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

1/2021 - 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 system; Trajectory planning; Optimization; Model predictive 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 **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
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 precise 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.

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 **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

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.

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.

Conference Paper **Robust real-time lidar-inertial initialization**
Authors: Fangcheng Zhu*, **Yunfan Ren***, Fu Zhang
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2022

Introduces an automatic initialization module that detects data excitation levels and calibrates key parameters such as spatial (i.e., extrinsic such as rotation and translation) and temporal offset in real-time, and has gained substantial recognition with over 600 stars on GitHub.

Conference Paper **Swarm-LIO: Decentralized Swarm LiDAR-inertial Odometry**
Authors: Fangcheng Zhu*, **Yunfan Ren***, Fanze Kong, Huajie Wu, Siqi Liang, Nan Chen, Wei Xu, Fu Zhang
IEEE International Conference on Robotics and Automation (ICRA) 2023

This work presents a decentralized state estimation method for aerial swarm systems, utilizing LiDAR and IMU sensors to facilitate object tracking and autonomous exploration in diverse applications.

Conference Paper **Bubble Explorer: Fast UAV Exploration in Large-Scale and Cluttered 3D-Environments using Occlusion-Free Spheres**
Authors: Benxu Tang*, **Yunfan Ren***, Fangcheng Zhu, Rui He, Siqi Liang, Fanze Kong, Fu Zhang
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2023

This work presents a novel method for fast UAV exploration in large-scale and cluttered 3-D environments, combining a computationally low-cost viewpoint generation approach with a hybrid strategy of greedy selection and global optimization, resulting in improved exploration efficiency and reduced computational time compared to state-of-the-art methods, as demonstrated in extensive real-world experiments.

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

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.

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 six years of experience since 2017.