

# Jongsang Son

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## Education

2009.09 – 2014.08 Ph.D. in Biomedical Engineering, Yonsei University Graduate School, Wonju, Gangwon, South Korea  
Entitled: Individual-Based Musculoskeletal Modeling Technology and Its Biomechanical Evaluation  
Advisor: Dr. Youngho Kim

2007.09 – 2009.08 M.S. in Biomedical Engineering, Yonsei University Graduate School, Wonju, Gangwon, South Korea  
Entitled: Real-time Muscle Force Estimation  
Advisor: Dr. Youngho Kim

2004.03 – 2007.08 B.S. in Biomedical Engineering (*summa cum laude*), Yonsei University, Wonju, Gangwon, South Korea  
Entitled: (1) A FES Sensor System for Improving Hemiplegic Gait  
(2) Changes in Muscle Length of Lower Limbs during Hemiplegic Walking Based on the Musculoskeletal Modeling  
Advisor: Dr. Youngho Kim

## Research Experience

2015.06 – present Postdoctoral Fellow, Department of Physical Medicine & Rehabilitation, Northwestern University, Chicago, IL, United States

2015.05 – present Post-Doctoral Fellow Research, Sensory Motor Performance Program, Rehabilitation Institute of Chicago, Chicago, IL, United States

2014.09 – 2015.04 Postdoctoral Researcher, Department of Biomedical Engineering, Yonsei University, Wonju, Gangwon, South Korea

2007.09 – 2014.08 Researcher, Institute of Medical Engineering, Yonsei University, Wonju, Gangwon, South Korea

2007.09 – 2011.08 Research Assistant, Yonsei University Graduate School, Wonju, Gangwon, South Korea

## Teaching Experience

2011.09 – 2015.02 Lecturer, Department of Biomedical Engineering, Yonsei University, Wonju, Gangwon, South Korea  
Junior class: Biomechanics; Rehabilitation Engineering  
Senior class: Motion Analysis; Biotransport Theory

2007.09 – 2011.08 Teaching Assistant, Yonsei University Graduate School, Wonju, Gangwon, South Korea  
Junior class: Biomechanics; Rehabilitation Engineering  
Senior class: Motion Analysis

## Awards and Honors

2013.07 Best Lecturer Award, Yonsei University  
Class: Motion Analysis

2012.01 Best Lecturer Award, Yonsei University  
Class: Biotransport Theory

2009.10	Participation Award, Yonsei University Graduate School Entitled: Real-time Muscle Force Estimation
2009.09	Happy Idea!! Award, Assistive Technology Research & Assistance Center Entitled: Assistant system for joint movements of quadriplegia patients using brain-computer convergence technology
2008.04	Best Presentation Award, Information and Control Symposium Entitled: Development of the robotic gait trainer for persons with gait disorder
2007.09 – 2013.08	Full Scholarship from Brain Korea 21 (BK21), Ministry of Education
2007.06	Best Paper Award, Department of Biomedical Engineering, Yonsei University Entitled: A FES Sensor System for Improving Hemiplegic Gait
2006 – 2007	Award for Excellent Records, Yonsei University
2007.09 – 2013.08	Full Scholarship from Brain Korea 21 (BK21), Ministry of Education
2005.03 – 2007.08	Full Scholarship from New University for Regional Innovation (NURI), Ministry of Education & Human Resources Development

