Minsung Kim

CURRENT
AFFILIATION

Ph.D. candidate (2021.08), Dynamic Robotic System Lab (DYROS Lab, http://dyros.snu.ac.kr/), Dept of Trandisciplinary Studies, Seoul National University

CONTACT
INFORMATION

Address:
Seoul: 2nd floor, 18-dong, Gwanak-ro 1, Gwanak-gu, Seoul, Republic of Korea, (08826)
Suwon: Building D, Room 312 864-1 Iui-dong, Yeongtong-gu Suwon-si, Gyeonggi-do, South Korea 443-270
E-mail: minsungkim@snu.ac.kr
Phone: +82-10-2846-6982
For my projects: https://westsidems.github.io/
For source codes: https://github.com/WestsideMS

EDUCATION

Seoul National University, Seoul, Korea   **2011.3 - 2021.8**
   Ph.D. of Dept of Trandisciplinary Studies (Robotics)
   - Lab: Dynamic Robotic System Lab (DYROS Lab, https://dyros.snu.ac.kr)
   - Advisor: Professor Jaeheung Park (park73@snu.ac.kr)

Chung-Ang University, Seoul, Korea   **2003.3 - 2010.2**
   B.A., Electrical and Electronics Engineering, March, 2010

RESEARCH
EXPERIENCE

Advanced Institute of Convergence Technology (AICT), Korea   **2010.7 - 2011.02**
   Internship
   - Lab: Dynamic Robotic System Lab (DYROS Lab,https://dyros.snu.ac.kr)
   - Advisor: Professor Jaeheung Park (park73@snu.ac.kr), Junghoon Kwon (Ph.D., AICT)

RESEARCH
INTERESTS

Path planning and Path tracking control of an Autonomous Vehicle using Optimal Control method (Model Predictive Control, etc.)
Sampling and Search Method based Motion Planning of a Nonholonomic Mobile Robot
Decision Making using Model Predictive Control scheme
Deep Learning method for Parking Lot Detection (YOLO v3, etc.) and Drivable Area Detection (VGG net)
Machine Learning for Human Gait Recognition
Manipulation of Industrial Robot (6-DOF)

RESEARCH
EXPERIENCE

During visiting researcher in Gepetto Team, LAAS-CNRS, France

Whole-body Planning for Humanoid   **2018 - Presence**
   - (Ongoing Work) Generating contact sequence, CoM trajectory, feet trajectories, and whole-body trajectory for legged robots.
      ✓ Video: https://youtu.be/JpwigzMQg6E
   - Implementation of CoM trajectory generator based on *Time Optimization*.
   - Implementation of feet trajectories using the concept of hyper-plane.
   - Implementation of Quadratic Programming (QP)-based whole-body planner in C++ and Python:
      ✓ Video: https://youtu.be/nHiLV89cMG8
      ✓ Codes: https://github.com/ggory15/tsid_python_binding

Model Predictive Control for Humanoid   **2018 - Presence**

- (Ongoing Work) Developing whole-body controller using Differential Dynamic Programming (DDP).
- (Ongoing Work) Implementation of DDP-based controller with the collision avoidance constraint.
  - ✓ (Preliminary) Video : https://youtu.be/rq3dXdt8t0E

During Ph.D. student

Multiple Task Execution Algorithm   2017 - 2020
- Dynamic task transition algorithm to generate complex behavior.
- Continuous transitions between arbitrary tasks using the activation parameter [J5].
  - ✓ Insertion and removal both equality and inequality tasks without discontinuity of the control input.
  - ✓ Development of avoidance tasks including joint-limit, singularity, and obstacle.
  - ✓ Video : https://youtu.be/-lfnLhmSk3M
  - ✓ Codes: https://ggory15.github.io/tasktransition-project
- (Ongoing Work) Applying the task transition method to operate mobile-based humanoid
  - ✓ Development controller for archiving complex tasks [C8]
  - ✓ Self-collision avoidance algorithm using the concept of attractive force [O1]
  - ✓ Video : https://youtu.be/K8RnMAA0rg4
- (Ongoing Work) Multi-contact transition for humanoids using Gravito-Inertial Wrench Cone (GIWC)

Whole-body Control of Torque-controlled Humanoids   2014 - Presence
- Design and development of torque-controlled humanoid, DYROS-Red [C2].
  - ✓ EtherCAT and RTX programming for real-time control
  - ✓ High-level controller: Whole-body controller
  - ✓ Low-level controller: Elmo motion controller
  - ✓ Video : https://youtu.be/01E-rKixNfE
- Implementation of whole-body controllers for torque-controlled humanoids.
  - ✓ Using operational-space controller [C2]
  - ✓ Using hierarchical QP-based controller [J4, J6]
  - ✓ Using DDP-based controller
- (Ongoing Work) Development contact force generator with multi-constraints for dynamic balance.

