Minku Kim

Philadelphia, PA, 19104 minkukim@seas.upenn.edu +1 (215)-730-4222

Education

University of Pennsylvania *Philadelphia, PA*
Master of Science in Mechanical Engineering and Applied Mechanics *Aug 2023 – May 2025*

- **Thesis**: Vision-based Hierarchical Controller for Bipedal Locomotion in Unstructured Terrains
- **Concentration**: Mechatronic and Robotic Systems
- **GPA**: 4.0/4.0

Chung-Ang University *Seoul, Korea*
Bachelor of Science in Mechanical Engineering with honors *Mar 2017 – Feb 2023*

- **Major GPA**: 4.12/4.5

Research Experience

Dynamic Autonomy and Intelligent Robotics Lab, GRASP Lab *Philadelphia, PA*
Graduate Research Assistant - Prof. Michael Posa *Jan 2024 – current*

- Proposed vision-based hierarchical controller for the underactuated biped *Cassie* in unstructured terrains utilizing terrain-aware reinforcement learning footstep planner and low-level operational space controller
- Developed full-stack RL pipeline in Drake, including training, sampling and deployment to hardware
- Validated the proposed framework on hardware and compared with MPC benchmark reduced mean square error of velocity tracking by 0.05 and improved success rate in various terrains by 11% in simulation

Integrated Systems Design Lab *Seoul, Korea*
Research Intern - Prof. Hae-Jin Choi *Aug 2022 – Jan 2023*

- Constructed data acquisition pipeline in MATLAB to collect and analyze real performance data from an electric vehicle (EV) reducer testbed using 3-axis accelerometers and current sensors
- Developed real-time fault diagnosis model with 98% detection, utilizing feature extraction methods such as Wavelet Packet Decomposition, Mel-Frequency Cepstral Coefficients and STFT spectrogram

Assistive and Rehabilitation Robotics Lab *Seoul, Korea*
Research Intern - Prof. Giuk Lee *Jan 2022 - May 2022*

- Modeled 4-DOF manipulator using Fusion 360 and 3D printers, incorporated stepper motors and fluid-actuated control system for motion control

Artificial Intelligence for Mechanical Systems Lab *Seoul, Korea*
Undergraduate Research Assistant - Prof. Woochul Nam *June 2021 – Apr 2022*

- Implemented hybrid vision-based UAV control system integrating one-stage detection algorithm and Siamese network to track moving drones in visually complex environments
- Designed custom loss function that improved small object detection by 5% and optimized model using quantization and pruning to achieve 30 fps real-time performance
- Built terrain recognition algorithm for wearable device using stereo camera, employing point cloud semantic segmentation model for ground classification in dense forest environments

Teaching Experience

ESE 650: Learning in Robotics *Philadelphia, PA*
Graduate Teaching Assistant - Prof. Pratik Chaudhari *Jan 2025 – May 2025*

MEAM 510: Design of Mechatronic System *Philadelphia, PA*
Graduate Teaching Assistant - Prof. Mark Yim, Dr. Jessica Weakly *Aug 2024 – Dec 2024*

- Assisted in teaching and managing a course of 100+ students, including leading recitation sessions, grading assignments and holding 3hr+/week office hours

Chung-Ang University Artificial Intelligence Society *Seoul, Korea*
Mentor *Apr 2021 – Sep 2021*

- Mentored 10+ basic track students in Machine Learning, Deep Learning and Computer Vision

Publications

Learning a Vision-Based Footstep Planner for Hierarchical Walking Control on Unstructured Terrain 2024
In IEEE Robotics and Automation Letters (RA-L), (In progress)
Minku Kim, Brian Acosta, Pratik Chaudhari and Michael Posa.

AI-based Real-Time Monitoring and Fault Diagnosis for Gear Failure in Electric Vehicle Reducers 2022
Thesis paper for B.S. Degree, Chung-Ang University
Minku Kim.

Design of a 4-DOF Robotic Arm using Hydraulic control 2022
Thesis paper for B.S. Degree, Chung-Ang University
Minku Kim.

