Yuhao Zhang

PhD Student in Mechanical Engineering
University of Wisconsin-Madison
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Summary

PhD student in Mechanical Engineering at the University of Wisconsin-Madison, graduating in August 2025. Specializing in formal analysis, verification, and control design for autonomous systems and learning-enabled systems to ensure safety in real-world applications.

Education

University of Wisconsin-Madison Madison, WI
Doctor of Philosophy in Mechanical Engineering *Sep 2020 – Present*

- Advisor: Prof. Xiangru Xu
- GPA: 4.00/4.00
- Research Interest: Analysis, verification and control design for safety-critical systems and learning-enabled systems

University of Michigan-Ann Arbor Ann Arbor, MI
Master of Science in Engineering in Mechanical Engineering *Sep 2017-May 2019*

- Advisor: Prof. Necmiye Ozay and Prof. Jean-Baptiste Jeannin
- GPA: 4.00/4.00
- Project: Vision-based Autonomous Taxiing and Landing of Aircraft

Peking University Beijing, China
Bachelor of Engineering in Energy and Power Engineering *Sep 2013-Jun 2017*
Bachelor of Economics (Double Degree) *Sep 2014-Jun 2017*

- Advisor: Prof. Jianchun Mi
- GPA: 3.46/4.00
- Thesis: Experimental and Simulation Research on MILD Combustion Properties in Methanol Boilers

Experience

University of Wisconsin-Madison Madison, WI
Research Assistant at Autonomous & Resilient Controls Lab *Sep 2020-Present*

- Developed rigorous analysis and control methodologies to ensure the reliability of autonomous intelligent systems, such as self-driving cars and quad-rotors.
- Employed optimal control and robust control techniques to design safe control algorithms for systems with various types of uncertainties.
- Conducted numerical simulations in MATLAB and Python for dynamic systems, including autonomous vehicles and robots.
- Designed and tested control algorithms in quadcopter experiments to ensure safety through effective obstacle avoidance.

- Proposed provable stability conditions for Neural Network Control Systems with dynamics uncertainties.
- Implemented optimization-based techniques for formal safety verification and reachability analysis of controlled systems with Artificial Neural Network components.

University of Michigan-Ann Arbor Ann Arbor, MI

Research Associate *Sep 2018-Jun 2020*

- Designed a high-level software architecture for autonomous taxiing and landing of aircraft.
- Implemented separate modules for the proposed architecture, including a path-finding algorithm, a taxi-way waypoint generator, and a low-level tracking controller based on Model Predictive Control (MPC).
- Employed falsification techniques to evaluate the performance of the designed controllers.

University of Michigan-Ann Arbor Ann Arbor, MI

Course Project - Self-driving Cars: Perception and Control *Sep 2017-Dec 2017*

- Designed a controller for a bicycle model to follow a pre-defined track as rapidly as possible.
- Developed a control algorithm based on MPC to avoid obstacles known only at run-time.

Peking University Beijing, China

Undergraduate Research Assistant *Feb 2016-Jun 2017*

- Simulated combustion in traditional boilers and studied the environmental influence of pollution.
- Experimental and simulation study of methanol MILD combustion in boilers, achieving higher thermal efficiency and lower pollution production.

The Chinese University of Hong Kong Hong Kong

Summer Research Intern *Jul 2016-Aug 2016*

- Worked on harvesting kinetic energy from human motion and vibrations, advised by Prof. Wei-Hsin Liao.

Skills

Programming: MATLAB, Python, C++, C
Software/Tools: Simulink, SolidWorks, PyTorch, Gurobi, Linux, CUDA, FEM, Git
Hardware: Crazyflie quadrotor, Raspberry Pi, Arduino
Language: English, Chinese (Mandarin)

Professional Service

Grader

- ECE 560 - Linear Systems Theory at the University of Michigan-Ann Arbor

Journal Reviewer

- IEEE Transactions on Control Systems Technology (TCST)
- IEEE Control Systems Letters (L-CSS)
- Systems & Control Letters
- Control Engineering Practice

Conference Reviewer

- IEEE Conference on Decision and Control (CDC)
- American Control Conference (ACC)
- IEEE International Conference on Robotics and Automation (ICRA)
- Annual Learning for Dynamics and Control Conference (L4DC)

