

Summary

The central theme of my research focuses on **collaborative autonomy to enable team awareness for multi-robot and human-autonomy teaming**. *This vision seeks to empower autonomous robots with the ability to collaboratively and autonomously comprehend both unstructured environments and their human and robotic teammates, thereby collaboratively acting and making decisions for complex tasks in open-world settings.* To achieve this goal, I have been pursuing interdisciplinary research about robotics, machine learning, explainable AI, control theory, optimization, and computer vision. My broad research interests include connected automated vehicles, heterogeneous multi-robot cooperation and adaptation, human-centered robotics, and the Internet of robotics things.

Over the past 4 years, I achieved a postdoc fellowship at Maryland Robotics Center, published 16 papers (13 papers are first-author) in top conferences and journals (RSS, ICRA, IROS, ICML, AAAI, IJRR, AuRo) and 1 patent, co-chaired "Multi-Robot and Distributed Robot Systems II" session at IROS 2023, served as an associate editor for IEEE RAL, and reviewed over 50 papers in premier journals/conferences. I also assisted with proposal writing, gave guest lectures, worked as a teaching assistant, mentored students, organized workshops, and participated in university outreach programs.

Education

Ph.D. Degree <i>Computer Science Department</i> <i>Thesis: Collaborative Perception for Multi-Robot Team Awareness</i> <i>Advisor: Dr. Hao Zhang</i>	<i>Colorado School of Mines</i> <i>2017 – 2022</i>
Master Degree <i>Automation Department</i>	<i>Southeast University, China</i> <i>2012 – 2015</i>
Bachelor Degree <i>Automation Department</i>	<i>Chongqing University, China</i> <i>2008 – 2012</i>

Professional Experience

University of Massachusetts, Amherst <i>Postdoc Associate (Doing Research with Umass)</i>	<i>2023 – Present</i> <i>MD, USA</i>
Colorado School of Mines <i>Postdoc Associate (Funding from Mines)</i>	<i>2023 – Present</i> <i>MD, USA</i>
University of Maryland, College Park <i>Postdoc Associate</i>	<i>2022 – 2023</i> <i>MD, USA</i>
Colorado School of Mines <i>Research Assistant</i>	<i>2019 – 2022</i> <i>CO, USA</i>
Toyota InfoTech Lab <i>Research Intern, Advised by Dr. Rui Guo and Dr. Hongsheng Lu</i>	<i>2019</i> <i>CA, USA</i>
Colorado School of Mines <i>Teaching Assistant</i>	<i>2017 – 2019</i> <i>CO, USA</i>
IBM <i>Software Engineer</i>	<i>2015 – 2017</i> <i>Beijing, China</i>

Awards

1. Best Paper Award for Agri-Robotics (Acceptance rate < 1%) in IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2023.
2. Outstanding Graduate Student Research Award, Colorado School of Mines (2021).
3. Graduate Student Government Travel Grants, Colorado School of Mines (2020).
4. AAAI Student Scholarship, Association for the Advancement of Artificial Intelligence (2020).
5. IBM Agile Innovator Award, IBM (2015)
6. Second Prize in National Graduate Contest of Mathematical Modeling, Southeast University (2013).
7. Outstanding Student Award (top 5%), Chongqing University (2012).
8. Outstanding Student Leadership in Chongqing Province, top 1 in Automation Department (2012).

