

Research Interests

Robotics, Safe Motion Planning, Autonomous Systems

My research focuses on advancing the capabilities of **robotics** and **autonomous systems** to operate safely and efficiently in dynamic, uncertain environments. The goal is to ensure reliable performance while addressing the challenges of system robustness, adaptability, and safety. I am particularly interested in the integration of **control systems** with **motion planning** to enable autonomous systems to make decisions and adapt to changing conditions. My work also explores the broader implications of **safety and reliability** in real-world applications, including the development of approaches that allow robots and autonomous systems to handle disturbances, unforeseen obstacles, and system faults. Ultimately, my research aims to push the boundaries of **autonomous systems** to enhance their functionality and performance across various domains.

Academic Preparation

University of Illinois at Urbana-Champaign (UIUC) Urbana, IL
Ph.D. in Mechanical Engineering Spring 2020 – May 2025
Advisor: Professor Naira Hovakimyan

University of Illinois at Urbana-Champaign (UIUC) Urbana, IL
M.S. in Mechanical Engineering Fall 2018 – Spring 2020
Advisor: Professor Naira Hovakimyan

Zhejiang University (ZJU) Hangzhou, China
B.S. in Mechanical Engineering Fall 2015 – Spring 2019
Advisor: Professor

Research Experience

PhD Researcher, Advanced Control Research Lab (ACRL), UIUC
Jan. 2020 – Present

Research Focus: Safe motion planning and control for cyber-physical systems with applications to robotic navigation. Developed and implemented novel algorithms on platforms including GemV-2, GemV-4, drones, and VTOLs. Research highlights include a guided sampling-based motion planning algorithm for dynamic and obstacle-cluttered environments, resilient control barrier functions for systems under disturbances and noise, and integration of optimization-based techniques with sampling-based guidance for trajectory optimization. These contributions have been validated through simulation and real-world experiments, advancing the fields of autonomous navigation and robust control.

Master Researcher, Advanced Control Research Lab (ACRL), UIUC

Mar. 2019 – Jan. 2020

Research Focus: Safe control of cyber-physical systems with applications to robotic navigation and human-robot interaction. Developed the "VR Environment: Socially Aware Motion Planning for a Flying Robot," implementing predictive control strategies in human-interactive VR environments. Collaborated on "Virtual Sully" project, creating control algorithms for fault-tolerant operations. Maintained ACRL's website.

Undergraduate Researcher, ZJU National Laboratory of Industrial Control Technology, ZJU

Fall 2017 – Fall 2018

Responsibilities: Designed the mechanical parts for the unicycle football robots and simulated the force analysis using Solidworks software.

Teaching Experience

ME 461: Computer Control of Mechanical Systems, UIUC

Course Instructor

Fall 2024 – Present

Delivered lectures and designed lab exercises focused on embedded systems, including topics such as digital I/O, PWM, ADC, SPI communication, and motor control. Developed comprehensive lab documents covering soldering and hardware setup, GPIO programming, PWM peripherals, ADC integration, and SPI communication with an IMU. Guided students through advanced control topics such as balancing a Segbot and steering a robotic car. Integrated LABVIEW assignments to teach system design and data communication, culminating in a final project involving state machine design.

ECE 470: Introduction to Robotics, UIUC

Teaching Assistant

Spring 2020 – Spring 2024

Lead TA, responsible for lab manual development, including projects on UR3 robotic hand manipulation, particle filters, and vision tasks in ROS. Involved in course exams and homework on kinematics through PrairieLearn platform.

Publications

- Tao, C., Kim, H., Yoon, H., Hovakimyan, N., & Voulgaris, P. (2022). Control barrier function augmentation in sampling-based control algorithm for sample efficiency. *In 2022 American Control Conference (ACC)* (pp. 3488–3493). IEEE.
- Tao, C., Yoon, H.-J., Kim, H., Hovakimyan, N., & Voulgaris, P. (2022). Path integral methods with stochastic control barrier functions. *In 2022 IEEE 61st Conference on Decision and Control (CDC)* (pp. 1654–1659). IEEE.

