# *CURRICULUM VITAE*


# Inseung Kang

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## EDUCATION

**Georgia Institute of Technology**

*Ph.D. in Mechanical Engineering* — *Aug 2021*

- *Dissertation Title: Adaptive User State Estimation for Assisting Human Locomotion Using Powered Hip Exoskeletons*
- *Advisor: Aaron J. Young Ph.D.*

*M.S. in Mechanical Engineering* — *May 2018*

*B.S. in Mechanical Engineering* — *May 2016*

## ACADEMIC POSITION

**Postdoctoral Associate** — *Jan 2022 - Current*
Seethapathi Motor Control Lab
Department of Brain and Cognitive Sciences
Massachusetts Institute of Technology

## EMPLOYMENT AND EXPERIENCE

**Research Scientist** — *Aug 2021 – Dec 2021*
School of Mechanical Engineering
Georgia Institute of Technology

**Graduate Research Assistant** — *Aug 2018 – Aug 2021*
School of Mechanical Engineering
Georgia Institute of Technology

**Graduate Teaching Assistant** — *Aug 2016 – Aug 2018*
School of Mechanical Engineering
Georgia Institute of Technology

**CAD/CAM Instructor** — *Spring 2017, 2018*
School of Biological Sciences
Georgia Institute of Technology

**Research Assistant** — *Summer 2017*
Neuro-Robotic Rehabilitation Team | The Center for Bionics
Korea Institute of Science and Technology

## PUBLICATIONS

***Journal Articles*** (*indicates equal contribution)

- J9: D. Molinaro, **I. Kang**, J. Camargo, M. Gombolay, A. Young, Subject-Independent, Biological Hip Moment Estimation During Multimodal Overground Ambulation Using Deep Learning, *IEEE Transactions on Medical Robotics and Bionics -Accepted*
- J8: D. Lee, B. McLain, **I. Kang**, A. Young, Biomechanical Comparison of Assistance Strategies Using a Bilateral Robotic Knee Exoskeleton, *IEEE Transactions on Biomedical Engineering*, May 2021
- J7: **I. Kang**, D. Molinaro, S. Duggal, Y. Chen, P. Kunapuli, A. Young, Real-time gait phase estimation for robotic hip exoskeleton control during multimodal locomotion, *IEEE Robotics and Automation Letters*, February 2021
- J6: D. Lee, **I. Kang**, D. Molinaro, A. Yu, A. Young, Real-Time User-Independent Slope Prediction using Deep Learning for Modulation of Robotic Knee Exoskeleton Assistance, *IEEE Robotics and Automation Letters*, February 2021
- J5: SE. Lee, C. Kilpatrick, **I. Kang**, H. Hsu, W. Childers, A. Young, Investigating the Impact of the User Interface for a Powered Hip Orthosis on Metabolic Cost and User Comfort: A Preliminary Study, *Journal of Prosthetics and Orthotics*, June 2020
- J4: G. Sawicki, O. Beck, **I. Kang**, A. Young, The Exoskeleton Expansion: Improving Walking and Running Economy, *Journal of NeuroEngineering and Rehabilitation*, February 2020
- J3: D. Lee, EC. Kwak, B. McLain, **I. Kang,** A. Young, Biomechanical Effects of a Robotic Knee Exoskeleton during Incline and Decline Walking, *IEEE Transactions on Neural Systems & Rehabilitation Engineering*, February 2020
- J2: **I. Kang***, P. Kunapuli*, A. Young, Real-Time Neural Network-based Gait Phase Estimation using a Robotic Hip Exoskeleton, *IEEE Transactions on Medical Robotics and Bionics*, December 2019
- J1: **I. Kang**, H. Hsu, A. Young, The Effect of Hip Assistance Levels on Human Energetic Cost Using Robotic Hip Exoskeletons, *IEEE Robotics and Automations Letters*, April 2019

