

# Seungmoon Song

*Assistant Professor at Northeastern University*

s.song@northeastern.edu

<https://neumove.org/>

<http://seungmoon.com/>

## 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 materials are available at: <http://seungmoon.com> and <https://neumove.org/>.  
 Counts: 12 journal articles, 17 peer-reviewed conference papers, 2 patents  
 (From Google Scholar) Citations: 1166; h-index: 15

### Journal articles

- P Shetty, J Menezes, **S Song**, A Young, M Shepherd. Ankle Exoskeleton Control via Data-Driven Gait Estimation for Walking, Running, and Inclines. *submitted*.
- J12 V Firouzi, A Seyfarth, **S Song**, O von Stryk, & MA Sharbafi, Biomechanical models in the lower-limb exoskeletons development: A review. *Journal of NeuroEngineering and Rehabilitation*. 2025.
- J11 A Dziewaltowski, AM Gonabadi, P Antonellis, **S Song**, & P Malcolm, Perturbation-based estimation of within-stride cycle metabolic cost. *Journal of NeuroEngineering and Rehabilitation*. 2024.
- J10 JGA Cashaback, JL Allen, AHY Chou, DJ Lin, M Mangalam, MA Price, NK Secerovic, **S Song**, H Zhang, HL Miller, NSF DARE—transforming modeling in neurorehabilitation: 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 Caggiano\* G Durandau\* C Wang\* CK Tan\*, P Schumacher\*, et al., & V Kumar. Myochallenge 2023: Towards human-level dexterity and agility. *submitted*.
- C17 CK Tan, et al., & **S Song**. MyoAssist 0.1: MyoSuite for Dexterity and Agility in Bionic Humans. *IEEE ICORR*, 2025.
- C16 V Ton, D Solav, & **S Song**. Impact of sole designs of offloading AFO on gait dynamics: a predictive neuromechanical simulation study. *IEEE BioRob*, 2024.
- C15 GM Bryan, PW Franks, **S Song**, & SH Collins. Pilot comparison of customized and generalized hip-knee-ankle exoskeleton torque profiles. *IEEE ICRA*, 2024.
- 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 al., & 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)

- A13 C Goyal, CK Tan, **S Song**. Towards a task-agnostic exoskeleton arm assistant using deep reinforcement learning and neuromechanical simulation. *American Society of Biomechanics*, 2024.
- A12 CK Tan, G Durandau, M Sartori, V Kumar, V Caggiano, **S Song**. MyoSuite: A unified neuromechanical simulation platform for human movement research. *American Society of Biomechanics*, 2024.
- A11 **S Song**. Modeling in-the-wild effects of gait assistive devices through neuromechanical simulations and deep reinforcement learning. *NSF DARE Conference*, 2023.
- A10 **S Song**. Toward predictive simulation framework for gait assistive ankle exoskeletons. *Ubiquitous Robotics*, 2022.
- A9 **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.
- A8 **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.
- A7 **S Song**, H Geyer, SH Collins, & CG Atkeson. Towards predictive neuromechanical simulations for pathological gait and assistive devices. *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)

ASB Symposium: Can machine learning drive the next generation of scientific discovery in human movement? (invited talk and panel discussion)	August 7, 2024
Institute of Control, Robotics and Systems (ICROS), 2024 (Invited talk)	July 2, 2024
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 <ul style="list-style-type: none"> <li>• ETRI</li> <li>• Pukyong National University</li> </ul>	Jul-Aug 2022

