Noel Csomay-Shanklin

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PhD candidate with 7+ years experience developing control strategies for agile robotic systems. Expertise in applying **optimization** and **machine-learning** to control **legged robots**, with extensive research and industry projects in **model predictive control**, **real-time path planning**, and **hierarchical control**.

EDUCATION

PhD	**Control and Dynamical Systems**, California Institute of Technology	2019 − 2025
	Hierarchical Control: Constructive Theory and Application to Legged Robots	
BS	**Mechanical Engineering**, Georgia Institute of Technology	2015 − 2019
	GPA: 4.0/4.0, Minors: Computer Science, Robotics	

RESEARCH SPOTLIGHT

Optimization-Based Control for Legged Systems

Optimization-based control provides a constructive means of stabilizing hybrid underactuated systems.

- Implemented whole-body MPC to stabilize bipeds [C_9] and hopping robots [C_{13}].
- Combined CPU and GPU compute to enable real-time long horizon path planning [C_{18}].
- Improved the robustness of trajectory optimization solutions via saltation matrices [C_{12}].

Hierarchical Autonomy with Guarantees

Hierarchical controllers enable the feasibility, efficiency, and generalizability of layered control systems.

- Enabled provably robust state and input constrained stabilization with Bézier curves [C_{11}].
- Performed long-horizon path planning efficiently via novel polytopic reachable sets [C_{19}].

Structured Use of Machine Learning in Robotic Systems

Machine learning can improve the stability, adaptability, and robustness of control strategies.

- Improved runtime-speed of optimal control with imitation learning [C_{16}][Video].
- Lowered complexity of learning safety [C_5] and stability [C_{10}] by projecting onto certificates.
- Simplified gait generation [C_6] and gain tuning [C_8] with learned user-preferences.
- Achieved safe path planning by leveraging massively parallel simulation [C_{17}].

INDUSTRY EXPERIENCE

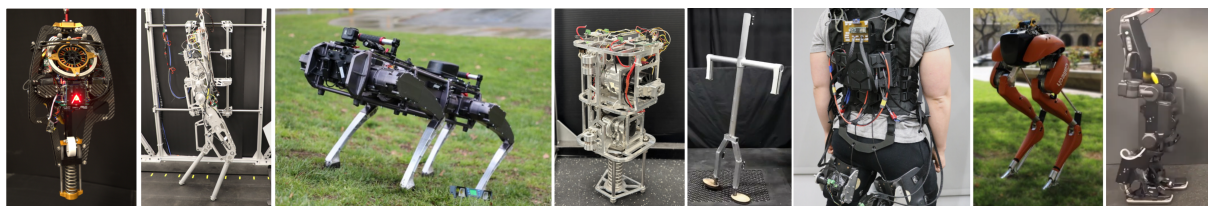**Research Intern**   2023
Boston Dynamics AI Institute, Mentor: Farbod Farshidian
Generated a dataset of trajectory optimized behaviors to investigate methods for combining MPC and RL to produce robust, precise locomotion for quadrupedal robots.

Control Systems Research Intern   2019
Disney Research, Mentor: Lanny Smoot
Developed control for an in-house omnidirectional treadmill, and demonstrated stabilization of a spherical pendulum and an unactuated "walking" armature [C_3].

Controls and Autonomy Software Engineering Intern   2018
NASA Jet Propulsion Laboratory, Mentors: Alex Brinkman, Paul Backes
Implemented a force controller on a 3-DOF robotic arm in order to test sampling tool geometries for a potential future mission to Enceladus, a moon of Saturn [C_1].

ROBOTS I HAVE WORKED WITH

Left to right by involvement: ARCHER, AMBER, Vision 60, 1D Hopper, Holotile, B-Exo, Cassie, Exo.

Technical Skills

CODING	Modern C++ (proficient), Matlab (proficient), Python (working), CUDA (basic), PyTorch (basic), Jax (basic), Labview (basic), Mathematica (basic)
SOFTWARE	CMake, CppAD, CVX, Eigen, Git, Linux, Mosek, MuJoCo, OSQP, Pinocchio, Solidworks, ROS
HARDWARE	3-axis CNC mill, manual lathe, waterjet, bandsaw, 3D printer, and most basic shop tools

Funding and Grants

NSF Graduate Research Fellowship Program — 2021 − 2024
3 years of full tuition and stipend support for PhD

Kortschak Scholars Program — 2019 − 2021
2 years of full tuition and stipend support for PhD

President's Undergraduate Research Award — 2017, 2018
2 terms of $1,500 funding for undergraduate research

Summer Undergraduate Research Fellowship — 2017
$6,000 of funding for summer undergraduate research

Awards and Recognition

Outstanding Dynamics and Control Paper Award (ICRA, [C_{13}]) — 2023

Best Oral Paper Award Finalist (Humanoids, [C_9]) — 2022

Richard K. Whitehead Jr. Memorial Award — 2019
In recognition of outstanding scholarship and service

Goldwater Scholarship Honorable Mention — 2019

Undergraduate Research Symposium College of Engineering Oral Presentation Third Place — 2017