### *Refereed Conference Proceedings*

- C9: H. Jin, **I. Kang**, G. Choi, D. Molinaro, A. Young, Wearable Sensor-Based Step Length Estimation During Overground Locomotion Using a Deep Convolutional Neural Network, *IEEE International Conference of the Engineering in Medicine and Biology Society (EMBC), October 2021*
- C8: G. Choi, D. Lee, **I. Kang**, A. Young, Effect of Assistance Timing in Knee Extensor Muscle Activation During Sit-To-Stand Using a Bilateral Robotic Knee Exoskeleton, *IEEE International Conference of the Engineering in Medicine and Biology Society (EMBC), October 2021*
- C7: **I. Kang**, D. Molinaro, G. Choi, A. Young, Continuous locomotion mode classification using a powered bilateral hip exoskeleton, *IEEE International Conference on Biomedical Robotics and Mechatronics (BioRob)*, June 2020

- C6: D. Molinaro, **I. Kang**, J. Camargo, A. Young, Biological Hip Torque Estimation using a Robotic Hip Exoskeleton, *IEEE International Conference on Biomedical Robotics and Mechatronics (BioRob)*, June 2020
- C5: **I. Kang**, P. Kunapuli, H. Hsu, A. Young, Electromyography (EMG) Signal Contributions in Speed and Slope Estimation Using Robotic Exoskeletons, *IEEE International Conference on Rehabilitation Robotics (ICORR)*, June 2019
- C4: H. Zheng, T. Shen, R. Afsar, **I. Kang**, A. Young, X. Shen A Semi-Wearable Robotic Device for Sit-to-Stand Assistance, *IEEE International Conference on Rehabilitation Robotics (ICORR)*, June 2019
- C3: **I. Kang**, H. Hsu, A. Young, Design and Validation of a Torque Controllable Hip Exoskeleton for Walking Assistance, *ASME Dynamic Systems and Control Conference*, October 2018
- C2: H. Hsu, **I. Kang**, A. Young, Design and Evaluation of a Proportional Myoelectric Controller for Hip Exoskeleton During Normal Walking, *ASME Dynamic Systems and Control Conference*, October 2018
- C1: S. Kim, X. Chen, G. Dreifus, J. Lindahl, **I. Kang**, A. Kim, M. Selim, D. Nuttal, A. Messing, A. Nycz, R. Minneci, J. Bowers, B. Braswell, A. Hassan, B. Pipes, V. Kunc, An Integrated Design Approach for Infill Patterning of Fused Deposition Modeling and its Application to an Airfoil, *SAMPE Conference*, February 2017

### *Conference Abstracts*

- A4: **I. Kang**, D. Molinaro, G. Choi, A. Young, A biomechanical analysis of adaptive assistance strategy for uphill walking using a powered hip exoskeleton, *American Society of Biomechanics Annual Conference*, August 2020
- A3: D. Molinaro, **I. Kang**, J. Camargo, A. Young, Estimating biological hip torque during overground ambulation: A machine learning approach, *American Society of Biomechanics Annual Conference*, August 2020
- A2: Y. Pan, **I. Kang**, K. Herrin, A. Young, The Biomechanical Effect of Bilateral Assistance for Hemiparetic Gait Poststroke Using a Powered Hip Exoskeleton, *American Society of Biomechanics Annual Conference*, August 2020
- A1: C. Kilpatrick, SE. Lee, **I. Kang**, H. Hsu, L. Childers, A. Young, The Impact of Hip Exoskeleton User Interface on User Comfort and Metabolic Cost: A Pilot Study, *American Academy of Orthotists & Prosthetists Conference*, March 2019

### *Under Review*

- J1: **I. Kang**, R. Peterson, K. Herrin, A. Mazumdar, A. Young, Optimizing Series Elastic Actuator Design for Hip Exoskeleton-Assisted Dynamic Locomotion, *IEEE/ASME Transactions on Mechatronics*