## Technical Skills

- Computer languages
  - Proficient in **MATLAB**, **C#**, C++, C, Java, HTML, **XML**, etc.
  - **Can understand logics** written in the other languages
- Research software
  - Proficient in musculoskeletal modeling software (**SIMM** and **OpenSim**)
  - Proficient in Microsoft Office (**Word**, **PowerPoint** and **Excel**), **SPSS Statistics**, EndNote, etc.
  - Good in LabVIEW, OrCAD, SolidWorks, Adams, ANSYS, COMSOL, etc.
- Research equipment
  - Proficient in motion capture system, **Vicon**, **Optotrak**, etc.
  - Proficient in isokinetic device, **Biodex System 3 Pro**
  - Proficient in electromyography (EMG) measurement system, **Delsys Trigno™ Wireless EMG**, **Noraxon MyoSystem 1200**, etc.
  - Proficient in force plate system, **Kistler 9286AA**, **AMTI OR6-6**, etc.
  - Proficient in pressure measurement system, **Tekscan BPMS™**, **CONFORMat®**, **Grip™**, etc.
  - Good in gas analyzer, CORTEX MetaMax® 3
  - Good in treadmill system, h/p/cosmos® gaitway II
  - Good in material testing system, Instron
- Electronic device design
  - Proficient in microprocessors: **ATMEL ATmega series** and STM32 32-bit ARM Cortex MCUs
  - Proficient in peripheral devices: **accelerometer**, **gyroscope**, **FSR**, **load cell**, **RS-232**, **Bluetooth**, etc.
  - **Can implement electronic devices** for control purpose

## Peer-Reviewed Journal Publications

Under review

35. **Jongsang Son**, Do-Won Kim, Janne M. Hahne, Han-Jeong Hwang, "A Review of Neurorehabilitation based on Neural Engineering Technologies," *BioMed Res. Int.*
34. Yunju Lee, Kai Chen, Yupeng Ren, **Jongsang Son**, Bruce A. Cohen, James A. Sliwa and Li-Qun Zhang, "Robot-guided ankle sensorimotor rehabilitation of patients with multiple sclerosis," *Mult. Scler. Relat. Disord.*
33. Li-Qun Zhang, **Jongsang Son**, Hyung Soon Park, Yupeng Ren, Sang Hoon Kang, Yunju Lee, "Changes of shoulder, elbow and wrist stiffness matrix post stroke," *IEEE Trans. Neural Syst. Rehabil. Eng.*
32. HoeJeong Chung, YeoSeung Yoon, **Jongsang Son**, JiSoo Shin, JunPyo Lee, Youngho Kim, DooSup Kim, "Evaluation of 3-dimensional in vivo Scapular Kinematics and Scapulohumeral Rhythm between Shoulders with a Clavicle Hook Plate and Contralateral Healthy Shoulders," *J. Bone Joint Surg.*
31. DooSup Kim, Hyeunkook Kim, YeoSeung Yoon, Jisoo Shin, Junpyo Lee, **Jongsang Son**, Youngho Kim, HoeJeong Chung, "The Effect of the clavicle hook plate on subacromial pressure in a cadaver model," *Bone Joint J.*

