CURRICULUM VITAE

Inseung Kang

ikang7@gatech.edu | inseungkang.github.io
813 Ferst Drive NW, Atlanta, GA, 30332

EDUCATION

Georgia Institute of Technology

Ph.D. in Mechanical Engineering — *May 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 Title: Adaptive user state estimation for assisting human locomotion using powered hip exoskeletons

- Incorporate real-time user state estimation/prediction utilizing sensor fusion-based machine learning algorithms
    - EMG pattern recognition for user intent recognition for continuous locomotion mode classification
    - Sensor fusion-based approach for user state estimation: walking speed, slope, and gait phase
    - Online adaptive 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 powered hip exoskeleton
    - Biologically inspired torque control
    - Proportional myoelectric (EMG) control
    - State machine-based impedance 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 an 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 *Aug 2016 – Aug 2018*
Georgia Institute of Technology

- 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 programing using NI myRIO and LabVIEW

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

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

- 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

In Preparation

- J3: **I. Kang**, H. Luk, J. Park, K. Herrin, A Mazumdar, A. Young, Series elastic actuator torque response optimization in dynamic locomotion for a robotic hip exoskeleton
- J2: P. Kunapuli, **I. Kang**, A. Young, Online Adaptation of User State Estimation in a Powered Hip Exoskeleton

- J1: D. Ward, L. Tiziani, **I. Kang**, D. Lee, J. Camargo, G. Barnes, G. Kogler, A. Young, F. Hammond, Design of a high-bandwidth, energy-efficient pneumatically actuated knee exoskeleton

Under Review

- J3: **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
- J2: 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
- 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*

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

Conference Papers

- 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

PRESENTATION

Invited Seminar Talk

- 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*

OUTREACH PROGRAM

- National Robotics Week, Georgia Tech *2017 – Present*

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*

PROFESSIONAL MEMBERSHIPS AND SERVICES

- Student Member, ASME *2013 – Present*
- Student Member, IEEE *2018 – Present*
- Member, Pi Tau Sigma *2014 – 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*