Jeeseop Kim

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Education

Postdoctoral Scholar	Mechanical and Civil Engineering California Institute of Technology (Caltech) Advisor: Dr. Aaron D. Ames	Oct. 2022 - present
Ph.D.	Mechanical Engineering Virginia Polytechnic Institute and State University (Virginia Tech) Dissertation: Collaborative Locomotion of Quadrupedal Robots: From Centralized Predictive Control to Distributed Control Advisor: Dr. Kaveh Akbari Hamed	August, 2022
M.S.	Intelligence and Information Seoul National University, South Korea Thesis: Improvement of Humanoid Gait Control using Actuator Deformation Model Advisor: Dr. Jaeheung Park	February, 2017
B.S.	Mechanical and Aerospace Engineering Seoul National University, South Korea	February, 2014

Research Interests

Areas of Interest

My primary academic interests span robotics, control theory, optimization, dynamical systems, and machine learning. My research goal is to establish a firm foundation that extends the state-of-the-art methods for designing resilient and intelligent control algorithms for a wide range of collaborative work. This overview includes but is not limited to 1) collaborative multi-agent systems with decentralized and distributed control policies, 2) autonomous robot control and planning for various applications, 3) agile robots without compromising safety features.

My research follows a trajectory that bridges theoretical concepts and experimental application, aiming to achieve two key objectives: 1) Creating algorithms to systematically design robust and intelligent controllers for high-dimensional and complex hybrid dynamical systems; and 2) Transferring the control framework into practice with a highly dynamic robot platform. These algorithms advance knowledge in the design of feedback controllers for dynamical models arising from various collaborative works that I target. The theoretical innovations also offer a unique opportunity to advance human-robot interaction, robotic legged locomotion, autonomous robot with safety features.

Honors

Awards

- ◇ 2023 IEEE ICRA Outstanding Paper Award 2023
- ◇ 2023 IEEE ICRA Outstanding Multi-Robot Systems Paper Award Finalist 2023
- ◇ ASME Dynamic Systems & Control Division Rudolf Kalman Best Paper Award 2022
- ◇ The Best Presentation Award, Institute of Control, Robotics and Systems 2016
- ◇ DARPA Robotics Challenge (DRC) Finalist 2015
- ◇ The Best Presentation Award for Bachelor Thesis, Seoul National University 2012

Fellowship

Research Assistant Scholarships, Virginia Tech, Blacksburg, USA 2017 - 2022
Gwan-ak Scholarship, Seoul National University, Seoul, South Korea 2014 - 2015
National Scholarship from Korea Student Aid Foundation, South Korea 2009 - 2010

Teaching Experience

Teaching Assistant

Mechanical Engineering, Virginia Polytechnic Institute and State University
ME5524: Bayesian Robotics (Spring, 2019)
ME5984: Advanced Experimental Robotics (Fall, 2018)

Transdisciplinary Studies, Seoul National University, South Korea
493.601: Convergent Robotics Technology (Spring, 2015)
493.611: Dynamics and Control of Robot-Environment Interaction (Fall, 2015)

Publications

Journal Articles

[J 6] **J. Kim**, R. T. Fawcett, V. R. Kamidi, A. D. Ames and K. Akbari Hamed, "Layered Control for Cooperative Locomotion of Two Quadrupedal Robots: Centralized and Distributed Approaches,"
IEEE Transactions on Robotics, vol. 39, no. 6, pp. 4728-4748, Dec. 2023.

[J 5] V. R. Kamidi, **J. Kim**, R. T. Fawcett, A. Ames, and K. Akbari Hamed, "Distributed Quadratic Programming-Based Nonlinear Controllers for Periodic Gaits on Legged Robots,"
IEEE Control Systems Letters, Vol. 6, pp. 2509-2514, Apr, 2022.

[J 4] **J. Kim**, and K. Akbari Hamed, "Cooperative locomotion via supervisory predictive control and distributed nonlinear controllers,"
ASME Journal of Dynamic Systems, Measurement, and Control, Vol. 144, Issue. 3, p. 031005, Mar, 2022.