30. Jason L. Koh, Todd A. Zimmerman, Savan Patel, Yupeng Ren, **Jongsang Son**, Li-Qun Zhang, "Tibiofemoral contact mechanics with horizontal cleavage tears and resection of the lateral meniscus in the human knee," *Am. J. Sports Med.*
  29. Myung Jun Lee, **Jongsang Son**, Jae-Hyeok Lee, Sang-Jin Kim, Chul Hyoung Lyoo, Myung-Sik Lee, "Impact of prolonged temporal discrimination threshold on finger movements of Parkinson's disease," *PLoS ONE*.
- 2016
28. Isu Shin, Soonjae Ahn, Eunyoung Choi, Jeseong Ryu, Sunwoo Park, **Jongsang Son**, Youngho Kim, "Fatigue Analysis of the Quadriceps Femoris Muscle Based on Mechanography," *Int. J. Precis. Eng. Manuf.*, Vol. 17, No. 4, pp. 473-478, 2016.
  27. **Jongsang Son**, Jeseong Ryu, Soonjae Ahn, Eun Joo Kim, Jung Ah Lee, Youngho Kim, "Effects of 4-week intensive active-resistive training with an EMG-based exoskeleton robot on muscle strength in older people: A pilot study," *BioMed Res. Int.*, Vol. 2016, No. 2016, 1256958, 2016.
  26. DooSup Kim, HoeJeong Chung, Chang-Ho Yi, Yeo-Seung Yoon, **Jongsang Son**, Youngho Kim, Myoung-Gi On, JaeHyung Yang, "Effect of Glenohumeral Position on Contact Pressure Between the Capsulolabral Complex and the Glenoid in free ALPSA and Bankart Lesions," *Knee Surg. Sports Traumatol. Arthrosc.*, Vol. 24, No. 2, pp. 350-356, 2016.
- 2015
25. Jeseong Ryu, **Jongsang Son**, Soonjae Ahn, Isu Shin, Youngho Kim, "Biomechanical analysis of the circular friction hand massage," *Technol. Health Care*, Vol. 23, No. S2, pp. S529-S534, 2015.
  24. **Jongsang Son**, Youngho Kim, "A Comparison of Four Different Muscle Pennation Models and their Effects on Predictions in Peak Fiber Force and Operating Range of Fiber Length," *Int. J. Precis. Eng. Manuf.*, Vol. 16, No. 6, pp. 1179-1185, 2015.
  23. Isu Shin, **Jongsang Son**, Soonjae Ahn, Jeseong Ryu, Jongman Kim, Baekdong Cha, Eunyoung Choi, Youngho Kim, "A novel short-time Fourier transform-based fall detection algorithm using 3-axis accelerations," *Math. Probl. Eng.*, Vol. 501, 394340, 2015.
  22. Myeonggu Son, Gyudo Lee, **Jongsang Son**, Seungyeop Choi, Youngho Kim, Sei-Young Lee, Young-Ro Yoon, Dae Sung Yoon, Sang Woo Lee, "Characterization of anomalous movements of spherical living cells on a silicon dioxide glassy substrate" *Biomicrofluidics*, Vol. 9, No. 1, 014102, 2015.
- 2014
21. Jungyoon Kim, **Jongsang Son**, Youngho Kim, "Bandwidth optimization for filter-based fatigue index in different inter-electrode distances," *Bio-Med. Mater. Eng.*, Vol. 24, No. 6, pp. 3701-3708, 2014.
  20. **Jongsang Son**, Jeseong Ryu, Jungyoon Kim, Youngho Kim, "Determination of inertial parameters using a dynamometer," *Bio-Med. Mater. Eng.*, Vol. 24, No. 6, pp. 2447-2455, 2014.
  19. Jungyoon Kim, **Jongsang Son**, Youngho Kim, "Consistency of the optimized bandwidth in filter-based fatigue index," *Int. J. Precis. Eng. Manuf.*, Vol. 15, No. 11, pp. 2473-2477, 2014.
  18. **Jongsang Son**, Dongyeop Lee, Youngho Kim, "Effects of involuntary eccentric contraction training by neuromuscular electrical stimulation on the enhancement of muscle strength," *Clin. Biomech.*, Vol. 29, No. 7, pp. 767-772, 2014.
  17. Bora Jeong, Seunghyeon Kim, **Jongsang Son**, Youngho Kim, "Kinetic analysis of the metatarsophalangeal joint in normal subjects, hallux valgus patients during walking using a four-segment foot model," *J. Foot Ankle Res.*, Vol. 7, No. Suppl 1, pp. A125, 2014.
  16. Jeseong Ryu, **Jongsang Son**, Youngkoo Lee, Kyungtai Lee, Youngho Kim, "Biomechanical analysis of operations for chronic ankle instability," *J. Foot Ankle Res.*, Vol. 7, No. Suppl 1, pp. A126, 2014.
  15. **Jongsang Son**, Hoyoon Lee, Jongman Kim, Youngho Kim, "Alternative objective function to predict reasonable muscle forces using a Hill-type muscle model," *J. Foot Ankle Res.*, Vol. 7, No. Suppl 1, pp. A127, 2014.
  14. Bora Jeong, Seunghyeon Kim, **Jongsang Son**, Youngho Kim, "3D Analysis of the Metatarsophalangeal Joint in Normal Group and Hallux Valgus Patients during Walking Using a Four-Segment Foot Model," *Int. J. Precis. Eng. Manuf.*, Vol. 15, No. 2, pp. 299-303, 2014.
- 2013
13. Minhyeon Lee, Jungyoon Kim, **Jongsang Son**, Youngho Kim, "Kinematic and Kinetic Analysis during Forward and Backward Walking," *Gait Posture*, Vol. 38, No. 4, pp. 674-678, 2013.
  12. Seunghyeon Kim, **Jongsang Son**, Changho Yi, Doosup Kim, Youngho Kim, "Pennation Angles of Ankle Dorsiflexor and Plantarflexors Depending on Muscle Contraction Intensity," *Int. J. Precis. Eng. Manuf.*, Vol. 14, No. 5, pp. 1-4, 2013.
  11. Seonhong Hwang, Seunghyeon Kim, **Jongsang Son**, Youngho Kim, "Upper Limb Joint Motion of Two Different User Groups during Manual Wheelchair Propulsion," *J. Korean Phys. Soc.*, Vol. 62, No. 4, pp. 648-656, 2013.

