Donghoon Baek

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Education

University of Illinois at Urbana-Champaign **Aug 2021 – June 2025**
Ph.D., Mechanical Science and Engineering (Advisor: Prof. Joao Ramos) *Urbana, IL, United States*

Korea Advanced Institute of Science and Technology (KAIST) **Sep 2017 – Jun 2019**
M.S., Robotics (Advisor: Prof. Dong-Soo Kwon) *Daejeon, Republic of Korea*

University of Kwangwoon **Feb 2011 – Feb 2017**
B.S., Robotics (Advisors: Prof. Whang Cho and Prof. Juhoon Baek) *Seoul, Republic of Korea*

Areas of Expertise & Research Interests

Whole-body Humanoid Control and Teleoperation (Model-based and Learning-based), System Identification and State Estimation, Embodied AI and Sim-to-Real Transfer, Reinforcement Learning and Imitation Learning, Optimization and Motion Planning, Computer Vision and Perception, Medical Robot Control and Design

Work Experience

Georgia Institute of Technology **July 2025 – Current**
Postdoctoral Researcher (Advisor: Prof. Sehoon Ha) *Atlanta, GA, United States*

- Developed an online policy-switching framework for whole-body humanoid control that unifies agile coupled policies and robust decoupled policies, enabling reliable long-horizon execution of diverse, dynamic tasks.
- Introduced a representation and decision-making framework combining vector-quantized latent models (VQ-VAE) with hierarchical reinforcement learning guided by offline sliding-horizon option evaluation, significantly improving sample efficiency and switching stability.
- Demonstrated one-shot sim-to-real transfer by deploying the framework on a Unitree G1 humanoid, achieving consistent performance gains over state-of-the-art methods (GMT, FALCON, SONIC, TWIST) in both simulation and hardware.
- Developed an end-to-end humanoid loco-manipulation system integrating state estimation, LiDAR/camera-based localization, and reinforcement learning with domain randomization, enabling zero-shot transfer for autonomous navigation and object manipulation tasks.
- Designed reinforcement learning-based loco-manipulation policies for quadruped-manipulator systems, incorporating adversarial training and sim-to-real deployment pipelines for robust physical interaction (e.g., cart pushing).
- Proposed a quantitative performance index for humanoid control and validated it through interactive evaluation, establishing a novel benchmark for assessing whole-body coordination.

RoboDesign Lab **Aug 2021 – Aug 2025**
Research Assistant (Advisor: Prof. Joao Ramos) *UIUC, United States*

- Developed fast online state estimation algorithms for 3D object inertial parameter identification, integrating EKF, unconstrained optimization, and decentralized cross-entropy methods (CEM), with successful sim-to-real validation.
- Proposed an end-to-end learning-based framework for object physical property identification, enabling efficient integration with whole-body humanoid control and demonstrating improved manipulation performance.
- Designed a mobile manipulation controller using robust control barrier functions (CBFs) and optimization-based methods, in collaboration with UC Berkeley, enabling safe and constraint-aware interaction.
- Developed a hybrid control framework combining model-based control (LQR) and ensemble reinforcement learning for wheeled humanoid systems (SATYRR), improving robustness under model uncertainty.
- Built a whole-body bilateral shared control framework for teleoperation with full-body haptic feedback, validated through extensive user studies and quantitative evaluation.
- Established sim-to-real transfer pipelines for learning-based controllers and deployed them on physical robotic systems.
- Integrated hardware systems for wheeled humanoid platforms, including custom experimental setups for manipulation and mobility tasks.
- Utilized high-fidelity rigid-body simulators (MuJoCo, Isaac Gym, RaiSim) for large-scale data generation, control design, and policy validation.

ROEN Surgical Inc. **Sep 2020 – Jun 2021**
Machine Learning and Control Engineer *Daejeon, Republic of Korea*

- Developed vision-based perception and control pipelines for surgical robotics, including GAN-based instrument segmentation (CycleGAN) and visual servoing-based feedforward control with Kalman filtering.

- Designed a perception-driven surgical tool pose estimation algorithm using Siamese neural networks, enabling robust tracking under occlusions and visual uncertainty.
- Developed a full-stack software framework for flexible surgical robots, including control, system architecture, communication, and GUI (C++, Python, ROS, EtherCAT, Qt, OpenGL, multi-threading).
- Implemented parameter optimization algorithms (PSO, genetic algorithms, SciPy-based methods) for control tuning and system calibration.
- Improved surgical robot control performance for ureteroscopy via real-time smooth trajectory planning and teleoperation-aware control strategies.
- Contributed to optimization-based port placement planning for laparoscopic surgical robots using simulation tools (MATLAB, Simscape).
- Designed and fabricated a flexible surgical robot testbed with wire-driven actuation, addressing tension control and hardware constraints (SolidWorks).

MosQ Inc. **Mar 2020 – Aug 2020**
Robotics Engineer *Seoul, Republic of Korea*

- Designed an automated intravenous blood collection robotic system (SolidWorks).
- Developed control software architecture including GUI, multi-threading, and motor control modules.

