# INKYU JANG (장인규)

Ph.D. Candidate, Department of Aerospace Engineering, Seoul National University
1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea
janginkyu.larr@gmail.com | janginkyu.github.io | linkedin.com/in/inkyu-jang-78a78a191/

## Research Interests

Robot Safety, Receding-Horizon Motion Planning, Stochastic Control

## Education

**Ph.D. Student, Aerospace Engineering** — September 2020 – present
Seoul National University, Seoul, Korea
Laboratory for Autonomous Robotics Research (LARR)
Advisor: Prof. H. Jin Kim

**B.S., Mechanical Engineering** — March 2014 – February 2020
Seoul National University, Seoul, Korea
*summa cum laude*

## Publications

* equal contribution

### Under Review

[U1] Upper bound on escape probability for stochastic control barrier functions
**I. Jang**, and H. J. Kim

[U2] Enhancing feature tracking reliability for visual navigation using real-time safety filter
D. Kim*, **I. Jang***, Y. Han, S. Hwang, and H. J. Kim

[U3] Invariance guarantees using continuously parametrized control barrier functions
**I. Jang**, and H. J. Kim

[U4] Decentralized trajectory planning for quadrotor swarm in cluttered environments with goal convergence guarantee
J. Park, Y. Lee, **I. Jang**, and H. J. Kim

### Journal Articles

[J1] Safe motion planning and control for mobile robots: A survey
S. Hwang, **I. Jang**, D. Kim, and H. J. Kim
*International Journal of Control, Automation, and Systems (**IJCAS**)*, vol. 22, no. 10, pp. 2955-2969, October 2024.

[J2] Towards fully integrated autonomous excavation: Autonomous excavator for precise earthcutting and onboard landscape inspection
**I. Jang***, J. Kim*, D. Lee*, C. Kim*, C. Oh, Y. Kim, S. Woo, H. Sung, and H. J. Kim
*IEEE Robotics and Automation Magazine (**RAM**)*, 2024.

[J3] Safe control for navigation in cluttered space using multiple Lyapunov-based control barrier functions
**I. Jang**, and H. J. Kim
*IEEE Robotics and Automation Letters (**RA-L**)*, vol. 9, no. 3, pp. 2056-2063, March 2024.

[J4] DLSC: Distributed multi-agent trajectory planning in maze-like dynamic environments using linear safe corridor
J. Park, Y. Lee, **I. Jang**, and H. J. Kim
*IEEE Transactions on Robotics (**T-RO**)*, vol. 39, no. 5, pp. 3739-3758, October 2023.

[J5] A hybrid controller enhancing transient performance for an aerial manipulator extracting a wedged object
J. Byun, **I. Jang**, D. Lee, and H. J. Kim
*IEEE Transactions on Automation Science and Engineering (**T-ASE**)*, vol. 21, no. 3, pp. 3264-3273, July 2024.

[J6] Real-time robust receding horizon planning using Hamilton-Jacobi reachability analysis
H. Seo, D. Lee, C. Y. Son, **I. Jang**, C. J. Tomlin, and H. J. Kim
*IEEE Transactions on Robotics (**T-RO**)*, vol. 39, no. 1, pp. 90-109, February 2023.

[J7] Learning and generalizing cooperative manipulation skills using parametric dynamic movement primitives
H. Kim, C. Oh, **I. Jang**, S. Park, H. Seo, and H. J. Kim
*IEEE Transactions on Automation Science and Engineering (**T-ASE**)*, vol. 19, no. 4, pp. 3968-3979, October 2022.

[J8] Fast computation of tight funnels for piecewise polynomial systems
**I. Jang**, H. Seo, and H. J. Kim
*IEEE Control Systems Letters (**L-CSS**)*, vol. 6, pp. 2234-2239, 2022.

[J9] Aerial manipulator pushing a movable structure using a DOB-based robust controller
D. Lee, H. Seo, **I. Jang**, S. J. Lee, and H. J. Kim
*IEEE Robotics and Automation Letters (**RA-L**)*, vol. 6, no. 2, pp. 723-730, April 2021.
**ICRA 2021 Best Paper Award on Unmanned Aerial Vehicles**

[J10] Fail-safe flight of a fully-actuated quadrotor in a single motor failure
S. J. Lee, **I. Jang**, and H. J. Kim
*IEEE Robotics and Automation Letters (**RA-L**)*, vol. 5, no. 4, pp. 6403-6410, October 2020.

[J11] Fully actuated autonomous flight of thruster-tilting multirotor
S. J. Lee, D. Lee, J. Kim, D. Kim, **I. Jang**, and H. J. Kim
*IEEE/ASME Transactions on Mechatronics (**T-MECH**)*, vol. 26, no. 2, pp. 765-776, April 2021.

[J12] Learning transformable and plannable se(3) features for scene imitation of a mobile service robot
J. H. Park, J. Kim, Y. Jang, **I. Jang**, and H. J. Kim
*IEEE Robotics and Automation Letters (**RA-L**)*, vol. 5, no. 2, pp. 1664-1671, April 2020.