2012

10. Sunwoo Park, Kihong Ryu, Jungyoon Kim, **Jongsang Son**, Youngho Kim, "Verification of accuracy and validity of gait phase detection system using motion sensors for applying walking assistive FES," *Comput. Method. Biomec.*, Vol. 15, No. 11, pp. 1129-1135, 2012.
  9. **Jongsang Son**, A Ra Ko, Young Hee Lee, Youngho Kim, "A Computer-based Finger-tapping System for Evaluating Movement of the Affected Hand Following Stroke: A Pilot Study," *Int. J. Precis. Eng. Manuf.*, Vol. 13, No. 11, pp. 2083-2086, 2012.
  8. In Soo Park, Kilho Eom, **Jongsang Son**, Woo-Jin Chang, Kidong Park, Taeyun Kwon, Dae Sung Yoon, Rashid Bashir, Sang Woo Lee, "Microfluidic Multifunctional Probe Array Dielectrophoretic Force Spectroscopy with Wide Loading Rates," *ACS Nano*, Vol. 6, No. 10, pp. 8665-8673, 2012.
  7. Youngho Kim, Seunghyeon Kim, **Jongsang Son**, Bora Jung, "Kinetic role of the metatarsophalangeal joint in normal walking: Joint moment and power," *Int. J. Precis. Eng. Manuf.*, Vol. 13, No. 8, pp. 1481-1485, 2012.
  6. Seonhong Hwang, Seunghyeon Kim, **Jongsang Son**, Youngho Kim, "Torque and Power Outputs on Different Subjects during Manual Wheelchair Propulsion under Different Conditions," *J. Kor. Phys. Soc.*, Vol. 60, No. 3, pp. 540-543, 2012.
  5. **Jongsang Son**, Sungjae Hwang, Youngho Kim, "A hybrid static optimisation method to estimate muscle forces during muscle co-activation," *Comput. Method. Biomec.*, Vol. 15, No. 3, pp. 249-254, 2012.
  4. **Jongsang Son**, Seunghyeon Kim, Soonjae Ahn, Jeseong Ryu, Seonhong Hwang, Youngho Kim, "Determination of the dynamic knee joint range of motion during leg extension exercise using an EMG-driven model," *Int. J. Precis. Eng. Manuf.*, Vol. 13, No. 1, pp. 117-123, 2012.
- Before 2011 (during coursework)
3. **Jongsang Son**, Sungjae Hwang, Youngho Kim, "An EMG-based muscle force monitoring system," *J. Mech. Sci. Technol.*, Vol. 24, No. 10, pp. 2099-2105, 2010.
  2. Gyudo Lee, Huihun Jung, **Jongsang Son**, Kihwan Nam, Taeyun Kwon, Geunbae Lim, Young Ho Kim, Jongbum Seo, Sang Woo Lee, Dae Sung Yoon, "Experimental and numerical study of electrochemical nanomachining using an AFM cantilever tip," *Nanotechnology*, Vol. 21, No. 18, 185301, 2010.
  1. Sungjae Hwang, Kisik Tae, Ryanghee Sohn, Jungyoon Kim, **Jongsang Son**, Youngho Kim, "The Balance Recovery Mechanisms Against Unexpected Forward Perturbation," *Ann. Biomed. Eng.*, Vol. 37, No. 8, pp. 1629-1637, 2009.

