

# XUSHENG LUO

✉ xushengl@andrew.cmu.edu

🌐 <https://xushengluo92.github.io>

☎ +1 (252) 263-8586

## RESEARCH INTERESTS

---

**Topics:** Robotics; control; machine learning & AI; assured autonomy; optimization; decision making; verification.

**Overview:** I am broadly interested in developing principled algorithms that empower general-purpose autonomous robots to operate safely and effectively in human environments, while maintaining robustness against real-world disturbances and adversarial attacks. I approach this problem through the lens of rigorous system design, precisely *specifying* requirements followed by *synthesizing* solutions in a principled manner, with the support of *verification* processes.

## ACADEMIC EMPLOYMENT

---

### Carnegie Mellon University

Pittsburgh, PA

- Postdoctoral Fellow at the Robotics Institute, School of Computer Science
- *Advisor:* Prof. Changliu Liu

*Apr. 2023 – Present*

## EDUCATION

---

### Duke University

Durham, NC

- Ph.D. in Mechanical Engineering | Concentration: Robotics
- M.S. in Mechanical Engineering | GPA: 3.9/4.0
- *Advisor:* Prof. Michael M. Zavlanos
- *Dissertation:* Scalable Control Synthesis for Multi-Robot Systems under Temporal Logic Specifications

*Aug. 2017 – Dec. 2020*

*Aug. 2017 – May 2020*

### Harbin Institute of Technology

Harbin, China

- M.S. in Aerospace Engineering | GPA: 90.7/100 (Rank: 8/199)
- B.S. in Aerospace Engineering | Honors School (top 5%) | GPA: 90.73/100 (Rank: 1/9)
- Formerly majored in Computer Science (2011–2012); transitioned to Aerospace Engineering

*Aug. 2015 – Jun. 2017*

*Sep. 2011 – Jun. 2015*

## PUBLICATIONS

---

\* indicates equal contribution.

I have published 5 peer-reviewed journal papers, 7 peer-reviewed conference papers, and 4 peer-reviewed workshop papers in top robotics, control and system venues, such as T-RO, RA-L, Automatica, RSS, CDC, T-CPS, ICCPS.

### Refereed Journal Publications

- [1] **Xusheng Luo**, Tianhao Wei, Simin Liu, Ziwei Wang, Luis Mattei-Mendez, Taylor Loper, Joshua Neighbor, Casidhe Hutchison, Changliu Liu, “[Certifying Robustness of Learning-Based Keypoint Detection and Pose Estimation Methods](#)”. *ACM Transaction on Cyber-Physical Systems*, 2025.
- [2] **Xusheng Luo**, Shaojun Xu, Ruixuan Liu and Changliu Liu. “[Decomposition-based Hierarchical Task Allocation and Planning for Multi-Robots under Hierarchical Temporal Logic Specifications](#)”. *IEEE Robotics and Automation Letters*, 2024, with presentation at ICRA 2025
- [3] **Xusheng Luo** and Michael M Zavlanos. “[Temporal Logic Task Allocation in Heterogeneous Multi-robot Systems](#)”. *IEEE Transactions on Robotics*, 38(6):3602-3621, 2022.
- [4] **Xusheng Luo**, Yiannis Kantaros, and Michael M Zavlanos. “[An Abstraction-Free Method for Multirobot Temporal Logic Optimal Control Synthesis](#)”. *IEEE Transactions on Robotics*, 37(5):1487–1507, 2021.

- [5] **Xusheng Luo**, Miroslav Pajic, and Michael M. Zavlanos. “An Optimal Graph-Search Method for Secure State Estimation”. *Automatica* 123 (2021): 109323.

