Simon (Hwanwoong) Kang

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Education

- **Columbia University** — New York, NY
  M.S. in Mechanical Engineering with concentration in Robotics & Control (GPA: 3.85/4.0) — *Sept 2022 – Current*
  - **Selected Coursework**: Digital Manufacturing(A+), Competitive Programming(A+), Artificial Intelligence, Evolutionary Computation, Robot Learning, Data Science for Mechanical Engineers
- **Chung-Ang University** — Seoul, Republic of Korea
  B.S. in Mechanical Engineering (GPA: 92.69/100) — *Feb 2022*

Research Experience

- **Creative Machines Lab** — Columbia University
  Graduate Research Assistant, Robot Metabolism Project — *May 2023 - Current*
  - **Fabrication**: Designed casing for camera PCB using Solidworks and 3D printed them with Ultimaker and Prusa
  - **Mechatronics**: Maintained 20+ robot links with its parts: particle photon, battery, motor, wifi antenna, etc
  - **Retinas**: Built world reconstruction and robot localization system with AprilTags and 4K RGB cameras
  - **Controller Design**: Closed loop controller design and Retinas Integration
  - **Sim2Real**: Deployment of controller on the 1D, 2D, 3D modular truss link robotics platform
  - **Neuroevolution**: Evolved DNN parameters using Genetic Algorithms (Roulette Wheel Selection) [In process]
  - **Simulation**: Nvidia Isaac Gym RL simulation for evolving controller (CUDA for GPU acceleration) [In Process]

Academic Projects

- **Autonomous Vehicle Project (F1TENTH)** — Columbia University
  Columbia University Robotics Club — *Sept 2022 - Current*
  - **Path Planning**: Customized A* and RRT algorithms to generate optimized waypoints for autonomous navigation
  - **Robot Operating System**: Developed various nodes and managed inter-process communication through topics
  - **Dynamic Window Approach**: Implemented DWA for efficient and safe maneuvering in dynamic environments
  - **Controls**: Solved vehicle stability issues by implementing a PID controller, significantly reducing wobbling
- **Digital Manufacturing and Design Automation** — Columbia University
  Delved into a variety of digital manufacturing methods, from 3D printing to laser cutting — *Jan 2023 - May 2023*
  - **Food Printing**: Developed a tailored G-code generator script for FDM based food printing
  - **Laser Cutting**: Wrote python script for automatically generating G-code when given a set of specifications
  - **Topology Optimization**: Leveraged nTopology for the design optimization of desks and chairs
  - **Lampshade Lattice**: Designed a script in OpenSCAD to produce STL files for geometric lattice structures
- **Robot Walking via Deep Deterministic Policy Gradient** — Chung-Ang University
  Implemented DDPG for RL agent training via MATLAB Simulink (Advisor: Dr. Seungtae Choi) — *Sept 2021 - Dec 2021*
  - **Algorithm Implementation**: Utilized DDPG on MATLAB's standard robot model for RL to optimize gait
  - **Reward Function Design**: Defined a multi-parameter reward function factoring in forward velocity, power consumption, and displacements (both vertical and lateral) for guiding the RL agent's actions
  - **Simulated Testing**: Set up a MATLAB simulated sidewalk environment, spanning 25 meters in length, where the robot learned to walk efficiently, showcasing trajectories without significant deviations
  - **Data Analysis**: Observed and interpreted fluctuations in rewards and potential convergence to local maxima throughout training episodes.
  - **Performance Outcome**: Successfully achieved robot walking with an episode reward of 846.6369, following real-world sidewalk constraints, and maintained an average of 554.65 steps per episode
- **Optimization of 3-DOF Humanoid Robot Leg Posture** — Chung-Ang University
  Determined optimal joint angles to minimize torque (Advisor: Dr. Dongjun Shin) — *Mar 2021 - June 2021*
  - **Kinematic Modeling**: Employed forward kinematics, Jacobian matrices, and dynamic equations for modeling
  - **Design & Assembly**: Designed and assembled robot components using CATIA, exporting the design as a URDF

- **Control System**: Developed block diagrams in MATLAB Simulink, integrating PD controllers
- **Performance Outcome**: Achieved a torque reduction of 1.5% on average and 11.3% at the knee joint by optimizing joint angles to (j1 = -32.3°, j2 = 87.6°, j3 = -85.5°)

- **Drowsiness Detection via Eye Movement Tracking** Chung-Ang University
  Leveraged flex sensors and OpenCV for drowsiness detection (Advisor: Dr. Giuk Lee) *Mar 2021 - June 2021*
  - **Sensor Integration**: Assembled a system using flex sensors, breadboard, electrical wiring, and Arduino Uno to quantify neck bending as an indicator of drowsiness.
  - **Visual Processing**: Implemented facial recognition using Raspberry Pi 4, Python, and OpenCV. Deployed Dlib library for face and eye detection and applied Histogram of Oriented Gradients for brightness-based object identification. Developed a blink ratio system using OpenCV's bilateral filter and thresholding for binary data conversion.
  - **System Fusion**: Synchronized mechanical and computer vision systems, introducing a time-based parameter. Triggered an LED warning if neck bending and eyelid closure persisted for over 2.5 seconds.
  - **Practical Application**: Potential to enhance safety for long-haul truckers, mitigating risks from unintended microsleep episodes.

Professional Experience

- **Hyundai Motor Group** Seoul, Republic of Korea
  Engineer, North America Field Analytic Engineering Team, Global HQ *Mar 2022 - Sep 2022*
  - **Project Leadership**: Directed the development of a machine learning based safety data analytics system for HMG's automotive brands (Kia, Hyundai, and Genesis) in collaboration with Deloitte. The final system was presented in partnership with Deloitte at a NHTSA event in Washington DC

- **NAVER LABS** Seongnam, Republic of Korea
  Data Assistant, AI Translation Team *Dec 2016 - Mar 2017*
  - **Deep Learning**: Engaged in a DNN initiative using TensorFlow aimed at enhancing the capabilities of the PAPAGO AI translator
  - **Data Management**: Curated and annotated a specialized speech dataset to advance ML models for translation

Leadership and Services

- **Literary Society Leader** Chung-Ang University
  Directed reading groups, curated reading lists, and facilitated literary discussions *Oct 2018 - Feb 2022*
  - **Literary Exploration**: Guided discussions on seminal works by authors including Orwell, Hemingway, Emerson, Whitman, and Faulkner
  - **Publication**: Spearheaded the compilation and publication of a book featuring select literary contributions from society members

- **Military Interpreter** Korea Military Academy
  Served in the Office of International Affairs *Jan 2015 - Oct 2016*
  - **International Relations**: Managed communications with renowned military academies globally, including the U.S. Military Academy at West Point
  - **Collaborative Efforts**: Orchestrated Memorandum of Understanding (MOU) processes with diverse entities, notably the National Medical Center

Technical Skills

- **Programming Languages**: Python, C++, MATLAB, Java, JavaScript
- **Robotics & AI**: Linux, ROS (Gazebo, RViz), OpenCV, TensorFlow, PyTorch, Simulink
- **Electronics & Hardware**: PCB Design and Assembly, Arduino, Raspberry Pi 4, Particle Photon(STM32), Intel Realsense D435i(IMU), Streolabs ZED Mini
- **CAD**: NX(NX Design Academic Certified), CATIA, Solidworks
- **Manufacturing**: Laser Cutting, CNC Mill/Lathing, Injection Molding, 3D Printing, Mechanical Systems Assembly
- **Version Control & Collaboration**: Git, GitHub, Docker