#### Peer-Reviewed Journal Publications (in Korean)

14. **Jongsang Son**, Youngho Kim, "Methods for Measurement of Moment of Segmental Inertia Using a Dynamometer," *J. Biomed. Eng. Res.*, Vol. 34, No. 3, pp. 156-162, 2013.
13. Seonhong Hwang, Seunghyeon Kim, **Jongsang Son**, Youngho Kim, "Manual Wheelchair Propulsion Torque and Power Outputs in Different Skill Groups," *J. Biomech. Sci. Eng.*, Vol. 7, No. 4, pp. 349-357, 2012.
12. Jung-joo Lee, **Jongsang Son**, Jungyoon Kim, Young Ho Kim, "Lower extremity stiffness over different landing methods during hopping," *J. Biomed. Eng. Res.*, Vol. 32, No. 2, pp. 105-108, 2011.
11. Seonhong Hwang, Sunwoo Park, **Jongsang Son**, Jeong Mee Park, Sung Joo Kwon, Ik Sun Choi, Young Ho Kim, "Gait Analysis of a Pediatric-Patient with Femoral Nerve Injury : A Case Study," *J. Biomed. Eng. Res.*, Vol. 32, No. 2, pp. 165-176, 2011.
10. Min Hyeon Lee, **Jongsang Son**, Jungyoon Kim, Young Ho Kim, "EMG-feedback Exoskeleton System for Active-assistive Rehabilitation Exercise to Hemiplegic Patients," *J. Biomed. Eng. Res.*, Vol. 32, No. 1, pp. 1-6, 2011.
9. Young Ho Kim, Jeseong Ryu, **Jongsang Son**, Seonhong Hwang, Ryanghee Sohn, Inhyuk Cha, Jaehoon Song, Sungjae Song, "Analysis of Motion and Pressure for Circular Friction Massage," *J. Biomed. Eng. Res.*, Vol. 31, No. 6, pp. 487-493, 2010.
8. Ryanghee Sohn, **Jongsang Son**, Hanjeong Hwang, Chang-Hwan Im, Young Ho Kim, "Steady-State Visual Evoked Potential (SSVEP)-based Rehabilitation Training System with Functional Electrical Stimulation," *J. Biomed. Eng. Res.*, Vol. 31, No. 5, pp. 359-364, 2010.
7. **Jongsang Son**, Sungjae Hwang, Jinsub Lee, Youngho Kim, "Development and evaluation of estimation model of ankle joint moment from optimization of muscle parameters," *J. Biomed. Eng. Res.*, Vol. 31, No. 4, pp. 310-315, 2010.
6. Hyun Dong Kim, Sungjae Hwang, **Jongsang Son**, Han Sung Kim, Young Ho Kim, "Analysis of Activation and Contribution of Muscles of the Elderly during Arm Flexion and Extension Resistance Exercise with Increased Load," *J. Ergonomics Soc. Kor.*, Vol. 28, No. 4, pp. 17-23, 2009.

5. Ryanghee Sohn, Hueseok Choi, **Jongsang Son**, Sungjae Hwang, Youngho Kim, "The Comparison of Overground Walking and Treadmill Walking According to the Walking Speed: Motion Analysis and Energy Consumption," *J. Biomed. Eng. Res.*, Vol. 30, No. 3, pp. 226-232, 2009.
4. **Jongsang Son**, Youngho Kim, "An algorithm for estimating muscle force using joint angle," *J. Biomed. Eng. Res.*, Vol. 30, No. 3, pp. 241-246, 2009.
3. **Jongsang Son**, Ryanghee Sohn, Youngho Kim, "A hybrid static optimization for estimating muscle forces during heel-rise movements," *J. Kor. Soc. Prec. Eng.*, Vol. 26, No. 3, pp. 129-136, 2009.
2. Sungjae Hwang, **Jongsang Son**, Jungyoon Kim, Hyundong Kim, Dohyung Lim, Youngho Kim, "Analysis of joint movements and changes of muscle length during STS(sit-to-stand) at various sitting heights in the Korean elderly's daily life," *J. Biomed. Eng. Res.*, Vol. 29, No. 6, pp. 484-492, 2008.
1. **Jongsang Son**, Hueseok Choi, Sungjae Hwang, Youngho Kim, "Changes of Muscle Length, Roll-Over Characteristics During High-heel Walking," *J. Kor. Soc. Prec. Eng.*, Vol. 24, No. 12, pp. 29-35, 2007.

