engineering

Fall 2017 - May 2021

- GPA: 3.99
- Highest Honor: University Honor
- MechSE Bei Tse & May Chao Award (Spring 2021)

RESEARCH EXPERIENCE

Advanced Controls Research Lab (PI: Naira Hovakimyan)

Fall 2021 – Present

Graduate Student Researcher

Urbana, IL

- Robust Adaptive Model Predictive Control
 - * Introduced a robust adaptive Model Predictive Control (MPC) framework utilizing uncertainty compensation for linear systems with both matched and unmatched uncertainties.
 - * Integrated L1 Adaptive Control for matched uncertainty estimation and compensation, ensuring uniform performance bounds.
 - * Proposed Uncertainty Compensation-based MPC (UC-MPC) for enhanced tracking performance and robust constraint satisfaction, effectively handling both matched and unmatched disturbances.
 - * Demonstrated the UC-MPC's effectiveness through simulations, showcasing its superiority in managing uncertainties and tracking performance compared with traditional robust and tube MPC approaches.
- Stability for Multi-objective Model Predictive Control
 - * Developed a feasibility maximization problem formulation using multi-objective model predictive control (MPC) with multi-horizon control inputs.
 - * Introduced a innovative MMPC algorithm that ensures asymptotic stability of the closed-loop system and maintains constraints enforcement.
- Optimal Agriculture Management
 - * Developed an optimal crop management system using crop simulations (using DSSAT) and optimal control methods.
 - * Achieved optimization of nitrogen fertilization and irrigation simultaneously, enhancing economic profit by over 45% while reducing environmental impact.
 - * Conducted simulation experiments on maize crops in Florida, USA, and Zaragoza, Spain, demonstrating significant improvements over baseline methods.
- Diff-TuneMPC: Closed-loop Tuning for Model Predictive Control
 - * Introduced DiffTune-MPC, an innovative approach for tuning Model Predictive Control (MPC) parameters, enhancing controller performance.
 - * Leveraged KKT conditions to find the implicit differentiation of the MPC problem and used gradient-based optimization for fine-tuning MPC cost function parameters.
 - * Demonstrated DiffTune-MPC's effectiveness in optimizing quadratic cost parameters for linear and non-linear systems.
 - * Showcased significant improvements in computational efficiency and loss reduction through simulations on various control systems.

TECHNICAL SKILLS

Research Expertise: Adaptive Control, MPC, Optimization, State Estimation, Dynamics Modeling, Simulation and Control of Mobile Systems

Programming Languages: Python, MATLAB

Technologies/Frameworks: Pytorch, LaTeX

3-D CAD Modeling: SolidWorks, Creo

- **Ran Tao**, Pan Zhao, Ilya Kolmanovsky, and Naira Hovakimyan. "Robust Adaptive MPC Using Uncertainty Compensation." Accepted at 2024 American Control Conference (ACC).
- **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.
- **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 (2023), accessed October 18, 2023. doi: 10.2514/1.G007627
- Jing Wu, **Ran Tao**, Pan Zhao, Nicolas F. Martin, and Naira Hovakimyan. "Optimizing Nitrogen Management with Deep Reinforcement Learning and Crop Simulations." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, pp. 1712-1720. 2022.