

## 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 (Beijing University of Aeronautics and Astronautics)** Sept. 2016 – June 2020  
*B. Eng. in Automation, ShenYuan Honors College, GPA: 89.7/100 (↑10%)* Supervisor: 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, Reinforcement 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. **[ICRA'23]** Ziwei Yan, Liang Han, Xiaoduo Li, Jinjie Li, Zhang Ren, “Event-Triggered Optimal Formation Tracking Control Using Reinforcement Learning for Large-Scale UAV Systems”, *IEEE International Conference on Robotics and Automation (ICRA)*, 2023. [\[pdf\]](#) [\[video\]](#)
3. **[ICRA'23 Workshop]** Jinjie Li, Haoyang Yu, Yuheng Lin, Liang Han, Qingdong Li, Zhang Ren, “Potato: A Data-Oriented Programming 3D Simulator for Large-Scale Heterogeneous Swarm Robotics”, *ICRA'23 Workshop on The Role of Robotics Simulators for Unmanned Aerial Vehicles*, 2023.
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”, *Submitted to IEEE Conference on Decision and Control (CDC)*, 2023. [\[pdf\]](#)

### 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

Stars 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 CDC, see pub. [4](#). Reduced 75.37% 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 DataFrame 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 the Mixed Reality experiment of one paper, see pub. [2](#). Simulating 1000 robots on one PC reached an order of magnitude improvement compared with the CPU-based simulator Gazebo, which supported only about 50, see pub. [3](#). [\[demo\]](#)

- **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 using Dyna-Q for Quadrotors with AprilTag 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 Aircraft** 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, L<sup>A</sup>T<sub>E</sub>X
- **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 drones and quadrotors), 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