Minjae Kim

CONTACT INFORMATION	POSTECH Department of Mechanical Engineering March Lab *E-mail:* minjaekim@postech.ac.kr 77 Cheongam-ro, Nam-gu, Pohang 37673, Korea

RESEARCH
INTERESTS

Surface electromyography, rehabilitation, prosthetics, biosignal processing, myoelectric interface, haptic interface, brain machine interface, wearable device

EDUCATION

Pohang University of Science and Technology, Pohang, Korea   Mar 2012 - Aug 2018
Combined M.S./Ph.D. in Mechanical Engineering
- Supervisor: Dr. Wan Kyun Chung
- Dissertation title: *"Development of sEMG Interface and Algorithm for Logn-tern Reliable Measurement"*

Chung-Ang University, Seoul, Korea   Mar 2008 - Feb 2012
B.S. in Mechanical Engineering
Minor in in Electrical & Electronics Engineering

HONORS AND
AWARDS

Sarah Baskin Outstanding Research Award (1st place), Shirley Ryan AbilityLab	Jun 2022
RMI Paper Award, Korea Institute of Science and Technology	Dec 2019
Outstanding Paper Award, Int. Conf. on Ubiquitous Robots	Jun 2018
Best Paper Award, Korean Conf. on Sensors	Nov 2015
Best Teaser Award, Haptic Symposium	Feb 2014
Participation Award, Information Search Competition, Chung-Ang University	Nov 2011

ACADEMIC
EXPERIENCE

March Lab., Pohang University of Science and Technology   Supervisor: Dr. Keehoon Kim
Post-Doctoral Fellow   Jun 2023 - present
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Center for Bionic Medicine, Shirley Ryan AbilityLab   Supervisor: Dr. Levi Hargrove
Post-Doctoral Fellow   Jan 2021 - May 2023
- Deep learning-based control of Prosthetic legs

Center for Bionic Medicine, Shirley Ryan AbilityLab   Supervisor: Dr. Levi Hargrove
Visiting Post-Doctoral Scholar supported by KIST and Hanyang University   Jan 2020 - Dec 2020
- Deep learning-based control of Prosthetic legs - Deep learning to map a benchmark dataset for controlling a prosthetic leg
  - Generation of GAN-based synthetic gait trajectories for controlling a prosthetic leg
- Development of sEMG filtering methods
  - Removal of spinal stimulation artifact

Center for Intelligent & Interactive Robotics, KIST   Supervisor: Dr. Keehoon Kim
Post-Doctoral Fellow   Sep 2018 - Aug 2019
- Development of microneedle array-based sEMG system
  - Integration of embedded systems and electrodes
- sEMG signal-based motion recognition)
  - Model-based sEMG electrode rotation compensation
  - Model-based robust motion recognition using a few numbers of sEMG electrodes
  - Model-based motion recognition independent of the properties of the electrode (amplifier gain, shape, or size)

Robotics Lab., Pohang University of Science and Technology   Supervisor: Dr. Wan Kyun Chung
Ph.D. student   Mar 2012 - Aug 2018
- Development of microneedle array-based sEMG systems
  - Fabricated polymer-based and metal-based microneedle array electrode
  - Evaluated sEMG electrode in various conditions
  - Studied electrode parameters affecting signal quality

- Developed high-density microneedle array electrode
- Developed wireless wearable systems for stable sEMG signal measurement
- sEMG signal-based motion recognition
  - Investigated conventional machine learning-based feature extraction methods
  - Proposed a novel sEMG feature extraction method: a source activation model
  - Decomposed sEMG signals using the source activation model
- Development of testbed for cell stimulation and signal measurement   Jan 2016 - Nov 2016
  - Manipulated XYZ-micro stage
  - Investigated cell stimulation and extracellular signal measurement
- Development of prosthetic hand   Feb 2012 - Aug 2012
  - Integrated/maintained the sensors (load cell, thermistor) and other hardware

Intelligent Mechatronics & Robotics Lab., Chung-Ang University   Advisor: Dr. Tae-Hyoung Kim

Summer Intern   Jul 2011 - Aug 2011
- Constrained particle swarm optimization (CPSO)
  - Implemented CPSO using MATLAB

JOURNAL PUBLICATIONS

[J11] **Minjae Kim**, and L.J. Hargrove, "A Method for Controlling Prosthetic Legs Using Deep Neural Network Models Trained On Synthetic Gait Trajectory." *Journal of NeuroEngineering and Rehabilitation*, accepted

[J10] S. Yang, **Minjae Kim**, S.K. Hong, S. Kim, W.K. Chung, G. Lim, and H. Jeon, "Design of 3D Controller Using Nanocracking Structure-Based Stretchable Strain Sensor," *Sensors*, vol. 23, 1–14, May 2023.

