

Education

- **Beihang University** Sept. 2020 – June 2023 (expected)
M. Sc. in Control Science and Engineering, GPA: 89.8/100 (10%) Advisors: Prof. [Liang Han](#), Prof. [Zhang Ren](#)
- **Beihang University** Sept. 2016 – June 2020
B. Eng. in Automation, Shen Yuan Honors College, GPA: 89.7/100 (10%) Advisor: Prof. [Lei Guo](#)

Courses: Matrix Theory, Linear System Theory, Optimal Control and State Estimation, Robot Theory, Embedded Systems, Digital Signal Processing, Pattern Recognition and Machine Learning, Artificial Intelligence Accelerator

Research Interests

My research interests are in the intersection of machine learning and control science, spanning the entire spectrum from algorithm design, large-scale simulations, to real-world applications in robotics and autonomy.

Publications

Papers

1. **[ICRA'22]** Jinjie Li, Liang Han, Zhang Ren, “Indoor Localization for Quadrotors using Invisible Projected Tags”, *IEEE International Conference on Robotics and Automation (ICRA)*, 2022. [\[oral\]](#) [\[pdf\]](#) [\[video\]](#)
2. Ziwei Yan, Liang Han, Xiaoduo Li, Jinjie Li, “Event-Triggered Optimal Formation Tracking Control using Reinforcement Learning for Large-Scale UAV Systems”, *Submitted to ICRA'23*, 2022. [\[video\]](#)
3. Hui Cao, Dongyu Li, Liang Han, Jinjie Li, Pengkun Hao, “Fully Distributed Dynamic Event-Triggering Formation Control of UAV Swarms under DoS Attacks”, *Submitted to ICRA'23*, 2022. [\[video\]](#)
4. Jinjie Li, Haoyang Yu, Yuheng Lin, Liang Han, Qingdong Li, Zhang Ren, “Nonlinear MPC for Quadrotors in Close-Proximity Flight with Neural Network Downwash Prediction”, *In Preparation for RA-L*, 2022.

Others

5. Liang Han, Jinjie Li, Zhang Ren, “An Indoor Localization Method based on Invisible Projected Tags”, *Chinese Invention Patent*, 202111154577.4. *Substantive Examination Stage*.
6. “A Localization Software based on Invisible Projected Fiducial Tags”, *Chinese Software Copyright*, 2022SR0123403.
7. “A Large-Scale Heterogeneous Multi-Agent Simulation Platform V1.0”, *Chinese Software Copyright*, 2021SR1039534.

Research Experiences

Starts Lab, Beihang University

Beijing & Hangzhou, China

- **Learning-Based MPC for Close Formation Tracking of Quadrotors** Nov. 2021 – Present
Master's Thesis Advisor: Prof. [Liang Han](#)
 - **Problem:** The downwash effect caused by other agents is a unique problem for aerial robotics and is hard to model. How could aerial robots observe the downwash effect and integrate it into the state-of-the-art trajectory tracking framework?
 - **Method:** Trained a neural network observer with *Spectral Normalization* to predict the downwash effect in close-proximity flight. Utilized the observer to predict the future disturbances from the relative motions of ego and other quadrotors. Integrated the predicted disturbances into *Nonlinear Model Predictive Control (NMPC)* to design a trajectory tracking controller. Implemented *Minimum Snap* method to generate reference trajectories.
 - **Experiment:** Identified the inertial parameters and the rotor parameters. Utilized a TX2 NX for running the algorithm onboard in real time, ROS for communication, PX4 for body rate control, and OptiTrack for state estimation.
 - **Achievement:** The paper is in preparation for RA-L, see pub. [4](#). Reduced 68.2% tracking error in Z axis.
- **Development of a 3D Simulator for Large-Scale Heterogeneous Swarm Robots** Sept. 2020 – Present
Student Software Architect Advisor: Prof. [Liang Han](#)
 - **Aim:** Developed a simulator that supports (1) over 1000 robot nodes, (2) 6-DoF dynamic models of four model types, including fixed-wing UAVs, quadcopters, tilt-rotor UAVs, and vehicles, (3) range of vision and collision, (4) 3D visualization, and (5) a dataset to build for off-line model training and an interface with Gym for on-line DRL training.
 - **Method:** Implemented the modular simulation for fixed-wing UAVs and quadrotors from scratch, including *path planner*, *path manager*, *path follower*, *autopilot*, and *dynamics*. Accelerated the computation for different model types and tasks via *Multiprocessing*. Accelerated the computation for the same model type via *Data-Oriented Programming (DOP)*, which was packaged by PyTorch TorchScript and ran on GPU. Used pandas for OOP and DOP conversion. Utilized Cesium platform for 3D visualization.
 - **Leadership:** Applied *Gitee* for version control and code review, and *Tencent Docs* for project management.
 - **Achievement:** The simulator has supported two papers, see pub. [2](#), [3](#). Simulating 1000 robots on one PC reached an order of magnitude improvement compared with the CPU-based simulator Gazebo, which supported only about 50. [\[demo\]](#)

