

Aerial Co-Workers: Augmenting Physical and Cognitive Human Capabilities

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Problem

- Augment human physical and cognitive capabilities through collaboration with a team of physically interconnected aerial robots
 - Teams of interconnected aerial vehicle with human interaction
 - Coordination of robot perception capabilities to aggregate data for navigation/mapping and augmenting human spatial and context awareness

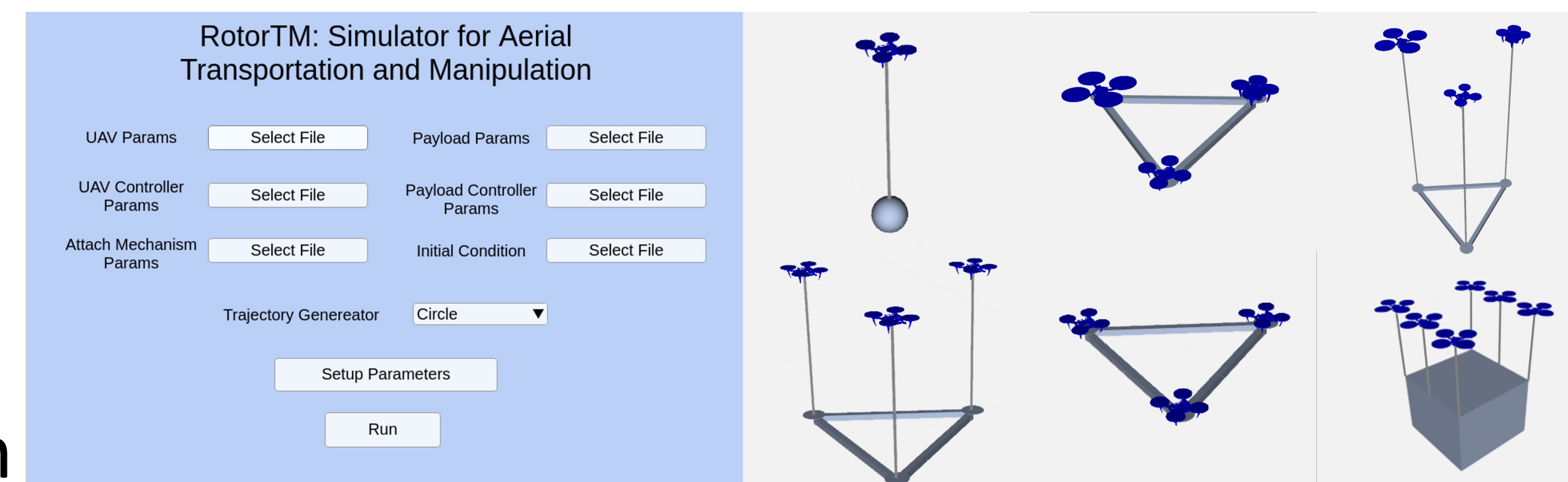
Challenges

- **Thrust 1 Physical Collaboration:** Modeling and control of different aerial topologies with pHRI
- **Thrust 2 Cognitive Collaboration:** Collaborative robot perception for enhanced navigation/mapping and human context-awareness