[J 3] R. T. Fawcett, A. Pandala, **J. Kim**, and K. Akbari Hamed, "Real-time planning and nonlinear control for quadrupedal locomotion with articulated tails,"
ASME Journal of Dynamic Systems, Measurement, and Control, Vol. 143, Issue. 7, p. 071004, Jul, 2021.
2022 ASME DSCD Rudolf Kalman Best Paper Award

[J 2] K. Akbari Hamed, **J. Kim**, A. Pandala, "Quadrupedal locomotion via event-based predictive control and QP-based virtual constraints,"
IEEE Robotics and Automation Letters, Vol. 5, Issue. 3, pp. 4463-4470, Jul, 2020.

[J1] **J. Kim**, Y. Omori, A. Sifat, and T. Furukawa,
"Adjustably designed torque controlled humanoid platform,"
International Journal of Mechanical and Production Engineering, Vol. 7, Issue. 2, pp. 52-57, May, 2019.

Conference Papers

[C17] A. B. Ghansah, **J. Kim**, K. Li, and A. D. Ames
"Dynamic Walking on Highly Underactuated Point Foot Humanoids: Closing the Loop between HZD and HLIP,"
2024 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2024), Accepted to appear.

[C16] J. Lee, **J. Kim**, A. D. Ames
"Safety-critical Autonomous Inspection of Distillation Columns using Quadrupedal Robots Equipped with Roller Arms,"
2024 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2024), Accepted to appear.

[C15] K. Li, **J. Kim**, X. Xiong, K. Akbari Hamed, Y. Yue, A. D. Ames
"Data-Driven Predictive Control for Robust Exoskeleton Locomotion,"
2024 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2024), Accepted to appear.

[C14] Y. Kim, **J. Kim**, A. D. Ames, and C. Sloth
"Robust Safety-Critical Control for Input-Delayed System with Delay Estimation,"
22nd European Control Conference (ECC24), Stockholm, Sweden, 25-28 Jun, 2024, pp. 2218-2223.

[C13] **J. Kim**, J. Lee, and A. D. Ames,
"Safety-Critical Coordination of Legged Robots via Layered Controllers and Forward Reachable Set based Control Barrier Functions,"
2024 IEEE International Conference on Robotics and Automation (ICRA 2024), Yokohama, Japan, 13-17 May, 2024, pp. 3478-3484.

[C12] J. Lee, **J. Kim**, W. Ubellacker, T. G. Molnar and A. D. Ames,
"Safety-critical Control of Quadrupedal Robots with Rolling Arms for Autonomous Inspection of Complex Environments,"
2024 IEEE International Conference on Robotics and Automation (ICRA 2024), Yokohama, Japan, 13-17 May, 2024, pp. 3485-3491.

[C11] **J. Kim**, R. T. Fawcett, V. R. Kamidi, A. D. Ames and K. Akbari Hamed,
"Layered Control for Cooperative Locomotion of Two Quadrupedal Robots: Centralized and Distributed Approaches,"
2024 IEEE International Conference on Robotics and Automation (ICRA 2024), Yokohama, Japan, 13-17 May, 2024.

[C10] J. Lee, **J. Kim**, and A. D. Ames,
"A Data-driven Method for Safety-critical Control: Designing Control Barrier Functions from State Constraints,"
2024 American Control Conference (ACC 2024), Toronto, Canada, 8-12 Jul, 2024.

[C9] A. B. Ghansah, **J. Kim**, M. Tucker, and A. D. Ames,
"Humanoid Robot Co-Design: Coupling Hardware Design with Gait Generation via Hybrid Zero Dynamics,"

2023 IEEE Conference on Decision and Control (CDC 2023), Marina Bay Sands, Singapore, 13-15 Dec, 2023, pp. 1879-1885.

[C 8] **J. Kim**, J. Lee, and A. D. Ames,
"Safety-Critical Coordination for Cooperative Legged Locomotion via Control Barrier Functions,"
2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023), Detroit, MI, USA, 01-05 Oct, 2023, pp. 2368-2375.

[C 7] J. Lee, **J. Kim**, and A. D. Ames,
"Hierarchical Relaxation of Safety-critical Controllers: Mitigating Contradictory Safety Conditions with Application to Quadruped Robots,"
2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023), Detroit, MI, USA, 01-05 Oct, 2023, pp. 2384-2391.