[J9] **Minjae Kim**, and L.J. Hargrove, "A Gait Phase Prediction Model Trained on Benchmark Datasets For Evaluating a Controller For Prosthetic Legs," *Frontiers in Neurorobotics*, vol. 16, 1–13, Jan 2023.

[J8] **Minjae Kim**, A.M. Simon, and L.J. Hargrove, "Seamless and intuitive control of a powered prosthetic leg using deep neural network for transfemoral amputees," *Wearable Technologies*, vol. 3, e24:1–16, Sep 2022.

[J7] **Minjae Kim**, and L.J. Hargrove, "Deep-Learning to Map a Benchmark Dataset of Non-amputee Ambulation for Controlling an Open Source Bionic Leg," *IEEE Robotics and Automation Letters*, Vol. 7, issue 4, 10597–10604, Jul 2022.

[J6] **Minjae Kim**, Y. Moon, J. Hunt, KA. McKenzie, A. Horin, M. McGuire, K. Kim, L.J. Hargrove, and A. Jayaraman, "A Novel Technique to Reject Artifact Components for Surface EMG Signals Recorded During Walking With Transcutaneous Spinal Cord Stimulation: A Pilot Study," *Frontiers in Human Neuroscience*, Vol. 15, Jun 2021.

[J5] **Minjae Kim**, W.K. Chung, and K. Kim, "Subject-Independent sEMG Pattern Recognition by Using a Muscle Source Activation Model," *IEEE Robotics and Automation Letters*, Vol. 5, issue 4, 5175–5180, Jul 2020.

[J4] **Minjae Kim**, K. Kim, and W. K. Chung, "Simple and Fast Compensation of sEMG Interface Rotation for Robust Hand Motion Recognition," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, Vol. 26, issue 12, 2397–2406, Dec 2018. **Selected as the front cover of the 12th issue in 26th volume**.

[J3] **Minjae Kim**, and W. K. Chung, "Spatial sEMG Pattern-Based Finger Motion Estimation in a Small Area Using a Microneedle-Based High-Density Interface," *IEEE Robotics and Automation Letters*, Vol. 3, no. 1, 234–241, Jan 2018

[J2] **Minjae Kim**, G. Gu, K. J. Cha, D. S. Kim, and W. K. Chung, "Wireless semg system with a microneedle-based high-density electrode array on a flexible substrate," *Sensors*, Vol. 18, no. 1, 92, Dec 2017.

[J1] **Minjae Kim**, T. Kim, D. S. Kim, and W. K. Chung, "Curved microneedle array-based sEMG electrode for robust long-term measurements and high selectivity," *Sensors*, Vol. 15, no. 7, 16265–

16280, Jul 2015.

CONFERENCE
PUBLICATIONS

[C10] **Minjae Kim**, A.M. Simon, K. Shah, and L.J. Hargrove, "Machine Learning-Based Gait Mode Prediction for Hybrid Knee Prosthesis Control." *Int. Conf. of the IEEE Engineering in Medicine and Biology Society (EMBC)*, pp. xx–xx, Jul 2023.

[C9] **Minjae Kim**, W. K. Chung, and K. Kim, "Motion Intensity Extraction Scheme for Simultaneous Recognition of Wrist/Hand Motions ," in *Proceedings of IEEE Int. Conf. on Robotics and Automation (ICRA)*, pp. 10112–10117, May 2020.

[C8] **Minjae Kim**, W. K. Chung, and K. Kim, "Preliminary Study of Virtual sEMG Signal-Assisted Classification," in *Proceedings of International Conference on Rehabilitation Robotics (ICORR)*, pp. 1133–1138, Canada, Jun 2019.