Publications

Conference Papers

1. **Peng Gao**, Jing Liang, Yu Shen, Sanghyun Son, and Ming C. Lin, Visual, Spatial, *Geometric-Preserved Place Recognition for Cross-View and Cross-Modal Collaborative Perception* in IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2023. **Best Paper Award for Agri-Robotics (<1%)**.
2. **Peng Gao**, Sriram Siva, Anthony Micciche, and Hao Zhang. “Collaborative Scheduling with Adaptation to Failure for Heterogeneous Robot Teams.” in *IEEE International Conference on Robotics and Automation (ICRA)*, 2023.
3. **Peng Gao**, Qingzhao Zhu, Hongsheng Lu, Chuang Gan, and Hao Zhang. “Deep Masked Graph Matching for Correspondence Identification in Collaborative Perception.” in *IEEE International Conference on Robotics and Automation (ICRA)*, 2023.
4. Yu Shen, Xijun Wang, **Peng Gao**, and Ming C. Lin, “Auxiliary Modality Learning with Generalized Curriculum Distillation”, in *International Conference on Machine Learning (ICML)*, 2023.
5. **Peng Gao**, Brian Reily, Rui Guo, Hongsheng Lu, Qingzhao Zhu and Hao Zhang. “Asynchronous Collaborative Localization by Integrating Spatiotemporal Graph Learning with Model-Based Estimation.” in *IEEE International Conference on Robotics and Automation (ICRA)*, 2022.
6. **Peng Gao** and Hao Zhang. “Bayesian Deep Graph Matching for Correspondence Identification in Collaborative Perception.” in *Robotics Science and System (RSS)*, 2021.
7. **Peng Gao**, Rui Guo, Hongsheng Lu, and Hao Zhang. “Multi-view Sensor Fusion by Integrating Model-based Estimation and Graph Learning for Collaborative Object Localization.” in *IEEE International Conference on Robotics and Automation (ICRA)*, 2021.
8. **Peng Gao**, Rui Guo, Hongsheng Lu, and Hao Zhang. “Regularized Graph Matching for Correspondence Identification under Uncertainty in Collaborative Perception.” in *Robotics Science and System (RSS)*, 2020.
9. **Peng Gao**, and Hao Zhang. “Long-Term Loop Closure Detection through Visual-Spatial Information Preserving Multi-Order Graph Matching.” in *AAAI Conference on Artificial Intelligence (AAAI)*, 2020.
10. **Peng Gao**, Ziling Zhang, Rui Guo, Hongsheng Lu, and Hao Zhang. “Correspondence identification in collaborative robot perception through maximin hypergraph matching.” in *IEEE International Conference on Robotics and Automation (ICRA)*, 2020.
11. **Peng Gao**, and Hao Zhang. “Long-term Place Recognition through Worst-case Graph Matching to Integrate Landmark Appearances and Spatial Relationships.” in *IEEE International Conference on Robotics and Automation (ICRA)*, 2020.
12. **Peng Gao**, Brian Reily, Savannah Paul, and Hao Zhang. “Visual reference of ambiguous objects for augmented reality-powered human-robot communication in a shared workspace.” in *International Conference on Virtual, Augmented and Mixed Reality (VAMR)*, 2020, invited paper.

13. Rui Guo, Hongsheng Lu, **Peng Gao**, Ziling Zhang, and Hao Zhang. "Collaborative localization for occluded objects in connected vehicular platform." in *IEEE Vehicular Technology Conference (VTC)*, 2019.

Journal Papers

1. **Peng Gao**, and Hao Zhang. "Correspondence identification for Human-Robot Collaborative Assembly through Bayesian Deep Graph Matching ." in *Autonomous Robots (AuRo)*, 2023, invited paper.
2. **Peng Gao**, Rui Guo, Hongsheng Lu, and Hao Zhang. "Correspondence identification for collaborative multi-robot perception under uncertainty." in *Autonomous Robots (AuRo)*, 1-16, 2022, invited paper.
3. Brian, Reily, **Peng Gao**, Fei Han, Hua Wang, and Hao Zhang. "Real-Time Recognition of Team Behaviors by Multisensory Graph Embedded Robot Learning." in *International Journal of Robotics Research (IJRR)*, 2021.

Patent

1. Rui Guo, Hongsheng Lu and **Peng Gao**. "Asynchronous observation matching for object localization in connected vehicles". U.S. Patent No. 11,564,116. 24 Jan. 2023.

Workshop

1. Sriram Siva, **Peng Gao**, Yiming Deng, Hao Zhang, "Multisensory Internal Pipe Threat Prediction Using Inline Inspection Robots", in *IEEE International Conference on Robotics and Automation (ICRA)*, Abstract-Only Poster, 2018.

Under Review

1. **Peng Gao**, Yu Shen and Ming C. Lin. "Collaborative Decision-Making Using Spatiotemporal Graphs in Connected Autonomy." submitted to *IEEE International Conference on Robotics and Automation (ICRA)*, 2024.
2. Jing Liang, **Peng Gao**, Xuesu Xiao, Adarsh Jagan Sathyamoorthy, Mohamed Elnoor, Ming C. Lin and Dinesh Manocha. "MTG: Mapless Trajectory Generator with Traversability Coverage for Outdoor Navigation." submitted to *IEEE International Conference on Robotics and Automation (ICRA)*, 2024.
3. **Peng Gao**, Ahmed Jaafar, Brian Reily, Christopher Reardon, and Hao Zhang. "Compositional Zero-Shot Learning for Attribute-Based Object Reference in Human-Robot Interaction", *Conference on Robot Learning*, workshop, 2024.

Grants and Proposal

1. Postdoc Associate Fellowship on "Collaborative Perception for Multi-Robot/Human-Robot Team Awareness", Maryland Robotics Center, University of Maryland, College Park, \$60,000 awarded, 2022.
2. Toyota Program on "Learnable Communications among Connected Vehicles for Collaborative Localization of Dynamic Street Objects", PI: Prof. Hao Zhang, \$70,000 awarded, 2022.
3. Army Research Lab (ARL) Project on "Correspondence Identification for Multi-Robot Collaborative Perception", PI: Prof. Hao Zhang, white paper, 2023.

Invited Talks and Presentations

Collaborative Perception in Connected Autonomy

1. Shanghai Jiao Tong University and Shanghai AI Laboratory, 2022.
2. Colorado School of Mines, CS Department, 2022.
3. Marquette University, ECE Department, 2021.

