SHREYANSH PITRODA

Curriculum Vitae

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RESEARCH INTEREST

Principles of legged dynamics and controls, Design of robots with locomotion plasticity, Developing multimodal systems, Non-linear controls theory, Motion planning, Estimation

EDUCATION

Ph.D. in Computer Engineering Year of completion: Expected 2026
Institution: Northeastern University
Department: Electrical and Computer Engineering
Advisor: Prof. Alireza Ramezani
Relevant Courses: Numerical Optimization, Mobile Robotics, Big Data and Sparsity, Legged Robotics

M.S. in Mechanical Engineering Year of completion: 2023
Institution: Northeastern University
Department: Mechanical and Industrial Engineering
Relevant Courses: Dynamic and Mechanical Vibration, Robot Mechanics and Control, Control System, Mechatronics

B.S. in Mechanical Engineering Year of completion: 2020
Institution: Mumbai University
Department: Mechanical and Industrial Engineering
Relevant Courses: Structure of Material, Finite Element Analysis, Dynamics of Machinery

Publications

Conference papers (peer-reviewed)

* Denotes project lead PI

ICRA, IROS, Humanoids, AIM, CDC, ACC, and ECC are 6-8 pages, peer-reviewed with acceptance rate between 30-50%.

C6 C. Wang, K. V. Krishnamurthy, **S. Pitroda**, A. Salagame, I. Mandralis, E. Sihite, *A. Ramezani, and M. Gharib, "Dynamic Quadrupedal Legged and Aerial Locomotion Via Structure Repurposing," *2025 IEEE/RSJ International Conference on Intelligence Robots and Systems (IROS)*, Hangzhou,China, October 19 - 23, 2025.

C5 **S. Pitroda**, E. Sihite, et al., "Conjugate momentum-based thruster force estimate in dynamic multimodal robot," *IEEE American Control Conference (ACC)*, Denver, CO, USA, July 8-10, 2025.

C4 E. Sihite, **S. Pitroda**, T. Liu, C. Wang, K. V. Krishnamurthy, A. Salagame, *A. Ramezani, G. Morteza, "Posture manipulation of thruster-enhanced bipedal robot performing dynamic wall-jumping using model predictive control," *IEEE-RAS 22nd International Conference on Humanoid Robots (Humanoids)*, Nancy, France, November 22-24, 2024 .

C3 **S. Pitroda** , A. Bondada, K.Venkatesh, A. Salagame, C. Wang, E. Sihite, R. Nemovi, *A. Ramezani, and M. Gharib, "Capture Point Control in Thruster-Assisted Bipedal Locomotion," *IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)*, Boston, MA, July 15-18, 2024.

C2 K. V. Krishnamurthy, C. Wang, **S. Pitroda**, A. Salagame, E. Sihite, R. Nemovi, *A. Ramezani, M. Gharib, "Narrow-Path, Dynamic Walking Using Integrated Posture Manipulation and Thrust Vectoring," *IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)*, Boston, MA, July 15-18, 2024.

C1 A. Salagame, M. Gianello, C. Wang, K. Venkatesh, **S. Pitroda**, R. Rajput, E. Sihite, M. Leeser, *A. Ramezani, "Quadrupedal Locomotion Control On Inclined Surfaces Using Collocation Method," *American Control Conference (ACC),* Toronto, Canada, July 8-12, 2024.

INTELLECTUAL PROPERTY

Patents and Invention Disclosures

INV 1 Bipedal Robot with Integrated Thruster-Assisted Locomotion, INV-24051, US Patent, 2025.

RESEARCH EXPERIENCE

PhD & Master's research project: Harpy, A Thruster Assisted Biped Date: Jan 2022 - May 2025

Harpy is a bipedal robot with two upward-facing thrusters attached to the side of its torso. The robot weighs $\approx$ 7 kg and each thruster can generate $\approx$ 5.5 kg maximum thrust, resulting in a 1.5 thrust-to-weight ratio (agile qaud-copters possess a 2 ratio).

Hardware Design:

1. Designed and assembled the electromechanical components of the Harpy biped robot using SolidWorks, inspired by the previous quadruped robot, Husky
2. Enhanced joint power density by 30% through topology optimization modifications, improving overall performance and efficiency.
3. Developed custom joints utilizing embedded 3D printing techniques, ensuring precision and adaptability in the assembly.
4. Conducted rigorous testing on joints to verify capabilities and ensure reliability in dynamic movements.
5. Utilized carbon fiber tubes for link construction instead of aluminum, significantly reducing the robot's overall weight while maintaining structural integrity.

Firmware Development:

1. Developed firmware using Simulink Real-Time to facilitate hardware-in-the-loop (HIL) testing for the Harpy biped robot.
2. Implemented an XpC target machine as a high-level controller, coordinating with the Elmo amplifier and Nucleo board using EtherCAT communication.
3. Developed an Extended Kalman Filter (EKF) package to fuse IMU and OptiTrack measurements, accurately estimating the robot's position, velocity, and orientation at 500 Hz.
4. Developed a novel buoyancy based Capture point controller to achieving the first-ever demonstration of thruster-assisted walking on hardware.

