YUNFAN REN

Ph.D. Candidate

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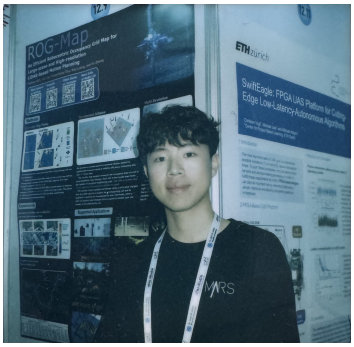
EDUCATION



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

Micro air vehicles (MAVs) navigating at high speeds in unknown environments are crucial for applications like search and rescue. However, achieving this requires reduced weight, strong obstacle detection, and advanced planning for safe and fast flights. This article presents the Safety-assUred high-sPeed aErial Robot (SUPER), a compact MAV equipped with a lightweight 3D LiDAR sensor for obstacle detection. SUPER's planning framework generates two trajectories to balance speed and safety, reducing failure rates while improving performance. Validated in real-world tests, SUPER achieves speeds over *20 m/s*, avoiding obstacles and outperforming commercial drones, making it a significant advancement in autonomous MAV technology.

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.

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

This paper introduces ROG-Map, a LiDAR-based occupancy grid map (OGM) optimized for robotic navigation. ROG-Map 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. Integrated into a quadrotor system, ROG-Map enables smooth autonomous flights in complex environments.

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 addresses the challenge of online quadrotor whole-body motion planning (SE(3) planning) in unknown and unstructured environments. Specifically, we investigate the feasibility of utilizing solely onboard sensing and computation units to enable drone maneuvering, including actively tilting the drone to navigate through narrow gaps.

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.

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 (under review)

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: Guozheng Lu*, **Yunfan REN***, Longji Yin*, Fanze Kong, Qingbo Liu, Ruize Xue, Wenyi Liu, Yixi Cai, Guozheng Lu, Haotian Li, Fu Zhang
IEEE Transactions on Robotics (under review)

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

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.

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

This work propose 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 address the challenges of avoiding sudden obstacles and robust navigation under disturbances.

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.

SKILLS

Programming: Proficient in C++, Python, and MATLAB with over five years of engineering experience

Robotics: Proficient in Robot Operating System (ROS) with over five years of engineering experience

3D Design: Proficient in 3D modeling tools, such as Blender and Solidworks

Other: Driving - More than 7 years of experience since 2017.