

Meng Zhai

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Bio

I am currently a Ph.D. Candidate at Nankai University, supervised by **Prof. Sun Ning**. Our academic team is led by **Prof. Yongchun Fang**. My research focuses on **underactuated mechatronic/robotic systems**, with equal emphasis on theory and application. I have published more than **10 peer-reviewed papers**, primarily in top journals in artificial intelligence and automatic control like **IEEE Trans.** Recognized with **4 Best Paper/Best Poster awards** at conferences. Recipient of the Autonomous Robotic Technology Seminar Scholarship Nomination Award (8 candidates worldwide each year), the National Scholarship for Doctoral Students, the BYD Scholarship, and several other academic awards. Independent reviewer for IEEE TIE, IEEE TCyber, IEEE RAL, ICRA, ACC, CDC, etc.

I have been awarded the **National Natural Science Foundation of China (NSFC)** Youth Student Basic Research Project (**for Ph.D. students**) as **principal investigator**.

Education

- **Nankai University (985, Double First Class)** Tianjin, China
• *Ph.D. Candidate in Artificial Intelligence* *Sep. 2021 - Jun. 2026 (expected)*
 - Supervisor: **Prof. Sun Ning** (Changjiang Young Scholars Program by the Ministry of Education)
 - Major Courses: Intelligent predictive control, Nonlinear control based on Lyapunov method, Adaptive control, Modeling and identification, etc.
- **Jilin University (985, Double First Class)** Changchun, China
• *B.S. degree in Automation* *Sep. 2017 - Jun. 2021*
 - Ranking: 8/161 (**Top 5%**) GPA: 3.79/4.0
 - Major Courses: Automatic control principles, Modern control theory, Electric drive automatic control system, Computer control system, etc.

Projects Leadership

- **Research on Variable Tension and Follow-Up Control of Suspension Systems Under Micro-Low Gravity Simulation Scenario:** **NSFC** Youth Student Basic Research Project (**for Ph.D. students**); Jun. 2025 - Dec. 2026; CNY 300,000; **PI**.
 - This project aims to achieve *high-fidelity simulation* of the equivalent mechanical environment of a micro-low gravity field using suspension systems, providing feasible experimental conditions for ground-based research on the dynamic behavior of spacecraft on extraterrestrial bodies. Targeted **system design, modeling, and control methods** are developed. The outcomes will be practically implemented at the China Academy of Space Technology (CAST) 518 Institute, which is expected to contribute to ground validation for extraterrestrial exploration missions in China.
- **Dynamics-Mechanism-Driven General Planning and Control Methods for Underactuated Systems:** Ph.D. Dissertation Research; Sep. 2021 - Jun. 2026.
 - This research aims to address the **common challenges in various underactuated robotic systems**, where the number of independent control inputs is *fewer* than the system's degrees of freedom. By analyzing and utilizing their dynamic structural characteristics and task demands, this research proposes a **class of unified control and planning methods** to enhance steady/transient performance, transient performance, safety, reliability, robustness, and intelligence in underactuated robotic systems.

Publications

1. **Meng Zhai**, Ning Sun, Tong Yang, and Yongchun Fang, "Underactuated mechanical systems with both actuator and actuated/unactuated state constraints: A predictive control-based approach," *IEEE/ASME Transactions on Mechatronics*, 2023, 28(3): 1359–1371.
2. **Meng Zhai**, Tong Yang, Qingxiang Wu, Shudong Guo, Ruiping Pang, and Ning Sun, "Extended Kalman filtering-based nonlinear model predictive control for underactuated systems with multiple constraints and obstacle avoidance," *IEEE Transactions on Cybernetics*, 2025, 55(1): 369–382.
3. **Meng Zhai**, Tong Yang, Ming Li, Xuerui Jiao, Yongchun Fang, and Ning Sun, "Adaptive neural network unified control for general MIMO underactuated mechatronic systems with disturbances via modified normal forms," *IEEE Transactions on Automation Science and Engineering*, 2025, 22: 19377–19391.