- 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
<ul style="list-style-type: none"> <li>• EPFL, Switzerland</li> <li>• University of Tübingen, Germany</li> <li>• University of Stuttgart, Germany</li> <li>• Heidelberg University, Germany</li> <li>• TU Darmstadt, Germany</li> <li>• KU Leuven, Belgium</li> <li>• University of Twente, Netherlands</li> </ul>	
Universities and research institutes in Korea	Jul 2017
<ul style="list-style-type: none"> <li>• Seoul National University</li> <li>• Korea Institute of Industrial Technology</li> <li>• Pohang University of Science and Technology</li> <li>• Korea Institute of Machinery and Materials</li> <li>• Inha University</li> </ul>	
Universities and companies in Korea	Nov 2015
<ul style="list-style-type: none"> <li>• Chung-Ang University</li> <li>• Samsung Advanced Institute of Technology</li> <li>• KAIST</li> <li>• ROBOTIS</li> <li>• Seoul National University</li> </ul>	
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	<b>Northeastern University</b> ME4555 – <b>System analysis and control</b> Senior-level, 4 credits Spring 2024: 51 students Spring 2023: 46 students Spring 2022: 29 students
Teaching Assistant	<b>Carnegie Mellon University</b> (Fall 2013) 16868 - <b>Biomechanics and motor control of legged locomotion</b> Instructor: Hartmut Geyer, Ph.D. Graduate-level, 12 units, 21 students Lectured three classes, designed class projects, assisted students, and graded assignments
Mentoring	<b>Northeastern University</b> (2022-present) Current: 2 Postdoc, 4 PhD, 2 MS students, and 7 undergraduate students Alumni: 7 MS students, 2 visiting students  <b>Stanford University</b> (2018-2021) 4 PhD and 1 MS students  <b>Carnegie Mellon University</b> (2014-2019) 4 MS and 2 undergraduate students

## Honors & Awards

---

Honor	<b>NSF DARE2023 Fellow</b> (2023)  <b>Richard King Mellon Foundation Presidential Fellowship in the Life Sciences at Carnegie Mellon University</b> (2016-2017)  <b>Summa cum Laude</b> , ICU (2008)
Competitions	<b>RoboCup</b> (2010) 3 <sup>rd</sup> place, adult-size humanoid league 4 <sup>th</sup> place, kid-size humanoid league  <b>Radio &amp; Wireless Engineering Prototypes</b> , 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

Total count: 15 MS and 11 undergraduate students

#### Groups:

- Reflex-based model (2023-present)
- Deep RL for neuromechanical simulations (2023-present)

#### 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 70K 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: 4)

#### NeurIPS 2022-2024: MyoChallenge

Role: Organizer

Theme:

- 2024: Physiological Dexterity and Agility in Bionic Humans
- 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

#### BioRob 2024: Neuromusculoskeletal Twins – Lab vs. Clinical



(count: 6)

**Reality**

Role: Organizer

Members: KK Peper (TU München), G Durandau (McGill U), D Häufle (Heidelberg U), V Kumar (MyoLab), P Schumacher (Max Planck Inst), V Caggiano (MyoLab)

**ICRA 2024: Expanding Frontiers of Sim2Real**

Role: Organizer

Members: V Kumar (MyoLab), N Fey (MIT), G Durandau (McGill U), V Caggiano (MyoLab) P Agrawal (MIT)

**NeurIPS 2022, 2023, 2024: 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**, Northeastern University (2023-present)

2 MS student

**Thesis Committee**, Boston University (2023-present)

1 PhD 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 Transactions on Neural Systems and Rehabilitation

- Special issue: Broadening the Impact of the DARE Conference:  
Transformative Opportunities for Modeling in Neurorehabilitation

(2024-2026)

IEEE Robotics and Automation Letters (2022-present)

IEEE IROS 2025

IEEE BioRob 2022, 2024

Ad-hoc reviewer  
(IOP trusted reviewer)**Journals**

ACM Transactions on Graphics

Advances in Mechanical Engineering

Bioinspiration &amp; Biomimetics

Engineering

Frontiers in Bioengineering and Biotechnology

Frontiers in Mechanical Engineering

Gait &amp; Posture

Human Movement Science

IEEE Robotics and Automation Letters

IEEE Transactions on Human-Machine Systems

IEEE Transactions on Neural Systems &amp; Rehabilitation Engineering

IEEE Transactions on Robotics

Journal of Biomechanics

Journal of Neural Engineering

Journal of NeuroEngineering and Rehabilitation

Journal of Physiology

Journal of the Royal Society Interface

Mechatronics

PLOS Computational Biology

PLOS ONE

Robotics and Autonomous Systems

Scientific Reports

Science Robotics

**Conferences**

IEEE BioRob

IEEE Humanoids

IEEE ICORR

IEEE ICRA

IEEE IROS

IEEE ISMR

NeurIPS (competition track)

SIGCHI

SIGGRAPH

SIGGRAPH Asia

UR

**Other Research Experience**

---

Lab Associate  
(summer intern)**Disney Research**, Pittsburgh, PA (May-Aug 2014)

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