Dean's List (8 terms) — 2015 − 2019

Service and Outreach

Reviewer — 2020 − Present
Journals: Automatica, RA-L, L-CSS
Conferences: ICRA, IROS, Humanoids, CCTA, ACC, CDC

FIRST Robotics Mentor with Neighbors Empowering Youth — 2021 − Present
Mentoring a community team of middle and high school students
design and build a robot to compete in the FRC competition

Lab Tours and Outreach Events — 2018 − Present
Over 30 tours given and events attended to students from kindergarten to community college level

SURF Mentor — Summer 2022
Mentored a summer student with communication protocols and the application of MPC to hopping robots

Rise Tutor — 2020 − 2021
Tutored a high school student with algebra and calculus

Teaching Experience

Nonlinear Control Teaching Assistant — 2020 − 2023
Caltech, Professor: Dr. Aaron Ames
Topics: feedback linearization, outputs, underactuation, control Lyapunov functions, Lyapunov backstepping, control barrier functions, robust nonlinear control, adaptive nonlinear control, and hybrid systems. Gave occasional lectures, held weekly recitations, and helped write and grade exams.

Nonlinear Dynamics Teaching Assistant — 2020 − 2023
Caltech, Professor: Dr. Aaron Ames
Topics: existence and uniqueness, comparison principles, linearizations, Lyapunov stability, invariance principles, input-to-state stability, barrier functions, periodic orbits, and Poincaré sections. Gave occasional lectures, held weekly recitations, and helped compose and grade exams.

PUBLICATIONS

Journals:

[J$_8$] M. Cohen, N. Csomay-Shanklin, W. D. Compton, T. Molnar, A. D. Ames
Safety-Critical Controller Synthesis with Reduced-Order Models
Submitted to IEEE Control Systems Letters, 2025.

[J$_7$] I. Incer, N. Csomay-Shanklin, A. D. Ames, R. M. Murray
Layered Control Systems Operating on Multiple Clocks
IEEE Control Systems Letters, 2024. [Paper]

[J$_6$] Y. Chen, U. Rosolia, W. Ubellacker, N. Csomay-Shanklin, A. D. Ames
Interactive Multi-Modal Motion Planning with Branch Model Predictive Control
IEEE Robotics and Automation Letters, 2022. [Paper]

[J$_5$] Y. Sun, W. Ubellacker, W. Ma, X. Zhang, C. Wang, N. Csomay-Shanklin, M. Tomizuka, K. Sreenath, A. D. Ames
Online Learning of Unknown Dynamics for Model-Based Controllers in Legged Locomotion
IEEE Robotics and Automation Letters, 2021. [Paper]

[J$_4$] J. Camargo, W. Flanagan, N. Csomay-Shanklin, B. Kanwar, A. Young
A Machine Learning Strategy for Locomotion Classification and Parameter Estimation using Fusion of Wearable Sensors
IEEE Transactions on Biomedical Engineering, 2021. [Paper]

[J$_3$] W. Ma, N. Csomay-Shanklin, S. Kolathaya, K. A. Hamed, A. D. Ames
Coupled Control Lyapunov Functions for Interconnected Systems, with Application to Quadrupedal Locomotion
IEEE Robotics and Automation Letters, 2021. [Paper]

[J$_2$] J. Camargo, A. Ramanathan, N. Csomay-Shanklin, A. Young
Automated Gap-Filling for Marker-Based Biomechanical Motion Capture Data
Computer Methods in Biomechanics and Biomedical Engineering, 2020.

[J$_1$] W. Ma, N. Csomay-Shanklin, A. D. Ames
Coupled Control Systems: Periodic Orbit Generation with Application to Quadrupedal Locomotion
IEEE Control Systems Letters, 2020. [Paper]

Conferences:

[C$_{19}$] N. Csomay-Shanklin, A. D. Ames
Bézier Reachable Polytopes: Efficient Certificates for Robust Motion Planning with Layered Architectures
Submitted to IEEE American Control Conference (ACC), 2025. [Paper]

[C$_{18}$] N. Csomay-Shanklin, W. D. Compton, A. D. Ames
Dynamically Feasible Path Planning in Cluttered Environments via Reachable Bézier Polytopes
Submitted to IEEE International Conference on Robotics and Automation (ICRA), 2025. [Video]

[C$_{17}$] W. D. Compton, N. Csomay-Shanklin, A. D. Ames
Dynamic Tube MPC: Learning Tube Dynamics with Massively Parallel Simulation for Robust Safety in Practice
Submitted to IEEE International Conference on Robotics and Automation (ICRA), 2025. [Video]

[C$_{16}$] N. Csomay-Shanklin*, W. D. Compton*, I. D. J. Rodriguez*, E. Ambrose, Y. Yue, A. D. Ames
Robust Agility via Learned Zero Dynamics Policies
IEEE International Conference on Intelligent Robots and Systems (IROS), 2024. [Paper][Video][Compilation Video]

[C15] W. D. Compton*, I. D. J. Rodriguez*, N. Csomay-Shanklin*, Y. Yue, A. D. Ames
Constructive Nonlinear Control of Underactuated Systems via Zero Dynamics Policies
Conference on Decision and Control (CDC), 2024. [Paper]

