

CURRICULUM VITAE

Inseung Kang

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813 Ferst Drive NW, Atlanta, GA, 30332

EDUCATION

Georgia Institute of Technology

Ph.D. in Mechanical Engineering

Aug 2021(expected)

M.S. in Mechanical Engineering

May 2018

B.S. in Mechanical Engineering

May 2016

ACADEMIC POSITIONS

PhD Candidate

Exoskeleton and Prosthetic Intelligent Control Lab

Aug 2016 - Current

School of Mechanical Engineering

Georgia Institute of Technology

Advised by Aaron J. Young PhD

Dissertation Topic: Adaptive user state estimation for assisting human locomotion using robotic hip exoskeletons

- Incorporate real-time user state estimation/prediction utilizing sensor fusion-based machine learning algorithms
 - User intent recognition (e.g., climbing stairs and ramps) for continuous locomotion mode classification
 - Sensor fusion-based approach for robust user state estimation (e.g., walking speed) during ambulation
 - Online adaptation approach (transfer learning) to accommodate variations in different user's gait dynamics
- Implement dynamic controllers to accommodate different locomotion tasks and user's gait patterns for a robotic hip exoskeleton
 - Biological torque control
 - State machine-based impedance control
 - Proportional myoelectric (EMG) control
- Design a robust mechatronic platform with capabilities in providing torques in wide ranges of locomotion tasks
 - Series elastic actuator: capability in high fidelity closed loop feedback control, additional compliance for mitigating disturbance
 - Quasi-direct drive actuator: high bandwidth, back-drivable, transparent actuator dynamics
- Understand human robot interaction through a formal biomechanical/biological analysis
 - Standard biomechanics measurement using motion capture system
 - Evaluation of user's biological measurement: metabolic cost, EMG signals

- Translate exoskeleton technology to understand the device efficacy in a clinical population (Elders and Stroke patients)
 - Understand the optimal assistance strategy for improving gait function in stroke populations
 - Explore different machine learning techniques to handle signal variations in stroke subjects

EMPLOYMENT AND EXPERIENCE

Graduate Teaching Assistant

School of Mechanical Engineering
Georgia Institute of Technology

Aug 2016 – Aug 2018

- Directed undergraduate students in ‘Creative Decision and Design’ course learning to build task driven robots for a competition
- Trained different machining techniques/design tools relating to manufacturability
- Instructed mechatronics/embedded programming using NI myRIO and LabVIEW

CAD/CAM Instructor

School of Biological Sciences
Georgia Institute of Technology

Spring 2017, 2018

- Instructed CAD (Solidworks) software to students in Master of Science in Prosthetics and Orthotics program
- Taught design ideation, feature extraction, manufacturability etc.
- Utilized an industry grade 3D scanner and taught its application with CAD software

Research Assistant

Neuro-Robotic Rehabilitation Team | The Center for Bionics
Korea Institute of Science and Technology

Summer 2017

- Designed and fabricated a full lower limb exoskeleton rehabilitation robot (COWALK) for SCI patients
- Analyzed and optimized data via Simulink for synchronizing the exoskeleton movement with user’s gait pattern
- Presented a full demo of the device to President of Republic of Korea (June, 2014)

PUBLICATIONS

Journal Articles

- 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

- 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**, A. Young, Estimation of biological hip moment 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

Under Review

- J4: **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 / International Conference on Robotics and Automation (ICRA), May 2021

- J3: 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 / International Conference on Robotics and Automation (ICRA), May 2021*
- J2: D. Ward, L. Tiziani, **I. Kang**, D. Lee, J. Camargo, G. Kogler, A. Young, F. Hammond, Compliance Characterization to Improve the Force Transmission of a Pneumatic Knee Exoskeleton, *IEEE Transactions on Robotics*
- J1: D. Lee, B. McLain, **I. Kang**, A. Young, Biomechanical Comparison of Assistance Strategies Using a Bilateral Robotic Knee Exoskeleton, *IEEE Transactions on Biomedical Engineering*

PRESENTATION

Invited Seminar Talk

- T4: **I. Kang**, Improving Human Locomotion Using a User State Adaptive Control of a Robotic Hip Exoskeleton, *Yonsei University College of Medicine*, January 2021
- T3: **I. Kang**, Robotic Exoskeleton for Improving Human Locomotion, *NAVER LABS*, December 2020
- T2: **I. Kang**, User State Adaptive Control of a Robotic Hip Exoskeleton to Improve Human Locomotion During Community Ambulation, *Samsung Electronics*, December 2020
- T1: **I. Kang**, 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: **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
- T4: 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
- T3: 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

- T2: 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
- T1: **I. Kang**, H. Hsu, A. Young, 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

PATENTS

- U.S. Patent 63,046,956: "Powered Bilateral Knee Exoskeleton" – Filed July 1, 2020

CONTRIBUTED RESEARCH FUNDING

- National Science Foundation: National Robotics Initiative Award *Aug 2018*
 - Title: Robotic Human Enhancement Enabled through Wearable Hip Exoskeletons Capable of Community Ambulation
- 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

AWARDS AND HONORS

- 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
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OUTREACH PROGRAM

- National Robotics Week, Georgia Tech 2017 – Present
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MENTORING

- Reese Peterson, MSME, Georgia Tech 2020 - Present
 - Julian Park, MSME, Georgia Tech 2019 – Present
 - 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 (Now in NAVER Labs) Spring 2017
 - Alice Zou, NSF SURE Program, Johns Hopkins University Summer 2017
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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, 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*