Kwang Hak Kim

Ph.D. Student, University of California San Diego, La Jolla, CA
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EDUCATION

Ph.D. Student in Mechanical and Aerospace Engineering Sept. 2022 – Jun. 2027 (expected)
University of California San Diego, La Jolla, CA

M.S. in Mechanical Engineering Sept. 2022 – May 2024
University of California San Diego, La Jolla, CA GPA: 3.84/4.00

B.S. in Aerospace Engineering Aug. 2016 – May 2020
The University of Texas at Austin, Austin, TX GPA: 3.82/4.00

RESEARCH EXPERIENCE

Graduate Student Researcher La Jolla, CA
Nonlinear and Adaptive Control Laboratory (UCSD) Sept. 2022 — Present
Advisors: Prof. Miroslav Krstić and Prof. Mamadou Diagne

- Developed novel **stabilization and safety-critical** control strategies for **nonholonomic underactuated vehicles**
- Designed safety filters for **autonomous traffic management** on aircraft carrier decks, and **presented results** to **ONR** program managers and **NAWCAD** in invited technical discussions
- Constructed **globally strict CLFs** for unicycle and Dubins vehicle models, enabling smooth time-invariant, inverse-optimal, adaptive, and prescribed/fixed-time stabilization
- Designed novel smooth robust CBFs for high-relative-degree systems to guarantee **collision avoidance with unknown moving obstacles**
- Introduced a constant-sum high-order CBF framework that guarantees **safety between parallel boundaries** by eliminating loss of control authority
- Extending stabilization and safety-critical control frameworks to **broader classes of nonholonomic vehicle models**, including higher-fidelity and three-dimensional systems.

Undergraduate Research Assistant Austin, TX
Autonomous Systems Group (UT Austin) Jun. 2019 — Feb. 2020
Advisor: Prof. Ufuk Topcu

- Studied **multi-agent logistics and coordination** in confined environments such as warehouses.
- Designed state-based controllers for **multi-quadcopter systems** using Slugs (reactive synthesis).
- Implemented and evaluated controllers in **AirSim** using custom **Unreal Engine** simulation environments using Python.

Undergraduate Research Assistant Intern Seoul, South Korea
eXtreme Energy Laboratory (Seoul National Uni.) Jun. 2019 — Feb. 2020
Advisor: Prof. Jai Ick Yoh

- Analyzed the impact velocity and precision of a **needless syringe design** for medical applications
- Researched and experimented **extreme temperature endurance materials** for electrodes

OTHER EXPERIENCES AND PROJECTS

Instructional Assistant (UCSD) La Jolla, CA
Nonlinear Systems (MAE 281A) and Linear Control (MAE 142B) Jan. 2025 — Jun. 2025

- Awarded **MAE PhD Outstanding Teaching Assistant of the Year**, recognized for exceptional student support and instructional contributions.
- Led weekly discussion sections and office hours to clarify complex concepts and collaborated with faculty to refine course materials and provide consistent learning outcomes across sections.

NASA's 2020 RASC-AL Competition Finalist (Theme 5) Austin, TX
Project Autoponics - Team Lead Aug. 2019 — Jun. 2020

- Led the design and presentation of an autonomous plant habitat for the Lunar Gateway, securing $11,000 in National Institute of Aerospace funding.

Aerial Robotics Autonomy Protocol Project Austin, TX
Aerial Robotics Course Project Jan. 2020 — May 2020

- Developed a C++ autonomy stack for a quadcopter using 3D A* path planning and polynomial trajectory smoothing.

Republic of Korea Air Force South Korea
Air Defense Artillery Brigade Oct. 2020 — Jul. 2022

- Led training of 20+ recruits in technical maintenance and tactical protocols

SKILLS

- **Autonomy & control:** Lyapunov-based methods (CLF/CBF), quadratic program (QP) safety filters, adaptive control, inverse-optimal control, PID, LQR, linear MPC
- **Learning-based methods:** Reinforcement learning methods (policy gradient, actor–critic, Q-learning, SARSA)
- **Signals & data analysis:** Filtering methods (low/high-pass), spectral analysis (DFT/FFT), system identification
- **Software:** MATLAB, Python, C++, Simulink, ROS 2, Git, SolidWorks
- **Languages:** English (native), Korean (native)

PUBLICATIONS

Journal Papers

[J1] **K. H. Kim**, M. Diagne and M. Krstić, *"Constant-Sum High-Order Barrier Functions for Safety Between Parallel Boundaries,"* in IEEE Control Systems Letters, vol. 9, pp. 1447-1452, 2025

Conference Papers

[C1] **K. H. Kim**, M Diagne, M Krstić, *"Robust Control Barrier Function Design for High Relative Degree Systems: Application to Unknown Moving Obstacle Collision Avoidance,"* in American Control Conference (ACC), Denver, CO, 2025

[C2] E. Zapien Ramos, **K. H. Kim**, M. Krstić, A. J. Rosengren, *"Safety-Critical Control Using Fully Nonlinear Equations of Relative Motion for Formation Flying in Cislunar Space,"* in AIAA SciTech Forum, 2026

Manuscripts in Review

[R1] V Todorovski, **K. H. Kim**, A Astolfi, and M Krstić, *"Nonholonomic Robot Parking by Feedback—Part I: Modular Strict CLF Designs,"* submitted to IEEE Transactions on Automatic Control, Available: arXiv:2511.15119

[R2] **K. H. Kim**, V Todorovski, and M Krstić, *"Nonholonomic Robot Parking by Feedback—Part II: Nonmodular, Inverse Optimal, Adaptive, Prescribed/Fixed-Time and Safe Designs,"* submitted to IEEE Transactions on Automatic Control, Available: arXiv:2511.15219

[R3] M Krstić, **K. H. Kim**, and V Todorovski, *"Dubins Vehicle Stabilization: Deadbeat Parking and Asymptotic 'Spinaway',"* submitted to Automatica.

[R4] **K. H. Kim**, V Todorovski, and M Krstić, *"Inverse Optimal Feedback and Gain Margins for Unicycle Stabilization,"* submitted to the American Control Conference (ACC) 2026, Available: arXiv:2509.25563

[R5] V Todorovski, **K. H. Kim**, and M Krstić, *"Modular Design of Strict Control Lyapunov Functions for Global Stabilization of the Unicycle in Polar Coordinates,"* submitted to the American Control Conference (ACC) 2026, Available: arXiv:2509.25575

[R6] M Krstić, V Todorovski, **K. H. Kim**, and A Astolfi, *"Integrator Forwarding Design for Unicycles with Constant and Actuated Velocity in Polar Coordinates,"* submitted to the American Control Conference (ACC) 2026, Available: arXiv:2509.25579

[R7] M Krstić, **K. H. Kim**, and V Todorovski, *"Half-Global Deadbeat Parking for Dubins Vehicle,"* submitted to the American Control Conference (ACC) 2026, Available: arXiv:2509.25571

INVITED TALKS

- RoboGrads Feed the Intellect (FTI) Seminar Nov. 2024
- MAE Student Seminar Nov. 2024

AWARDS

- MAE PhD Outstanding Teaching Assistant of the Year (UCSD) Jun. 2025
- Steve K. Sin Endowed Presidential Scholarship in Engineering (UT Austin) Jan. 2020
- University Honors (UT Austin) Aug. 2016 - May 2020