- Tao, C., Kim, H., & Hovakimyan, N. (2023). RRT guided model predictive path integral method. *In 2023 American Control Conference (ACC)* (pp. 776–781). IEEE.
- Tao, C., Cheng, S., Zhao, Y., Wang, F., & Hovakimyan, N. (2024). An optimization-based planner with B-spline parameterized continuous-time reference signals. *In 2024 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*.
- Tao, C., Wan, W., Gao, J., Mo, B., Kim, H., & Hovakimyan, N. (2024). Resilient estimator-based control barrier functions for dynamical systems with disturbances and noise. *In AIAA AVIATION Forum and ASCEND 2024* (p. 4498).
- Tao, C., & Kim, H. (2024). Guided sampling-based motion planning algorithm for dynamic and obstacle cluttered environments. *To be submitted to Journal of Guidance, Control, and Dynamics, AIAA*.
- Tao, C., Cheng, S., Ke, Y., Mo, B., & Hovakimyan, N. (2024). B-spline parameterized continuous-time differential dynamic programming. *To be submitted to IEEE Robotics and Automation Letters (RAL)*.
- Zhao, P., Mao, Y., Tao, C., Hovakimyan, N., & Wang, X. (2020). Adaptive robust quadratic programs using control Lyapunov and barrier functions. *In 2020 59th IEEE Conference on Decision and Control (CDC)* (pp. 3353–3358). IEEE.
- Song, L., Wan, N., Gahlawat, A., Tao, C., Hovakimyan, N., & Theodorou, E. (2022). Generalization of safe optimal control actions on networked multiagent systems. *IEEE Transactions on Control of Networked Systems*, 10(1), 491–502.
- Yoon, H. J., Tao, C., Kim, H., Hovakimyan, N., & Voulgaris, P. (2023). Adaptive risk-sensitive path integral for model predictive control via reinforcement learning. *In 31st Mediterranean Conference on Control and Automation (MED)* (pp. 926–931).
- Yoon, H. J., Tao, C., Kim, H., Hovakimyan, N., & Voulgaris, P. (2022, June). Sampling complexity of path integral methods for trajectory optimization. *In 2022 American Control Conference (ACC)* (pp. 3482–3487). IEEE.
- Wu, J., Lai, Z., Liu, S., Chen, S., Tao, R., Zhao, P., Tao, C., Cheng, Y., & Hovakimyan, N. (2025). CROPS: A Deployable Crop Management System Over All Possible State Availabilities. *Submitted to Proceedings of the AAAI Conference on Artificial Intelligence (AAAI 2025)*.

Honors and Awards

Second Class, Zhejiang University Energy Conservation Contest	2018
Third Prize, National Energy Conservation Contest	2018
First Class, Zhejiang Mechanic Design Contest	2017
Third Prize, Zhejiang Undergraduate Physics Tournament	2016
Third Prize, Mechanics Comics Design	2016

Professional Services**Journal Reviewer**

IEEE Transactions on Control Networks and Systems (TCNS)

IEEE Transactions on Automatic Control (TAC)

Robotics and Automation Letters (RAL)

IEEE Transactions on Robotics (TRO)

Conference Reviewer

IEEE American Control Conference (ACC)

IEEE Conference on Decision and Control (CDC)

IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)

IEEE International Conference on Robotics and Automation (ICRA)

Professional Experience**Mechanical Design Intern, ZJU National Laboratory of Industrial Control Technology**

Fall 2017 – Fall 2018

Developed mechanical designs and force simulations in SolidWorks for unicycle football robots.

Mentor, ALERT Program

Summer 2023

Mentored students in the ALERT Program, guiding them through engineering projects, providing technical support, and helping them develop problem-solving skills in mechanical design and control systems.

Mechanical Design Intern, Dongfeng Automobile Co. Ltd. Summer 2018

Contributed to mechanical design projects, focusing on the development of vehicle components and systems, and assisted in simulations and performance testing for automotive systems.