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*

University of Illinois Urbana-Champaign
M.Sc., B.Sc. in Mechanical Engineering — *Aug 2017 - May 2021, Aug 2021 - Dec 2022*

- Highest Honor: University Honor

Technical Skills

Research Expertise: Adaptive Control, Model Predictive Control, Motion Planning, Optimization, State Estimation, Dynamics Modeling and Simulation, 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**
  - Developed an innovative path planning algorithm to enhance safety for autonomous vehicles during complex operations with long-horizon emergency response and mission uncertainties.
  - Formulated a multi-objective model predictive control to maximize the feasibility of all missions, 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 uncertainties and disturbances in system dynamics.
  - Integrated L1 Adaptive Control for uncertainty estimation and compensation, and ensured robust constraints enforcement through constraints tightening.
  - Achieved superior tracking performance over existing robust and tube MPC methods, demonstrated through simulations involving longitudinal aircraft motion control and a soft landing of a spacecraft on an asteroid.
- **Closed-loop Learning for Model Predictive Control**
  - Developed an innovative closed-loop learning method to auto-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 performance by 20% compared with hand-tuned parameters through simulations in RotorPy and reduced tuning iterations for convergence compared with state-of-the-art methods.

Intern Experience

Zoox — May 2025 – August 2025
Planner Motion Intern — *Foster City, California*

- 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 refine the framework through public road vehicle testing.

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. Pages 6228-6236.
- **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.