Hamidreza Montazeri | Curriculum Vitæ

(617) 833-8905 • montazerihedesh.h@northeastern.edu
Website | LinkedIn | GitHub | Google Scholar

Professional Summary

Ph.D. researcher developing foundational methods for trustworthy and scalable artificial intelligence in dynamical systems. My work lies at the intersection of data-driven learning, optimization, and control theory, with a focus on formal verification, robustness, and safety guarantees for neural-network-based control systems. I develop theory and algorithms for certifying learning-enabled systems operating in complex, safety-critical environments, with applications spanning autonomous systems and robotics. I have introduced a novel neural network (NN) bounding method and a novel stability and robustness verification method that utilizes positivity characteristics of the system and achieves up to $10^4\times$ runtime improvement over existing approaches while retaining formal guarantees. I have developed a self-sufficient **Matlab-Python** pipeline for the simulation, data acquisition, and verification algorithm, and released two open-source Python and MATLAB libraries, **nnsector** and **nnstab**, that implement the bounding and verification methods.

Core Skills

Control Systems: Linear/Nonlinear Control, Optimal control, Identification, Robust control, MPC, Observers, EKF/UKF, Reachability and region-of-attraction analysis, Constrained optimization, Sensitivity analysis, Lyapunov methods, Passivity, Networked systems

ML/Verification: Machine learning, Reinforcement learning, TensorFlow, PyTorch, Training for control, Safe and verifiable learning, Imitation learning, Verification analysis using AutoLiRPA & JAX-Verify, Hybrid learning–model-based systems

Programming: MATLAB, Python, Julia, C

Modeling Tools: Simulink, Fluent, Gambit, SolidWorks, Vensim, Abaqus, Ansys, Maple

Math Tools: Convex optimization, Nonlinear optimization (SNOPT), LMIs, (Integral) quadratic constraints, Numerical analysis

Education

PhD in Electrical Engineering — **Northeastern University, Boston, USA**
• *Current GPA: 3.81* — *Sept. 2021 - Present*
• Thesis: Scalable Method for Stability and Robustness Verification of Systems with NN Feedback using Positivity Constraints.

MSc in Aerospace Engineering — **Sharif University of Technology**
• *Control Courses GPA: 3.75* — *Sept. 2017 - June 2020*
• Thesis: Coupled Attitude–Orbit Dynamics and Control of a Solar Sail via Center-of-Mass Manipulation.

BSc in Aerospace Engineering — **Sharif University of Technology**
• *Thesis: Attitude Control of an Under-Actuated Satellite by Two Reaction Wheels.* — *Sept. 2012 - June 2017*

Selected Publications

• H. Montazeri Hedesh and M. Siami, "Ensuring Both Positivity and Stability Using Sector-Bounded Nonlinearity for Systems With Neural Network Controllers," IEEE Control Systems Letters, vol. 8, pp. 1685-1690, 2024.

• H. Montazeri Hedesh, M. Wafi, and M. Siami, "Local Stability and Region of Attraction Analysis for Neural Network Feedback Systems under Positivity Constraints," 2025 IEEE 64th Conference on Decision and Control (CDC), Rio de Janeiro, Brazil, 2025, pp. 1142-1149

• H. Montazeri Hedesh, M. K. Wafi, B. Shafai, and M. Siami, "Robust Stability Analysis of Positive Lur'e System with Neural Network Feedback," 2025 IEEE Conference on Control Technology and Applications (CCTA), San Diego, CA, USA, 2025, pp. 976-981.

• A. Darabi, H. M. Hedesh, M. Siami and M. Sznaier, "Predator-Swarm-Guide Dynamics: A Hybrid Approach to Crowd Modeling and Guidance in Mass Shooting Scenarios," 2024 American Control Conference, Toronto, ON, Canada, 2024, pp. 4402-4408.

• H. Montazeri Hedesh, and M. Siami, "Delay Independent Safe Control with Neural Networks: Positive Lur'e Certificates for Risk-Aware Autonomy," 2026 American Control Conference (ACC), New Orleans, LA, USA, 2026, pp. 134-141.

• H. Montazeri Hedesh, and M. Siami, "Taming Neural Feedback Loops via Positivity: Stability, Robustness, and Region of Attraction," Submitted to IEEE Transactions on Automatic Control.

• M. Wafi, H. Montazeri Hedesh, and M. Siami, "Distributed Adaptive Estimation over Sensor Networks with Partially Unknown Source Dynamics," accepted at the IFAC World Congress 2026.

• M. Wafi, H. Montazeri Hedesh, and M. Siami, "A Passivity-Agnostic Framework for Distributed Adaptive Synchronization under Unknown Leader Dynamics," 2026 American Control Conference (ACC), New Orleans, LA, USA, 2026, pp. 3385-3391.

Research and Impact

• Developed novel **global and local sector bounds for FFNNs**, enabling depth-agnostic and input-aware bounds with tighter and faster certification than state-of-the-art methods (e.g., CROWN).

• Developed a **scalable stability and robustness verification pipeline** for **learning-enabled autonomous systems**, providing formal guarantees for NN feedback interacting with autonomous dynamical systems under positivity constraints, achieving up to $\sim\mathbf{10}^4\times$ speedup over the state-of-the-art.

• Designed **safe-by-design NN controllers** for systems with **time delays** and **model uncertainty**: the architecture enforces the required stability sector on the controller's gain at the origin by construction, and a **sector-regularized imitation-learning** loss pushes the trained controller to stay inside the sector.

• Integrated state-of-the-art **NN verification tools** (AutoLiRPA, JAX-Verify) with **classical control analysis** (Lyapunov-based methods, MPC, robust analysis) to build reproducible verification workflows bridging MATLAB and Python.

• Investigated **safety-critical control scenarios** by modeling crowd dynamics via fluid analogies and designing optimal egress control policies, demonstrating the use of control-theoretic tools for decision-making under uncertainty in real-world human-centered systems.

• Conducted **IQC-based** stability and robustness analysis of NNs in feedback with dynamical systems, accounting for **structural uncertainty**, **parametric variations**, and **time delays** in both the plant and learning components.

• