Yulun Tian

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Research Interests

I am passionate about developing **scalable and trustworthy multi-agent systems** that operate robustly over long periods of time without human intervention. My current research applies tools from nonlinear and distributed optimization, graph theory, and machine learning to develop principled **algorithms with theoretical guarantees** and **real-world systems** for multi-agent perception and navigation.

Education

2019 – 2023 **Ph.D. Aeronautics and Astronautics**, *Massachusetts Institute of Technology*.
- Thesis: *Algorithms and Systems for Scalable Multi-Agent Geometric Estimation*.
- Minor concentration: Optimization Methods.
- Cumulative GPA: 5.0/5.0.

2017 – 2019 **S.M. Aeronautics and Astronautics**, *Massachusetts Institute of Technology*.
- Cumulative GPA: 5.0/5.0.

2013 – 2017 **B.A. Computer Science**, *University of California, Berkeley*.
- Cumulative GPA: 3.94/4.0 (*High Distinction*).

Awards and Recognitions

2022 **King-Sun Fu Memorial Best Paper Award**, *IEEE Transactions on Robotics (T-RO)*

2023 **Outstanding Reviewer**, *IEEE Robotics and Automation Letter (RA-L)*

2021 **Honorable Mention for King-Sun Fu Memorial Best Paper Award**, *IEEE Transactions on Robotics (T-RO)*

2020 **Honorable Mention for Best Paper**, *IEEE Robotics and Automation Letter (RA-L)*

2020 **AUVSI XCELLENCE Humanitarian Award**, *Association for Uncrewed Vehicle Systems International (AUVSI)*

Experience

2017 – 2023 **Graduate Research Assistant**, *MIT LIDS & AeroAstro*.
My work focused on developing *provably correct algorithms* and *real-world systems* for collaborative estimation in multi-agent systems, including:
- Distributed optimization for multi-agent SLAM with guaranteed convergence under asynchronous communication and global optimality certificates.
- Distributed and outlier-robust system for multi-agent metric-semantic SLAM.

Summer 2020 **Research Intern**, *Meta Reality Labs*.
- Researched rotation/translation averaging algorithms for global structure-from-motion.
- Benchmarked algorithm performance using large-scale internet photo datasets.

Invited Talks

Aug 2023 **"Multi-Agent Geometric Estimation: Algorithms and Systems"**, *NEURAL Lab, Northeastern University*.

July 2023 **"Rotation Averaging via Fast Laplacian Solvers"**, *Spectral Graph Theoretic Methods (SGTM) Workshop, RSS 2023, Video*.

July 2022 **"Kimera-Multi: Robust, Distributed, Dense Metric-Semantic SLAM for Multi-Robot Systems"**, *UC Berkeley Semiautonomous Seminar*.

Journal Articles

[1] **Yulun Tian**, Yun Chang, Fernando Herrera Arias, Carlos Nieto-Granda, Jonathan P How, and Luca Carlone. "Kimera-Multi: Robust, Distributed, Dense Metric-Semantic SLAM for Multi-Robot Systems". In: *IEEE Transactions on Robotics (T-RO)* (2022). King-Sun Fu Memorial Best Paper Award.

[2] **Yulun Tian**, Kasra Khosoussi, David M Rosen, and Jonathan P How. "Distributed Certifiably Correct Pose-Graph Optimization". In: *IEEE Transactions on Robotics (T-RO)* (2021). Honorable Mention for King-Sun Fu Memorial Best Paper Award.

[3] **Yulun Tian**, Kasra Khosoussi, and Jonathan P How. "A Resource-Aware Approach to Collaborative Loop-Closure Detection with Provable Performance Guarantees". In: *International Journal of Robotics Research (IJRR)* (2021). Invited paper.

[4] **Yulun Tian**, Alec Koppel, Amrit Singh Bedi, and Jonathan P How. "Asynchronous and Parallel Distributed Pose Graph Optimization". In: *IEEE Robotics and Automation Letters (RA-L)* (2020). Honorable Mention for Best Paper Award.

[5] **Yulun Tian**, Katherine Liu, Kyel Ok, Loc Tran, Danette Allen, Nicholas Roy, and Jonathan P. How. "Search and Rescue under the Forest Canopy using Multiple UAVs". In: *International Journal of Robotics Research (IJRR)* (2020). Invited paper.

