Min-Geun Park

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Personal Website

RESEARCH INTERESTS

Advancing **Intelligent Mechatronics** through **Control Theory** and **Advanced Control Techniques**

My research focuses on fundamental areas of Intelligent Mechatronics, Control Theory, and Nonlinear Dynamics. By leveraging advanced control techniques—such as adaptive and impedance control—and utilizing system modeling and simulation, I aim to optimize performance and robustness in nonlinear dynamic systems. This includes improving safety and reliability through performance optimization. My interests span applications in robotics and automation, wearable and assistive technologies, and human-machine interaction.

EDUCATION

Georgia Institute of Technology — Atlanta, GA
M.S. in Mechanical Engineering. GPA 4.00 / 4.00 — May 2024

Georgia Institute of Technology — Atlanta, GA
B.S. in Mechanical Engineering. GPA: 3.93 / 4.00 — May 2023
- Minored in Computing & Intelligence

Georgia State University — Atlanta, GA
A.S. in Engineering. GPA: 4.00 / 4.00 — Aug 2017 – May 2019

Sungkyunkwan University — Suwon, South Korea
B.S. in Chemical Engineering (Incomplete) — Mar 2013 – Jun 2017
- Includes two years of military service

RESEARCH EXPERIENCE

Georgia Institute of Technology — Atlanta, GA
Graduate Research Assistant; Supervisor: Prof. Kok-Meng Lee — Aug 2023 – Present
Topic: Development and Control of a Magnetic Series Elastic Actuator (Mag-SEA)
- Prototyped the Mag-SEA, optimizing its design through iterative refinement and performance testing; additionally, designed and developed a benchmarking Mechanical SEA for comparative analysis.
- Simulated the step response of the linearized Mag-SEA model to evaluate system stability and performance across varying parameters.
- Currently developing an embedded control system, utilizing wireless data transfer between peripheral sensors and central controller for real-time impedance control.

Georgia Institute of Technology — Atlanta, GA
Undergraduate Research Assistant; Supervisor: Prof. Frank L. Hammond III — Aug 2021 – Dec 2022
Topic: Design and Control of Pneumatic Variable-Stiffness Joints for Underactuated Gripper
- Prototyped an underactuated gripper with pneumatic variable-stiffness joints, iteratively refining the design through performance testing, resulting in a 20% increase in workspace compared to the initial design.
- Formulated a mathematical model linking joint stiffness (pneumatic pressure), tendon tension, and end-point position/orientation, and estimated the gripper's workspace.
- Developed an embedded control system for pneumatic actuation, translating end-point position, orientation, and desired force into optimized tendon tension and joint stiffness for adaptive control.

Pohang Institute of Science and Technology Pohang, South Korea
Undergraduated Researcher; Supervisor: Prof. Wan Kyun Chung Sep 2020 – Mar 2021
Topic: Multisensory Anomaly Detection for Mobile Robot Using Spatiotemporal Context Extraction

- Developed a novel multi-stage anomaly detection system for thermal imagery, achieving 92% normal data reconstruction accuracy and 100% anomaly detection probability.
- Implemented the RANSAC-Flow model using PyTorch to extract the flow of RGB images and applied it to align thermal images, achieving an alignment success rate of 933/934 under varying conditions.
- Designed and implemented a custom 1-D f-AnoGAN architecture based on the 2-D version, creating new 1-D layers and modifying the architecture for time-series data using PyTorch.

CONFERENCE PAPER

C1: W. Li, K.-M. Lee*, **M.-G. Park**, R. Huang and M. Li, "Magnetic Stiffness of Soft Continuous Permanent Magnet and its Parametric Effects on a Magnetic Series Elastic Actuator Control System", *IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM),* 7, 2024

TEACHING EXPERIENCE

Teaching Assistant Fall 2023, Spring 2024
Georgia Institute of Technology, ME4452 Control Dynamic Systems
Topics: Classical Control Methods, Modern Control Methods, System Modeling and Analysis

- Earned a 4.9/5.0 rating in TA evaluations with 100% student endorsement while guiding 60+ students in advanced control systems through office hours and review sessions.
- Utilized MATLAB's SISO Tool to efficiently visualize system behavior and quickly tune control parameters, allowing students to explore real-time effects of parameter changes.