### Refereed Conference Proceedings

- [6] Zhongqi Wei\*, **Xusheng Luo**\*, Changliu Liu, “Hierarchical Temporal Logic Task and Motion Planning for Multi-Robot Systems”. *Robotics: Science and Systems*, 2025.
- [7] Tianhao Wei, Luca Marzari, Kai Yun, Hanjiang Hu, Peizhi Niu, **Xusheng Luo** and Changliu Liu. “ModelVerification.jl: a Comprehensive Toolbox for Formally Verifying Deep Neural Networks”. *International Conference on Computer Aided Verification*, 2025.
- [8] Shiqi Sun, Yan Zhang, **Xusheng Luo**, Panagiotis Vlantis, Miroslav Pajic, and Michael M. Zavlanos. “Formal Verification of Stochastic Systems with ReLU Neural Network Controller”. *IEEE 39th International Conference on Robotics and Automation (ICRA)*, Philadelphia, USA, 2022.
- [9] Yijie Zhou, Yan Zhang, **Xusheng Luo**, and Michael M. Zavlanos. “Human-in-the-loop Robot Planning with Non-Contextual Bandit Feedback”. In *2021 60th IEEE Conference on Decision and Control (CDC)*, pp. 2848-2853. IEEE, 2021
- [10] **Xusheng Luo**\*, Yan Zhang\*, and Michael M. Zavlanos. “Socially-aware Robot Planning via Bandit Human Feedback”. In *2020 ACM/IEEE 11th International Conference on Cyber-Physical Systems (ICCPS)*, pp. 216-225. IEEE, 2020.
- [11] Le, Duc M., **Xusheng Luo**, Leila J. Bridgeman, Michael M. Zavlanos, and Warren E. Dixon. “Single-Agent Indirect Herding of Multiple Targets using Metric Temporal Logic Switching”. In *2020 59th IEEE Conference on Decision and Control (CDC)*, pp. 1398-1403. IEEE, 2020.
- [12] **Xusheng Luo**, and Michael M. Zavlanos. “Transfer Planning for Temporal Logic Tasks”. In *2019 IEEE 58th Conference on Decision and Control (CDC)*, pp. 5306-5311. IEEE, 2019.

### Refereed Workshop Publications

- [13] **Xusheng Luo**, Tianhao Wei, Simin Liu, Ziwei Wang, Luis Mattei-Mendez, Taylor Loper, Joshua Neighbor, Casidhe Hutchison, Changliu Liu, “Certifying Robustness of Learning-Based Keypoint Detection and Pose Estimation Methods”. Workshop on *Public Trust in Autonomous Systems*, *IEEE International Conference on Robotics and Automation (ICRA)*, 2025.
- [14] **Xusheng Luo** and Changliu Liu. “Hierarchical Temporal Logic Specifications for Abstract Safety Tasks”. Workshop on *Robot safety under uncertainty from “intangible” specifications*, *IEEE International Conference on Robotics and Automation (ICRA)*, 2025.
- [15] **Xusheng Luo**\*, Shaojun Xu\* and Changliu Liu. “Obtaining Hierarchy from Human Instructions: an LLMs-based Approach”. Workshop on *Learning Effective Abstractions for Planning (LEAP)*, *Conference on Robot Learning (CoRL)*, 2023.
- [16] **Xusheng Luo**, Shaojun Xu, Ruixuan Liu and Changliu Liu. “Robotic Planning under Hierarchical Temporal Logic Specifications”. Workshop on *Formal Methods Techniques in Robotics Systems: Design and Control*, *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2023.

### Preprints

- [17] **Xusheng Luo**, Changliu Liu, “Simultaneous Task Allocation and Planning for Multi-Robots under Hierarchical Temporal Logic Specifications”. *arXiv:2401.04003*, 2024 (*IEEE Transactions on Robotics*, conditionally accepted as Regular).

- [18] Shaojun Xu\*, **Xusheng Luo\***, Yutong Huang, Letian Leng, Ruixuan Liu, Changliu Liu, “NL2HLTL2PLAN: Scaling Up Natural Language Understanding for Multi-Robots Through Hierarchical Temporal Logic Task Representation”. *arXiv:2408.08188*, 2024 (*IEEE Robotics and Automation Letters*, revise and resubmit).
- [19] Ruixuan Liu, Alan Chen, **Xusheng Luo** and Changliu Liu. “Simulation-aided Learning from Demonstration for Robotic LEGO Construction”. *arXiv:2309.11010*, 2023.