Control of Position-controlled Humanoids   2014 - 2018
- Design and development of position-controlled humanoid, DYROS-Jet [J2, J4].
  - ✓ RS-232 communication with 200 Hz
  - ✓ High-level controller: Jacobian-based controller
  - ✓ Low-level controller: Robotis controller
  - ✓ Video : https://youtu.be/9UwJQREUjtc
- Implementation of inverse kinematics controllers for position-controlled humanoids
  - ✓ using Jacobian-based inverse kinematics controller [J2, J4, C3, W2]
  - ✓ using Forward And Backward Reaching Inverse Kinematics (FABRIK) [C7]
  - ✓ using Recursive Neural Network (RNN) [C5]
- Disturbance observer to enhance balancing performance [C6]
  - ✓ Feed-forward joint disturbance observer for compliant motion
  - ✓ Video: https://youtu.be/LHGxx0M9ijs

Singularity avoidance algorithm   2016 - 2017
- Comparative analysis of six representative singularity avoidance algorithms:
  Damped Pseudo Inverse, Error Damped Pseudo Inverse, Jacobian Transpose, Selectively Damped Inverse, Filtered Inverse, and Task Transition Method

Development of humanoid system for DRC Finals 2015   2014 - 2016
- Student leader of Team SNU

✓ Managing the whole framework of robot
　　　✓ Developing the upper-body and lower-body position controller
- No falling down during the competitions and 12th in DRC Finals 2015 [J2, J4, C3, W2]
　　　✓ Video: https://youtu.be/aWpyfKkbzf0

Artificial intelligence robot CPR system   2014 - 2016
- Robot manipulator to perform CPR in emergency situations [P2, J3]
- Automatic System based biological data from a patient
- Simulation on mannequin and animal test
　　　✓ Video: https://youtu.be/D9saZERvzf8

Robot hand tele-operation control   2012 - 2014
- Robot hand synergy mapping using multi-factor model [P1, J1, W1]
- Extracting synergy by considering individual characteristic as well as grasping motion
　　　✓ Video: https://youtu.be/QzGgV9KHaZI
- Grasping Force Estimation using sEMG signals [J5]

Tele-opeartion control of ultrasonic examination system   2012 - 2013
- Tele-operated robotic arm for remote ultra-sound exam
- Automated orientation control for ultrasound
- Contact force feedback using haptic device
　　　✓ Video: https://youtu.be/_OSkL5e70fI

During internship in GIST, Korea

Friction and Gravity Compensator for Surgery Simulator   2010.6 - 2010.9
- Research and development on the Laparoscopic simulator
- Haptic Feedback using friction and gravity compensator [C1]

TECHNICAL SKILLS **Hardware Experience**
Intelligent Vehicle, Mobile Platform
- Hyundai Grandeur HG 240, *DYROS-Spirit1*
- Wheeled Mobile Robot, *TETRA-DS*

Manipulator
- 6-DoF arm, *Roman-3D*
- 6-DoF arm, *Hyundai HA020*

Software Experience
Programming Skills
- Intermediate C++, Python, and Matlab programming for robotics (Windows, Ubuntu 16.04)
- Carsim: Comparison of Path-following algorithms, Autonomous Parking (Perpendicular, Parallel and Angle Parking, Highway navigation, Collision avoidance)
- ROS (Robot Operating System), V-Rep, CARLA, Gazebo,

Libraries
- Math - Eigen, Lapack, MKL
- Optimization - CVXGEN, Gurobi, qpOASES, IFOPT and IPOPT

HONORS AND   **Best thesis award** from Seoul National University, 2020.
AWARDS   **Best conference paper award** in IEEE/ASME International Conference on Advanced Robotics and Mechatronics, 2019.
Korean government grant for Visiting Scholar of LAAS-CNRS, 2018.
Best paper award in Journal of Korea Robotics Society (JKROS), 2018.
Cum laude from Dept. of Mechanical Engineering at Seoul National University, 2012.

INTERNATIONAL JOURNAL ARTICLES

[J6] S. Hong, K. Jang, **S. Kim**, and J. Park. Regularized Hierarchical Quadratic Program for Real-Time Whole-Body Motion Generation , IEEE/ASME Transactions on Mechatronics, 2020. 10 (Early Access)

[J5] **S. Kim**, M. Kim, J. Kim, S, Kim, and J. Park. Grasping Force Prediction by EMG Signals and Arm Posture: Tensor Decomposition Based Approach, Journal of Bionic Engineering, Vol. 16, No. 3, pp. 455-467, 2019.05

[J4] **S. Kim**, K. Jang, S. Park, Y. Lee, S. Y. Lee, and J. Park, Continuous Task Transition Approach for Robot Controller based on Hierarchical Quadratic Programming, IEEE Robotics and Automation Letters (with International Conference on Robotics and Automation 2019), Vol. 4, No. 2, pp. 1603-1610, 2019.05