- J2: **I. Kang**, D. Molinaro, G. Choi, J. Camargo, A. Young, Subject-Independent Continuous Locomotion Mode Classification for Robotic Hip Exoskeleton Applications, *IEEE Transactions on Biomedical Engineering*
- J3: **I. Kang***, Y. Pan*, J. Joh, P. Kim, K. Herrin, A. Young, Effects of Bilateral Assistance for Hemiparetic Gait Post-Stroke Using a Powered Hip Exoskeleton, *Annals of Biomedical Engineering*
- C1: H. Cho, **I. Kang**, D. Park, D. Molinaro, A. Young, Real-Time Walk Detection for Robotic Hip Exoskeleton Applications, *IEEE International Symposium on Medical Robotics,* April 2022

## PRESENTATION

### *Invited Seminar Talk*

- T4: Improving Human Locomotion Using a User State Adaptive Control of a Robotic Hip Exoskeleton, *Yonsei University College of Medicine*, January 2021
- T3: Robotic Exoskeleton for Improving Human Locomotion, *NAVER LABS*, December 2020
- T2: User State Adaptive Control of a Robotic Hip Exoskeleton to Improve Human Locomotion During Community Ambulation, *Samsung Electronics*, December 2020
- T1: User State Adaptive Assistance Strategy to Enhance Human Locomotion Using a Robotic Hip Exoskeleton, *Georgia Tech IRIM RoboGrads Student Virtual Seminar Session*, August 2020

### *Conference Talk*

- T5: Real-time gait phase estimation for robotic hip exoskeleton control during multimodal locomotion, *IEEE International Conference on Robotics and Automation*, May 2021
- T4: Continuous locomotion mode classification using a powered bilateral hip exoskeleton, *IEEE International Conference on Biomedical Robotics and Mechatronics (BioRob)*, December 2020
- T3: Electromyography (EMG) Signal Contributions in Speed and Slope Estimation Using Robotic Exoskeletons, *IEEE International Conference on Rehabilitation Robotics (ICORR)*, June 2019
- T2: Design and Validation of a Torque Controllable Hip Exoskeleton for Walking Assistance, *ASME Dynamic Systems and Control Conference*, October 2018
- T1: Effects of Assistance Levels on Energetic Savings Using a Robotic Hip Exoskeleton, *Dynamic Walking Conference*, May 2018

***Poster Presentation***

- P7: B. McLain, D. Lee, **I. Kang**, A. Young, EMG-informed neuromusculoskeletal model for knee joint load estimation with a powered knee exoskeleton during inclined walking, *American Society of Biomechanics Annual Conference*, August 2020
- P6: A. Groff, S. Thai, **I. Kang**, H. Hsu, A. Young, Control Strategies of a Powered Assist Hip Exoskeleton in Subject with Stroke, *American Academy of Orthotists & Prosthetists Conference*, March 2019
- P5: **I. Kang**, A. Young, Understanding the Optimal Assistance Levels for Human Augmentation Using Robotic Hip Exoskeletons, *The Career, Research, and Innovation Development Conference*, February 2019
- P4: P. Kunapuli, **I. Kang**, A. Young, Neural Network Based Estimation of Gait Phase in a Powered Hip Exoskeleton, *Biomedical Engineering Society Conference*, October 2018
- P3: EC. Kwak, D. Lee, **I. Kang**, A. Young, The Effect of Powered Assistance on Uphill Human Walking Using a Robotic Knee Exoskeleton, *Biomedical Engineering Society Conference*, October 2018
- P2: C. Kilpatrick, SE. Lee, **I. Kang**, H. Hsu, L. Childers, A. Young, Investigating the Impact of Hip Exoskeleton User Interface on User Comfort and Metabolic Cost, *American Academy of Orthotists & Prosthetists Conference*, February 2018
- P1: **I. Kang**, H. Hsu, D. Lee, A. Young, Robotic Human Augmentation using Exoskeleton Devices, *NextFlex Workshop: Powering the Internet of Everything*, November 2017

