YUNFAN REN

Ph.D. Candidate

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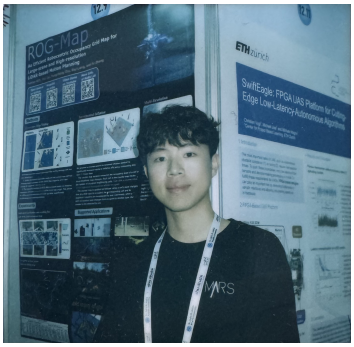
EDUCATION



9/2017 - 7/2021 **B.E. in Automation** — **Harbin Institute of Technology**
Three times *Academic scholarships*
Outstanding Thesis Award

1/2020 - 5/2020 **Exchange Student** — **University of California, Berkeley**
Selected major courses: Mechatronics Design (A+),
Feedback Control System (A),
Geometry and Learning for 3D Vision (A-)

10/2021 - Present
Graduating: 2025 **Ph.D. Student** — **The University of Hong Kong**
Research Interests:
Autonomous Navigation; Aerial Swarm; Trajectory Planning; Optimization; Optimal Control

AWARDS

Paper Awards **Outstanding Navigation Paper - Finalist** **5/2023**
International Conference on Robotics and Automation (ICRA) 2023
Paper title: Online whole-body motion planning for quadrotor using multi-resolution search.
Authors: **Yunfan REN***, Siqi Liang*, Fangcheng Zhu, Guozheng Lu, Fu Zhang

Paper Awards **Best Overall and Best Student Paper - Finalist** **10/2023**
International Conference on Intelligent Robots and Systems (IROS) 2023.
Paper title: Decentralized Swarm Trajectory Generation for LiDAR-based Aerial Tracking in Cluttered Environments
Authors: Longji Yin*, Fangcheng Zhu*, **Yunfan REN***, Fanze Kong, Fu Zhang (* indicates co-first authors)

SELECTED PUBLICATIONS

Journal Article **Safety-assured High-speed Navigation for MAVs**
Authors: **Yunfan REN***, Fangcheng Zhu*, Guozheng Lu, Yixi Cai, Longji Yin, Fanze Kong, Jiarong Lin, Nan Chen, Fu Zhang
AAAS, Science Robotics

Developed the Safety-assUred high-sPeed aErial Robot (SUPER), a compact MAV designed for high-speed autonomous navigation in cluttered environments. Utilizing a lightweight LiDAR sensor for long-range obstacle detection, SUPER integrates an efficient planning framework that generates dual trajectories: one for safety in known-free spaces and another for speed in both known and unknown areas. This framework reduces failure rates by 35.9 times while cutting planning time in half. In real-world tests, SUPER achieved autonomous speeds exceeding 20 m/s, avoiding thin obstacles and navigating narrow spaces.

Journal Article **A Survey on LiDAR-based Autonomous Aerial Vehicles**
Authors: **Yunfan REN**, Yixi Cai, Haotian Li, Nan Chen, Fangcheng Zhu, Longji Yin, Fanze Kong, Rundong Li, Fu Zhang
IEEE Transactions on Mechatronics (under review)

This survey provides a comprehensive overview of recent advancements in LiDAR-based autonomous UAVs, focusing on design, perception, planning, and control. Highlighting LiDAR's pivotal role in GPS-denied navigation due to its accuracy and range, we examine sensor evolution and integration with UAVs to enable complex missions in challenging environments.

Journal Article **Autonomous Tail-Sitter Flights in Unknown Environments**
Authors: Guozheng Lu*, **Yunfan REN***, Fangcheng Zhu, Haotian Li, Ruize Xue, Yixi Cai, Ximin Lyu, Fu Zhang
IEEE Transactions on Robotics (Co-first author)

This paper introduces the first fully autonomous tail-sitter UAV for high-speed navigation in complex environments, leveraging LiDAR sensing and onboard trajectory planning. We propose an optimization-based planning framework with a novel NLP solver for real-time trajectory generation, achieving efficiency and feasibility under constraints. Tests demonstrate speeds up to 15 m/s in varied settings.