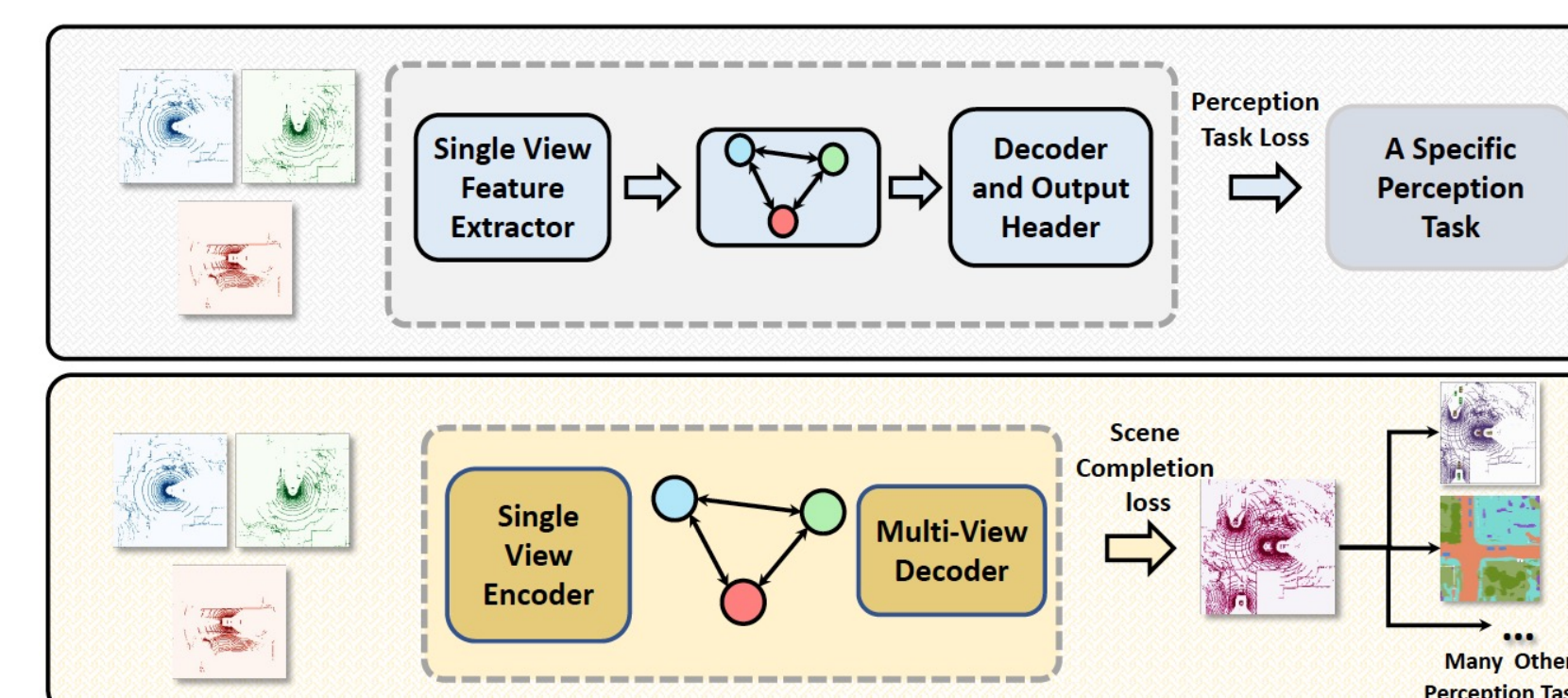
Scientific

- Human in-the loop CPS architectures design
- Study human-machine interaction
- AI/ML solutions for real-time CPS

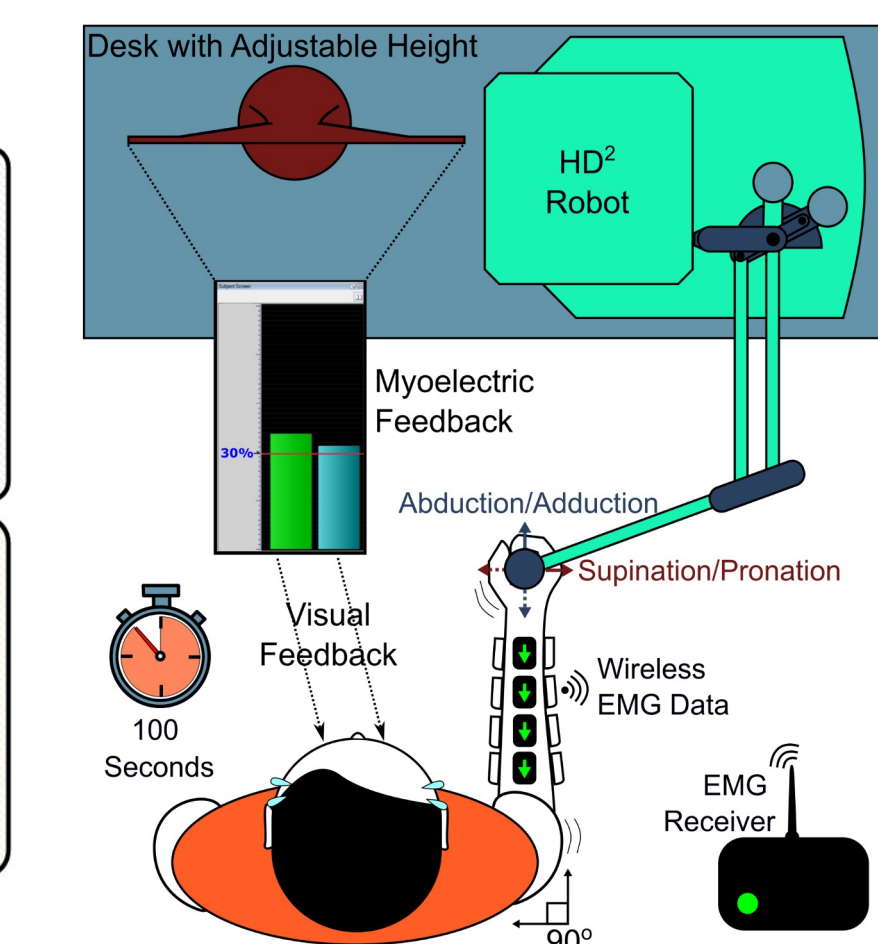
RotorTM: Aerial Transportation and Human-Robot Collaborative Manipulation (IEEE TRO 2023)