[C 6] R. T. Fawcett, L. Amanzadeh, **J. Kim**, A. D. Ames and K. Akbari Hamed,
"Distributed Data-Driven Predictive Control for Multi-Agent Collaborative Legged Locomotion,"
2023 IEEE International Conference on Robotics and Automation (ICRA 2023), London, UK, 29 May- 02 Jun, 2023, pp. 9924-9930.
2023 IEEE ICRA Outstanding Paper Award
2023 IEEE ICRA Outstanding Multi-Robot Systems Paper Award Finalist

[C 5] V. R. Kamidi, **J. Kim**, R. T. Fawcett, A. Ames and K. Akbari Hamed,
"Distributed Quadratic Programming-Based Nonlinear Controllers for Periodic Gaits on Legged Robots,"
2022 IEEE Conference on Decision and Control (CDC), Cancun, Mexico, 6-9 Dec, 2022.

[C 4] **J. Kim**, Y. Omori, A. Sifat, and T. Furukawa,
"Adjustably designed torque controlled humanoid platform,"
International Conference on Control, Automation, Robotics and Vision Engineering, Washington DC, USA, 21-22 Nov, 2018.

[C 3] **J. Kim**, M. Kim, and J. Park,
"Improvement of humanoid walking control by compensating actuator elasticity,"
International Conference on Humanoid Robots (ICHR), Cancun, Mexico, 15-17 Nov, 2016, pp. 29-34.

[C 2] 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 (ISER), Tokyo, Japan, 3-6 Oct, 2016.

[C 1] **J. Kim**, M. Kim, and J. Park,
"Improvement of humanoid gait stability using reduction gear deformation model,"
The 31st Institute of Control, Robotics and Systems (ICROS), Seoul, Korea, 10-11 Mar, 2016.

Papers Under Review & Preprints

[U 13] A. B. Ghansah, **J. Kim**, K. Li, and A. D. Ames
"Dynamic Walking on Highly Underactuated Point Foot Humanoids: Closing the Loop between HZD and HLIP," preprint arXiv 2024.

[U 12] J. Lee, **J. Kim**, A. D. Ames
"Safety-critical Autonomous Inspection of Distillation Columns using Quadrupedal Robots Equipped with Roller Arms," preprint arXiv 2024.

[U 11] K. Li, **J. Kim**, X. Xiong, K. Akbari Hamed, Y. Yue, A. D. Ames
"Data-Driven Predictive Control for Robust Exoskeleton Locomotion," preprint arXiv 2024.

[U 10] B. M. Imran, R. T. Fawcett, **J. Kim**, A. Leonessa, and K. Akbari Hamed
"A Distributed Layered Planning and Control Algorithm for Teams of Quadrupedal Robots: An Obstacle-Aware Nonlinear MPC Approach," under review 2024.

[U 9] J. Lee, **J. Kim**, and A. D. Ames,
"A Data-driven Method for Safety-critical Control: Designing Control Barrier Functions from State Constraints," preprint arXiv 2023.

[U 8] **J. Kim**, J. Lee, and A. D. Ames,
"Safety-Critical Coordination of Legged Robots via Layered Controllers and Forward Reachable Set based Control Barrier Functions," preprint arXiv 2023.

[U 7] J. Lee, **J. Kim**, W. Ubellacker, T. G. Molnar and A. D. Ames,
"Safety-critical Control of Quadrupedal Robots with Rolling Arms for Autonomous Inspection of Complex Environments," preprint arXiv 2023.

[U 6] A. B. Ghansah, **J. Kim**, M. Tucker, and A. D. Ames,
"Humanoid Robot Co-Design: Coupling Hardware Design with Gait Generation via Hybrid Zero Dynamics," preprint arXiv 2023.

[U 5] **J. Kim**, J. Lee, and A. D. Ames,
"Safety-Critical Coordination for Cooperative Legged Locomotion via Control Barrier Functions," preprint arXiv 2023.

[U 4] J. Lee, **J. Kim**, and A. D. Ames,
"Hierarchical Relaxation of Safety-critical Controllers: Mitigating Contradictory Safety Conditions with Application to Quadruped Robots," preprint arXiv 2023.

