Sang-Min Baek

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Research Interests

- Bio-inspired robotics, Soft robotics, Origami inspired mechanisms
- Smart actuators & fabrications
- Locomotive robots
- Dynamic modeling & Simulation
- Robot control

Experience

Sep. 2023 - Present

Postdoctoral Research Associate
- Biorobotics Lab, Soft Robotics Research Center (SRRC), Seoul National University
- Biomimetic Robotics Research Center (BMRR), Seoul National University
- Advisor: Prof. Kyu-Jin Cho
- Research Projects
  - Bioinspired Robot : Crawling, jumping, gliding, and multi-modal robots

Education

Sep. 2014 - Aug. 2023

Ph.D. in Mechanical Engineering
- Seoul National University, Seoul, Korea
- Dissertation: “Bioinspired Mechanisms for Jump-Gliding Robot: A Ladybird Beetle-Inspired Deployable Gliding and a Biarticular Jumping”
- Advisor: Prof. Kyu-Jin Cho

Feb. 2009 - Aug. 2013

B.S. in Mechanical Engineering / Double Major: Business & Technology Management
- Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea
  Advisor: Prof. Suk-Joo Na

PUBLICATIONS

Journals

1. **Baek, S. M.**, Yim, S., Chae, S. H., Lee, D. Y., & Cho, K. J. (2020). Ladybird beetle‐inspired compliant origami. *Science Robotics*, *5*(41).
2. Byun, J., Park, M., **Baek, S. M.**, Yoon, J., Kim, W., Lee, B., ... & Cho, K. J. (2021). Underwater maneuvering of robotic sheets through buoyancy-mediated active flutter. *Science Robotics*, *6*(53).
3. S.-H. Chae, **S.-M. Baek**, J. Lee, and K.-J. Cho, "Agile and Energy-Efficient Jumping-Crawling Robot Through Rapid Transition of Locomotion and Enhanced Jumping Height Adjustment," *IEEE/ASME Transactions on Mechatronics*, 2022.
4. Gwang-Pil Jung , Carlos S. Casarez, Jongeun Lee, **Sang-Min Baek**, So-Jung Yim, Soo-Hwan Chae, Ronald S. Fearing, and Kyu-Jin Cho., "JumpRoACH: A Trajectory-Adjustable Integrated Jumping-Crawling Robot," IEEE/ASME Transactions on Mechatronics, 2019.
5. J. Lee, G. P. Jung, **S. M. Baek**, S. H. Chae, S. Yim, W. Kim, and K. J. Cho, "CaseCrawler: A Lightweight and Low-Profile Crawling Phone Case Robot," IEEE Robot. Autom. Lett., vol. 5, no. 4, pp. 5858-5865, October 2020.
6. Jun-Young Lee, Brian Byunghyun Kang, Dae-Young Lee, **Sang-Min Baek**, Woong-Bae Kim, Woo-Young Choi, Jeong-Ryul Song, Hyeong-Joon Joo, Daegeun Park and Kyu-Jin Cho*, "Development of a Multi-functional soft robot (snUMaX) and Performance in robosoft grand challenge", Frontiers in Robotics and AI, 2016.
7. Yim, S., **Baek, S. M.**, Lee, P., Chae, S. H., Lee, J., Huh, S. H., ... & Cho, K. J. (2024). Development of the sub-10 cm, sub-100 g jumping–crawling robot. *Intelligent Service Robotics*, *17*(1), 19-32. (co-first)
8. Koh, J.-S., **Baek, S.-M.**, Kim, B., Cho, K.-J., & Kim, H.-Y. (2024). Comparison of water and terrestrial jumping in natural and robotic insects. *Ann NY Acad Sci.*, *1537,* 13–31. (co-first)

Patents

1. Jaekwan Ryu, Yongjin Cho, Jihoon Koo, Kyu-Jin Cho, **Sang-Min Baek**, Sojung Yim, Jong-Eun Lee, and Soo-Hwan Chae, "DIRECTIONAL LOCOMOTION ROBOT", 10-2337275-0000 , KR
2. Kyu-Jin Cho, **Sang-Min Baek**, Sojung Yim, Soo-Hwan Chae, Dae-Young Lee, "Deployable Wing Module for Multi-modal Locomotion and Wing Fusion Type Robot", 10-2276602-0000, KR

Conferences

1. **Sang-Min Baek**, Dae-Young Lee, Kyu-Jin Cho, "Curved Compliant Facet Origami-based Self-deployable Gliding Wing Module for Jump-gliding", *Proceedings of the ASME 2016 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC/CIE) 2016*, pp. 4680-4685, 2016.
2. *Sojung Yim, **Sang-Min Baek**, Gwang-Pil Jung and Kyu-Jin Cho, "An Omnidirectional Jumper with Expanded Movability via Steering, Self-Righting and Take-off Angle Adjustment", IROS 2018*
3. **Sang-Min Baek**, Dae-Young Lee, and Kyu-Jin Cho, Development of Foldable Glider for Multi-modal Robot, 14th International Conference on Intelligent Unmanned Systems (ICIUS 2018), 2018