PROJECT

Design and Evaluation of Control Systems for Inverted Pendulum May 2024 - Present

- Developed and applied a comprehensive range of control methods to the inverted pendulum, including:
  - **Classical Control**: PID Control, Bang-Bang Control
  - **Modern Control**: Pole-Placement Method, Sliding Mode Control, Computed Torque Method
  - **Optimal Control**: Linear Quadratic Regulator (LQR), Model Predictive Control (MPC)
  - **Energy-Based Control**: Energy Shaping Control
- Designed simulations using MATLAB/Simulink and Simscape to model nonlinear system dynamics of the inverted pendulum, enabling comparative analysis of controller performance.
- Assessed robustness of controllers against external disturbances and parameter uncertainties to ensure reliable system performance.
- Documented methodologies and findings through detailed blog posts on my personal website.

Structural Optimization of Robotic Arm Using FEA Jan 2024 - May 2024

- Utilized Finite Element Analysis (FEA) in ANSYS to optimize a robotic arm's design, addressing stress distribution, fatigue resistance, thermal effects, and weight constraints.
- Developed a multi-objective optimization approach integrating mechanical and thermal considerations.
- Achieved 15% weight reduction while maintaining structural integrity and improving thermal management.

RELATED PROFESSIONAL EXPERIENCE

Research Engineer Intern Jun 2023 - Aug 2023
Samsung Electronics - Mechatronics R&D Center | Hwasung, Korea
Topic: Mobile Robot Arm Auto Calibration

- Developed and implemented a novel calibration algorithm integrating ROS with high-precision laser tracking, refining Denavit–Hartenberg (DH) parameters to improve robotic arm kinematic accuracy.
- Tested robotic arm accuracy and repeatability post-calibration using ISO 9283 standards, ensuring compliance with industry benchmarks.
- Conducted in-depth analysis of calibration data, identifying key performance factors that contributed to refining calibration procedures and improving overall system accuracy.

Research Engineer Intern Jun 2022 - Aug 2022
Samsung Electronics - Global Technology Research Center | Suwon, Korea
Topic: Anomaly Classification

- Developed a TensorFlow-based anomaly classification model for image data from the visual inspection of the manufacturing process, achieving 92% top-1 accuracy in identifying and classifying anomalies.
- Facilitated weekly technical deep learning seminars, presenting literature reviews on state-of-the-art models.

TECHNICAL SKILLS

- **Engineering Software**: MATLAB, Simulink, SolidWorks, Ansys, AutoCAD
- **Measurement & Fabrication**: Laser Tracker, Quadrature Encoder, 3D Printing, Laser Cutting
- **Programming Languages**: Python, C/C++, Java, JavaScript
- **Frameworks & Libraries**: PyTorch, TensorFlow, ROS (Robot Operating System)

VOLUNTEERING & OUTREACH PROGRAMS

Science Tutor Jul 2024 - Aug 2024
Summer Science Outreach Series, Atlanta Children's Shelter

- Facilitated engaging science experiments for preschoolers, including non-Newtonian fluids, chromatography, and phase changes, fostering early STEM interest in underserved communities.

STEM Tutor May 2024
STEM Saturday, Georgia Institute of Technology

- Guided 10+ K-12 students in building and testing model cars, introducing fundamental physics concepts such as aerodynamics and energy conservation through hands-on activities.

Science Outreach Facilitator March 2024
Atlanta Science Festival, Georgia Institute of Technology

- Led interactive bioengineering workshops for 100+ attendees, showcasing the intersection of biology and engineering through the construction of artificial hands and robotic prosthetics.

Math Tutor May 2015 – Sep 2016
Rural Education Support Initiative, ROK Army Intelligence School

- Developed and implemented tailored curricula in Algebra and Pre-Calculus for 10+ K-12 students in rural areas, improving their understanding and performance in standardized tests.

DIVERSITY, EQUITY & INCLUSION

SKKU Global Mentoring and Assisting People, Sungkyunkwan University Jan 2017 – Jul 2017

- Helped 50+ international exchange students from over 30 countries in adapting to Korean culture and university life, contributing to a more inclusive and welcoming campus environment.
- Facilitated cultural exchange activities and social events to help students integrate into the local community, promoting cross-cultural friendships and understanding.

PROFESSIONAL MEMBERSHIPS

- Student Member, Institute of Electrical and Electronics Engineers (IEEE) May 2024 – Present
- Georgia Tech chapter of The American Society of Mechanical Engineers Aug 2023 – May 2024

REFERENCES

- **Dr. Kok-Meng Lee**
  Professor, School of Mechanical Engineering
  Georgia Institute of Technology
  kokmeng.lee@me.gatech.edu, +1 (404)-894-7402

- **Dr. Nader Sadegh**
  Associate Professor, School of Mechanical Engineering
  Associate Director & Education Director, Robotics Ph.D. Program
  Georgia Institute of Technology
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