

# Hanli Zhang

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## Research Interests

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Autonomous Systems, Multi-agent Systems, Optimal Control, Robotics, and Machine Learning.

## Education

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### University of Pennsylvania

Philadelphia, PA

M.S. Electrical Engineering, School of Engineering and Applied Science

Sept 2022 - Present

- Relevant Courses: Machine Learning, Optimization Theory, Reinforcement Learning, F1/10 Autonomous Racing Cars, Artificial Intelligence.

### Qufu Normal University

Shandong, China

B.S. in Statistics, School of Mathematical Science

Sept 2017 - May 2021

- Relevant Courses: Mathematical Analysis, Advanced Algebra, Probability Theory, Time Series Analysis, Operations Research.
- Awarded Annual Academic Excellence Scholarship.

## Research Projects

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### ADMM-based Optimal Control for Quadrotor Dynamics with Air Drag

University of Pennsylvania

GRASP Lab | Vijay Kumar, Nikolai Matni

Sept 2023 - Present

- Engineered a layered control architecture employing Alternating Direction Method of Multipliers (ADMM) and iterative linear-quadratic regulator (iLQR) to optimize a planner and feedback tracking controller for quadrotors, considering aerodynamic drag.
- Demonstrated through simulation that the refined control strategy achieves zero tracking error, representing a significant advance over traditional approaches that neglect air drag effects.
- Developing the framework further to support real-world implementation in robotic systems, with ongoing work including integration of complex quadrotor dynamics into RotorPy simulator. Findings and code samples are documented [here](#).

### Data-aware Trajectory Optimization with Air Drag

University of Pennsylvania

GRASP Lab | Vijay Kumar, Nikolai Matni

July 2023 - Present

- Adopted a layered approach to derive trajectory planning and feedback tracking control layers from a nonlinear optimal control problem tailored to quadrotor dynamics with air drag.
- Curated an extensive dataset of distinct trajectories within the RotorPy simulator, analyzing the effects of asymmetric air drag on drone maneuverability. Utilized JAX to enhance training and inference processes.
- Achieved a significant reduction in tracking errors for UAV trajectories, outperforming standard approaches both with and without drag compensation, and confirming the efficacy of our model. [This paper](#) is currently under review at the L4DC conference.

## **Rangefinder-Calibrated Monocular Depth Estimation on F1/10 Auto-Racing Cars**

*University of Pennsylvania*

xLAB | Rahul Mangharam

*May 2023*

- Refined autonomous depth estimation for racing vehicles using the MiDaS v2.1 small model, optimized for real-time performance with 40 FPS inference speed on NVIDIA Jetson Xavier NX.
- Conducted histogram analysis and sensor fusion techniques, synchronizing monocular camera views with laser time-of-flight (TOF) sensor data for enhanced distance measurement accuracy.
- Enhanced navigational decision-making by processing 2D depth scans, enabling precise obstacle detection and path planning for competitive auto-racing environments. The final project report is available [here](#).

## **Model Predictive Control(MPC) for Autonomous Racing Cars**

*University of Pennsylvania*

xLAB | Rahul Mangharam

*Mar 2023*

- Validated an MPC framework designed for autonomous racing cars, fine-tuning control inputs to adhere closely to the designated trajectory with high precision.
- Implemented a systematic approach to linearize the car's dynamic model, discretized it for the prediction horizon, and applied optimization strategies using cvxpy to solve the problem efficiently.

## **Work Experience**

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### **LYF Innovation Ltd., Inc.**

*Philadelphia, PA*

Robotic Engineer Intern

*June 2023 - Aug 2023*

- Augmented grass terrain navigation for the lawn mowing robot by leveraging VINS-Fusion algorithms with panoramic cameras and IMU data, utilizing RANSAC and masking techniques for a 15% increase in tracking accuracy.
- Boosted the perception model's accuracy by 10% for the robotic mower through meticulous refinement and modification of existing labels and annotations.

### **Suzhou Beacon Robot Technology Co., Ltd.**

*Suzhou, China*

Algorithm Engineer

*Aug 2021 - Aug 2022*

- Optimized Simultaneous Localization and Mapping(SLAM) algorithm SVD, particle filter, and Kalman filter, achieving  $\pm 5\text{mm}$  pose accuracy and a 30% reduction in pose loss in chaotic environments, contributing to the success of 7 projects and generating nearly \$50,000 in revenue.
- Reconstructed the infrastructure by improving 12 embedded drive-layer programs with C++ on ROS, and introduced robust communication and error feedback mechanisms, which facilitated three-level obstacle avoidance for safer operations of autonomous transport robots in dynamic settings.
- Troubleshooted and resolved over 30 field issues, optimizing code and system performance, and led Linux tool training for Field Application Engineers to bolster on-site efficiency.

## **Skills**

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**Programming** Python (TensorFlow, PyTorch, cvxpy, Keras. etc.), C/C++, Matlab, R, Java

**Miscellaneous** Linux, Shell, ROS1/2, Git, Docker,  $\text{\LaTeX}$ , Power BI