[C7] **Minjae Kim**, and W. K. Chung, "Muscle Activation Source Model-based sEMG Signal Decomposition and Recognition of Interface Rotation," in *Proceedings of IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS)*, pp. 2780–2786, Spain, Oct 2018.

[C6] **Minjae Kim**, G. Gu, and W. K. Chung, "Pneumatic Microneedle-Based High-Density sEMG Sleeve for Stable and Comfortable Skin Contact during Dynamic Motion," in *Proceedings of IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS)*, pp. 5477–5482, Spain, Oct 2018.

[C5] **Minjae Kim**, G. Gu, and W. K. Chung, "Pneumatic Sleeve-Assisted Stable sEMG Measurement for Microneedle Array Electrode," in *Proc. of Int. Conf. on Ubiquitous Robots (UR)*, pp. 1–4, USA, Jun 2018.

[C4] **Minjae Kim**, G. Gu, and W. K. Chung, "Skin Grasping sEMG Interface Based on Microneedle Array Electrode," in *Proc. of Int. Conf. on Ubiquitous Robots and Ambient Intelligence (URAI)*, pp. 839–840, Korea, Jun 2017.

[C3] **Minjae Kim**, D. S. Kim, and W. K. Chung, "Microneedle-based high-density surface EMG interface with high selectivity for finger movement recognition," in *Proc. of IEEE Int. Conf. on Robotics and Automation (ICRA)*, Sweden, pp. 973–978, May 2016.

[C2] J. Lee, E. Cho, **Minjae Kim**, Y. Yoon, S. Choi, "PreventFHP: Detection and Warning System for Forward Head Posture," in *Haptic Symposium*, pp. 295–298, USA, Feb 2014.

[C1] **Minjae Kim**, S. Park, and W. K. Chung, "Flexible Polymer-based Micro Needle Array sEMG Sensor," in *Proc. of Int. Conf. on Ubiquitous Robots and Ambient Intelligence (URAI)*, pp. 1–4, Korea, Oct 2013.

NON-REFEREED
PUBLICATIONS

[N10] G. Jeong, Y. Kim, Y. Oh, G. Gu, S. Park, **Minjae Kim**, J. An, K. Kim, "Design and analysis of underactuated prosthetic hand using slider-crank mechanism,", Korea Robotics Society Annual Conference, Jan 2019.

[N9] G. Gu, **Minjae Kim**, W. K. Chung, "Development of Wireless High-Density sEMG Acquisition System,", Korea Robotics Society Annual Conference, Jan 2018.

[N8] **Minjae Kim**, W. K. Chung, "sEMG Source Activation Model-Based Motion Estimation Robust to Electrode Placement Change,", Korea Robotics Society Annual Conference, Jan 2018.

[N7] **Minjae Kim**, W. K. Chung, "Novel sEMG-Muscle Model-based Approach for Robust Motion Identification,", The Sixth Asia International Symposium on Mechatronics, Sep 2017.

[N6] G. Gu, **Minjae Kim**, W. K. Chung, "Design of Portable sEMG Sensor System,", Korea Robotics Society Annual Conference, Feb 2017.

[N5] **Minjae Kim**, T. Kim, D. S. Kim, and W. K. Chung, "Metal Microneedle-based Multi-channel Interface for Biosignal Measurement," Korean Conference on Sensors, Nov 2015.

[N4] **Minjae Kim**, D. S. Kim, and W. K. Chung, "Reliability of surface electromyographic measurement using microneedle array electrode," International Conference on Biofabrication in Korea, Sep 2014.

[N3] **Minjae Kim**, T. Kim, D. S. Kim, and W. K. Chung, "Biocompatible microneedle array electrode for surface electromyography," Korean Society of Mechanical Engineers (KSME) conference

of bioengineering , Apr 2014.

[N2] **Minjae Kim** and W. K. Chung, "ICRA 2013 Review," Journal of Korea robotics society (lightly refereed), Oct 2013.

[N1] **Minjae Kim** and W. K. Chung, "The comparison of the sEMG pattern classification performance depends on the electrode impedance,", Korea Robotics Society Annual Conference, May 2013.