Projects

Evaluation of MPC, LQR and RL Footstep Planners in Simulation *Philadelphia, PA*
Team Leader *Mar 2024 – May 2024*

- Implemented MLP-based Reinforcement Learning footstep planner and Model Predictive Controller footstep planner and created *Cassie* simulation environment in Drake
- Benchmarked velocity tracking and success rates of RL, LQR and MPC controller across varied terrain

Optimization-based Estimation of Obstacles from Human Demonstration using Control Lyapunov Function and Control Barrier Functions *Philadelphia, PA*
Oct 2023 – Dec 2023
Team member

- Developed and presented poster on CLF-CBF-QP optimization-based algorithm to estimate obstacle position and size from human demonstrations
- Leveraged Gaussian Mixture Models and Gaussian Mixture Regression to probabilistically learn parameters

Inverse-Kinematics Control for 7-DOF Manipulator *Philadelphia, PA*
Team Leader *Oct 2023 – Dec 2023*

- Created vision-based pick-and-place algorithm for 7-DOF *Franka Emika Panda* manipulator
- Utilized inverse kinematics with gradient-based optimization and real-time perception feedback to pick and stack static and dynamically moving blocks

Mobile Wheeled-Robot for Autonomous Navigation *Philadelphia, PA*
Team Leader *Oct 2023 – Dec 2023*

- Implemented PID motor control for mobile robot using encoders, integrating Vive sensor, infrared (IR) detection circuit, and ToF sensors, with inter-chip communication via I2C protocol
- Achieved localization via Vive system, wall-following, and IR beacon detection for autonomous navigation

Chung-Ang University Artificial Intelligence (CUAI) Association *Seoul, Korea*
Team Leader *Oct 2023 – Dec 2023*

- Created real-time logo detector and automatic mosaic algorithm using object detection for Youtube videos, with web crawling-based data collection pipeline
- Developed multi-modal algorithm for emotion prediction using video detection, speech and tone recognition

X-Corps Research Festival *Seoul, Korea*
Team Leader *Oct 2023 – Dec 2023*

- Deployed mobile application for energy prosumers and designed solar-tracking controller for solar panels
- Designed rooftop solar panel installation algorithm using semantic segmentation with aerial image api
- Implemented energy supply and demand estimation and price prediction model using metadata from KEPCO

CDIC Competition *Seoul, Korea*
Team member *Oct 2023 – Dec 2023*

- Implemented multi-modal detection model using real-time CCTV videos and audio analysis to identify child abuse in daycare centers

Honors and Awards

Outstanding Graduate Honor *2023*
Chung-Ang University

CUAI 4^{th} Advanced Track Excellent Completion *2022*
Only non-CS major applicant in top 3 out of 29 applicants

Chung-Ang University Da Vinci Software Institute Excellence Award *2021*
Winter Conference Smart Factory

Chung-Ang University Da Vinci Software Institute Encouragement Award *2021*
Summer Conference Smart Factory

Academic Excellence Scholarship *2021*
Chung-Ang University

Technical Skills

Programming Languages: Python, C/C++, MATLAB

Software/Frameworks: Pytorch, Tensorflow, ROS, Drake, MuJoCo, Isaac-Sim, Bazel, Git, Docker, SLURM

CAD: CATIA, Solidworks, 3D WOX, Fusion 360

Voluntary and Extra-Curricular Activities

Mechanical Engineering and Applied Mechanics Mentorship Program *Philadelphia, PA*
Mentor *July 2024 – Aug 2024*

- Advised incoming students on details of the MEAM program and student life at Penn

Korean Graduate Student Association (KoGSA) *Philadelphia, PA*
Treasurer *Oct 2023 – Current*

- Organized 4+ events accommodating 50+ students each and authored grants to secure funding

Republic of Korea Army *Namyangju, Korea*
Missile Command, 1100 Battalion, Air Defense *Sep 2018 - May 2020*

- Served as squad counselor and leader, completing military service with honorable discharge

Sarangtuh, Child Care Volunteer Club *Seoul, Korea*
Club News Committee *Apr 2017 - Aug 2018*

- Volunteered to provide STEM education and hands-on learning experiences to underprivileged children