[J3] **S. Kim**, M. Kim, J. Lee, S. Hwang, J. Chae, B. Park, H. Cho, J. Sim, J. Jung, H. Lee, S. Shin, M. Kim, W. Choi, Y. Lee, S. Park, J. Oh, Y. Lee, S. Lee, M. Lee, S. Yi, K. Chang, N. Kwak, and J. Park. Team SNU's Control Strategies to Enhancing Robot's Capability: Lessons from the DARPA Robotics Challenge Finals 2015, The DARPA Robotics Challenge Finals: Humanoid Robots to the Rescue, Springer, pp. 347-379, 2018.04

[J2] **S. Kim**, M. Kim, J. Lee, S. Hwang, J. Chae, B. Park, H. Cho, J. Sim, J. Jung, H. Lee, S. Shin, M. Kim, W. Choi, Y. Lee, S. Park, J. Oh, Y. Lee, S. Lee, M. Lee, S. Yi, K. Chang, N. Kwak, and J. Park. Team SNU's Control Strategies to Enhancing Robot's Capability: Lessons from the 2015 DARPA Robotics Challenge Finals. Journal of Field Robotics, Vol. 34, No. 2, pp. 359-380, 2017.03

[J1] **S. Kim**, M. Kim, J. Lee, and J. Park. Robot Hand Synergy Mapping Using Multi-factor Model and EMG signal. (with International Symposium on Experimental Robotics 2014), Springer, pp.671-683, 2015.11

INTERNATIONAL CONFERENCE ARTICLES

[C8] **S. Kim**, K. Jang, S. Park, Y. Lee, S. Y. Lee, and J. Park, Whole-body Control of Non-holonomic Mobile Manipulator Based on Hierarchical Quadratic Programming and Continuous Task Transition. IEEE International Conference on Advanced Robotics and Mechatronics (ARM), Osaka, Japan, 2019, **Best Conference Paper Award**

[C7] **S. Kim**, J. Kim, and J. Park. Real-time Inverse Kinematics Technique for Controlling Humanoid Avatar with Redundant Arm, Ubiquitous Robot 2018, Hawaii, USA, 2018.

[C6] M. Kim, J. Kim, **S. Kim**, J. Sim, and J. Park. Disturbance Observer based Linear Feedback Controller for Compliant Motion of Humanoid Robot, International Conference on Robotics and Automation (ICRA), Australia, 2018.

[C5] M. Kim, **S. Kim**, and J. Park. Human Motion Imitation for Humanoid by Recurrent Neural Network. The 13th International Conference on Ubiquitous Robots and Ambient Intelligence, Xian, China, 19-22 Aug, 2017.

[C4] J. Jung, J. Kim, **S. Kim**, W. Kwon, S. Na, K. Kim, J. Lee, G. Suh, and J. Park. Application of Robot Manipulator for Cardiopulmonary Resuscitation, International Symposium on Experimental Robotics 2016, Springer, pp. 266-274, 2017.03

[C3] **S. Kim**, M. Kim, J. Lee, S. Hwang, J. Chae, B. Park, H. Cho, J. Sim, J. Jung, H. Lee, S. Shin, M. Kim, N. Kwak, Y. Lee, S. Lee, M. Lee, S. Yi, K. K.C. Chang, and J. Park. Approach of Team SNU to the DARPA Robotics Challenge Finals. 2015 IEEE-RAS International Conference on Humanoid Robots, Seoul, Korea, 3-5 Nov 2015.

[C2] M. Schwartz, S. Hwang, Y. Lee, J. Won, **S. Kim**, and J. Park. Aesthetic Design and Devel-

opment of Humanoid Legged Robot. The 2014 IEEE-RAS International Conference on Humanoid Robots, Madrid, Spain, 18-20 Nov 2014.

[C1] **S. Kim**, C. Lee, and J. Ryu. Data-driven Haptic Rendering of Friction between Surgical Device and Trocar for Laparoscopic Surgery Simulator, ACCAS 2010, Busan, Korea, 2010.

DOMESTIC
JOURNAL ARTICLES

[DJ6] K. Jang, **S. Kim**, S. Park, and J. Park. Unified Framework for Overcoming Motion Constraints of Robots Using Task Transition Algorithm, Journal of Korea Robotics Society, Vol. 13, No. 2, 2018.

[DJ5] J. Kim, **S. Kim**, and J. Park. The Trends of HRI: Focusing on Task Oriented Robot User Interface, Robot and Human, Vol. 14, No. 4, 2017.