4. **Meng Zhai**, Shuzhen Diao, Tong Yang, Qingxiang Wu, Yongchun Fang, and Ning Sun, “Adaptive fuzzy control for underactuated robot systems with inaccurate actuated states and unavailable unactuated states,” *IEEE Transactions on Automation Science and Engineering*, 2025, 22: 1566–1578.
5. **Meng Zhai**, Tong Yang, Ning Sun, and Yongchun Fang, “Observer-based adaptive fuzzy control of under-actuated offshore cranes for cargo stabilization with respect to ship decks,” *Mechanism and Machine Theory*, 2022, 175: 104927.
6. **Meng Zhai**, Yixuan Wang, Weijie Hou, Qingxiang Wu, Ning Sun, “Safety follow-up control of under-actuated suspension systems for spacecrafts with unknown motion trajectories,” *Robot*, in press, DOI: 10.13973/j.cnki.robot.250049. (in Chinese)
7. **Meng Zhai**, Yu Gao, Tong Yang, Ming Li, and Ning Sun, “Trajectory planning for underactuated mechatronic systems with unactuated mechanical energy limits: A power regulation perspective,” *Proceedings of the 2025 International Conference on Mechatronics, Robotics, and Artificial Intelligence (MRAI 2025)*, Jinan, China, Jun. 19–21, 2025, pp. 113–117. **(Best Paper Award)**
8. **Meng Zhai**, Tong Yang, and Ning Sun, “Oscillations damping control of variable cable length pendulum systems by gain adaptive MPC,” *Proceedings of the 2023 IEEE International Workshop on Sensing, Actuation, Motion Control, and Optimization (SAMCON 2023)*, Southeast University, China, Mar. 24–26, 2023.
9. Yue Wang[#], Tong Yang[#], **Meng Zhai**, Yongchun Fang, and Ning Sun, “Ship-mounted cranes hoisting underwater payloads: Transportation control with guaranteed constraints on overshoots and swing,” *IEEE Transactions on Industrial Informatics*, 2023, 19(10): 9968–9978.
10. Tong Yang, **Meng Zhai**, Yongchun Fang, and Ning Sun, “Adaptive fuzzy control of underactuated switched systems with disturbance observation and actuated/unactuated motion constraints,” *IEEE Transactions on Fuzzy Systems*, 2024, 32(3): 1195–1207.
11. Tong Yang, Ning Sun, **Meng Zhai**, and Yongchun Fang, “Unactuated and actuated states simultaneously constrained optimal trajectory planning-based path-following control for underactuated robots,” *IEEE Transactions on Cybernetics*, 2024, 54(9): 5127–5140.
12. Yaxuan Wu, Qingxiang Wu, Menghua Zhang, Shudong Guo, **Meng Zhai**, Ruiping Pang, Ning Sun, “A model predictive control method for 7-DoF tower cranes with distributed mass payloads and variable rope lengths,” *Mechanical Systems and Signal Processing*, 2025, 229: 112513.
13. Tong Yang, Ning Sun, **Meng Zhai**, Yongchun Fang, and Qingxiang Wu, “Data-based dual-loop learning control of underactuated systems with disturbance prediction and input-output constraints,” *IEEE Transactions on Artificial Intelligence*, 2024, 5(7): 3419–3430.

Awards and Honors

• Academic Competitions Awards

- **Excellent Articles**, The 1st Conference on Systems Engineering and Electronics, 2025
- **Best Paper Award**, The 2025 International Conference on Mechatronics, Robotics, and Artificial Intelligence (MRAI), 2025
- **Best Poster Paper Award**, The 7th Chinese Conference on Swarm Intelligence and Cooperative Control (CCSICC), 2023
- The 3rd Autonomous Robotic Technology Seminar (ARTS) Scholarship Nomination Award **(8 candidates worldwide each year)**, 2025
- First Prize, Robot Competition for College Student in Five Provinces (Municipalities and Autonomous Regions) of North China, 2022
- Outstanding Graduation Thesis (Design), Jilin University, 2021
- Second Prize, China Undergraduate Physics Tournament (CUPT) (Team Captain), 2019

• Personal Honors

- **National Scholarship** for Doctoral Students, Nankai University & BYD Scholarship, 2025
- Outstanding Graduate Student Leader, Nankai University, 2025
- First Prize Gongneng Scholarship, Nankai University, 2025 and 2022 (cumulative 2 times)
- Merit Graduate Student, Nankai University, 2023
- Outstanding Graduate Student, Nankai University, 2022
- Graduate Admission Scholarship, Nankai University & Wukong Investment Scholarship, 2021
- National Encouragement Scholarship, Jilin University, 2020, 2019, and 2018 (cumulative 3 times)