Seungmoon Song

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Faculty Appointment

Assistant Professor	**Northeastern University** (Jan 2022 – present) Mechanical and Industrial Engineering

Education

Postdoctoral Fellow	**Stanford University** (Jun 2018 – Dec 2021) Mechanical Engineering Supervisor: Steven H. Collins, Ph.D. **Carnegie Mellon University** (Jun 2017 – May 2018) Robotics Institute Supervisor: Christopher Atkeson, Ph.D.
M.S., Ph.D.	**Carnegie Mellon University** (Aug 2010 – May 2017) Robotics Institute Advisor: Hartmut Geyer, Ph.D.
M.S.	**Virginia Tech** (Aug 2008 – Aug 2010) Electrical and Computer Engineering Advisor: Dennis Hong, Ph.D.
B.E., *summa cum laude*	**ICU** (*KAIST) (Feb 2004 – Feb 2008) Electrical and Communications Engineering Research advisor: Jeongsuk Ha, Ph.D. * ICU was Korea's IT-specialized university that merged into KAIST in 2009.

Scholarly Contributions

Papers, videos, and other supporting materials are available at: http://seungmoon.com
Counts: 10 journal articles, 14 peer-reviewed conference papers, 2 patents
(From Google Scholar) Citations: 960; h-index: 15

Journal articles

A Dzewaltowski, AM Gonabadi, P Antonellis, **S Song**, & P Malcolm, Perturbation-based estimation of within-stride cycle metabolic cost. *submitted*.

V Firouzi, A Seyfarth, **S Song**, O von Stryk, & MA Sharbafi, Biomechanical models in the lower-limb exoskeletons development: A review, *submitted, Authorea Preprints*.

J10 JGA Cashaback, JL Allen, AHY Chou, DJ Lin, M Mangalam, MA Price, NK Secerovic, **S Song**, H Zhang, HL Miller, Advancing neurorehabilitation through computational modelling within a patient-in-the-loop framework, *Journal of NeuroEngineering and Rehabilitation*. 2024.

J9 A Lakmazaheri*, **S Song***, BB Vuong, B Biskner, DM Kado, & SH Collins. Optimizing exoskeleton assistance to improve walking speed and energy economy for older adults. *Journal of NeuroEngineering and Rehabilitation*. 2024.

J8 GM Bryan, PW Franks, **S Song**, R Reyes, MP O'Donovan, KN Gregorczyk, & SH Collins. Optimized hip-knee-ankle exoskeleton assistance reduces the metabolic cost of walking with worn loads. *Journal of NeuroEngineering and Rehabilitation*. 2021.

J7 GM Bryan, PW Franks, **S Song**, AS Voloshina, R Reyes, MP O'Donovan, KN Gregorczyk, & SH Collins. Optimized hip-knee-ankle exoskeleton assistance at a range of walking speeds. *Journal of NeuroEngineering and Rehabilitation*. 2021.

J6 **S Song**, Ł Kidziński, XB Peng, C Ong, J Hicks, S Levine, CG Atkeson, & SL Delp. Deep reinforcement learning for modeling human locomotion in neuromechanical simulation. *Journal of NeuroEngineering and Rehabilitation*. 2021.

J5 **S Song** & SH Collins. Optimizing exoskeleton assistance for faster self-selected walking speed. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*. 2021.

J4 **S Song**, H Choi, & SH Collins. Using force data to self-pace an instrumented treadmill and measure self-selected walking speed. *Journal of NeuroEngineering and Rehabilitation*. 2020.

J3 **S Song** & H Geyer. Predictive neuromechanical simulations indicate why walking performance declines with aging. *The Journal of Physiology*. 2018.

J2 **S Song** & H Geyer. Evaluation of a neuromechanical walking control model using disturbance experiments. *Frontiers in Computational Neuroscience*. 2017.

J1 **S Song** & H Geyer. A neural circuitry that emphasizes spinal feedback generates diverse

behaviours of human locomotion. *The Journal of Physiology*. 2015.

Peer-reviewed conference papers

V Ton, D Solav, & **S Song**. Impact of sole designs of offloading AFO on gait dynamics: a predictive neuromechanical simulation study. *IEEE BioRob*, 2024. *accepted*.

GM Bryan, PW Franks, **S Song**, & SH Collins. Pilot comparison of customized and generalized hip-knee-ankle exoskeleton torque profiles. *IEEE ICRA*, 2024. *accepted*.

