

Chaoying Pei, Ph.D.

✉ peic@purdue.edu

🌐 <https://chaoyingpei.github.io/>

Expertise

- 📌 Control Theory (Optimal, Robust, Nonlinear); Optimization (Convex, Nonconvex); Feature Learning; Guidance, Navigation, and Control (GNC).

Education

- 2020.09 – 2024.08 📌 **Ph.D., Purdue University** Aeronautics and Astronautics Engineering.
Thesis title: *Multi-phase Optimization for Mixed-Integer Optimal Control*.
Advisor: *Ran Dai*
- 2020.01 – 2020.09 📌 **Ph.D., Ohio State University** Mechanical and Aerospace Engineering.
Advisor: *Ran Dai*
- 2015.09 – 2018.01 📌 **M.Eng., Beihang University** Inertial Technology and Navigation Instruments.
Key Coursework: *Advanced Inertial Navigation System, Precision Instrument Design, Embedded System Design and Application*.
- 2011.09 – 2015.07 📌 **B.Eng., Beihang University** Instrumentation and Optoelectronic Engineering.
Key Coursework: *Inertial Component Principle, The Principle of Automatic Control*.



Awards and Honors

- 2022 📌 **Bilsland Dissertation Fellowship**, prestigious funding program supporting exceptional doctoral students in their dissertation research at Purdue University.
- 2013 📌 **Team Champion in Aeromodeling**, secured at the 23rd National Model Aviation Championships for excellence in Vertical Takeoff and Landing.
- 2014 📌 **Third Prize, Electromechanical Class**, in the "Feng Ru Cup" Competition, an academic, scientific, and technological innovation event at Beihang University.
- 2013 📌 **Second Prize**, American Mathematical Modeling Competition, distinguished performance in mathematical modeling and problem-solving.






Invited Talk

- 2024 📌 **Mississippi State University (forthcoming)**, title: Advancing Aerospace Optimization: Harnessing Advanced Computational Techniques
- 📌 **University of Minnesota Twin Cities**, title: Advancing Aerospace Optimization: Harnessing Advanced Computational Techniques
- 📌 **The University of Texas at San Antonio**, title: Advancing Aerospace Optimization: Harnessing Advanced Computational Techniques
- 📌 **Missouri University of Science and Technology**, title: Advancing Aerospace Optimization: Harnessing Advanced Computational Techniques
- 📌 **Clarkson University**, title: Advancing Aerospace Optimization: Harnessing Advanced Computational Techniques
- 📌 **University of Arkansas**, title: Advancing Aerospace Optimization: Harnessing Advanced Computational Techniques
- 2023 📌 **Florida Institute of Technology**, title: Optimal Control meets Machine Learning: From Mars Landings to Autonomous System
- 📌 **Purdue AAE Research Symposium Series**, title: Integration of Mixed-Integer Optimization with Machine Learning for Practical Applications



Invited Talk (continued)

- 2022  **AIAA SCITECH 2023 Forum**, title: Mixed-Input Learning for Multi-point Landing Guidance with Hazard Avoidance
- 2022  **AIAA SCITECH 2022 Forum**, title: A Unified Optimization Algorithm for Bang-bang Optimal Control.


Services

- 2021-2023  **Paper Review**, American Control Conference (ACC)
-  **Paper Review**, IEEE Conference on Decision and Control (CDC)
-  **Paper Review**, Journal of Guidance, Control, and Dynamics
-  **Paper Review**, IEEE Transactions on Aerospace and Electronic Systems
- 2021  **Volunteer Organizer**, IEEE Conference on Decision and Control




Employment History

- 2020 –  **Research Assistant**, School of Aeronautics and Astronautics, Purdue University.
 - Developed a multi-stage, Second-Order Cone Programming (SOCP)-based iterative algorithm to address mixed-integer nonconvex optimization challenges, enhancing fuel efficiency in powered descent and advancing multi-point landing guidance with integrated hazard avoidance.
 - Devised a theoretically-grounded, intelligent learning approach for tackling fuel-optimal powered descent guidance in complex deterministic dynamical systems, merging iterative optimization with machine learning to enable real-time onboard application.
 - Designed an integrated system that leverages reinforcement learning to provide initial estimates for iterative algorithms, significantly improving the performance and solution quality for non-convex problems.
 - Crafted a pioneering structure for non-convex optimization, merging a distributed system with stochastic search strategies, thereby enhancing processing efficiency and elevating solution quality, confirmed by detailed simulation trials.
 - Developed an innovative atmospheric entry guidance model that enhances vehicle agility and accuracy by integrating translational and rotational motions through dual quaternions.
 - Designed a hybrid Alternating Direction Method of Multipliers (ADMM) algorithm for large-scale Quadratically Constrained Quadratic Programming (QCQP) challenges, ensuring bounded error and linear convergence rate.
 - Engineered an efficient distributed optimization framework for large-scale rank-constrained semidefinite programming (RCSP), improving the solvability of complex RCSPs.
- 2018 – 2020  **Planning and Control Algorithms Engineer**, Baidu Inc, P.R.China
 - Engineered and deployed a cost-effective, real-time path planning system utilizing state machines and geometric algorithms for autonomous parking, successfully integrated and validated in **commercial vehicles and scaled to mass production**.
 - Developed and deployed an advanced valet parking algorithm enabling vehicles to autonomously navigate through parking lots, skillfully avoid obstacles, and precisely stop at assigned spots, with proven efficacy in **live vehicle operations**.

