Changseob Song

PhD Candidate, Department of Mechanical Engineering, Carnegie Mellon University
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EDUCATION

Carnegie Mellon University — Pittsburgh, PA
Ph.D. in Mechanical Engineering (Advisor: Inseung Kang) — 2024 – Present
- Kwanjeong Educational Foundation Scholarship

Korea University — Seoul, South Korea
M. S. in Mechanical Engineering (Advisor: Donghyun Hwang, Shinsuk Park) — 2021 – 2023
- Academic-research cooperative program at Korea Institute of Science and Technology (KIST)

Korea University — Seoul, South Korea
B. S. in Mechanical Engineering — 2015 – 2021
- Graduated with great honor

RESEARCH STATEMENT

I study lower-limb exoskeleton to enhance human mobility. By leveraging physics-based simulation and machine learning, I aim to rapidly and efficiently personalize exoskeleton control frameworks towards patient user groups with gait disabilities, allowing them to minimize user effort across diverse locomotor tasks.

PUBLICATIONS

FULL-LENGTH ARTICLES

D. Dinesh*, A. Krieger*, **C. Song**, D. Park, A. J. Young, I. Kang, "Generating Personalized Lower-Limb Kinematics Across Walking Speeds Using Subject-Conditioned Diffusion," *arXiv* [Paper] [Project page]

C. Song, I. Kang, "Continual Online Personalization of Exoskeleton Control via Manifold-Aware Experience Replay," *arXiv* [Paper] [Project page]

I. Park, **C. Song**, I. Kang, "Learning Hip Exoskeleton Control Policy via Predictive Neuromusculoskeletal Simulation," *arXiv* [Paper] [Project page]

C. Song*, B. Ivanyuk-Skulskyi*, A. Krieger, K. Luo, I. Kang, "Personalization of Wearable Sensor-Based Joint Kinematic Estimation Using Computer Vision for Hip Exoskeleton Applications," *2025 International Conference On Rehabilitation Robotics (ICORR)* [Paper] [Project page]

J. An, **C. Song**, E. Halilaj, I. Kang, "Optimizing Locomotor Task Sets in Biological Joint Moment Estimation for Hip Exoskeleton Applications," *2025 International Conference On Rehabilitation Robotics (ICORR)* [Paper] [Video]

Y.-H. Chiu*, U. H. Lee*, **C. Song**, M. Hu, I. Kang, "Learning Speed-Adaptive Walking Agent Using Imitation Learning with Physics-Informed Simulation," *2025 International Conference On Rehabilitation Robotics (ICORR)* [Paper] [Video]

C. Song, H.-S. Lee, S. Park, D. Hwang, "Stiffening Iron Particles to Modulate Physical Interactions," *Nature Communications* [Paper]

T. Lee, H.-S. Lee, **C. Song,** D. Hwang, "On the Design of Fast-Response Variable-Stiffness Continuum Robot with Electro-Permanent Magnet-Based Ball Joints," *2025 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* [Paper] [Video] *(Best Paper Award)*

C. Song*, G. Yang*, S. Park, N. Jang, S. Jeon, S. Oh, and D. Hwang, "On the Design of Integrated Tele-Monitoring/ Operation System for Therapeutic Devices in Isolation Intensive Care Unit," *IEEE Robotics and Automation Letters* [Paper] [Video]

PEER-REVIEWED ABSTRACTS

D. M. Page, N. Zhao, A. S. Monteiro, **C. Song**, I. Kang, O. N. Beck, N. P. Fey, “Subject Independent Baseline Walking Data Predicts Lower Limb Joint Kinetics Across Age Groups and Functional Electrical Stimulation Conditions,” *South Central American Society of Biomechanics*, Texas, United States, 2026 (Poster)

C. Song*, B. Ivanyuk-Skulskyi*, A. Krieger, K. Luo, I. Kang, “Personalization of IMU-Based Joint Kinematic Estimation Using Computer Vision,” *American Society of Biomechanics*, Pittsburgh, United States, 2025 (Poster)

A. Krieger, **C. Song**, I. Kang, “Toward Biomechanically Valid Synthetic Human Motion: An Initial Assessment,” *American Society of Biomechanics*, Pittsburgh, United States, 2025 (Poster)

N. Jang, **C. Song**, G. Yang, D. Hwang, “Experimental Reliability Assessment on the System to Tele-operate Medical Ventilators in Intensive Care Unit,” *The 45th Annual International Conference of the IEEE Engineering in Medicine & Biology Conference (EMBC)*, Sydney, Australia, 2023. (Poster)

C. Song and D. Hwang, “Stiffening Iron Powder to Grasp Objects,” *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) Late-Breaking Results Posters*, Kyoto, Japan, 2022. (Poster)

C. Song and D. Hwang, “Magnetic Granular Jamming-Based Tangible Display,” *The 19th Korea Robotics Society Annual Conference (KRoC) RED Show*, Pyeongchang, Korea, 2024. (Poster)

H. Seo, **C. Song**, and D. Hwang, “Magnetic Granular Jamming-Based Gripper Capable of Delicate Manipulation,” *The 19th Korea Robotics Society Annual Conference (KRoC)*, Pyeongchang, Korea, 2024. (Poster) *(Best Paper Award)*

