Minku Kim

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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 a vision-based 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*

- Created data acquisition pipeline in MATLAB to collect and analyze 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*

- Designed and created a 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*

- Developed 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 to improve small object detection and optimized model using quantization and pruning for real-time performance
- Created terrain recognition algorithm for a 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 2024
Control on Unstructured Terrain
In IEEE Robotics and Automation Letters (RA-L), (In progress)
<u>Minku Kim</u>, Brian Acosta, Pratik Chaudhari and Michael Posa.

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

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

Projects

Evaluation of MPC, LQR and RL Footstep Planners in Simulation *Philadelphia, PA*
Team Leader *Mar 2024 – May 2024*
- Created *Cassie* simulation environment in Drake
- Implemented MLP RL and MPC footstep planner
- Evaluated velocity tracking and success rates of the RL controller to residual Q-function learning LQR and MPC controller on both flat and uneven terrain

Optimization-based Estimation of Environment Obstacles from Human *Philadelphia, PA*
Demonstration using CLF and CBF *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 by probabilistically learning parameters with Gaussian Mixture Models (GMM) and Gaussian Mixture Regression (GMR)

Inverse-Kinematics Control for 7-DOF Manipulator *Philadelphia, PA*
Team Leader *Oct 2023 – Dec 2023*
- Implemented vision-based pick-and-place algorithm for 7DOF *Franka Emika Panda* manipulator
- Utilized inverse kinematics with gradient-based optimization and real-time perception feedback to pick and place static and dynamically moving blocks

Mobile Wheeled-Robot for Autonomous Navigation *Philadelphia, PA*
Team Leader *Oct 2023 – Dec 2023*
- Implemented PID motor control for a 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 a multi-modal algorithm for emotion prediction using videos, speech recognition, ———

X-Corps Research Festival *Seoul, Korea*
Team Leader *Oct 2023 – Dec 2023*
- Developed an app for solar energy prosumers and sun-tracking controller for solar panels
- Designed solar panel installation algorithm with semantic segmentation for rooftop detection

- 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 model using real-time CCTV and audio to detect child abuse in daycare centers

Honors and Awards

Outstanding Graduate Honor *2023*

CUAI 4th 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*

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 an 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