PRESENTATIONS

[P22] "Deep-Learning to Map a Benchmark Dataset of Non-amputee Ambulation for Controlling an Open Source Bionic Leg," in *Proceedings of IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS)*, JPN, Oct 2022.

[P21] "Deep Learning-Based Control of Prosthetic Legs," in *Chung-Ang University*, KOR, Oct 2022.

[P20] "Deep Learning-Based Control of Prosthetic Legs," in *KAIST*, KOR, Oct 2022.

[P19] "Deep Learning-Based Control of Prosthetic Legs," in *KIST*, KOR, Oct 2022.

[P18] "Deep learning-based control of Bionic Legs," in *SRAlab Research Webinar*, USA, Sep 2022.

[P17] "Deep learning-based mapping of non-amputee ambulation for controlling an open-source bionic leg," in *Workshop of IEEE Int. Conf. on Robotics and Automation (ICRA)*, USA, May 2022.

[P16] "Subject-Independent sEMG Pattern Recognition by Using a Muscle Source Activation Model," in *Proceedings of IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS)*, USA, Oct 2020.

[P15] "Motion Intensity Extraction Scheme for Simultaneous Recognition of Wrist/Hand Motions," in *Proceedings of IEEE Int. Conf. on Robotics and Automation (ICRA)*, France, Jun 2020.

[P14] "Preliminary Study of Virtual sEMG Signal-Assisted Classification," in *Proceedings of International Conference on Rehabilitation Robotics (ICORR)*, Canada, Jun 2019.

[P13] "Muscle Activation Source Model-based sEMG Signal Decomposition and Recognition of Interface Rotation," in *Proceedings of IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS)*, Spain, Oct 2018.

[P12] "Pneumatic Microneedle-Based High-Density sEMG Sleeve for Stable and Comfortable Skin Contact during Dynamic Motion," in *Proceedings of IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS)*, Spain, Oct 2018.

[P11] "Pneumatic Sleeve-Assisted Stable sEMG Measurement for Microneedle Array Electrode," in *Proc. of Int. Conf. on Ubiquitous Robots (UR)*, USA, Jun 2018.

[P10] "sEMG Source Activation Model-Based Motion Estimation Robust to Electrode Placement Change,", in *Korea Robotics Society Annual Conference*, Korea, Jan 2018.

[P9] "Spatial sEMG Pattern-Based Finger Motion Estimation in a Small Area using a Microneedle-Based High-Density Interface," in *Proceedings of IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS)*, Canada, Sep 2017.

[P8] "Novel sEMG-Muscle Model-based Approach for Robust Motion Identification,", in *The Sixth Asia International Symposium on Mechatronics*, Korea, Sep 2017.

[P7] "Skin Grasping sEMG Interface Based on Microneedle Array Electrode," in *Proc. of Int. Conf. on Ubiquitous Robots and Ambient Intelligence (URAI)*,Korea, Jun 2017. (Poster)

[P6] "Microneedle-based high-density surface EMG interface with high selectivity for finger movement recognition," in *Proc. of IEEE Int. Conf. on Robotics and Automation (ICRA)*, Sweden, May 2016.

[P5] "Metal Microneedle-based Multi-channel Interface for Biosignal Measurement," in *Korean Conference on Sensors*, Korea, Nov 2015. (Poster)

[P4] "Reliability of surface electromyographic measurement using microneedle array electrode," in *International Conference on Biofabrication in Korea*, Korea, Sep 2014.

[P3] "Biocompatible microneedle array electrode for surface electromyography," in *Korean Society*

of Mechanical Engineers (KSME) conference of bioengineering , Korea, Apr 2014.

[P2] "Flexible Polymer-based Micro Needle Array sEMG Sensor," in *Proc. of Int. Conf. on Ubiquitous Robots and Ambient Intelligence (URAI)*, Korea, Oct 2013.

