

Kai Yun

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Graduate Student Researcher, Robotics Institute at Carnegie Mellon University
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RESEARCH INTEREST

I work on **safety-critical control** for drone and manipulator applications. My research goal is to create safe and efficient controllers using methods at the intersection of **control theory** and **machine learning**. I aim to deploy these controllers on **real robots** to enhance their safety and performance in practical applications.

EDUCATION

Carnegie Mellon University, Pittsburgh, PA Class of 2025 (Expected)
Master of Science in **Mechanical Engineering - Research** 4.00/4.00
Advisors: Dr. Changliu Liu, Dr. John M. Dolan

University of California, Berkeley, Berkeley, CA Class of 2023
Bachelor of Science in **Mechanical Engineering** 3.68/4.00
Minor in **Electrical Engineering and Computer Science (EECS)**

PUBLICATIONS

* Equal Contribution

- [1] Simin Liu*, **Kai S. Yun***, John M. Dolan, Changliu Liu, “Synthesis and Verification of Robust-Adaptive Safe Controllers”. *arXiv preprint at arxiv.org:2311.00822, 2023*, Accepted at 2024 European Control Conference (ECC), 2024.
- [2] Tianhao Wei, Luca Marzari*, **Kai S. Yun***, Hanjiang Hu*, Peizhi Niu*, Xusheng Luo, Changliu Liu, “ModelVerification.jl: a Comprehensive Toolbox for Formally Verifying Deep Neural Networks”. *arXiv preprint at arxiv.org:2407.01639, 2024*.
- [3] Jack C. Harms, Ethan M. Grame, **SirkHoo Yun**, Bushra Ahmed, Leah C. O’Brien, James J. O’Brien, “Mass-independent Dunham Analysis of the $[7.7]Y^2\Sigma^+ - X^2\Pi_i$ and $[16.3]A^2\Sigma^- - X^2\Pi_i$ Transitions of Copper Monoxide, CuO”. *Journal of Molecular Spectroscopy*, 2019.

SKILLS

- **Area of expertise:** Control Barrier Function, Control Lyapunov Function, Adversarial Training, Model Learning, Sum-of-squares Programming, Safe Reinforcement Learning, Model-based Reinforcement Learning
- **Libraries:** PyTorch, TensorFlow, Gazebo, OpenAI Gym, PyBullet, PX4, Ray, Numpy, Pandas.
- **Programming:** Python, MATLAB, Julia, C++.
- **Physical Robots/Machines:** PX4 Autopilot Quadrotor, Sawyer, Kinova, CrazyFlie, Tanks.
- **Other skills:** ROS, Linux, Git, SolidWorks, \LaTeX , Simulink, CAN Bus, MoTeC.
- **Languages:** Fluent in English, Korean.

RESEARCH EXPERIENCE

Intelligent Control Lab Pittsburgh, PA
Advisors: Dr. Changliu Liu, Dr. John M. Dolan June 2023 — Present

- Research on developing and deploying a learning-based safe controller for quadrotor hardware [ongoing].
 - Develop an adversarial training method that generates neural control barrier functions for high-dimensional systems.
 - Deploy neural safe controller on quadrotor-pendulum hardware for safety and performance experiments.
- Research on algorithm development for synthesizing safe controllers for robotic systems. [1]
 - Devised an optimization algorithm that generates robust-adaptive control barrier functions given uncertain systems.
- Developed *ModelVerification.jl*, a Julia library containing state-of-the-art neural network verification algorithms. [2]
- Research on motion planning for manipulating moving objects using optimization-based kinodynamic planner.

Hybrid Robotics Lab Berkeley, CA
Advisor: Dr. Koushil Sreenath August 2021 — April 2022

- Research on safe reinforcement learning for worst-case scenarios. [\[Report\]](#)
 - Devised a safe RL algorithm called *PPO-Worst-Case*, to ensure safety constraints are met in the worst-case scenarios.
 - Achieved up to 110% performance compared to CPO and PPO-Lagrangian.

SELECTED COURSES

Carnegie Mellon University

Provably Safe Robotics (16.883), Optimal Control & Reinforcement Learning (16.745), Advanced Control Systems Integration (24.774).

UC Berkeley

Deep Reinforcement Learning (CS 285), Nonlinear Systems (EE C222), Machine Learning (CS 189), Robotic Manipulation & Interaction (EECS C106B), Vehicle Dynamics and Control (ME 131), Dynamic Systems & Feedback (ME 132), Mechatronics Design (ME 102B), Experimentation and Measurements (ME 103).

ACADEMIC PROJECTS

- **Balancing an Inverted Pendulum on Quadrotor (2024).** Used LQR to balance an inverted pendulum on a quadrotor in flight. The quadrotor was built with PX4 firmware. [Video]
- **Extended Kalman Filter (EKF) for Autonomous Racing (2023).** Implemented EKF system identification for tire loads and side-slip angles for a lateral stability MPC for the [Indy Autonomous Challenge](#).
- **Model-based Reinforcement Learning (MBRL) for Trajectory Optimization (2022).** Developed an image-based model-learning algorithm using MBRL to locally approximate the linear dynamics and cost function for iterative LQR. [Report]
- **Dart-launching Robot (2022).** Devised a method to track dart boards with computer-vision and launch darts using spring-actuated dart-launcher with Sawyer manipulator for bullseye. [Website]

PROFESSIONAL EXPERIENCE

Tesla, Inc.

Vehicle Dynamics / Software Engineering Intern

Palo Alto, CA

May 2022 — August 2022

- Developed a correlation framework for comparing subjective vehicle evaluation and objective test data.
- Analyzed vehicle dynamics data to improve the ride, handling, and steering experiences of Models S, 3, and Semitruck.
- Instrumented Tesla vehicles and competitor vehicles with sensors and robots. Assisted vehicle tests on proving grounds.
- Developed automated ticketing, reporting, and logging systems utilizing internal software and corresponding API.

NeuroCore.ai

Reinforcement Learning Research Intern

Seoul, South Korea

Oct 2020 — July 2021

- Designed and developed RL training and deployment frameworks, which increased training efficiency by 84%.
- Developed simulators for Supply Chain Management (SCM) tasks for semiconductor manufacturers.
- These are currently deployed in South Korean semiconductor manufacturers, such as SK Hynix.

OTHER EXPERIENCE

Robotics Institute at Carnegie Mellon University

Robotics Institute Summer Scholars (RISS) Mentor

Pittsburgh, PA

May 2024 — Aug 2024

- Graduate research mentor for undergraduate students for summer research at the Robotics Institute at CMU.

Republic of Korea Army

K-1 Tank Mechanic, Sergeant, Squad Leader

South Korea

Jan 2019 — Aug 2020

- Performed malfunction diagnostics and maintenance of K-1 tank systems, including track, turret, hydraulic system, etc.
- Assisted logistics and resource management at Control and Command Center of the Combat Service Support Battalion.
- Served as a Squad Leader: responsible for the discipline, accountability, and development of 10 soldiers.