Interdisciplinary Study on Vision-based Long-Term Pipelines Inspection

1. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA) Forum, Competitive Academic Agreement Program (CAAP), poster 2020.

Conference Poster Presentation

1. Cross-View Cross-Modal Multi-Robot Collaborative Perception, IROS 2023
2. Heterogeneous Multi-Robot Task Allocation and Failure Adaptation, ICRA 2023
3. Correspondence Identification in Connected Autonomous Driving, ICRA 2023
4. Asynchronous Collaborative Localization, ICRA 2022
5. Human-Robot Collaborative Assembly, RSS 2021
6. Collaborative Object Localization, ICRA 2021
7. Uncertainty-Aware Correspondence Identification, RSS 2020
8. Long-Term Loop Closure Detection, ICRA 2020, AAAI 2020

Teaching

Guest Lecturer, University of Maryland, College Park, Spring 2023

1. ENAE4880/7880 Introduction to Autonomous Multi-Robot Swarms

Teaching Assistant, Colorado School of Mines, 2017-2018

1. CSCI-101: Introduction of Computer Science, Fall 2017.
2. CSCI-573: Human-Centered Robotics, Spring 2018.
3. CSCI-598: Robot Planning and Manipulation, Spring, 2018.

Mentorship

1. Jasmine Taank, Ama Sefah, Jorge Murillo Bajana, Neena Thota, Sahana Satish, Omar Osman (undergraduate team): University of Massachusetts, Amherst, 2023
2. Li Chen (graduate): University of Massachusetts, Amherst, 2023
3. Zihao Deng (graduate): University of Massachusetts, Amherst, 2023
4. Ahmed Jaafar (undergraduate): University of Massachusetts, Amherst, 2023
5. Chris Jose (Undergraduate): University of Maryland, College Park, 2023
6. Williard Joshua Jose (Ph.D.): University of Massachusetts, Amherst, 2022
7. Qingzhao Zhu (Ph.D.): Colorado School of Mines, 2022.
8. Pheobe Wu (high school): PROGRESS, Colorado School of Mines, 2021.
9. Mehmet Yilmaz (undergraduate): Colorado School of Mines, 2020-2021.
10. Savannah Paul (graduate): Colorado School of Mines, 2020
11. Luc Lafave (undergraduate): Colorado School of Mines, 2021.
12. Carl Schader (undergraduate): Colorado School of Mines, 2018-2019.
13. Evan Lim (graduate): Colorado School of Mines, 2021.
14. Shutong Qi (graduate): Colorado School of Mines, now at University of Toronto, 2019
15. Ziling Zhang (graduate): Colorado School of Mines, 2018-2019.

Academia Service

Co-Chair

1. "Multi-Robot and Distributed Robot Systems II" session at IROS 2023.

Organizing Workshop

1. Co-Organizer: "Bridging the Gap between Cognitive Science and Robot Learning in the Real World: Progresses and New Directions" in Conference on Robot Learning (CoRL) Workshop, 2023 (accepted).

Associate Editor

1. IEEE Robotics and Automation Letters (**RAL**), 2022-present

Program Committee Member

1. IEEE Vehicular Technology Conference (**VTC**), 2023-present

Reviewer

1. IEEE International Conference on Robotics and Automation (**ICRA**), 2020-present.
2. IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**), 2019-present.
3. AAAI International Conference on Automated Planning and Scheduling (**ICAPS**), 2021
4. IEEE Vehicular Technology Conference (**VTC**), 2021.
5. IEEE International Conference on Humanoid Robots (**Humanoids**), 2019.
6. IEEE Robotics and Automation Letters (**RAL**), 2019-present.
7. The ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (**IMWUT**), 2022.
8. Elsevier Robotics and Autonomous Systems (**RAS**), 2021.
9. Elsevier Intelligent Service Robotics, 2021
10. Elsevier Journal of Visual Communication and Image Representation, 2021
11. ASME Journal of Dynamic Systems Measurement and Control, 2021

DEI Outreach

1. Undergraduate mentor for independent study at the University of Massachusetts, Amherst, including 1 Latin, 1 Africa American, and 3 female students.
2. Graduate mentor for PROGRESS (Program for Robotics Outreach on Gender and Racial Equity in School and Society), providing mentorship to K-12 students and teachers, at Colorado School of Mines.
3. Student representative for the suggestion and evaluation of the computer science department at Colorado School of Mines.

References

Prof. Hao Zhang, Associate Professor

University of Massachusetts Amherst.

Prof. Ming C. Lin, Former Chair of Computer Science and Distinguished University Professor

University of Maryland, College Park.

Prof. Tracy Camp, Founding Department Head and Emeritus Professor

Colorado School of Mines

Prof. Thomas Williams, Associate Professor

Colorado School of Mines

Dr. Hongsheng Lu, Principal Researcher

Toyota InfoTech Lab