Junheng Li

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Education

2022-present ◇ **Ph.D., University of Southern California** in Mechanical Engineering.
Advisor: Prof. Quan Nguyen
Thesis: *Hierarchical-optimization-based Control for Dynamic Humanoid Loco-manipulation*

2020-2021 ◇ **M.S., University of Southern California** in Mechanical Engineering.

2016-2020 ◇ **B.S., Loyola Marymount University** in Mechanical Engineering.

Research Experiences

Graduate Research Assistant at University of Southern California

2024 – 2025 ◇ **Survey on Humanoid Loco-manipulation** [P1]

- Advisors: Quan Nguyen, Ph.D., Ye Zhao, Ph.D.
- Collaborating Institutes: Georgia Tech, CMU, TUM, Duke, Stanford, etc.
- Reviewed and analyzed the current technical progress of humanoid loco-manipulation technology in control, planning, sensing, learning, and foundation models.

◇ **DiffTune and DiffCoTune for Cross-domain Control on Humanoid Robots** [P2,P4]

- Advisors: Quan Nguyen, Ph.D., Naira Hovakimyan, Ph.D., Sheng Cheng, Ph.D
- Collaborating Institutes: UIUC, Standford University.
- Investigated differentiable-simulator-based optimal control parameter-tuning on humanoid MPC.
- Investigated differentiable co-tuning of control and system parameters jointly for cross-domain robot control deployment.

◇ **Scalable Control of Humanoid Tele-operation through ForceBot** [C1]

- Advisors: Quan Nguyen, Ph.D., Kaveh A. Hamed, Ph.D., Alexander Leonessa, Ph.D.
- Collaborating Institutes: Virginia Tech.
- Implemented long-distance tele-locomotion framework between ForceBot and Hector V2 humanoid with MPC and CoM reference command scaling.

2021 – 2025 ◇ **Dynamic Locomotion via Hierarchical Optimizations on HECTOR Humanoid** [P3, P5, P6, J1, C2, C6]

- Advisor: Quan Nguyen, Ph.D.
- Implementing and investigating dynamic locomotion control strategies on an in-house mini-humanoid robot platform, including MPC, WBC, trajectory optimization, and data-driven control. https://github.com/DRCL-USC/Hector_Simulation
- Proposed and realized the first-ever continuous dynamic jumping on bipedal robots with hierarchical optimization and variable modeling strategies.
- Proposed force-and-moment humanoid robot dynamics model and augmented the simplified model with Gait Network for variable-frequency walking control.

2023 – 2025 ◇ **Dynamic Humanoid Whole-body Loco-manipulation Control** [C3, C4, P6]

- Advisor: Quan Nguyen, Ph.D.
- Investigated kino-dynamic pose optimization for whole-body pose planning in heavy-weight humanoid pushing.
- Proposed multi-contact external force modeling for controlling humanoid robots perform dynamic object transfer.

2022 ◇ **Wheel-legged Robot Navigating High Obstacles via Pose Optimization** [C5]

- Advisor: Quan Nguyen, Ph.D.
- Proposed and developed kinematics-based pose optimization framework to optimize the driving pose when traversing high obstacles.

Teaching Experiences

2023-2025 ◇ **Teaching Assistant**, University of Southern California.

- AME 451: Linear Control Systems I (*Fall 2023, Spring 2024, and Spring 2025*)
- Led discussion sessions, lecture review, and coding sessions.
- Course covers Laplace transform, frequency domain analysis, compensator design, Root Locus, Bode plots, and Nyquist plot.

2024 ◇ **Invited Project Advisor**, University of Southern California.

- AME 556: Robot Dynamics and Control (*Fall 2024*)
- Participated in project advising, coding sessions, and project reviews.
- Course covers robot kinematics, dynamics, optimal control (LQR, QP, MPC, direct optimization), control barrier function, and input-output linearization.

Research Publications

Preprint

P1 Q. Chen, J. Li, S. Cheng, N. Hovakimyan, and Q. Nguyen, *Autotuning bipedal locomotion mpc with grfm-net for efficient sim-to-real transfer*, 2025, submitted to IROS.

P2 Z. Gu, J. Li, W. Shen, *et al.*, *Humanoid locomotion and manipulation: Current progress and challenges in control, planning, and learning*, 2025, submitted to TMECH.