C14 D Vasu, **S Song**, H Kainz, J Lee, MRI Segmentation of Musculoskeletal Components Using U-Net: Preliminary Results, *ICBBB*, 2024.

C13 V Caggiano*, G Durandau*, et int., V Kumar. MyoChallenge 2022: Learning contact-rich manipulation using a musculoskeletal hand, *Proceedings of Machine Learning Research*, 2023.

C12 A Rai, R Antonova, **S Song**, W Martin, H Geyer, & CG Atkeson. Bayesian optimization using domain knowledge on the ATRIAS biped. *IEEE ICRA*, 2018.

C11 **S Song**. Towards a hierarchical neuromuscular control model with reflex-based spinal control – a study with a simple running model. *International Symposium on Advanced Intelligent Systems*, 2015.

C10 **S Song** & H Geyer. Regulating speed in a neuromuscular human running model. *IEEE Humanoids*, 2015.

C9 Z Batts, **S Song**, & H Geyer. Toward a virtual neuromuscular control for robust walking in bipedal robots. *IEEE IROS*, 2015.

C8 **S Song**, J Kim, & K Yamane. Development of a bipedal robot that walks like an animation character. *IEEE ICRA*, 2015.

C7 **S Song**, R Desai, & H Geyer. Integration of an adaptive swing control into a neuromuscular human walking model. *IEEE EMBC*, 2013.

C6 **S Song** & H Geyer. Generalization of a muscle-reflex control model to 3D walking. *IEEE EMBC*, 2013.

C5 **S Song**, C LaMontagna, SH Collins, & H Geyer. The effect of foot compliance encoded in the windlass mechanism on the energetics of human walking. *IEEE EMBC*, 2013.

C4 **S Song** & H Geyer. Regulating speed and generating large transitions in a neuromuscular human walking model. *IEEE ICRA*, 2012.

C3 **S Song** & H Geyer. The energetic cost of adaptive feet in walking. *IEEE ROBIO*, 2011.

C2 **S Song**, Y Ryoo, & D Hong. Development of an omnidirectional walking engine for full-sized lightweight humanoid robots. *ASME IDETC*, 2011.

C1 **S Song**, D Hwang, S Seo, & J Ha. Linear-Time Encodable Rate-Compatible Punctured LDPC Codes with Low Error Floors. *IEEE VTC*, 2008.

Conference abstracts (selected)

A12 **S Song**. Modeling in-the-wild effects of gait assistive devices through neuromechanical simulations and deep reinforcement learning, *NSF DARE Conference*, 2023.

A11 **S Song**. Toward predictive simulation framework for gait assistive ankle exoskeletons. *Ubiquitous Robotics*, 2022.

A10 **S Song**, H Choi, K Poggensee, CG Atkeson, & SH Collins. Human-in-the-loop optimization of ankle-exoskeleton assistance for faster preferred walking speed: a preliminary study. *Dynamic Walking*, 2019.

A9 **S Song**, Ł Kidziński, R Khidorka, C Ong, S Mohanty, J Hicks, J Ku, S Carroll, S Levine, M Salathé, CG Atkeson, SH Collins & S Delp. Learn to Move: a competition to bridge biomechanics, neuroscience, robotics, and machine learning to model human motor control. *Dynamic Walking*, 2019.

A8 **S Song**, H Geyer, SH Collins, & CG Atkeson. Towards predictive neuromechanical simulations for pathological gait and assistive devices. *World Congress of Biomechanics*, 2018.

A7 A Falisse, G Serrancoli, C Dembia, **S Song**, I Jonkers, & F De Groote. Computationally efficient predictive muscle-driven simulations of 3D walking. *World Congress of Biomechanics*, 2018.

A6 **S Song**, Y Aucie, & G Torres-Oviedo. Can split-belt treadmill walking be explained with a reflex-based model. *Neuroscience*, 2017.

A5 **S Song** & H Geyer. Modeling and exploring elderly walking with neuromechanical simulations. *Dynamic Walking*, 2017.

A4 **S Song** & H Geyer. A spinal reflex based neuromuscular model of human locomotion investigated against unexpected disturbances. *Neuroscience*, 2016.

A3 **S Song** & H Geyer. Testing a neuromuscular locomotion control model against human experiments. *Dynamic Walking*, 2016.