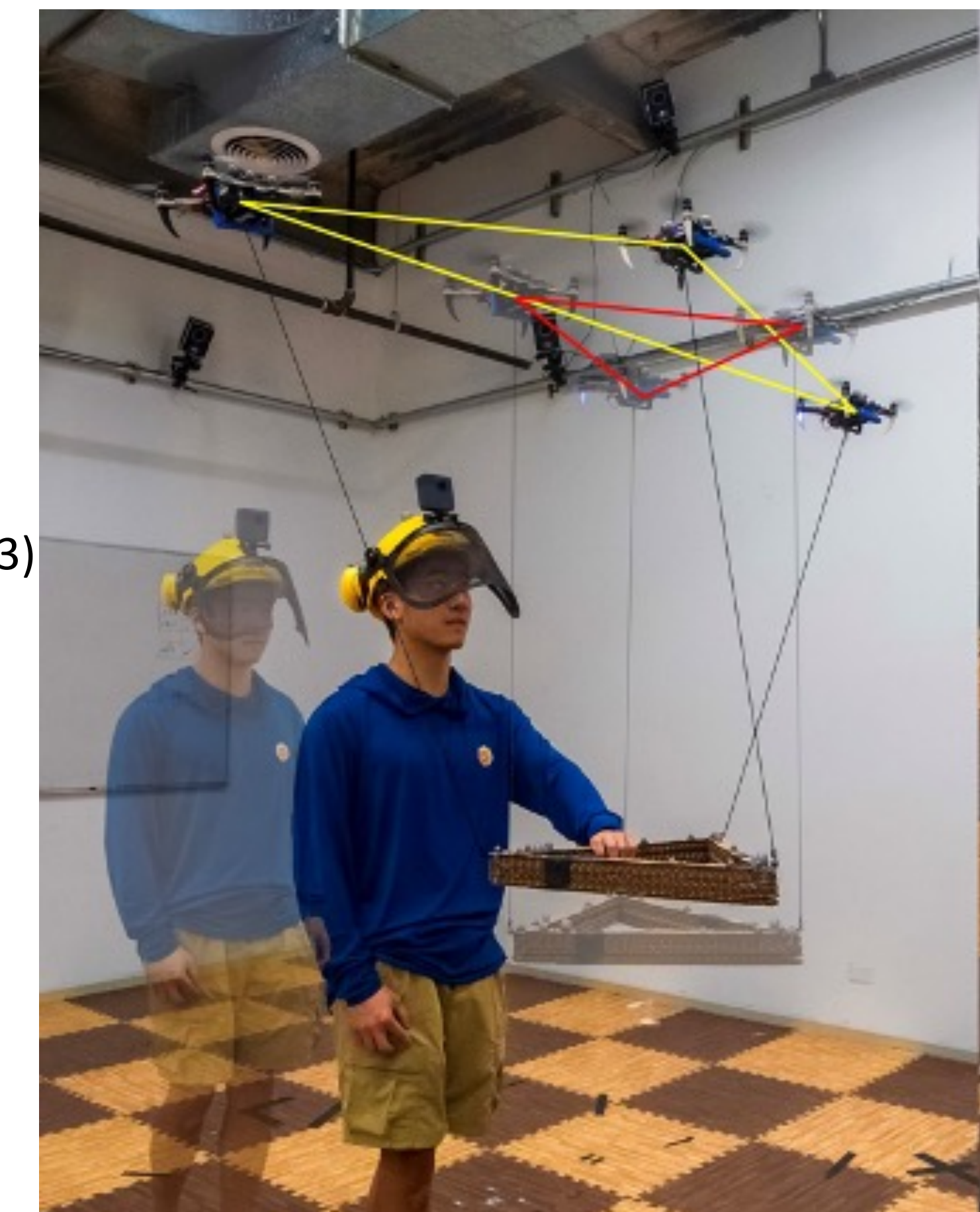
Towards Task-Agnostic Multi-Robot Perception (CoRL 2023)