P3 L. Krishna, S. Cheng, J. Li, Q. Chen, N. Hovakimyan, and Q. Nguyen, *Diffcotune: Differentiable co-tuning for enhanced cross-domain robot control*, 2025, submitted to RSS.

P4 J. Li, Z. Duan, J. Ma, and Q. Nguyen, *Gait-net-augmented implicit kino-dynamic mpc for dynamic variable-frequency humanoid locomotion over discrete terrains*, 2025, submitted to RSS.

P5 J. Li, O. Kolt, and Q. Nguyen, *Continous dynamic bipedal jumping via adaptive-model optimization*, 2024, submitted to RAS.

P6 J. Li, J. Ma, O. Kolt, M. Shah, and Q. Nguyen, *Dynamic loco-manipulation on hector: Humanoid for enhanced control and open-source research*, 2023, arXiv.

Journal Articles

J1 J. Li and Q. Nguyen, "Dynamic walking of bipedal robots on uneven stepping stones via adaptive-frequency mpc," *IEEE Control Systems Letters*, vol. 7, pp. 1279–1284, 2023.

Conference Proceedings

C1 A.-C. He, J. Li, J. Park, *et al.*, "A novel telelocomotion framework with com estimation for scalable locomotion on humanoid robots," in *2025 IEEE International Conference on Robotics and Automation (ICRA)*, 2025, accepted and to appear.

- **C2** J. Li, Z. Le, J. Ma, and Q. Nguyen, “Adapting gait frequency for posture-regulating humanoid push-recovery via hierarchical model predictive control,” in *2025 IEEE International Conference on Robotics and Automation (ICRA)*, 2025, accepted and to appear.
- **C3** J. Li and Q. Nguyen, “Kinodynamic pose optimization for humanoid loco-manipulation,” in *2023 IEEE-RAS 22nd International Conference on Humanoid Robots (Humanoids)*, 2023, pp. 1–8.
- **C4** J. Li and Q. Nguyen, “Multi-contact mpc for dynamic loco-manipulation on humanoid robots,” in *2023 American Control Conference (ACC)*, 2023.
- **C5** J. Li, J. Ma, and Q. Nguyen, “Balancing control and pose optimization for wheel-legged robots navigating high obstacles,” in *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, IEEE, 2022, pp. 8835–8841.
- **C6** J. Li and Q. Nguyen, “Force-and-moment-based model predictive control for achieving highly dynamic locomotion on bipedal robots,” in *2021 60th IEEE Conference on Decision and Control (CDC)*, IEEE, 2021, pp. 1024–1030.

Services

2025 ◇ *Assistant to Registration Chairs* of Robotics: Science and Systems Conference (RSS)

2024-2025 ◇ *Reviewer* of IEEE Robotics and Automation Letters (RA-L)

2024 ◇ *Reviewer* of IEEE Control System Letters (L-CSS)

◇ *Reviewer* of International Journal of Robotics and Automation

2023-2024 ◇ *Reviewer* of Robotics and Autonomous Systems (RAS)

2022 ◇ *Reviewer* of IEEE/ASME Transactions on Mechatronics (TMECH)

◇ *Reviewer* of Autonomous Robots (AURO)

2022-2025 ◇ *Reviewer* of IEEE International Conference on Robotics and Automation (ICRA)

◇ *Reviewer* of IEEE International Conference on Intelligent Robots and Systems (IROS)

2021-2024 ◇ *Reviewer* of IEEE Conference on Decision and Control (CDC)

2022-2025 ◇ *Coordinator of Lab Outreach* for Dynamic Robotics and Control Lab, hosted more than 50 lab tours and outreach events.