A2 **S Song** & H Geyer. Using a neuromuscular model of human locomotion to control bipedal robots. *Dynamic Walking*, 2015.

A1 **S Song** & H Geyer. Robust 3D locomotion models using primarily reflex control. *Dynamic Walking*, 2013.

Patents

P2 J Kim, K Yamane, & **S Song**, Method for developing and controlling a robot to have movements matching an animation character, United States Patent 9427868, 2016.

P1 J Nam, J An, D Hwang, J Ha, & **S Song**, Apparatus and method for encoding low density parity check code, Korean patent 10-0999272-00-00, 2010.

Invited Talks (selected)

Meeting with the Robot Expert, Intelligent Robotics Innovation Consortium for Universities (seven universities in Korea) — May 10, 2024

Robotics workshop, Pázmány Péter Catholic University, Hungary — Feb 21, 2024

HRI Colloquium, Tufts University — Oct 6, 2023

Symposium on Robots & AI, Gwangju Institute of Science and Technology — Sep 22, 2023

Summer robot expert international workshop, Hanyang University — Jul 7, 2023

Meeting with the Robot Expert, Intelligent Robotics Innovation Consortium for Universities (seven universities in Korea) — May 19, 2023

AI Robotics Seminar, Seoul National University — April 2, 2023

Mechanical & Aerospace Engineering Special Robotics Seminar, UCLA — March 2, 2023

Boston Action Club — Oct 20, 2022

Universities and research institutes in Korea — Jul-Aug 2022
- ETRI
- Pukyong National University
- Pusan National University
- Korea Institute of Science and Technology
- Korea University
- Seoul National University
- Hyundai Motor Research Institute
- KAIST

ASCC 2022 Workshop on Control of Soft Wearable Robots — May 7, 2022

BioRob 2020 Workshop on Community-Based Rehabilitation Research using Wearable Devices — Nov 29, 2020

Mechanical Engineering Department Seminar, University of Delaware — Sep 25, 2020

Session Speaker, WearRAcon — Mar 31, 2020

NeurIPS Deep RL workshop — Dec 14, 2019

Universities in Europe — Jul 2018
- EPFL, Switzerland

- University of Tübingen, Germany
- University of Stuttgart, Germany
- Heidelberg University, Germany
- TU Darmstadt, Germany
- KU Leuven, Belgium
- University of Twente, Netherlands

Universities and research institutes in Korea Jul 2017
- Seoul National University
- Korea Institute of Industrial Technology
- Pohang University of Science and Technology
- Korea Institute of Machinery and Materials
- Inha University

Universities and companies in Korea Nov 2015
- Chung-Ang University
- Samsung Advanced Institute of Technology
- KAIST
- ROBOTIS
- Seoul National University

The 10th Workshop on Humanoid Soccer Robots at IEEE Humanoids Nov 3, 2015

Grant

Principal Investigator ($985,100)	**NIH K99AG065524**, **R00AG065524** (2020 – present) Simulation framework to develop ankle exoskeleton gait assistance for older adults K99: $238,100 over 2 years; R00: $747,000 over 3 years

Teaching

Instructor	**Northeastern University** ME4555 – **System analysis and control** Senior-level, 4 credits Spring 2024: 52 students Spring 2023: 46 students Spring 2022: 29 students
Teaching Assistant	**Carnegie Mellon University** (Fall 2013) 16868 - **Biomechanics and motor control of legged locomotion** Instructor: Hartmut Geyer, Ph.D. Graduate-level, 12 units, 21 students Lectured three classes, designed class projects, assisted students, and graded assignments

Mentoring

Northeastern University (2022 – present)
1 Postdoc, 2 PhD, 8 MS students, and 1 undergraduate students

Stanford University (2018 – 2021)
4 PhD and 1 MS students

Carnegie Mellon University (2014 – 2019)
4 MS and 2 undergraduate students

Honors & Awards

Honor

NSF DARE2023 Fellow (2023)

Richard King Mellon Foundation Presidential Fellowship in the Life Sciences at Carnegie Mellon University (2016-2017)

Summa cum Laude, ICU (2008)

Competitions

RoboCup (2010)
3rd place, adult-size humanoid league
4th place, kid-size humanoid league

Radio & Wireless Engineering Prototypes, Radio Education and Research Center, S. Korea
Finalist, Ubiquitous Medical Information System (2006)
Finalist, Building Power Control System (2005)

Scholarship

Ford Engineering Scholarship, Golden Key International Honour Society (2010)