## PROFESSIONAL WORKSHOPS

- **I. Kang**, A. Young, M. Shepherd, D. Molinaro, G. Evangelopoulos, Online Machine Learning-based Control of Lower-Limb Exoskeletons, *IEEE International Conference on Robotics and Automation*, May 2022 – Accepted

## PATENTS

- U.S. Patent PCT/US21/40068: "Powered Bilateral Knee Exoskeleton" – Filed July 1, 2021

## CONTRIBUTED RESEARCH FUNDING

- National Institute of Health: R03 New Investigator Award *Apr 2019*
    - *Title: Improving Community Ambulation for Stroke Survivors using Powered Hip Exoskeletons with Adaptive Environmental Controllers*

- National Science Foundation: National Robotics Initiative Award *Aug 2018*

- *Title: Robotic Human Enhancement Enabled through Wearable Hip Exoskeletons Capable of Community Ambulation*

## AWARDS AND HONORS

- VIP Mentor Award, Georgia Tech's Vertically Integrated Projects Program *2021*
- Outstanding Capstone Research Award, P&O Research Symposium *2018*
- Best Poster Award, AAOP Conference *2018*
- Highest honor upon graduation for bachelor's degree *2016*
- Georgia Tech Korean Student Association Scholarship *2015*

## OUTREACH PROGRAM

- National Robotics Week, Georgia Tech *2017 – 2021*
- US-Japan Nakatani RIES Program, Georgia Tech *2019 - 2021*

## MENTORING

- Dongho Park, PhD ME, Georgia Tech *Fall 2021*
- Patrick Kim, PURA Program, Georgia Tech *Summer 2021*
- Gayeon Choi, PURA Program, Georgia Tech *Spring 2021*
- James Joh, PURA Program, Georgia Tech *Spring 2021*
- Reese Peterson, MSME, Georgia Tech *2020 - 2022*
- Julian Park, MSME, Georgia Tech *2019 – 2021*
- Henry Luk, MSME, Georgia Tech *2019 – 2020*
- Srijan Duggal, PURA Program, Georgia Tech *Fall 2020*
- Emily Keller, NSF SURE Program, NCSU *Summer 2019*
- Dawit Lee, MSME, Georgia Tech *2017 – 2018*
- Hsiang Hsu, MSME, Georgia Tech *2017 – 2019*
- Michael Groff, MSCS, Georgia Tech *2019*
- Bailey McLain, Petit Scholar Program, Georgia Tech *2019*
- Michelle Myrick, Petit Scholar Program, Georgia Tech *2017*
- Harnjoo Kim, PURA Program, Georgia Tech *Spring 2019*
- Pratik Kunapuli, PURA Program, Georgia Tech *Summer 2018*
- Joonho Seo, PURA Program, Georgia Tech *Spring 2017*
- Alice Zou, NSF SURE Program, Johns Hopkins University *Summer 2017*

## PROFESSIONAL MEMBERSHIPS AND SERVICES

- Student Member, ASME *2013 – Present*
- Student Member, IEEE *2018 – Present*
- Member, Pi Tau Sigma *2014 – Present*
- Reviewer, IEEE Robotics and Automation Letters *2019 – Present*
- Reviewer, IEEE Transactions on Mechatronics *2018 – Present*

- Reviewer, IEEE Transactions on Robotics *2018 – Present*
- Reviewer, IEEE Transactions on Biomedical Engineering *2017 – Present*
- Reviewer, IEEE Transactions on Medical Robotics and Bionics *2019 – Present*
- Reviewer, IEEE Transactions on Neural Systems and Rehabilitation Engineering *2020 – Present*
- Reviewer, Frontiers in Neurorobotics *2018 – Present*
- Reviewer, Scientific Report *2021 – Present*
- Reviewer, President's Undergraduate Research Award, Georgia Tech *2017 – Present*
- Mentor, Petit Undergraduate Research Scholars Program *2017 – 2019*
- Member, Korean Scientist and Engineers Association *2014 – Present*
- Organizer, KSEA Ygnite Conference *2015, 2016, 2020, 2021*