# Haegu Lee

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## Research Statement

My research vision is to enable robots to perform human-like manipulation in contact-rich environments, where tasks require both compliance and precision. Humans can carry out sensitive physical interactions with remarkable adaptability, even under uncertainty and complex contact conditions. I want to bring this capability to robotic systems so that robots can move beyond simple repetitive automation and toward more sophisticated, dexterous, and human-centered tasks. My research therefore focuses on identifying planning and control methods that can operate robustly in real contact-rich manipulation settings. I am particularly interested in combining the strengths of model-based approaches, which provide physical insight and structure, with simulation environments that support the development of more advanced learning-based methods. Ultimately, I hope to establish a principled understanding of how physically grounded modeling, control, and simulation can support more capable and scalable learning in complex robotic manipulation.

## Education

**University of Southern Denmark** Dec. 2023 – Present
*Ph.D Student. in SDU Robotics* *Denmark, Odense*

**Ulsan National Institute of Science and Technology (UNIST)** Mar. 2020 – Feb. 2022
*M.S. in Mechanical Engineering, GPA: 3.8/4.0* *Ulsan, South Korea*

- Master's thesis: *Optimal Posture Planning of Manipulator for Direct Drilling on Unknown Freeform Surface*

**Hanyang University** Mar. 2014 – Feb. 2020
*B.S. in Robot Engineering, GPA: 3.48/4.0* *Seoul, South Korea*

## Experience

**Doosan Robotics** Dec. 2021 – Dec. 2023
*Control Algorithm Researcher, Control Framework Team and Task Force Team* *South Korea*

- Conducted on-site kinematic and laser calibration to improve robot accuracy
- Developed minimum-time trajectory planning methods based on torque optimization
- Improved the dynamic model of a spring-based gravity compensator

**Convergence Research Program, Seoul National University** Jul. 2019 – Aug. 2019
*Research Intern* *Seoul, South Korea*

- Developed a perception system for a furniture assembly robot

**Machine Dynamics Laboratory, Hanyang University** Jul. 2018 – Aug. 2018
*Research Student* *Seoul, South Korea*

- Developed a test environment for analyzing friction between wire and tube

## Projects

**CAPeX: Power-to-X Lab Automation** | *SDU* Dec. 2023 – Present

- Lab automation with fragile object

**Freeform Surface Drilling with Manipulator** | *UNIST* Feb. 2021 – Jan. 2022

- Developed a direct drilling method with a high-stiffness posture planning algorithm for a manipulator
- Optimized manipulator posture by exploiting kinematic redundancy to increase stiffness during drilling
- Generated 3D surfaces of target workpieces for non-CAD drilling using a depth camera and line scanner

**Mobile Robot for Large-Area Machining** | *UNIST* Feb. 2020 – Jan. 2021

- Improved depth accuracy for a mobile robot-based CNC system for large-scale products
- Investigated posture optimization strategies for stable and accurate machining
- Used 3D sensing pipelines to reconstruct target surfaces for machining applications

## Journal Publications

* indicates equal contribution.

1. **Safety-Critical Control under Smoothed Implicit Contact Dynamics via Robust Control Barrier Functions**
   *Haegu Lee, Yitaek Kim, and Christoffer Sloth*
   IEEE Robotics and Automation Letters (RA-L), 2026 **(Under review)**

2. **Enhancement of the Hole Quality of Freeform CFRP with Industrial Robot Posture Optimization**
   *Yun Seok Kang*, Haegu Lee*, Dong Chan Kim, Jaewoo Seo, and Hyung Wook Park*
   International Journal of Advanced Manufacturing Technology, 2025

## Conference Publications

1. **Manipulation via Force Distribution at Contact**
   *Haegu Lee, Yitaek Kim, Casper Hewson Rask, and Christoffer Sloth*
   *arXiv preprint*, 2026

2. **Trajectory Optimization for In-Hand Manipulation with Tactile Force Control**
   *Haegu Lee, Yitaek Kim, Victor Melbye Staven, and Christoffer Sloth*
   International Conference on Intelligent Robots and Systems (IROS), 2025

3. **Sim-to-Real Transfer for Cable Manipulation with Tactile Sensing and Homotopy-Constrained Path Planning**
   *Haegu Lee*, Victor Melbye Staven*, and Christoffer Sloth*
   International Conference on Control, Mechatronics and Automation (ICCMA), 2024

## Activities

**AI-Robotics KR - Community Organizer** Jan. 2023 – Dec. 2023
- Manage and operate an online AI-Robotics Korea community

**HYMEC, Hanyang University - Club Leader** Feb. 2018 – Jan. 2020
- Led a robot-making club and organized team activities
- Mentored junior students in the Department of Robot Engineering and organized hackathons

**Interin, Hanyang University - Club Leader** Jun. 2018 – Jun. 2019
- Led a debate club focused on culture and robotics

## Skills

**Programming Languages**: Python, MATLAB, C++
**Engineering Tools**: CAD, 3D Laser Tracker, RoboDyn
**Frameworks**: ROS, MoveIt, MuJoCo
**Libraries**: Eigen, Open3D, OpenCV, PCL
**Languages**: Korean (Native), English (Professional working proficiency)

## Awards and Scholarships

**Silver Prize, Portfolio Contest, Hanyang University** 2019
- Recognized for a portfolio summarizing overall academic and extracurricular activities during university years

**Second Prize, Free-Subject Club Conference, Hanyang University** 2019
- Project: *Legged Robot for Burrito Delivery*

**First Prize, Free-Subject Club Conference, Hanyang University** 2018
- Project: *Vision-Based Autonomous Self-Driving Car Control*

**Robot Engineering Scholarship, Hanyang University** 2018
- Awarded for leadership as chairman of the robot engineering club

**Leadership Scholarship, Hanyang University** 2017
- Awarded in recognition of leadership activities

**Hanyang Brain Scholarship, Hanyang University** 2014
- Competitive academic scholarship