Science and Engineering National Scholarship, Korea Science and Engineering Foundation, S. Korea (2006)

Academic Excellence Scholarship, ICU, S. Korea (2004 – 2006)

Full-tuition scholarship, Ministry of Information and Communication, S. Korea (2004 – 2007)

Academic Activities

NeuMove study groups

Study materials provided to students, with potential research opportunities following successful completion

Reflex-based model (2023 – present)
7 MS and 3 undergraduate students

Deep RL for neuromechanical simulations (2023 – present)
9 MS and 1 undergraduate students

MyoSuite (2022 – present)
(open-source project)

Description: A suite of musculoskeletal models and task environments, enabling the simulation of diverse motor control behaviors within the MuJoCo simulator

Over 30K downloads on Pypi

Leadership team: V Caggiano (MyoLab), V Kumar (MyoLab), G Durandau (McGill U), M Sartori (U Twente), and **S Song**

Academic competition organizations
(count: 3)

NeurIPS 2022, 2023: MyoChallenge
Role: Organizer
Theme:
- 2023: Towards Human-Level Dexterity and Agility
- 2022: Learning contact-rich manipulation for musculoskeletal hands

Members: V Caggiano (Meta AI), V Kumar (Meta AI), G Durandau (McGill U), M Sartori (U Twente), et al.

NeurIPS 2019: Learn to Move competition
Role: Lead organizer
Theme: Deep reinforcement learning for human movement
Participation: 323 teams
Members: Ł Kidziński (Stanford), S Delp (Stanford), S Levine (UC Berkeley), XB Peng (UC Berkeley), et al.

Workshop organizations
(count: 3)

NeurIPS 2022, 2023: MyoSymposium
Role: Organizer
Members: V Caggiano (Meta AI), V Kumar (Meta AI), G Durandau (McGill U), M Sartori (U Twente), et al.

ICRA 2023: Neuromechanics meets deep learning
Role: Organizer
Members: G Durandau (McGill U), H Wang (U Twente), M Sartori (U Twente), V Caggiano (Meta AI), V Kumar (Meta AI)

External mentoring

Thesis Committee, Boston University (2023 – present)
1 PhD student

Thesis Committee, Northeastern University (2023 – present)
2 PhD students, 1 MS student

Research Mentor, Yorktown High School Science Research Program (2023 – present)
1 high school student

Thesis Committee, TU Darmstadt (2022 - present)
1 MS student, 1 PhD student

Research Mentor, Seoul National University (2022 – present)
2 PhD students

Thesis Committee, University of Stuttgart (2023)

1 PhD student

Research Mentor, Stanford Aging and Ethnogeriatrics (SAGE) Center (2022 – 2023)

Research Mentor, Stanford University (2022 – 2023)
1 PhD student

Thesis Committee, University of Delaware (2021 – 2024)
1 PhD student

Associate editor

IEEE Robotics and Automation Letters (2022 – present)
IEEE BioRob 2022, 2024

Ad-hoc reviewer
(IOP trusted reviewer)

Journals
ACM Transactions on Graphics
Advances in Mechanical Engineering
Bioinspiration & Biomimetics
Engineering
Frontiers in Bioengineering and Biotechnology
Gait & Posture
Human Movement Science
IEEE Robotics and Automation Letters
IEEE Transactions on Neural Systems & Rehabilitation Engineering
IEEE Transactions on Robotics
Journal of Biomechanics
Journal of Neural Engineering
Journal of Physiology
Journal of the Royal Society Interface
PLOS Computational Biology
PLOS ONE
Scientific Reports
Science Robotics

Conferences
IEEE BioRob
IEEE Humanoids
IEEE ICRA
IEEE IROS
IEEE ISMR
NeurIPS (competition track)
SIGCHI
SIGGRAPH
SIGGRAPH Asia
UR

Other Research Experience

Lab Associate

Disney Research, Pittsburgh, PA (May – Aug 2014)

(summer intern)	Robotics Supervisor: Katsu Yamane, Ph.D. and Joohyung Kim, Ph.D. Research: Develop and control animation-like bipedal robot Keywords: bipedal robot design, 3D printing, trajectory optimization
Student Intern	**ETRI**, S. Korea (Jan – Mar 2008) Robot AI server team Supervisor: Hyungsun Kim, Ph.D. Task: Review real-time robot-motion-control interface programs