[C14] W. Ubellacker, N. Csomay-Shanklin, A. D. Ames
Approximating Regions of Attraction via Flow-Control Barrier Functions and Constrained Polytope Expansion
IEEE Americal Control Conference (ACC), 2024. [Paper]

[C13] N. Csomay-Shanklin, V. D. Dorobantu, A. D. Ames
Nonlinear Model Predictive Control of a 3D Hopping Robot: Leveraging Lie Group Integrators for Dynamically Stable Behaviors
IEEE International Conference on Robotics and Automation (ICRA), 2023. **Presented with the Outstanding Dynamics and Control Paper Award**. [Paper][Video]

[C12] M. Tucker, N. Csomay-Shanklin, A. D. Ames
Robust Bipedal Locomotion: Leveraging Saltation Matrices for Gait Optimization
IEEE International Conference on Robotics and Automation (ICRA), 2023. [Paper][Video]

[C11] N. Csomay-Shanklin*, A. J. Taylor*, U. Rosolia, A. D. Ames
Multi-Rate Planning and Control of Uncertain Nonlinear Systems: Model Predictive Control and Control Lyapunov Functions
IEEE Conference on Decision and Control (CDC), 2022. [Paper][Talk]

[C10] I. D. R. Jimenez*, N. Csomay-Shanklin*, A. D. Ames
Neural Gaits: Learning Bipedal Locomotion via Control Barrier Functions and Zero Dynamics Policies
Learning for Dynamics and Control Conference (L4DC), 2022. [Paper][Video]

[C9] M. Y. Galliker*, N. Csomay-Shanklin*, R. Grandia, A. Taylor, F. Farshidian, M. Hutter, A. D. Ames
Planar Bipedal Locomotion with Nonlinear Model Predictive Control: Online Gait Generation using Whole-Body Dynamics
IEEE-RAS International Conference on Humanoid Robots (Humanoids), 2022. [Paper] [Video]

[C8] N. Csomay-Shanklin, M. Tucker, M. Dai, J. Reher, A. D. Ames
Learning Controller Gains on Bipedal Walking Robots via User Preferences
IEEE International Conference on Robotics and Automation (ICRA), 2022. [Paper] [Video]

[C7] W. Ubellacker, N. Csomay-Shanklin,T. G. Molnár, A. D. Ames
Verifying Safe Transitions Between Dynamic Motion Primitives on Legged Robots
IEEE/RSJ International Conference on Intelligent Robots ad Systems (IROS), 2021. [Paper][Video]

[C6] M. Tucker, N. Csomay-Shanklin, W. Ma, A. D. Ames
Preference-Based Learning for User-Guided HZD Gait Generation on Bipedal Walking Robots
IEEE International Conference on Robotics and Automation (ICRA), 2021. [Paper] [Video] [Blog]

[C5] N. Csomay-Shanklin*, R. K. Cosner*, M. Dai*, A. J. Taylor, A. D. Ames
Episodic Learning for Safe Bipedal Locomotion with Control Barrier Functions and Projection-to-State Safety
Learning for Dynamics and Control Conference (L4DC), 2021. [Paper] [Video] [Blog]

[C4] W. Ma, N. Csomay-Shanklin, A. D. Ames
Quadrupedal Robotic Walking on Sloped Terrains via Exact Decomposition into Coupled Bipedal Robots
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2020. [Paper] [Video]

[C3] J. Reher*, N. Csomay-Shanklin*, D. L. Christensen, B. Bristow, A. D. Ames, L. Smoot
Passive Dynamic Balancing and Walking in Actuated Environments
IEEE International Conference on Robotics and Automation, 2020. [Paper][Video]

[C₂] E. Ambrose, N. Csomay-Shanklin, Y. Or, A. D. Ames
Design and Comparative Analysis of 1D Hopping Robots
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2019. [Paper]

[C₁] M. Badescu, P. Backes, S. Moreland, A. Brinkman, D. Riccobono, M. Dotson, N. Csomay-Shanklin, S. Ubellacker, J. Molaro, M. Chouroun, G. Genta
Sampling Tool Concepts for Enceladus Lander In-Situ Analysis
IEEE Aerospace Conference (AeroConf), 2019. [Paper]

PRESENTATIONS

[P₄] **A Hierarchical Perspective on Control**
SoCal Control Workshop, November 2024. Neuromorphic Cognition Engineering Workshop, June 2023. MILA Robot Learning Seminar, November 2023. SIAM Seminar, November 2023.

[P₃] **Bipedal Locomotion with Nonlinear Model Predictive Control: Online Gait Generation using Whole-Body Dynamics**
Dynamic Walking, June 2022

[P₂] **Integrated Multi-Rate Control**
Rigorous Systems Research Group Meeting, July 2021

[P₁] **Fast Trajectory Generation for Quadrupedal Walking on Slopes**
Dynamic Waking, June 2021

PATENTS

J. Li, B. Kanwar, T. Johnson, J. Meditz, A. Yang, N. Csomay-Shanklin, J. Bishop, D. Molinaro, A. Young
Exosuit Support Systems and Methods (US 2022/0193887 A1)