[U 3] **J. Kim**, R. T. Fawcett, V. R. Kamidi, A. D. Ames and K. Akbari Hamed,
"Layered Control for Cooperative Locomotion of Two Quadrupedal Robots: Centralized and Distributed Approaches,," preprint arXiv 2022.

[U 2] R. T. Fawcett, L. Amanzadeh, **J. Kim**, A. D. Ames and K. Akbari Hamed,
"Distributed Data-Driven Predictive Control for Multi-Agent Collaborative Legged Locomotion," preprint arXiv 2022.

[U 1] K. Akbari Hamed, **J. Kim**, A. Pandala,
"Quadrupedal locomotion via event-based predictive control and QP-based virtual constraints," preprint arXiv 2020.

Theses & Dissertation

[T 2] Jeeseop Kim
Collaborative Locomotion of Quadrupedal Robots: From Centralized Predictive Control to Distributed Control
PhD Dissertation, Virginia Polytechnic Institute and State University, 2022.

[T 1] Jeeseop Kim
Improvement of Humanoid Gait Control using Actuator Deformation Model
Master Thesis, Seoul National University, South Korea, 2017.

PATENT

[P2-2] Automatic cardiopulmonary resuscitation device and control method therefor, 2021. No. US11071686B2 (US Patent)

[P2-1] Automatic cardiopulmonary resuscitation device and control method therefor, 2020. No. 108697572B (CN Patent), No. 3409258B1 (EU Patent)

[P1] Apparatus for automatic cardiovascular pulmonary resuscitation, 2016. Korea Patent No.10-2016-0172286.

Professional Activities

Associate Editor (Conference)

- IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob 2024)

Session Chair

- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) Session on "Motion Control", Detroit, MI, 2023

Journal Reviewer

- IEEE Transactions on Robotics (T-RO)
- IEEE Transactions on Industrial Electronics (T-IE)
- IEEE /ASME Transactions on Mechatronics (TMECH)
- ASME Journal of Dynamic Systems, Measurement and Control
- IEEE Robotics and Automation Letters (RA-L)
- IEEE Robotics & Automation Magazine (RAM)
- IEEE Open Journal of Control Systems (OJCSYS)

Conference Reviewer

- American Control Conference (ACC)
- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE Conference on Decision and Control (CDC)
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- IEEE-RAS International Conference on Humanoid Robots (Humanoids)
- IEEE International Conference on Safety, Security, and Rescue Robotics (SSRR)

Invited Presentations

Presentations

[P 2] **Safety-ensured Collaborative Robot Team**
Department of Mechanical Engineering,
Robotics and Mechatronics seminar,
Virginia Tech, Blacksburg VA (virtually), Nov, 2023.

[P 1] **Collaborative Locomotion of Quadrupedal Robots: From Centralized Predictive Control to Distributed Control**
Dept. of Mechanical and Civil Engineering, Control and Dynamical Systems, AMBER Lab & Burdick group seminar,
California Institute of Technology, Pasadena CA (virtually), May, 2022.

Professional Skills

Trained Area

Domain:
Robotics, Collaborative Robot Team Control, Legged Locomotion, Underactuated System Control, Safety-Critical Control, Autonomy, Data-Driven Method, Optimization, Mixed Integer Programming

Theory:
Control Theory, Nonlinear Control, Optimization & Optimal Control, Distributed/Decentralized Control

Dynamic System Modeling:
Nonlinear Systems, Hybrid Dynamical Systems, Underactuated Systems, High-DoF Systems, Multiagent Systems

Skill set

Programming Language/Tools/domains:
C/C++, Python, CMake, MATLAB, STMCubeIDE/MX, vim, VScode, ROS, OOP-based controller development, Embedded programming, real-time system

Optimization Libraries/Tools:
OSQP, qpSWIFT, ECOSQP, C quadprog, MATLAB Optimization Tool box

Numerical Simulations:
Mujoco, RaiSim, Gazebo, MATLAB

Mechanical Design and Analysis:
Unigraphics (NX), Solidworks

Circuit Design and Analysis:
Autodesk Eagle, KiCad Electronics Design Automation (EDA)

References available upon request

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