[DJ4] **S. Kim** and J. Park. Singularity Avoidance Algorithms for Controlling Robot Manipulator: A Comparative Study, Journal of Korea Robotics Society, Vol. 12, No. 1, 2017. **Best Paper Award**

[DJ3] S. Shin, M. Kim, J. Ahn, **S. Kim**, and J. Park. Development of Tele-operation Interface and Stable Navigation Strategy for Humanoid Robot Driving, Journal of Institute of Control, Robotics and Systems, Vol. 22, No. 11, 2016.

[DJ2] **S. Kim**, B. Park, and J. Park. DRC Finals 2015 – Analysis of Participants, Robot and Human, Vol. 12, No. 4, 2015.

[DJ1] **S. Kim**, C. Lee, J. Kim, and J. Ryu. Approximate Friction and Gravity Compensation in Haptic Laparoscopic Surgery Simulator, Transactions of the KSME, Vol. 35, No. 8, 2010.

DOMESTIC
CONFERENCE
ARTICLES

[DC9] S. Park, K. Jang, S. Kim, **S. Kim**, and J. Park. nverse Kinematics Minimizing JointsTorque with Given Target Wrench, The 15th Korea Robotics Society Annual Conference (KROC), Korea, 2020.

[DC8] S. Y. Lee, S. Park, K. Jang, **S. Kim**, S. Kim, and J. Park. A Comparative Study of Tracking Control with Closed Loop Inverse Kinematics Algorithm, The 14th Korea Robotics Society Annual Conference (KROC), Korea, 2019.

[DC7] J. Jang, **S. Kim**, S. Park, S. Y. Lee, and J. Park Self-collision Avoidance Algorithm for Robot Manipulator using Continuous Task Transition Algorithm, The 14th Korea Robotics Society Annual Conference (KROC), Korea, 2019.

[DC6] K. Jang, **S. Kim**, S. Park, and J. Park, Joint Limit Avoidance of Non-holonomic Mobile Manipulator using Weighting Matrix in Generalized Pseudo-Inverse, Conference on Korean Society for Precision Engineering, Korea, 2017.

[DC5] M. Kim, R. Destenay, **S. Kim**, J. Kwon, K. Yeom, J. Park, and B. You. Avatar Motion Generation by Null-Space Mapping Based on Minimum Number of Markers. 2015 Conference on Information and Control Systems, Sokcho, Korea, 2015.

[DC4] **S. Kim**, M. Kim, and J. Park. Extracting Postural Synergies Using Grasping Taxonomy, The 9th Korea Robotics Society Annual Conference (KROC), Korea, 2014.

[DC3] J. Lee, M. Kim, **S. Kim**, and J. Park. Estimation of Hand Posture and Grasping Force Using Surface EMG, The 9th Korea Robotics Society Annual Conference (KROC), Korea, 2014.

[DC2] **S. Kim**, C. Lee, J. Kim, and J. Ryu. Friction and Gravity Compensation in Haptic Laparoscopic Surgery Simulator, Conference on Korean Society of Mechanical Engineers (KSME), Korea,

2010.

[DC1] **S. Kim**, C. Lee, J. Kim, and J. Ryu. Trocar Friction modelling for Friction and gravity Compensation, Conference on Korean Society of Mechanical Engineers (KSME), Korea, 2010.

WORKSHOPS   [W2] **S. Kim** and J. Park. Control Strategies of Team SNU for DRC Finals, and Future Directions for Robots in Human Environment. Invited speaker at Workshop on "What did we do for the DARPA Robotics Challenge?, 2015 IEEE-RAS International Conference on Humanoid Robots, Seoul, Korea, 3-5 Nov 2015.

[W1] **S. Kim**, J. Lee, M. Kim, and J. Park. Teleoperated Robot Hand Control using Tensor Decomposition. Full-day Tutorial on Robotics-based Methods for the Identification, Recognition, and Synthesis of Human Motions, IEEE/RSJ International Conference on Intelligent Robots and Systems, Tokyo, Japan, 3 Nov 2013.

ONGOING PAPERS   [O1] Y. Lee, **S. Kim**, J. Park, N. Tsagarakis, and J. Lee, EOS-WBC: Enhanced Operational-space Based Whole Body Control Framework under Inequality Constraints, Roboics and Autonomous Systems, under review, 2020.

[O2] S. Hong, K. Jang, **S. Kim**, J. Park, Regularized Hierarchical Quadratic Program for Real-Time Whole Body Motion Generation, Transaction on Mechatronics, minor revision, 2020.

ACADEMIC
SERVICES

Reviewer for IEEE Robotics and Automation Letters (RAL), 2015.
Reviewer for IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2018.
Reviewer for IEEE International Conference on Ubiquitous Robots (UR), 2018.
Reviewer for IEEE International Conference on Robotics and Automation (ICRA), 2019.
Reviewer for IEEE Robotics and Automation Letters (RAL), 2019.
Reviewer for IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2020.