Journal Article

Swarm-LIO2: Decentralized, Efficient LiDAR-inertial Odometry for UAV Swarms
Authors: Fangcheng Zhu*, **Yunfan REN***, Longji Yin*, Fanze Kong, Qingbo Liu, Ruize Xue, Wenyi Liu, Yixi Cai, Guozheng Lu, Haotian Li, Fu Zhang
IEEE Transactions on Robotics (Co-first author)

This paper introduces Swarm-LIO2: a decentralized, plug-and-play LiDAR-inertial odometry system for aerial swarms, achieving centimeter-level localization accuracy. Enabled efficient state estimation with minimal data exchange and scalable performance across large UAV teams. Validated in real-world and GPS-denied environments, demonstrating high adaptability for swarm missions.

Conference Paper

Online whole-body motion planning for quadrotor using multi-resolution search
Authors: **Yunfan REN***, Siqi Liang*, Fangcheng Zhu, Guozheng Lu, Fu Zhang
IEEE International Conference on Robotics and Automation (ICRA) 2023
Outstanding Navigation Paper Finalist

This study tackles the challenge of online whole-body motion planning for quadrotors in unknown and unstructured environments. We explore the feasibility of using only onboard sensing and computational units to enable the drone to actively tilt and navigate through narrow gaps.

Journal Paper

Integrated Planning and Control for Quadrotor Navigation in Presence of Suddenly Appearing Objects and Disturbances
Authors: Wenyi Liu*, **Yunfan REN***, Fu Zhang
IEEE Robotics and Automation Letters (Co-first author)

This work proposes IPC (Integrated Planning and Control), an integrated framework for quadrotor drones. IPC have high bandwidth and extremely low latency (e.g., 1 - 3 ms), successfully addressing the challenges of avoiding sudden obstacles and robust navigation under disturbances.

Conference Paper

ROG-Map: An Efficient Robocentric Occupancy Grid Map for Large-scene and High-resolution LiDAR-based Motion Planning
Authors: **Yunfan REN**, Yixi Cai, Fangcheng Zhu, Siqi Liang, Fu Zhang
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2024

ROG-Map is a LiDAR-based occupancy grid map (OGM) optimized for robotic navigation. It maintains a local map that moves with the robot, enhancing efficiency and reducing memory use for large-scale autonomous flights. We propose a novel obstacle inflation method that lowers computation costs, outperforming existing methods on public datasets.

Conference Paper

Bubble planner: Planning high-speed smooth quadrotor trajectories using receding corridors
Authors: **Yunfan REN***, Fangcheng Zhu*, Wenyi Liu, Zhepei Wang, Yi Lin, Fei Gao, Fu Zhang
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2022

Achieve high-speed (exceeding 13.7 m/s) autonomous navigation for LiDAR-based quadrotors in unknown and cluttered environments. To accomplish this, we propose a highly integrated onboard module that combines perception, planning, and control functionalities. This integrated system aims to enable efficient and high-speed navigation for quadrotors, utilizing LiDAR sensing technology in real time.

Conference Paper

Decentralized Swarm Trajectory Generation for LiDAR-based Aerial Tracking in Cluttered Environments
Authors: Longji Yin*, Fangcheng Zhu*, **Yunfan REN***, Fanze Kong, Fu Zhang
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2023
Best Overall and Best Student Paper Finalist

This paper presents a decentralized planner for swarm tracking, addressing the challenge of maintaining high target visibility in cluttered environments, by utilizing a decentralized kinodynamic searching front-end and a spatial-temporal optimizer to generate safe flight corridors, visible sectors, and collision-free trajectories for multiple unmanned aerial vehicles (UAVs) in real-world experiments.

IMPACT

Media Exposure: Transformed research work into engaging videos, accumulating over **150 k** views on video-sharing platforms such as Bilibili and YouTube.

Open-source Contribution: Open-source contributions on GitHub received a total of over **3.6k** stars.

SERVICE

Teaching assistant: *ME 3418* (Dynamics and Control), *IDAT 7213* (UAV Design, Navigation, and Control)

Student mentor: Mentored 8 MSc students in UAV research since 2021

Reviewer: Reviewed **20+** papers for *IEEE T-Mech*, *RA-L*, *ICRA*, and *IROS*

Talks: Delivered talks and oral presentations at *IROS 2022*, *ICRA 2023*, and *IROS 2024*