4. Jong-Eun Lee, Gwang-Pil Jung, **Sang-Min Baek** and Kyu-Jin Cho, An adaptive leg structure for a meso-scale crawler, 14th International Conference on Intelligent Unmanned Systems (ICIUS 2018), 2018
5. Sojung Yim, **Sang-Min Baek**, Gwang-Pil Jung, and Kyu-Jin Cho, A Jumping Robot Capable of Steering, Adjusting the Take-off Angle, Self-righting and its Obstacle Detection Method, The 1st IFAC Workshop on Robot Control. IFAC CAMS WROCO 2019

Dissertation

1. **Sang-Min Baek**, "Bioinspired Mechanisms for Jump-Gliding Robot: A Ladybird Beetle-Inspired Deployable Gliding and a Biarticular Jumping", Doctoral Dissertation, Seoul National University, Seoul, Korea

Research Projects

2016 - Present	**Jump-gliding robot** • Deployable glider module design based on the compliant origami structure • Jumping mechanism design for repetitive locomotion
2020 - Present	**Jumping mechanism with bi-articular springs** • Jumping robot design • Exo suit for increasing jumping performance • Dynamic model for jumping • Principle wise analysis on mechanics of the jumping with bi-articulation
2016 - 2020	**Ladybird beetle inspired compliant origami** • Novel origami design, which is rapid self-deployable and has self-locking ability • Modeling and analysis on the compliant origami design • Fabrication of the origami structure • Various applications : Deployable wing, jumping mechanism, complex origami pattern
2021 - Present	**Swarm of various locomotive robots with leashed constraints** • Leashing multiple robots using a string ease the localization of the individual robots • The string connection enables the collaborative functions of the multiple robots • Design of various locomotive robots • Design of active leashing / un-leashing mechanism
2019 - 2021	**Under water swimming robot using fluttering motion** • Design of sheet like thin swimming robot • Design of soft actuator for buoyancy control • Application to the origami structure

2018 - 2022	**Jump-crawing robot with high locomotion agility** • Clutching between the transmission and the energy storage component of the jumping mechanism increased the agility of the jump-crawling locomotion • Design of the jumping mechanism, crawling mechanism, clutch mechanism
2016 - 2018	**Jumping robot capable of untethered omnidirectional movement** • Design of jumping mechanism capable of jumping direction control, jumping angle control, and posture correction • Applied mechanism and actuator sharing design to reduce the weigh and size
2016 - 2020	**Crawling robot with high payload capacity** • Design of thin crawling mechanism with high payload capacity based on the slider-crank with flexure-hinge design
2015 - 2019	**Jump-crawling robot with trajectory adjusting capability** • Jumping robot design • Integration of the jumping mechanism and crawling mechanism
2020 - 2022	**Jump-crawling robot with constrained form factor (sub 100 g, sub 10 cm)** • Miniaturizing the jumping and crawling mechanism • Utilization of the smart actuator for miniaturizing

Technical Skills

Robot Design & Manufacturing, Embedded system, Robot Modeling

- Various prototyping skills and experiences (3D printer, Laser machining, CNC, Sewing machine, *etc.*)
- CAD design (SOLIDWORKS, Auto CAD)
- Robot Modeling, Simulation, and Analysis (MATLAB, SIMULINK, LabVIEW, C, etc.)
- Embedded controller hardware design (STM, KiCAD, etc.)

Honor and Awards

May. 2016	RoboSoft Grand Challenge Winner (SNUMAX)
Nov. 2017	SEMES-KSME Open innovation challenge 2nd prize (Soft-contact edge gripper for wafer handling)
Oct.2021	Best paper award, “Design of Mechanism for Insect-inspired Ground Mobile Robot”, *Korean Society for Precision Engineering* (KSPE)
Oct.2022	Best paper award, “Turning Mechanism of the Bio-inspired Deployable Glider”, *Korean Society for Precision Engineering* (KSPE)

Teaching Experience

Sep. 2015 - Dec. 2015	**Teaching Assistant** • Dynamics (Prof. Kyu-Jin Cho) • Seoul National University
Sep. 2016 - Jun. 2017	**Teaching Assistant** • Management in mechanical engineering (Prof. Young-Sang You) • Seoul National University
Mar. 2020 - Jun. 2020	**Teaching Assistant** • Bioinspired robotics (Prof. Kyu-Jin Cho) • Seoul National University
2016 - current	**Tutoring B.S. students / UROP** • Led the B.S. Thesis of four undergraduate students (Prof. Kyu-Jin Cho) • Led the multiple students for the Undergraduate Research Opportunities (Prof. Kyu-Jin Cho)
2019 - 2020	**High school lecture** • Careers and Occupations - robot engineer, Book-il high school

References

Dr. Kyu-Jin Cho, Ph.D.
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Dr. Dae-Young Lee, Ph.D.
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