### Invited Talks

5. (Feb. 16, 2016) "**A novel upper arm robot for diagnosis, therapy, outcome evaluation in stroke rehabilitation.**" Department of Biomedical Engineering, Yonsei University, Wonju, South Korea.
4. (Feb. 12, 2016) "**A quantitative cadaveric study with an assistance of robotic devices.**" Department of Orthopaedic Surgery, Wonju Severance Christian Hospital, Yonsei University, Wonju, South Korea.
3. (Jan. 15, 2015) "**Introduction to Electromyography.**" Department of Orthopaedic Surgery, Wonju Severance Christian Hospital, Yonsei University, Wonju, South Korea.
2. (Dec. 6, 2014) "**Biomechanical approaches to analyze foot-related diseases.**" 6<sup>th</sup> Korean Academy of Foot & Ankle Medicine Conference, The Catholic University of Korea Seoul St. Mary's Hospital, Seoul, South Korea.
1. (Apr. 22, 2011) "**Introduction of muscle force calculation using a muscle model, and optimization technique to determine subject-specific model parameters.**" 9<sup>th</sup> User Meeting, VICON Motion Systems KOREA, Kyobo Tower, Seoul, South Korea.

### Patents

11. Youngho Kim, Jungyoon Kim, **Jongsang Son**, Isu Shin, Jeseong Ryu, Soonjae Ahn, Sunwoo Park, "System for sensing electromyogram and motion, controlling method thereof," 10-2014-0030083 (application).
10. Youngho Kim, Jungyoon Kim, **Jongsang Son**, Jeseong Ryu, "Spine posture evaluation system and method for generating evaluation data," 10-2013-0154987 (application).
9. Youngho Kim, **Jongsang Son**, Dongyeop Lee, Jeseong Ryu, "Efferent contraction training device and training method using the same," 10-2013-0081061 (application).
8. Youngho Kim, **Jongsang Son**, Jeseong Ryu, Seunghyeon Kim, "Calibration apparatus for wheelchair dynamometer, wheelchair dynamometer having the same and method of calibrating wheelchair dynamometer using the same," 10-2013-0031074 (application), PCT/KR2013/011352 (application).
7. Youngho Kim, **Jongsang Son**, Jeseong Ryu, Seunghyeon Kim, "Wheelchair dynamometer," 10-2013-002842 (application), PCT/KR2013/003707 (application).
6. Youngho Kim, Sungjae Hwang, **Jongsang Son**, Jungyoon Kim, Sunwoo Park, Jeseong Ryu, Minhyeon Lee, "System and method of robotic gait training," 10-1384988 (registration), PCT/KR2012/002678 (application).
5. Youngho Kim, Min Hyeon Lee, **Jongsang Son**, Jungyoon Kim, "EMG-feedback active training system for rehabilitation exercise", 10-1317817 (registration).
4. Sang Woo Lee, **Jongsang Son**, Insoo Park, "Measurement method of biomolecule binding force by dielectrophoretic technique using poisson statistical analysis method and thereof system," 10-1380716 (registration).
3. Youngho Kim, Ryanghee Sohn, **Jongsang Son**, Chang-Hwan Im, Han-Jeong Hwang, "Rehabilitation training system with functional electrical stimulation based on steady-state visually evoked potentials," 10-1229244 (registration).
2. Youngho Kim, Sunwoo Park, Seonhong Hwang, **Jongsang Son**, Ki-Hong Ryu, "Medical electrode pad and walking assistive equipment using the same," 10-1164779 (registration).
1. Youngho Kim, **Jongsang Son**, Sungjae Hwang, Hueseok Choi, Seonhong Hwang, Sunwoo Park, Jungyoon Kim, Ryanghee Sohn, "An algorithm and system for estimating muscle force using joint angles in real-time," 10-1114138 (registration).

### **Academic social activities**

- Guest editor
  - Open Special Issue in BioMed Research International
- Reviewer
  - Journal of NeuroEngineering and Rehabilitation
  - Journal of Medical and Biological Engineering
  - Biomedical Engineering/Biomedizinische Technik