C. Song and D. Hwang, “Magnetic Grain-Based Rapid Variable-Stiffness Mechanism,” *The 18th Korea Robotics Society Annual Conference (KRoC)*, Pyeongchang, Korea, 2023. (Poster)

C. Song, G. Yang, S. Park, N. Jang, S. Jeon, S. Oh, and D. Hwang, “Development of Master-Slave System for Tele-Monitoring/Operating Mechanical Ventilators in Isolation Intensive Care Unit,” *The 17th Korea Robotics Society Annual Conference (KRoC)*, Pyeongchang, Korea, 2022. (Oral)

N. Jang, **C. Song**, G. Yang, S. Park, and D. Hwang, “Tele-Monitoring/Operation System for Therapeutic Devices in Isolation Intensive Care Unit,” *The 17th Korea Robotics Society Annual Conference (KRoC) RED Show*, Pyeongchang, Korea, 2022. (Oral)

PATENTS

D. Hwang and **C.Song**, “Magnetic Jamming Mechanism,” US Patent Application No. 18/423,759, Jul 2024.

D. Hwang and **C. Song**, “Magnetic Jamming Mechanism,” Korea Patent Application No. 10-2023-0046420, Apr 2023.

D. Hwang, **C. Song**, G. Yang, S. Park, and N. Jang, “Remote Monitoring and Remote Operation System for Therapeutic Devices,” Korea Patent Application No. 10-2023-0002485, Jan 2023.

AWARDS AND HONORS

IROS Best Paper Award on Robot Mechanisms and Design Hangzhou, China, Oct. 2025.
Kwanjeong Educational Foundation Scholarship Jul. 2024
Best Paper Award Korea Robotics Society Annual Conference (KRoC), Feb. 2024.
KIST Student Excellence Award KIST, Republic of Korea, Aug. 2023.
AIR Paper Award AI and Robotics Institute, KIST, Dec 2022.
Great Honor Korea University, Feb 2021.

SERVICES - REVIEW

IEEE Robotics and Automation Letters (RAL), 2026*
IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob), 2026
IEEE Transactions on Robotics (TRO), 2025
PLOS One, 2025, 2026
IEEE Transactions on Neural Systems and Rehabilitation Engineering (TNSRE), 2025
IEEE/RAS-EMBS International Conference on Rehabilitation Robotics (ICORR), 2024*

TALKS

Locomotion seminar, Carnegie Mellon University, Mar 2025

EXHIBITIONS AND DEMONSTRATIONS

Integrated Tele-monitoring and Tele-operation Systems for Therapeutic Medical Devices in Isolation ICU

- **Arab Health 2024** Dubai World Trade Centre, Dubai, UAE, Jan 2024.
- **K-Hospital+Health Tech Fair** COEX, Seoul, Korea, Sep 2023.
- **Korea Science & Technology Fair** KINTEX, Goyang-si, Korea, Dec 2021.

Barista Robot System with Robotic Hand Capable of Somatosensory Feedback

- **ROBOTWORLD 2023 – International Robot Exhibition** KINTEX, Goyang-si, Korea, Oct 2023.
- **KIST Roboteria Barista Robot Service** KIST, Seoul, Korea, Jun 2023 - Jul 2024.

MENTORSHIP

Marvin Lim Master student in ECE Feb 2026 – Present
- Online reinforcement learning for optimizing control parameters of hip exoskeletons

David Newsom Undergraduate in ME Oct 2025 – Present
- Preference-based online personalization of hip exoskeleton controllers

Diya Dinesh Master student in CS Jan 2025 – Present
- Diffusion-based synthetic motion generation of personalized, cross-task human motion

Adrian Krieger Master student in ME Fall 2024 – Present
- Diffusion-based synthetic motion generation of personalized, cross-task human motion

Thomas Luo Undergraduate in ME Fall 2024 – Summer 2025
- Speed-adaptive exoskeleton control using physics-informed simulation and imitation learning

Kolin Huang Undergraduate in AI Fall 2024 – Summer 2025
- Physics-informed simulation-based exoskeleton control optimization using deep reinforcement learning

Sunny Kim Undergraduate in CS Fall 2024 – Spring 2025
- Development of imitation learning algorithms to personalize the digital twin inside physics simulation

Bogdan Ivanyuk-Skulskyi Research scientist Fall 2024
- Deploying of vision model for human pose estimation

REFERENCES

Dr. Inseung Kang | PhD advisor
Assistant Professor, Department of Mechanical Engineering, Carnegie Mellon University

Dr. Owen Beck | Collaborator
Assistant Professor, Department of Kinesiology and Health Education, University of Texas at Austin

Dr. Donghyun Hwang | Master advisor, Research scientist advisor
Principal Researcher, Center for Humanoid Research, Korea Institute of Science and Technology

Dr. Shinsuk Park | Master advisor
Professor, Dept. of Mechanical Engineering, Korea University

Dr. Sungwook Yang | Collaborator
Principal Researcher, Center for Humanoid Research, Korea Institute of Science and Technology

Dr. Sehyuk Yim | Collaborator
Principal Researcher, Center for Humanoid Research, Korea Institute of Science and Technology