Publications

Journal Publications

J1. **Yuhao Zhang**, Xiangru Xu, "Robust Stability of Neural Feedback Systems with Interval Matrix Uncertainties", *Automatica*, 2024. (Provisionally accepted) https://arxiv.org/abs/2311.15109

J2. **Yuhao Zhang**, Hang Zhang, Xiangru Xu, "Reachability Analysis of Neural Network Control Systems with Tunable Accuracy and Efficiency", *IEEE Control Systems Letters*, 8: 1697-1702, 2024. https://doi.org/10.1109/LCSYS.2024.3415471

J3. **Yuhao Zhang**, Hang Zhang, Xiangru Xu, "Backward Reachability Analysis of Neural Feedback Systems Using Hybrid Zonotopes", *IEEE Control Systems Letters*, 7: 2779-2784, 2023. https://doi.org/10.1109/LCSYS.2023.3289572

Peer-reviewed Conference Publications

C1. Hang Zhang, **Yuhao Zhang**, Xiangru Xu, "Hybrid Zonotope-Based Backward Reachability Analysis for Neural Feedback Systems With Nonlinear Plant Models", *American Control Conference*, Toronto, ON, Canada, page 4155–4161, 2024. https://doi.org/10.23919/ACC60939.2024.10644573

C2. **Yuhao Zhang**, Xiangru Xu, "Reachability Analysis and Safety Verification of Neural Feedback Systems via Hybrid Zonotopes", *American Control Conference*, San Diego, CA, USA, page 1915–1921, 2023. https://doi.org/10.23919/ACC55779.2023.10156417

C3. **Yuhao Zhang**, Xiangru Xu, "Safety Verification of Neural Feedback Systems Based on Constrained Zonotopes", *IEEE Conference on Decision and Control*, Cancun, Mexico, page 2737-2744, 2022. https://doi.org/10.1109/CDC51059.2022.9992655

C4. **Yuhao Zhang**, Sequoyah Walters, Xiangru Xu, "Control Barrier Function Meets Interval Analysis: Safety-Critical Control with Measurement and Actuation Uncertainties", *American Control Conference*, Atlanta, GA, USA, page 3814–3819, 2022. https://doi.org/10.23919/ACC53348.2022.9867681

C5. Sara Shoouri, Shayan Jalili, Jiahong Xu, Isabelle Gallagher, **Yuhao Zhang**, Joshua Wilhelm, Jean-Baptiste Jeannin, Necmiye Ozay, "Falsification of a Vision-based Automatic Landing System", *AIAA SciTech Forum*, 2021. https://doi.org/10.2514/6.2021-0998

C6. **Yuhao Zhang**, Guillaume Poupart-Lafarge, Huaiyuan Teng, JoshuaWilhelm, Jean-Baptiste Jeannin, Necmiye Ozay, Eelco Scholte, "A Software Architecture for Autonomous Taxiing of Aircraft", *AIAA SciTech Forum*, 2020. https://doi.org/10.2514/6.2020-0139

Preprints

P1. **Yuhao Zhang**, Xiangru Xu, "Finding Matrix Sequences with a High Asymptotic Growth Rate for Linear Constrained Switching Systems", *arXiv:2009.12948*, 2021. https://arxiv.org/abs/ 2009.12948

Courses

Nonlinear Optimization, Dynamic Programming, High Performance Computing, Advanced Computational Dynamics, Linear System Theory, Robot Kinematics and Dynamics, Self-Driving Cars: Perception and Control

Leadership and Community Service

Engineering EXPO Madison, WI
Student Exhibitor *Apr 2023*

- Demonstrated quadrotor experiments to middle school students, earning the Honorable Mention Award.

Practice Department in College of Engineering Beijing, China
Vice President *Sep 2014-Jun 2015*

- Organized summer internship programs and coordinated local company visits for undergraduates.

Awards and Achievements

Student Research Grants Competition Award
University of Wisconsin-Madison Graduate School *Apr 2023*

LeRoy Fellowship
Department of Mechanical Engineering, University of Wisconsin-Madison *Sep 2023*

XIA Shouyu and HUANG Yuqin Scholarship
College of Engineering, Peking University *May 2016*

Community Service Award
College of Engineering, Peking University *Dec 2015*

Second prize in National High School Mathematics Competition
Chinese Mathematical Society *Nov 2012*