ROEN Surgical Inc. **Sep 2019 – Feb 2020**
Research Intern *Daejeon, Republic of Korea*

- Developed control software for flexible surgical robots (C++, Python, ROS, OpenGL).
- Improved control performance using vision-based hysteresis reduction algorithms.

Republic of Korea Army **Oct 2011 – Jul 2013**
Tactical Assistant *Yeong-Cheon, Republic of Korea*

Journal Publications

Whole-Body Bilateral Teleoperation with Multi-Stage Object Parameter Estimation for Wheeled Humanoid Locomanipulation, **D. Baek**, A. Purushottam, J. J. Choi, J. Ramos. *Under Review (IEEE Transactions on Robotics)*, 2025.

AdaptManip: Learning Adaptive Whole-Body Object Lifting and Delivery with Online Recurrent State Estimation, M. Byrd, **D. Baek**, K. Garg, H. Jung, D. Cho, M. Sorokin, R. Wright, S. Ha. *Under Review (IEEE Robotics and Automation Letters)*, 2026.

Online Learning-Based Inertial Parameter Identification of Unknown Object for Model-Based Control of Wheeled Humanoids, **D. Baek**, B. Peng, S. Gupta, J. Ramos. *IEEE Robotics and Automation Letters (RA-L)*, Accepted, 2024.

A Study of Shared-Control with Bilateral Feedback for Obstacle Avoidance in Whole-body Telelocomotion of a Wheeled Humanoid, **D. Baek**, J. Chang, J. Ramos. *IEEE Robotics and Automation Letters (RA-L)*, 2023.

ViO-Com: Feed-forward Compensation Using Vision-Based Optimization for High-Precision Surgical Manipulation, **D. Baek**, Y.-H. Nho, D.-S. Kwon. *IEEE Robotics and Automation Letters (RA-L)*, vol. 7, no. 1, pp. 263–270, 2022.

Hysteresis Compensator With Learning-Based Hybrid Joint Angle Estimation for Flexible Surgical Robots, **D. Baek**, J.-H. Seo, J. Kim, D.-S. Kwon. *IEEE Robotics and Automation Letters (RA-L)*, vol. 5, no. 4, pp. 6837–6844, 2020.

Learning-Based Discrete Hysteresis Classifier Using Wire Tension and Compensator for Flexible Endoscopic Surgical Robots, D. Lee, **D. Baek**, H. Kim, J. Kim, D.-S. Kwon. *International Journal of Precision Engineering and Manufacturing*, 2022.

A Novel Encountered-Type Master Device with Precise Manipulation for Robot-Assisted Microsurgery, D.-S. Kim, U.-J. Yang, B. Cheon, **D. Baek**, D.-S. Kwon. *International Journal of Medical Robotics and Computer Assisted Surgery*, 2021.

Shape-Locking Mechanism of Flexible Joint Using Mechanical Latch With Electromagnetic Force, D.-G. Chung, J. Kim, **D. Baek**, J. Kim, D.-S. Kwon. *IEEE Robotics and Automation Letters (RA-L)*, vol. 4, no. 3, pp. 2661–2668, 2019.

Selected Conference Publications

Switch-JustDance: Benchmarking Whole-Body Motion Tracking Policies Using a Commercial Console Game, J. Kim*, W. Kim*, Y. Lu*, J. Cheng*, F. Zargarbashi*, Z. Zeng*, Z. Qi*, Z. Dou, N. Sontakke, **D. Baek**, S. Ha, T. Li. *Conference on Computer Vision and Pattern Recognition (CVPR) Findings*, 2026.

FSL-LVLM: Friction-Aware Safety Locomotion Using Large Vision-Language Models in Wheeled Robots, B. Peng, **D. Baek**, Q. Wang, J. Ramos. *IEEE-RAS 24th International Conference on Humanoid Robots*, 2025.

Real-to-Sim Adaptation via High-Fidelity Simulation to Control a Wheeled-Humanoid Robot with Unknown Dynamics, **D. Baek**, Y. Sim, A. Purushottam, S. Gupta, J. Ramos. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2024.

Hands-Free Telelocomotion of a Wheeled Humanoid, A. Purushottam, Y. Jung, K. Murphy, **D. Baek**, J. Ramos. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2022.

Hybrid LMC: Hybrid Learning and Model-Based Control for Wheeled Humanoid Robots via Ensemble Deep Reinforcement Learning, **D. Baek**, A. Purushottam, J. Ramos. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2022.

Hysteresis Compensator with Learning-Based Pose Estimation for Flexible Endoscopic Surgical Robots, **D. Baek**, J.-H. Seo, J. Kim, D.-S. Kwon. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2019.

Effects of Flexible Surgical Robots on Endoscopic Procedures: Preliminary Bench-Top User Study, J. Kim, M. Hwang, D. Lee, H. Kim, J. Ahn, J. You, **D. Baek**, D.-S. Kwon. *IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 2019.

Image-Based Hysteresis Compensator for Flexible Endoscopic Surgical Robots, **D. Baek**, J.-H. Seo, J. Kim, D.-S. Kwon. *International Conference on Ubiquitous Robots (UR)*, 2019 (*Best Paper Award*).