MyoPassivity Map (IEEE RA-L 2023)



NMPC for optimal pHRI redundancy and admittance allocation (IROS 2023)



Broader Impacts (Society)

- Faster transportation and manipulation
- Reduction working costs and human effort
- Modernize and automate US construction and manufacturing processes and industries

Broader Impacts (Impact)

- Reduced human effort during complex tasks
- New generation of researchers
- Promote the use of robots and CPS in real-world tasks

Broader Impacts (Education and Outreach)

- Dissemination in three workshops at ICRA 2023 and two workshops at IROS 2023
- Multiple talks at ICRA 2023 and IROS 2023
- PhD, K-12 and UG mentorship
- Open-source code

Publications

- G. Li, X. Liu, and G. Loianno, "RotorTM: A Flexible Simulator for Aerial Transportation and Manipulation", IEEE Transactions on Robotics, vol. 40, pp. 831-850, 2024, doi: <https://doi.org/10.1109/TRO.2023.3336320>.
- X. Liu, G. Li, and G. Loianno, "Safety-Aware Human-Robot Collaborative Transportation and Manipulation with Multiple MAVs", IEEE Transactions on Robotics, 2024, submitted, doi: <https://doi.org/10.48550/arXiv.2210.05894>.
- G. Li and G. Loianno, "Nonlinear Model Predictive Control for Cooperative Transportation and Manipulation of Cable-Suspended Payloads with Multiple Quadrotors", IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2023, pp. 5034-5041, doi: <https://doi.org/10.1109/IROS55552.2023.10341785>.
- J. Yeom, G. Li, and G. Loianno, "Geometric Fault-Tolerant Control of Quadrotors in Case of Rotor Failures: An Attitude Based Comparative Study", IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2023, pp. 4974-4980, doi: <https://doi.org/10.1109/IROS55552.2023.10341669>.
- A. Dionigi, M. Leomanni, A. Savio, G. Loianno and G. Costante, "Exploring Deep Reinforcement Learning for Robust Target Tracking Using Micro Aerial Vehicles", IEEE International Conference on Advanced Robotics (ICAR), Abu Dhabi, 2023, pp. 506-513, doi: <https://doi.org/10.1109/ICAR58858.2023.10407017>.
- X. Zhou, P. Paik, and S. F. Atashzar, "Upper-limb Geometric MyoPassivity Map for Physical Human-Robot Interaction", IEEE International Conference on Robotics and Automation (ICRA), 2023, pp. 12065-12070, doi: <https://doi.org/10.1109/ICRA48891.2023.10161188>.
- X. Zhou, P. Paik, R. O'Keefe, and S. F. Atashzar, "Interday Reliability of Upper-limb Geometric MyoPassivity Map for Physical Human-Robot Interaction", in IEEE Transactions on Haptics, vol. 16, no. 4, pp. 658-664, Oct.-Dec. 2023, doi: <https://doi.org/10.1109/TOH.2023.3277453>.
- S. Oliver, P. Paik, X. Zhou and S. F. Atashzar, "MyoPassivity Map: Does Multi-Channel sEMG Correlate With the Energetic Behavior of Upper-Limb Biomechanics During Physical Human-Robot Interaction?", in IEEE Robotics and Automation Letters, vol. 8, no. 11, pp. 6915-6922, Nov. 2023, doi: <https://doi.org/10.1109/RA.2023.3313489>.
- Y. Li, J. Zhang, D. Ma, Y. Wang, and C. Feng, "Self-Supervised Collaborative Scene Completion: Towards Task-Agnostic Multi-Robot Perception", 6th Annual Conference on Robot Learning, 2022.
- Y. Li, J. Zhang, D. Ma, Y. Wang, and C. Feng, "Multi-robot scene completion: Towards task-agnostic collaborative perception", Conference on Robot Learning (CoRL), 2062-2072, 2023, PMLR. Available: <https://proceedings.mlr.press/v205/li23e/li23e.pdf>.
- C. Chen, X. Liu, Y. Li, L. Ding, and C. Feng, "DeepMapping2: Self-Supervised Large-Scale LIDAR Map Optimization", IEEE/CVF Conference on Computer Vision and Pattern Recognition pp. 9306-9316, 2023, doi: <https://doi.org/10.1109/CVPR52729.2023.00898>.