- Low-Cost Indoor Localization in Augmented Reality Robotic Systems**
May 2021 – Feb. 2022
Researcher
Advisor: Prof. Liang Han
 - **Problem:** How could robots fully exploit the AR scenarios projected by projectors for low-cost indoor localization?
 - **Method:** Proposed a real-time centimeter-level indoor localization method based on psycho-visually invisible projected tags (IPT), which required a projector as the sender and quadrotors with high-speed cameras as the receiver. The method includes a modulation process for the sender, as well as demodulation and pose estimation steps for the receiver, where *Screen-Camera Communication* is applied to hide fiducial tags using human vision property. Implemented an AR platform for experiments, which demonstrated an accuracy within ten centimeters and a speed of about ten FPS.
 - **Achievement:** The paper has been accepted by ICRA 2022, see pub. [1](#). The first time screen-camera communication is utilized for AR robot localization.

Academic Projects, Beihang University

Beijing, China

- Formation Control for Quadrotors with RL and Visual Fiducial Localization**
Dec. 2019 – June 2020
Bachelor's Thesis
Advisor: Prof. Liang Han
 - Utilized a downward camera to capture the fiducial tags on the ground for visual localization, and combined the result with an IMU to improve reliability and accuracy. Implemented the Dyna-Q reinforcement learning algorithm to train a multi-UAV system to achieve a formation. Verified the system on a ROS/Gazebo simulation platform.
 - The thesis was ranked No.1 in my major.
- Development of a Water Tank with a Settable Temperature Controller**
Feb. 2018 – June 2018
Team Leader, Course Project of Fundamentals of Analog Electronics
Advisor: Prof. Yao Tang
 - Developed a physical temperature control system for a water tank from scratch, which could be controlled via Bluetooth and adjusted to a specified temperature within 5 minutes. Mastered circuit design and PCB drawing. [\[video\]](#) [\[blog\]](#)
 - Ranked No.1 in my class. Invited by [Lunar Palace 1 Lab](#) to design a temperature control system for plant cultivation.

Practical Experiences

Human-Machine Interaction Lab, Huawei Technologies

Shenzhen, China

- Development of a Virtual Keyboard Prototype with Force Feedback**
Aug. 2020 – Sept. 2020
Research Intern
Supervisor: Dr. Xuan Zhou
 - Implemented a virtual keyboard prototype based on a Raspberry Pi, piezoelectric sensors, and acrylic sheets. Created the combination of different vibration waveforms to provide a natural touch feeling for users.

Beihang Aeromodelling Team, Beihang University

Beijing, China

- Development of Heavy Load and High Maneuverability Aircrafts**
Nov. 2016 – Oct. 2018
Leader of the Composite Material Team & Pilot
Supervisor: Prof. Zhiqiang Wan
 - Developed the composite part of a heavy-load aircraft. Employed carbon and glass fiber reinforced polymer (CGFRP) to make D-box structures, increasing the torsional rigidity to 261.07%. [\[blog\]](#) Trained to be a pilot as well. [\[blog\]](#)
 - Won the championship in the 2018 China Aeromodelling Design Challenge (Time-limited Airdrop Project), the best record in history. Reported by *BMFA (British Model Flying Association) News* magazine. [\[pdf\]](#)

Skills Summary

- **Languages:** English (TOEFL iBT 100, Reading 29, Listening 27, Speaking 20 → 24, Writing 24), Chinese (Mother Tongue)
- **Coding:** Python, C/C++, MATLAB, Mathematica, Bash, Git, Data-Oriented Programming, LaTeX
- **Software:** ROS 1&2, Gazebo, PX4, PyTorch, TensorFlow, OpenCV, Pandas, ACADOS, CasADi, Eigen, Docker, OptiTrack
- **Hardware:** NVIDIA Jetson, Raspberry Pi, STM32, Pixhawk, Circuit Design (Altium Designer), CAD (SolidWorks), CNC
- **Hobbies:** Model Airplane (Pilot for Fixed-Wing, Quadrotor, and Glider), Photography [\[homepage\]](#), Table Tennis, Ski

Honors and Awards

- Merit Student Scholarship 2016 ~ 2018, 2022
- Beihang Scholarship, Freshman Scholarship 2021
- Beihang Outstanding Graduates 2020
- The Champion of “Simulated Search and Rescue Project” in China Aeromodelling Design Challenge (CADC) 2017