

# ZHEHAN LI

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## EDUCATION

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**Zhejiang University (Chu Kochen Honors College)** Zhejiang, China  
*Bachelor* in Mechatronics and Automation (Double Degree) Sep. 2018 – Jun. 2022

- Overall GPA: **3.81/4.00** (Rank 1/13)
- Graduate of the Chu Kochen Honors Program

**Zhejiang University (College of Control Science and Engineering)** Zhejiang, China  
*Master student* in Control Science and Engineering, Expected March 2025 Sep. 2022 – Present

## RESEARCH INTERESTS

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**Multi-Robot Perception:** multi-robot SLAM, relative state estimation, distributed algorithm, certifiable optimization, outlier rejection, consistent maps, continuous-time SLAM, active SLAM.

**Multi-Robot Collaboration:** collaborative heterogeneous multi-robot system, exploration, decentralized decision-making, swarm intelligence.

## PUBLICATIONS

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- [1] Zhehan Li, Zheng Wang, Jiadong Lu, Zhiren Xun, Chao Xu, Fei Gao, and Yanjun Cao, “CREPES-Multi: A Robust Tightly-Coupled Bearing-Distance-Inertial Relative State Estimation System for Swarm Robots,” *IEEE Transactions on Robotics*. (In Preparation)
- [2] Zhehan Li\*, Rui Mao\*, Nanhe Chen, Cao Xu, Fei Gao, and Yanjun Cao, “CoLAG: A Collaborative Air-Ground Framework for Perception-Limited UGVs’ Navigation,” in *2024 IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2024, pp. 16781–16787.
- [3] Nanhe Chen, Zhehan Li, Lun Quan, Xinwei Chen, Cao Xu, Fei Gao, and Yanjun Cao, “Cost-effective Swarm Navigation System via Close Cooperation,” *IEEE Robotics and Automation Letters*, vol. 9, no. 11, pp. 9343–9350, 2024.
- [4] Zhiren Xun\*, Jian Huang\*, Zhehan Li, Zhenjun Ying, Yingjian Wang, Cao Xu, Fei Gao, and Yanjun Cao, “CREPES: Cooperative RELative Pose Estimation System,” in *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE, 2023, pp. 5274–5281.
- [5] Baozhe Zhang\*, Xinwei Chen\*, Zhehan Li, Giovanni Beltrame, Cao Xu, Fei Gao, and Yanjun Cao, “CoNi-MPC: Cooperative Non-inertial Frame Based Model Predictive Control,” *IEEE Robotics and Automation Letters*, vol. 8, no. 12, pp. 8082–8089, 2023.

## RESEARCH EXPERIENCE

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**FAST Lab, Huzhou Institute of Zhejiang University** Zhejiang, China  
Research Assistant, Supervised by Chao Xu, Fei Gao, and Yanjun Cao Jun. 2021 – Present

➤ **Precise Dropping with a UAV**

- Identified the position of a cylinder using LiDAR and point cloud registration.
- Controlled the UAV to reach the target, dropped a ring, and attached it to the cylinder.

➤ **Relative State Estimation for Swarm Robots**

- Developed a high-accuracy real-time relative pose estimation system for swarm robots.
- Designed the hardware prototype consisting of active infrared (IR) LEDs, an IR fisheye camera, an IMU, and a UWB, which is compact for installation on various robots.
- Designed a fast detection algorithm by triggering LED and camera alternately based on time synchronization, achieving multiple ID recognition within 0.1 seconds.
- Derived the relative kinematics of two robots and refined the IMU factor to allow multi-robot IMU pre-integration in the optimization process, following the maximum likelihood estimation.
- Designed an online, robust, and fast hierarchical initialization method, which can overcome over 90% outliers and obtain accurate states of all neighbors in a time window.
- Enhanced the system to work in non-line-of-sight environments by using multiple IMUs' pre-integrations, UWBs' distance, and cameras' bearing measurements to build a tightly-coupled sliding-window optimization in relative kinematics and solved in real-time.
- Paper [4] is accepted in *IROS-2023*, Evolved Paper [1] is in preparation for *TRO-2025*.

➤ **Collaborative Navigation for Perception-Limited Robots**

- Used one UAV to support the safe navigation of a group of perception-limited UGVs.
- Designed a path planning strategy for the blind UGVs, which aggressively plans the trajectory and conservatively predicts the possible collision of the UGVs caused by the localization uncertainty to improve the efficiency and guarantee the safety of the UGVs.
- Formulated the scheduling of the UAV as dynamic vehicle routing problems with time windows to provide the support order for UGVs' motion, which can minimize the UAV's trajectory length and maximize the support before UGVs reach the predicted collision positions.
- Replaced costly lidar with a camera with a limited field of view and optimized the UAV's efficiency by integrating yaw planning and support into a unified exploration framework.
- Paper [2] is accepted in *ICRA-2024*, Paper [3] is accepted in *RAL-2024*.
- Source code released at [github.com/fast-fire/ColAG](https://github.com/fast-fire/ColAG).

➤ **Model Predictive Control in Non-inertial Frame**

- Controlled a UAV only using the relative state of the UAV with respect to a non-inertial frame
- Derived the relative kinematics and provide relative state estimation support for the system
- Paper [5] is accepted in *RAL-2023*
- Source code released at [github.com/fast-fire/CoNi-MPC](https://github.com/fast-fire/CoNi-MPC).

**MIST Lab, Polytechnique Montréal**

Montréal, Canada

Research Intern, Supervised by Giovanni Beltrame

Aug. 2024

➤ **Autonomous Exploration with a UGV**

- Deployed a trajectory planner on a UGV and successfully follow waypoints and avoid obstacles
- Deployed a hierarchical autonomous exploration planner on the UGV and completed exploration tasks for a single floor in the building

## ADDITIONAL INFORMATION

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- Programming Languages: C++/C, Python, MATLAB, LaTeX
- Software Development: Linux, ROS, Gazebo, Git, Docker, CMake, CI/CD
- Hardware Development: PX4, Jetson Xavier, SOLIDWORKS, STM32, CAD, Ansys
- GitHub: [github.com/dukuhfgfji](https://github.com/dukuhfgfji)
- Google Scholar: [scholar.google.com/citations?user=EvKoyq0AAAAJ](https://scholar.google.com/citations?user=EvKoyq0AAAAJ)