## AWARDS AND HONORS

- NSF Cyber-Physical System (CPS) Rising Stars (16.4%=36/220) 2024
- Student Travel Grant for the IEEE 59th Conference on Decision and Control 2020
- Outstanding Graduate of Harbin Institute of Technology 2015, 2017
- The Samsung Scholarship 2016
- Summer School Scholarship at Technion in Israel 2016
- National Endeavor Fellowship 2012, 2014

## WORK AND RESEARCH EXPERIENCE

### Intelligent Control Lab, Carnegie Mellon University

*Apr. 2023 – Present*

Postdoctoral Fellow, supervised by Prof. Changliu Liu

Pittsburgh, PA

- Created hierarchical task specification language for symbolic AI, incorporating a convex optimization-based algorithm to address long-horizon Simultaneous Task Allocation and Motion Planning (STAMP) for multiple robot arms.
- Designed a Large Language Model (LLM)-based framework to translate human instructions into hierarchical task specifications, evaluating in simulator AI2-THOR for mobile manipulation tasks.
- Developed and trained a keypoint detection neural network using PyTorch, converted the model to Flux in Julia via ONNX, and designed a verification framework for the local robustness of learning-enabled keypoint-based 6D object pose estimation from images in collaboration with Boeing.

### DJI

*Jan. 2021 – Feb. 2023*

Autonomous Driving Research Engineer, Planning

Shenzhen, China

- Enhanced vehicle interaction models and speed profiles for adaptive lane changes in both mandatory and discretionary scenarios using C++, aligned with AUTOSAR standards. This functionality was integrated into a product and released.
- Developed safe and comfortable vehicle trajectory optimization based on the iterative Linear Quadratic Regulator (iLQR), effectively handling both static and dynamic constraints.
- Led a team of three engineers in developing a memory-enhanced driving framework, enabling vehicles to learn driving behaviors on specific routes. Designed and implemented the core architecture with a focus on route planning.
- Collaborated cross-functionally with system, perception and testing teams, and handed off the memory-enhanced driving framework to the engineering team, contributing to its market launch.
- Designed and implemented a multi-layer hierarchical evaluation framework for behavior planning and trajectory selection—including yield, overtaking, and lane changes—in urban driving scenarios, enhancing decision-making capability.

### Zavlanos’s Lab, Duke University

*Aug. 2017 – Dec. 2020*

Research Assistant, supervised by Prof. Michael M. Zavlanos

Durham, NC

- Developed a sampling-based motion planning algorithm, inspired by RRT\*, for multi-robot navigation under temporal logic goals, optimizing sampling bias and reusing prior planning results to achieve computational efficiency.
- Developed a hierarchical task allocation and path planning framework inspired by the vehicle routing problem, leveraging Mixed Integer Linear Programming (MILP) to enable efficient multi-robot coordination for temporal logic tasks.
- Applied a derivative-free optimization approach with Model Predictive Control (MPC) to generate the robot trajectory, ensuring collision-free, dynamically feasible, and socially-aware motion by minimizing human negative feedback.

- Developed a graph-search-based secure state estimation algorithm for large-scale cyber-physical systems to correctly identify sensors under malicious attacks.

