Zhongqiang (Richard) Ren

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Postdoctoral Fellow (09/2022-Current)
Robotics Institute, Carnegie Mellon University

Research Interests

Robotics, combinatorial search, multi-agent path finding, optimization, and optimal control.

Education

- 09/2019 - 08/2022, Ph.D., Carnegie Mellon University. Advised by Prof. Howie Choset and Maxim Likhachev, Ph.D. Thesis: Search-Based Multi-Agent Multi-Target Multi-Objective Path Planning.
- 09/2015 - 05/2017, M.S., Carnegie Mellon University. Advised by Howie Choset.
- 08/2011 - 07/2015, B.Eng. (Dual Degree), Tongji University, P.R. China and FH Aachen, Germany.

Industrial Experience

- 05/2017 - 09/2019, CTO and Co-founder, BITO Robotics, the U.S. and P.R. China. Tech department management, multi-robot planning and autonomous navigation software development.
- 01/2015 - 06/2015, Intern, APS GmbH-European Center for Mechatronics, Germany. Packet detection and stacking using an ABB manipulator with embedded Linux.

Teaching Experience

- 2022 Spring, TA for CMU course 24-352 Dynamic Systems and Controls.
- 2021 Fall, TA for CMU course 24-351 Dynamics.
- Students mentored at CMU: Shanshan Xie (BS ’16-17), Nayana Suvarna (RISS program ’21), Akshaya K. Srinivasan (MSR ‘21-23), Chaoran Zhang (MSR ‘21-22), Valmiki Kothare (BS ‘21-23)

Publications

Under Review / Preprints

[P4] Z. Ren, Z. Rubinstein, S. Smith, S. Rathinam, H. Choset, "ERCA*: A New Approach for Resource Constrained Shortest Path Problem," IEEE Transactions on Intelligent Transportation Systems (T-ITS), under review.
[P3] **Z. Ren**, A. K. Srinivasan, I. Abraham and H. Choset, "A Pareto-Optimal Local Optimization Framework for Multi-Objective Ergodic Search," IEEE Transaction on Robotics (T-RO), under review.
[P2] **Z. Ren**, S. Rathinam and H. Choset, "Conflict-Based Steiner Search: A Framework for Multi-Agent Combinatorial Path Finding," IEEE Transaction on Robotics (T-RO), under review.
[P1] J. Yan, X. Lin, **Z. Ren**, S. Zhao, J. Yu, C. Cao, P. Yin, J. Zhang, and S. Scherer. "MUI-TARE: Multi-Agent Cooperative Exploration with Unknown Initial Position," IEEE Robotics and Automation Letters (RA-L), 2022, under review.

Journal

[J4] **Z. Ren**, S. Rathinam, M. Likhachev andH. Choset, "Multi-Objective Safe-Interval Path Planning with Dynamic Obstacles," IEEE Robotics and Automation Letters (RA-L), 2022. (Presented at IROS 2022)
[J3] **Z. Ren**, S. Rathinam and H. Choset, "A Conflict-Based Search Framework for Multi-Objective Multi-Agent Path Finding," IEEE Transactions on Automation Science and Engineering (T-ASE), 2022.
[J2] **Z. Ren**, S. Rathinam, M. Likhachev and H. Choset, "Multi-Objective Path-Based D* Lite," IEEE Robotics and Automation Letters (RA-L), 2022. (Presented at ICRA 2022)
[J1] **Z. Ren**, S. Rathinam and H. Choset, "Subdimensional Expansion for Multi-Objective Multi-Agent Path Finding," IEEE Robotics and Automation Letters (RA-L), 2021. (Presented at IROS 2021)

Conference

[C11] **Z. Ren***, J. Li*, H. Zhang, S. Koenig, S. Rathinam and H. Choset, "Binary Branching Multi-Objective Conflict-Based Search for Multi-Agent Path Finding," International Conference on Automated Planning and Scheduling (ICAPS), 2023, accepted.
[C10] **Z. Ren**, C. Zhang, S. Rathinam and H. Choset, "Search Algorithms for Multi-Agent Teamwise Cooperative Path Finding," IEEE International Conference on Robotics and Automation (ICRA), 2023, accepted.
[C9] **Z. Ren**, S. Rathinam and H. Choset, "Conflict-Based Steiner Search for Multi-Agent Combinatorial Path Finding," Robotics: Science and Systems (RSS), 2022.
[C8] **Z. Ren**, A. K. Srinivasan, H. Coffin, I. Abraham and H. Choset, "A Local Optimization Framework for Multi-Objective Ergodic Search," Robotics: Science and Systems (RSS), 2022.
[C7] **Z. Ren**, R. Zhan, S. Rathinam, M. Likhachev and H. Choset, "Enhanced Multi-Objective A* Using Balanced Binary Search Trees," International Symposium on Combinatorial Search (SoCS), 2022.
[C6] **Z. Ren**, S. Rathinam, and H. Choset, "A Lower Bounding Framework for Motion Planning amid Dynamic Obstacles in 2D," International Workshop on the Algorithmic Foundations of Robotics (WAFR), 2022.
[C5] **Z. Ren**, S. Rathinam and H. Choset, "Loosely Synchronized Search for Multi-agent Path Finding with Asynchronous Actions," IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2021.
[C4] **Z. Ren**, S. Rathinam and H. Choset, "MS*: A New Exact Algorithm for Multi-agent Simultaneous Multi-goal Sequencing and Path Finding," IEEE International Conference on Robotics and Automation (ICRA), 2021.
[C3] **Z. Ren**, S. Rathinam and H. Choset, "Multi-objective Conflict-based Search for Multi-agent Path Finding," IEEE International Conference on Robotics and Automation (ICRA), 2021.
[C2] C. Gong, **Z. Ren**, J. Whitman, J. Grover, B. Chong and H. Choset, "Geometric motion planning for systems with toroidal and cylindrical shape spaces," Dynamic Systems and Control Conference (DSCC), 2018.
[C1] **Z. Ren**, C. Gong and H. Choset, "Deformed state lattice planning," IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2017.

Patent

[P3] D. Zhou, K. Ariana, C. Gong, **Z. Ren**, Z. Zhu, "Battery swapping system for autonomous guided vehicle," WO2020033474A1, 2020.
[P2] **Z. Ren**, D. Jiang, "Robot dispatching method, electronic equipment and computer readable storage medium," CN110270998A, 2019.
[P1] C. Xie, **Z. Ren**, Z. Li, S. Fu, H. Shi, Y. Tang, "Energy-conservation smart window," CN104358488B, 2016.

Awards

06/2022, Travel Award, International Workshop on the Algorithmic Foundations of Robotics (WAFR).
05/2017, Best paper award in computational group, symposium of mechanical engineering department at CMU.
08/2014, Chinese Government Scholarship, China Scholarship Council (CSC) (Top 3 out of 65)
05/2014, First Prize, the Third Shanghai Mechanical Engineering Innovation Competition
11/2013, National Scholarship, Ministry of Education of P.R. China (Top 1 out of 65)
11/2013, First Prize, Academic Scholarship, Tongji University (Top 5% in school)

Academic Activities

Reviewer for the following journals and conferences:
AIJ (‘22), T-RO(23’), RA-L (‘22,‘23), T-ITS (‘21), JAAMAS (‘22), SOCS (‘22), WAFR (‘22), ICRA (‘22,‘23), MRS (‘21), IROS (‘21).

Organizing Committee
AAAI 2023 Workshop on Multi-Agent Path Finding (WoMAPF)

Program Committee
The 16th International Symposium on Combinatorial Search (SoCS)
AAAI 2023 Student Abstract and Poster Program