Employment History (continued)

- 2015 – 2018  **Research Assistant**, Department of Instrumentation and Optoelectronics, Beihang University, Beijing, P.R.China.
- Crafted an offline path planning technique for Unmanned Aerial Vehicles (UAVs) using genetic algorithms, integrating threat maps with real maps, and enhancing population initialization and genetic factors.
 - Introduced an enhanced D* algorithm for real-time UAV path planning, integrating map height data and the cost function for three-dimensional UAV route determination.
 - Designed a swift UAV planning and control technique to enable the UAV to approach and tail a moving ship from any location.
 - Engineered the hardware system, including microprocessor chips and a suite of sensors, for the flight control circuitry of a tilting rotor UAV.

Professional Societies

- 2021-Present  Member of American Institute of Aeronautics and Astronautics (AIAA).
- 2022-Present  Member of Institute of Electrical and Electronics Engineers (IEEE).
-  Society of Women Engineers member.

Publication List

Journal Articles (Peer Reviewed)

- 1 V. Kenny, S. You, and **C. Pei**, “Optimal abort guidance and experimental verification based on feature learning,” *Journal of Aerospace Engineering*, 2023, Accepted.
- 2 **C. Pei**, S. You, and R. Dai, “A multi-phase optimization algorithm for mixed-integer optimal control,” *Journal of Guidance, Control, and Dynamics*, 2023, Under review.
- 3 **C. Pei**, C. Wan, R. Dai, and J. R. Rea, “A hybrid adm for six-degree-of-freedom entry trajectory optimization based on dual quaternions,” *IEEE Transactions on Aerospace and Electronic Systems*, 2022.
- 4 **C. Pei**, S. You, C. Sun, and R. Dai, “Distributed optimization for rank-constrained semidefinite programs,” *IEEE Control Systems Letters*, vol. 7, pp. 103–108, 2022.
- 5 Q. Zhang, X. Wang, X. Xiao, and **C. Pei**, “Design of a fault detection and diagnose system for intelligent unmanned aerial vehicle navigation system,” *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, vol. 233, no. 6, pp. 2170–2176, 2019.
- 6 **C. Pei**, J. Zhang, X. Wang, and Q. Zhang, “Research of a non-linearity control algorithm for uav target tracking based on fuzzy logic systems,” *Microsystem Technologies*, vol. 24, pp. 2237–2252, 2018.
- 7 Q. Zhang, X. Wang, S. Wang, and **C. Pei**, “Application of improved fast dynamic allan variance for the characterization of mems gyroscope on uav,” *Journal of Sensors*, vol. 2018, 2018.
- 8 S. Wang, J. Zhang, Q. Zhang, and **C. Pei**, “An innovative fuzzy backstepping sliding mode controller for a tri-rotor unmanned aerial vehicle,” *Microsystem Technologies*, vol. 23, pp. 5621–5630, 2017.
- 9 Y. Zhang, Y. Guo, K. Li, **C. Pei**, and M. Li, “Error-compensation method for inclination measurement under the influence of the dynamic interference,” *IEEE Sensors Journal*, vol. 16, no. 3, pp. 734–741, 2015.

Conference Proceedings (Peer Reviewed)

- 1 **C. Pei**, Z. Xu, S. You, and R. Dai, “Reinforcement learning-guided quadratically constrained quadratic programming for enhanced convergence and optimality,” in *2023 IEEE Conference on Decision and Control (CDC)*, Accepted, 2024.
- 2 **C. Pei**, D. Yu, S. You, and R. Dai, “A stochastic distributed optimization framework for quadratically constrained quadratic programs,” In working, 2024.

- 3 Z. Xu, **C. Pei**, and R. Dai, "Adaptive low-rank tensor approximation based on mixed-integer representations," in *2024 IEEE American Control Conference (ACC)*, 2024.
- 4 V. Kenny, S. G. Hendrix, S. You, R. Dai, and J. R. Rea, "Feature-based learning for optimal abort guidance," in *AIAA SCITECH 2023 Forum*, 2023, p. 0302.
- 5 **C. Pei**, S. You, R. Dai, and J. R. Rea, "Mixed-input learning for multi-point landing guidance with hazard avoidance part i: Offline mission planning based on multi-stage optimization," in *AIAA SCITECH 2023 Forum*, 2023, p. 1445.
- 6 S. You, **C. Pei**, R. Dai, and J. R. Rea, "Mixed-input learning for multi-point landing guidance with hazard avoidance part ii: Learning-based guidance algorithm," in *AIAA SCITECH 2023 Forum*, 2023, p. 1446.
- 7 V. Kenny, S. You, **C. Pei**, and R. Dai, "Feature learning for optimal control with b-spline representations," in *2022 American Control Conference (ACC)*, IEEE, 2022, pp. 2917–2923.
- 8 **C. Pei**, S. You, R. Dai, and J. R. Rea, "A unified optimization algorithm for bang-bang optimal control," in *AIAA SCITECH 2022 Forum*, 2022, p. 0953.
- 9 **C. Pei**, S. You, C. Sun, and R. Dai, "Distributed optimization for rank-constrained semidefinite programs," in *2022 IEEE Conference on Decision and Control (CDC)*, IEEE, 2022.
- 10 M. Jung, Q. Ze, **C. Pei**, *et al.*, "Enhanced power generation of airborne wind energy system by a foldable aircraft," in *AIAA Scitech 2021 Forum*, 2021, p. 0868.
- 11 C. Wan, **C. Pei**, R. Dai, G. Jing, and J. R. Rea, "Six-dimensional atmosphere entry guidance based on dual quaternion," in *AIAA Scitech 2021 Forum*, 2021, p. 0507.
- 12 **C. Pei**, J. Zhang, X. Wang, and Q. Zhang, "A method of path planning and control strategy for carrier-based uav in return section," in *2017 2nd International Conference on Automation, Mechanical and Electrical Engineering (AMEE 2017)*, Atlantis Press, 2017, pp. 9–17.