## TALKS

---

### Refereed Conference and Workshop Presentations

- Decomposition-based Hierarchical Task Allocation and Planning for Multi-Robots under Hierarchical Temporal Logic Specifications
  - In 2025 *IEEE International Conference on Robotics and Automation (ICRA)* May 2025
- Certifying Robustness of Learning-Based Keypoint Detection and Pose Estimation Methods
  - Workshop on *Public Trust in Autonomous Systems*, *IEEE International Conference on Robotics and Automation (ICRA)* May 2025
- Hierarchical Temporal Logic Specifications for Abstract Safety Tasks
  - Workshop on *Robot safety under uncertainty from “intangible” specifications*, *IEEE International Conference on Robotics and Automation (ICRA)* May 2025
- Integrating Autonomy with Formal Methods
  - Workshop on *2024 NSF CPS Rising Stars* May 2024
- Obtaining Hierarchy from Human Instructions: an LLMs-based Approach
  - Workshop on *Learning Effective Abstractions for Planning*, *Conference on Robot Learning (CoRL)* Nov. 2023
- Robotic Planning under Hierarchical Temporal Logic Specifications
  - Workshop on *Formal Methods Techniques in Robotics Systems: Design and Control*, *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* Oct. 2023
- Socially-aware Robot Planning via Bandit Human Feedback.
  - In *2020 ACM/IEEE 11th International Conference on Cyber-Physical Systems (ICCPS)* April 2020
- Transfer Planning for Temporal Logic Tasks.
  - In *2019 IEEE 58th Conference on Decision and Control (CDC)* Dec. 2019

### Invited Talks

- Scalable Control Synthesis for Multi-Robot Systems under Temporal Logic Specifications
  - *Intelligent Control Lab* at CMU Nov. 2022
  - *Reliable Autonomous System Lab* at MIT Aug. 2021

## PROFESSIONAL SERVICE

---

### Session Chair

- Verification and Formal Methods at ICRA May 2025

### Paper Review

- *Journals*:
  - IEEE Transactions on Mechatronics (T-MECH) 2025
  - IEEE Journal of Dynamic Systems, Measurement and Control 2025
  - IEEE Robotics and Automation Letters (RA-L) 2025
  - IEEE Transactions on Robotics (T-RO) 2022, 2023, 2024
  - IEEE Control Systems Letters (L-CSS) 2024
  - IEEE Transactions on Automation Science and Engineering (T-ASE) 2021
  - IEEE Transactions on Control of Network Systems (T-CNS) 2019, 2021

- *Conferences:*
  - IEEE Conference on Decision and Control (CDC) 2025
  - Robotics: Science and Systems (R:SS) 2024, 2025
  - IEEE International Conference on Robotics and Automation (ICRA) 2024, 2025
  - AACC/IFAC Conference on Modeling, Estimation and Control Conference (MECC) 2024
  - IEEE International Conference on Intelligent Robots and Systems (IROS) 2022, 2025
  - IEEE American Control Conference (ACC) 2022
  - IEEE International Conference on Ubiquitous Robots (UR) 2021
  - ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS) 2019, 2020

## TEACHING EXPERIENCE

---

### Teaching Assistant, *Harbin Institute of Technology*

- “MATLAB for Engineering” taught by Prof. Changsheng Gao *Fall 2016*
- “ME 627 Linear System Theory” taught by Prof. Michael M. Zavlanos *Fall 2019*

### Guest Lecturer, *Carnegie Mellon University*

- On the Application of Formal Methods to Robotics
  - In Course “16-883 Special Topics: Provably Safe Robotics” taught by Prof. Changliu Liu *Spring 2024*
- Certification of Neural Certificates and Certification of Pose Estimation Models
  - In Course “16-883 Special Topics: Provably Safe Robotics” taught by Prof. Changliu Liu *Spring 2025*

## MENTORING

---

- Zhongqi Wei, Ph.D. student in Mechanical Engineering at CMU
- Yutong Huang, Master in Mechanical Engineering at CMU
- Letian Leng, Master in Mechanical Engineering at CMU
- Alan Chan, Highschool Student at Westlake Highschool
- Shaojun Xu, visiting undergrad at Zhejiang University. Next: Ph.D. student at Tsinghua University
- Shiqi Sun, Master in Mechanical Engineering at Duke. Next: Ph.D. student at the Chinese University of Hong Kong
- Yijie Zhou, Master in Mechanical Engineering at Duke. Next: Ph.D. student at Northwestern Polytechnical University
- Shuo Yang, visiting undergrad at Shanghai Jiao Tong University. Next: Ph.D. student at University of Pennsylvania