Invited Talks, Presentations, and Demonstrations

2024/11 ◇ *“HECTOR: A Novel Mini-humanoid Platform for Accessible and Accelerated Research and Development”*
Invited talk, USC Robotics Seminar

2024/06 ◇ *“Demonstration of Dynamic Loco-manipulation on HECTOR: Humanoid for Enhanced ConTrol and Open-source Research”*
Demonstration, IEEE International Conference on Robotics and Automation (ICRA)

2023/12 ◇ *“Kinodynamic Pose Optimization for Humanoid Loco-manipulation”*
Poster, IEEE International Conference on Humanoid Robots (Humanoids)

2023/11 ◇ *“Toward Dynamic Locomotion and Loco-manipulation on Humanoid Robots via Model Predictive Control with Linear Dynamics Models”*
Invited talk, LMU Department of Mechanical Engineering

2023/10 ◇ *“Toward Dynamic Locomotion and Loco-manipulation on Humanoid Robots via Model Predictive Control with Linear Dynamics Models”*
Invited talk, 42nd Southern California Control Workshop

- *"Demonstration of Dynamic Locomotion on Bipedal Robots via Force-and-moment-based Model Predictive Control"*
  Demonstration, IEEE International Conference on Intelligent Robots and Systems (IROS)

2023/05
- *"Multi-contact Mpc for Dynamic Loco-manipulation on Humanoid Robots"*
  Oral Presentation, American Control Conference (ACC)
- *"Dynamic Walking of Bipedal Robots on Uneven Stepping Stones via Adaptive-frequency MPC"*
  Oral Presentation, American Control Conference (ACC)

2023/02
- *"Toward Dynamic Locomotion and Loco-manipulation on Humanoid Robots via Model Predictive Control"*
  Invited talk, USC Robotics Seminar

2022/10
- *"Balancing Control and Pose Optimization for Wheel-legged Robots Navigating High Obstacles"*
  Oral Presentation, IEEE International Conference on Intelligent Robots and Systems (IROS)

2021/11
- *"Force-and-moment-based Model Predictive Control for Achieving Highly Dynamic Locomotion on Bipedal Robots"*
  Oral Presentation, IEEE Conference on Decision and Control (CDC)

Mentoring Experience

Graduate Students:

2024-2025
- Dakota Mercer, M.S. in Mechanical Engineering, USC
  Project: *Hierarchical-Optimization for Dynamic Stair Climbing on Bipedal Robots*
- Ziwei Duan, M.S. in Computer Science, USC
  Project: *Gait-Net: A Data-driven Approach to Enhance Bipedal Locomotion Control*

2023-2024
- Zhanhao Le, M.S. in Mechanical Engineering, USC
  Project: *Bipedal Robot Push Recovery via Hierarchical-MPC*
  Now: Prospective Ph.D. student
- Omar Kolt, M.S. in Mechanical Engineering, USC.
  Project: *Control and Software Infrastructure of HECTOR Humanoid*
  Now: Software Engineer at Tesla, Optimus Team
- Omar Berra, M.S. in Mechanical Engineering, USC
  Project: *Design and Whole-body Control of Bipedal Wheel-legged Robot*
  Now: Testing Engineer at the Boring Company

2022-2023
- Han Gong, M.S. in Mechanical Engineering, USC
  Project: *Terrain-aware Bipedal Robot Control and Simulation Design*
  Now: Ph.D. student at UMass Amherst

2021-2022
- Xinyu Zhu, M.S. in Mechanical Engineering, USC
  Project: *Uneven Terrain Locomotion of Wheel-legged Robots via Whole-body Control*
  Now: Engineer at Xiaomi Robotics Lab
- Tiansheng Wu, M.S. in Mechanical Engineering, USC
  Project: *Terrain-aware Trajectory Optimization and Control on Bipedal Robots*

Undergraduate Students:

2024-2025
- Rodrigo Andrade, B.S. in Mechanical Engineering, USC
  Project: *Design-control Co-optimization of Mid-size Humanoid Robot*
- Nathan Chun, B.S. in Mechanical Engineering, USC
  Project: *Optimal Control of High-degree-of-freedom Mechanical Systems*
- Bill Ouyang, B.S. in Mechanical Engineering, USC

2022-2024 ◇ Mana Shah, B.S. in Mechanical Engineering, USC
Project: *Design of a Mini Humanoid Robot Platform*

High School Students:

Summer 2024 ◇ Chinmay Ramamurthy, Ethan Le, Ian Chen, Perceiver Summer Research
Project: *Modeling and Control of Series Elastic Actuators for Knee Exoskeletons*

◇ Jonathan Li, Ted Han, Sophia Fu, Perceiver Summer Research
Project: *Package Transferring with UAV and Passive Manipulation Mechanism*

Summer 2022 ◇ Dylan Dharwadkar, USC SHINE Program
Project: *Swing Trajectory Design and Control in Bipedal Robot Walking*