[P1] "The comparison of the sEMG pattern classification performance depends on the electrode impedance,", in *Korea Robotics Society Annual Conference*, Korea, May 2013. (Poster)

PATENTS **Korea**
[T5] G. Lim, W. K. Chung, H. Jun, S. Hong, S. Cho, S. Yang, S Kim, I. Kim, **Minjae Kim**, D. Park, "THREE DIMENSIONAL CONTROL DEVICE UTILIZING HIGHLY SENSITIVE AND STRETCHABLE STRAIN SENSOR AND SYSTEM HAVING THAT," Registration No. 10-2003123, Jul, 2019.

[T4] W. K. Chung, **Minjae Kim**, G. Gu, "WEARABLE INTERFACE AND APPARATUS MEASURING BIOLOGICAL SIGNAL," Registration No. 10-1966516, Apr, 2019.

[T3] W. K. Chung, **Minjae Kim**, D. S. Kim, T. Kim, K. J. Cha, "THE MULTI-CHANNEL METAL MICRONEEDLE ARRAY ELECTRODE FOR BIOSIGNAL MEASUREMENT AND THE MANUFACTURING METHOD THEREOF," Registration No. 10-1689769, Dec, 2016.

[T2] W. K. Chung, **Minjae Kim**, D. S. Kim, K. J. Cha, T. Kim, "MANUFACTURING METHOD OF MICRONEEDLES ARRAY PANEL," Registration No. 10-1501283, Mar, 2015.

[T1] S. Choi, **Minjae Kim**, D. Kim, W. K. Chung, J. Lee, E. Cho, Y. Yoon "SYSTEM FOR WARNING FORWARD HEAD POSTURE AND METHOD THEREOF," Registration No. 10-1443666, Sep, 2014.

SKILLS
- Languages: MATLAB, C/C++, Python, Java, Swift
- Operating Systems: Windows, Linux, Android, IOS
- Microprocessors: Atmel AVR, Android, Arduino, Intel Edison, Nordic Semiconductor nRF5, ESPressif Systems ESP32
- Design Tools: 3D CAD (Inventor, SolidWorks, Pro/ENGINEER), circuit design (Eagle PCB, Fusion 360)
- Communication: bluetooth, BLE, tcp/ip, WiFi, SPI, CAN
- Programming libraries: TensorFlow, OpenGL, ARToolKit, OPENCV, QT, MFC, CHAI3D
- Sensors: EMG sensors, stereo vison, IMU, infra-red sensor, load cell, F/T sensor, ultrasonic sensor
- Fabrications: basic MEMS fabrication (spin coating, TMAH etching), polymer molding

ACTIVITIES
- Member of Robotics club (CHIRO), Chung-Ang University (2008 - 2011)
  - Programming of ATmega128 (DC motor, ultrasonic sensor, infra-red sensor) (2008 - 2009)
  - Development of Augmented reality chess game using ARToolKit (2010)
  - Mobile robot navigation using Pioneer (2011)
  - Stereo vision-based object tracking using MATLAB and C++ (with OpenCV) (2011)
- Student mentoring & teaching
  - Research assistant, AR&IOT Input system construction using LSTM machine learning algorithm and sEMG sensor, Best Research Award, Undergraduate Group Research Program, POSTECH (2018)
  - Research assistant, Finger rehabilitation system using surface EMG, R&E Program, Korea Science Academy of KAIST (2017)
  - Teaching assistant, sEMG signal processing lecture and demo, SKP MOOC, Pohang University of Science and Technology (2016)
  - Robotics club seminar on microprocessor, Robotics club, Chung-Ang University (2011)

REFERENCE **Dr. Wan Kyun Chung** (wkchung@postech.ac.kr)
Professor, Dept. of Mechanical Engineering, Pohang University of Science and Technology, Korea

Dr. Keehoon Kim (khk@postech.ac.kr)
Associate Professor, Dept. of Mechanical Engineering, Pohang University of Science and Technology, Korea

Dr. Dong Sung Kim (smkds@postech.ac.kr)

Associate Professor, Dept. of Mechanical Engineering, Pohang University of Science and Technology, Korea

Dr. Levi J. Hargrove (l-hargrove@northwestern.edu)
Associate Professor, Dept. of Physical Medicine and Rehabilitation, Northwestern University, USA
Director, Center for Bionic Medicine, Shirley Ryan AbilityLab, USA