### Conference Proceedings

[C1] Leakage rate as a measure of continuous-time stochastic set invariance
**I. Jang**, M. Yoon, and H. J. Kim
*2024 63rd IEEE Conference on Decision and Control (**CDC**)*

[C2] Safe receding horizon motion planning with infinitesimal update interval
**I. Jang**, S. Hwang, J. Byun, and H. J. Kim
*2024 IEEE International Conference on Robotics and Automation (**ICRA**)*

[C3] Invariance guarantees using continuously parametrized control barrier functions
**I. Jang**, and H. J. Kim
*2023 23rd International Conference on Control, Automation and Systems (**ICCAS**)*
**ICCAS 2023 Best Student Paper Award**

[C4] Safe and distributed multi-agent motion planning under minimum speed constraints
**I. Jang**, J. Park, and H. J. Kim
*2023 IEEE International Conference on Robotics and Automation (**ICRA**)*

[C5] Decentralized deadlock-free trajectory planning for quadrotor swarm in obstacle-rich environments
J. Park, **I. Jang**, and H. J. Kim
*2023 IEEE International Conference on Robotics and Automation (**ICRA**)*

[C6] DHRL: A graph-based approach for long-horizon and sparse hierarchical reinforcement learning
S. Lee, J. Kim, **I. Jang**, and H. J. Kim
*2022 36th Conference on Neural Information Processing Systems (**NeurIPS**)*
**Oral Presentation**

[C7] Robust and recursively feasible real-time trajectory planning in unknown environments
**I. Jang**, D. Lee, S. Lee, and H. J. Kim
*2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**)*

[C8] Real-time motion planning of a hydraulic excavator using trajectory optimization and model predictive control
D. Lee*, **I. Jang***, J. Byun, H. Seo, and H. J. Kim
*2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**)*

[C9] Stability and robustness analysis of plug-pulling using an aerial manipulator
J. Byun, D. Lee, H. Seo, **I. Jang**, J. Choi, and H. J. Kim
*2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**)*

[C10] Provably safe real-time receding horizon trajectory planning for linear time-invariant systems
**I. Jang**, D. Lee, and H. J. Kim
*2020 20th International Conference on Control, Automation and Systems (**ICCAS**)*
**ICCAS 2020 Outstanding Paper Award**

[C11] Efficient multi-agent trajectory planning with feasibility guarantee using relative Bernstein polynomial
J. Park, J. Kim, **I. Jang**, and H. J. Kim
*2020 IEEE International Conference on Robotics and Automation (**ICRA**)*
**ICRA 2020 Multi-Robot Systems Award Finalist**

## Honors

### Scholarships and Grants

| | |
|---|---|
| Research Grant for Doctorate Research (박사과정생 연구장려금), NRF Korea | 2024 – 2026 |
| Brain Korea 21 (BK21) Research Fellowship | 2021 – 2022 |
| The National Scholarship for Science and Engineering | 2018 – 2020 |

### Awards

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| ICCAS 2023 Best Student Paper Award | 2023 |
| Top Prize, Korea Aerospace Industries (KAI) Aerospace Paper Award | 2022 |
| ICRA 2021 Best Paper Award on Unmanned Aerial Vehicles | 2021 |
| ICRA 2020 Multi-Robot Systems Award Finalist | 2020 |
| ICCAS 2020 Outstanding Paper Award | 2020 |
| Outstanding B.S. Thesis Presentation Award | 2019 |
| Silver Medal, 6th International Olympiad on Astronomy and Astrophysics (IOAA) | 2012 |

## Invited Talks

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| Safety filter in complex environments using continuously parametrized invariant sets<br>Semiautonomous Seminar, UC Berkeley | August 2024 |
| Invariance guarantees using continuously parametrized control barrier functions<br>2024 ICROS Conference (제어로봇시스템학회 학술대회), Daejeon, Korea | July 2024 |

## Other Activities

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| **Visiting Student Researcher**<br>University of California at Berkeley, Berkeley, CA, USA<br>Hybrid Systems Laboratory (advisor: Prof. Claire J. Tomlin) | 2024 |

## Projects

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|---|---|
| Safety Filter Design for Real-Time Safety Assurance of Autonomous Mobile Robots<br>National Research Foundation (NRF), Korea | 2024 – present |
| Motion Planning and Environment Perception for Autonomous Wheel Loader System<br>HD Hyundai Construction Equipment | 2022 – present |
| Online Path Planning Algorithms for Multi-Robot System<br>Hyundai Motor Company | 2022 – 2023 |
| Motion Planning and Landscape Inspection Algorithms for Autonomous Excavator System<br>Hyundai Construction Equipment | 2020 – 2022 |

## Skills

**Programming**

(Expert) C/C++, Python, Matlab

(Intermediate) C#, Julia, Javascript, Typescript

**Tools / Platform**

ROS1, ROS2, WinForm, TCP/IP, STM32

**Math Topics**

Riemannian Geometry, Lie Group Theory, Stochastic Calculus