[6] Kaveh Fathian, Kasra Khosoussi, **Yulun Tian**, Parker Lusk, and Jonathan P How. "CLEAR: A Consistent Lifting, Embedding, and Alignment Rectification Algorithm for Multiview Data Association". In: *IEEE Transactions on Robotics (T-RO)* (2020).

Conference Proceedings

[7] **Yulun Tian**, Yun Chang, Long Quang, Arthur Schang, Carlos Nieto-Granda, Jonathan P How, and Luca Carlone. "Resilient and Distributed Multi-Robot Visual SLAM: Datasets, Experiments, and Lessons Learned". In: *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*. 2023.

[8] **Yulun Tian**, Amrit Singh Bedi, Alec Koppel, Miguel Calvo-Fullana, David M Rosen, and Jonathan P How. "Distributed Riemannian Optimization with Lazy Communication for Collaborative Geometric Estimation". In: *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*. 2022.

[9] Yun Chang, **Yulun Tian**, Jonathan P. How, and Luca Carlone. "Kimera-Multi: a System for Distributed Multi-Robot Metric-Semantic Simultaneous Localization and Mapping". In: *IEEE Intl. Conf. on Robotics and Automation (ICRA)*. 2021.

[10] **Yulun Tian**, Katherine Liu, Kyel Ok, Loc Tran, Danette Allen, Nicholas Roy, and Jonathan P. How. "Search and Rescue Under the Forest Canopy Using Multiple UAS". In: *Intl. Sym. on Experimental Robotics (ISER)*. 2018.

[11] **Yulun Tian**, Kasra Khosoussi, and Jonathan P How. "Resource-Aware Algorithms for Distributed Loop Closure Detection with Provable Performance Guarantees". In: *Intl. Workshop on the Algorithmic Foundations of Robotics (WAFR)*. 2018.

[12] **Yulun Tian**, Kasra Khosoussi, Matthew Giamou, Jonathan P How, and Jonathan Kelly. "Near-Optimal Budgeted Data Exchange for Distributed Loop Closure Detection". In: *Robotics: Science and Systems (RSS)*. 2018.

[13] Ming Jin, Shichao Liu, **Yulun Tian**, Mingjian Lu, Stefano Schiavon, and Costas Spanos. "Indoor Environmental Quality Monitoring by Autonomous Mobile Sensing". In: *4th ACM International Conference on Systems for Energy-Efficient Built Environments*. 2017.

Preprints

[14] **Yulun Tian** and Jonathan P. How. *Spectral Sparsification for Communication-Efficient Collaborative Rotation and Translation Estimation*. `https://arxiv.org/pdf/2210.05020.pdf`. 2022.

[15] **Yulun Tian**, Kasra Khosoussi, and Jonathan P. How. *Block-Coordinate Minimization for Large SDPs with Block-Diagonal Constraints*. `https://arxiv.org/pdf/1903.00597.pdf`. 2019.

Skills

Software **Languages**: C, C++, Python, MATLAB.
Robotics: ROS, Eigen, OpenCV, OpenGV, PCL.
Optimization: GTSAM, Ceres Solver, g2o, Manopt, ROPTLIB, cvx, YALMIP.
Learning: PyTorch.

Hardware **Sensors**: RealSense, Velodyne, Ouster.
Platforms: Intel NUC, Jetson Xavier.

Open-Source Software

Kimera-Multi A complete system for *distributed* and *robust* multi-robot metric-semantic SLAM, featuring distributed loop closure, pose graph optimization, and onboard metric-semantic mapping. Implemented in C++ and ROS (code).

dpgo A suite of distributed pose graph optimization (PGO) algorithms based on Riemannian optimization. Additional features include asynchronous communication and outlier-robust optimization. Implemented in C++ with ROS wrapper (code).

Services

Journal Reviewer International Journal of Robotics Research (IJRR), IEEE Transactions on Robotics (T-RO), IEEE Robotics and Automation Letters (RA-L), Field Robotics, Artificial Intelligence, Autonomous Robots (AURO)

Conference Reviewer IEEE International Conference on Robotics and Automation (ICRA), IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)

References available upon request.