Simulation:

QP-MPC Framework for Dynamic Hopping on Rough Terrain (2025)

1. Developed novel real-time trajectory optimization for thruster-augmented SLIP model achieving robust hopping on terrains with 25° slopes and 0.2m step discontinuities through QP-based MPC running at 250Hz.
2. Implemented linearized friction cone constraints and unilateral spring constraints within the QP formulation, ensuring slip-free operation while maintaining computational efficiency ($<$3 ms worst-case).
3. Validated framework through hardware experiments on Harpy platform, demonstrating successful parameter identification and trajectory tracking with 10 jumping experiments.

Active Friction Cone Control for Vertical Surface Locomotion (2025)

1. Developed novel control strategy for wall-jumping maneuvers where friction constraints become active rather than geometric, enabling locomotion on vertical surfaces through coordinated thrust-ground force regulation.
2. Formulated SLIP-based MPC with real-time friction cone enforcement, achieving bidirectional exit velocities (-0.6 to 0.6 m/s) during wall contact while maintaining no-slip conditions.
3. Demonstrated successful ground-to-wall jumping in high-fidelity Simscape simulation, with trajectory tracking validated through whole-body control at 250Hz.

Thruster-assisted Capture point control for walking and push rejection (2024)

1. Designed and implemented a thruster-assisted Capture Point (CP) controller to enhance stability during trotting and push recovery, leveraging external thrust forces to actively modulate the robot's center of mass trajectory.
2. Developed and simulated a thruster-augmented Linear Inverted Pendulum (LIP) model to incorporate external actuation forces into CP-based locomotion, enabling improved posture stabilization and fall prevention.
3. Validated the controller in a MATLAB Simscape environment, demonstrating enhanced robustness in dynamic walking scenarios, including push recovery and rough terrain negotiation.

QP-based steep slope walking controller for harpy (2024)

1. Computed inverse dynamics and kinematics using the Pinocchio library, formulating whole-body motion constraints for thruster-assisted bipedal locomotion.
2. Developed an MPC-based QP controller running at 100 Hz, optimizing ground reaction forces while enforcing friction cone and contact constraints for stable locomotion.
3. Validated a high-fidelity 1 kHz numerical model in simulation, demonstrating thruster-assisted 30° incline walking with real-time force distribution between legs and thrusters.

Conjugate momentum based observer for thruster force estimation on harpy (2024)

1. Developed a momentum-based thruster force estimator for Harpy, a bipedal robot with legged-aerial locomotion, to improve thruster force characterization under varying operating conditions.
2. Analyzed the impact of terrain knowledge on estimation accuracy, comparing results with and without ground interaction modeling using a pinned (constraint-based) approach.

3. Implemented and validated the estimator in a numerical simulator, demonstrating its effectiveness in enabling thruster-assisted walking by accurately estimating applied thrust forces.

Class project: Shortest path search using graph based method in dynamic environment Date: Sept 2023 - Dec 2023
Institution: Northeastern University

1. Implemented and compared graph search algorithms such as Dijkstra's and A* in Python to evaluate efficiency and path optimality.
2. Developed a 3D visualization environment in Rviz for TurtleBot, enabling real-time simulation and navigation analysis.
3. Generated a 2D occupancy grid map using TurtleBot's LiDAR data, facilitating autonomous path planning and localization.
4. Designed and implemented a shortest-path algorithm, integrating it with the mapped environment for efficient goal-directed navigation.

Class project: Bridging Sim-to-Real gap for motor Date: Jan 2023 - May 2023
Institution: Northeastern University

1. Developed and deployed real-time firmware for position and velocity control of a BLDC motor joint using Simulink Real-Time, ensuring precise actuation.
2. Integrated potentiometer feedback as a reference for both position and velocity control, utilizing Arduino Uno as the controller board.
3. Designed and validated a Simscape model, applying identical reference inputs and tuning parameters to achieve accurate model matching.
4. Performed FFT analysis of the system response, designing a bandpass filter to isolate and retain only the dominant frequency components for improved signal quality.

Class project: Benchmarking various controller on Inverted pendulum system Date: Sept 2022 - Jan 2023
Institution: Northeastern University

1. Created an numerical model of Inverted pendulum on cart model with disturbance using MATLAB. One degree of underactuation (joint connecting cart and pendulum)
2. Designed PD controller using Ackermann's pole placement method and found optimum value for poles.
3. Designed LQR controller for the same system and found the optimum cost function matrix.

EMPLOYMENT

R&D Electromechanical Engineer Date: July 2022- January 2023
Company: Endovascular Robotics - Siemens Healthineers

1. Design electromechanical test fixtures to assist test operations and assembly.
2. Test new or existing products in the development cycle to characterize their performance.
3. Develop and revise test protocols, test reports, assembly procedures, and work instructions.
4. Assist in ordering parts, receiving, inspecting, documentation, and building and integrating medical robots such as cable assemblies, motors, PCBs, and mechanical subsystems.

CAE Engineer Date: April 2021- June 2021
Company: Simulation Lab

1. Performed 60+ analyses on enhanced wing flap in Ansys Fluent to determine aerodynamic efficiency.
2. Found the maximum efficiency for the wing flap by changing the angle of attack.
3. Presented detailed report of testing to the project head and gave appropriate modification to improve the design.

TEACHING / GRADING EXPERIENCE

Teaching Assistant Date: Jan 2022 - Dec 2024
Institution: Northeastern University
Course: Circuits/Signals: Bio-med Apps, Statics, Dynamics, Mechanics of Material