Path Planning for Automation of Surgical Robots Based on Probabilistic Roadmaps and Reinforcement Learning, **D. Baek**, M. Hwang, H. Kim, D.-S. Kwon. *International Conference on Ubiquitous Robots (UR)*, 2018.

Robust Trajectory Tracking of Master-Slave Surgical Robot Systems Using PD Control with Integral Sliding Mode, H. Kim, M. Hwang, **D. Baek**, D.-S. Kwon. *International Conference on Ubiquitous Robots (UR)*, 2018.

A Flexible Endoscopic Surgical Robot (K-FLEX) and Its Feasibility Validation in In-Vivo Animal Trials, M. Hwang, J.-H. Kim, D. Lee, J. Ahn, J. You, **D. Baek**, H. Kim, D. Son, D.-S. Kwon. *Asian Conference on Computer Aided Surgery (ACCAS)*, 2018 (*Best Paper Award*).

Development of a Rescue Robot for Earthquake Zones, **D. Baek**, Y.-T. Kim, H.-S. Kim, S.-Y. Lee, H.-S. Lee, T.-M. Hwang, G.-W. Park, J.-H. Baek. *Korea Robotics Society Annual Conference (KRoC)*, 2017 (*Best Student Paper Award*).

Patents

Flexible Drive Manipulator, D.-S. Kwon, J.-M. You, J.-H. Kim, J.-D. Ahn, H.-S. Kim, **D. Baek**, D.-G. Lee, Y.-S. Yi, U.-J. Yan. *US Patent 11,433,558*, 2022.

Surgical Tool Device with Wire Hysteresis Compensation Function and Control Method, **D. Baek**, Y.-H. Nho, D.-S. Kwon. *US Patent Application 18/562,175.*

Method of Determining Hysteresis of Surgical Robot and Compensation Method Thereof, and Endoscopic Surgical Apparatus, D.-S. Kwon, **D. Baek**, J.-H. Seo, J.-H. Kim, J.-D. Ahn, H.-S. Kim, J.-M. You. *US Patent Application 17/277,159.*

Asymmetric Rolling Joint Device of Surgical Instrument, D.-S. Kwon, J.-D. Ahn, J.-H. Kim, J.-M. You, H.-S. Kim, D.-G. Lee, Y. Yi, **D. Baek**. *US Patent Application 17/406,834.*

Teaching Experience

University of Illinois Urbana-Champaign **2024**

Teaching Assistant, ME 453: Data Science in Manufacturing Quality Control *Urbana, IL, United States*

Assisted instruction on statistical modeling and machine learning for manufacturing quality control.

Supported coursework on statistical process control and data-driven quality analysis.

Soongsil University **2017**

Instructor, Robot Operating System (ROS) Seminar *Seoul, Republic of Korea*

Delivered lectures on ROS fundamentals and system integration for robotics applications.

Awards and Honors

Best Application Award and Overall Winner, Hamlyn Surgical Robot Challenge, London, UK, 2018.
Top 10 Mechanical Technology Award, Korean Federation of Mechanical Engineering Societies (KFMES), 2019.
Best Paper Award, International Conference on Ubiquitous Robots (UR), 2019.
Best Paper Award, Asian Conference on Computer Aided Surgery (ACCAS), 2018.
Best Paper Award, Korea Robotics Society Annual Conference (KRoC), 2017.
Minister of National Defense Award, Military Defense Start-up Competition, Korea, 2018.
Excellent Paper Award, Kwangwoon University, 2016.
Second Prize, International Robot Contest, Korea, 2015.
Scholarship for Academic Excellence, Kwangwoon University, 2013–2016.
Robocup Finalist, RoboCup, Germany, 2016.
Robot Demonstration, IEEE-RAS Humanoids, 2015.

Programming Experience

Languages: Python, C, C++, MATLAB
Machine Learning: PyTorch, TensorFlow, OpenCV
Robotics & Systems: ROS, EtherCAT, Multi-threading
Optimization & Control: CasADi, OSQP, SciPy, PSO, Genetic Algorithms
Design & Prototyping: SolidWorks (CAD), 3D Printing
Simulation: MuJoCo, Isaac Gym, RaiSim

Reference

Prof. Joao Ramos Assistant Professor in the Mechanical Science and Engineering Electrical & Electrical and Computer Engineering at the University of Illinois at Urbana Champaign, Illinois, United States. Email: jlramos@illinois.edu

Prof. Sehoon Ha Assistant Professor in the School of Interactive Computing at the Georgia Institute of Technology, Atlanta, GA, United States. Email: sehoonha@gatech.edu

Prof. Dong-Soo Kwon Professor in the School of Mechanical Engineering, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, South Korea. Email: kwonds@kaist.ac.kr

Prof. Jason Jangho Choi Assistant Professor in the Electrical and Computer Engineering Department at the University of California, Los Angeles, Los Angeles, CA, United States. Email: jjhchoi@ucla.edu

Prof. Minho Hwang Assistant Professor in the Department of Robotics and Mechatronics Engineering at the Daegu Gyeongbuk Institute of Science and Technology (DGIST), Daegu, South Korea. Email: minho@dgist.ac.kr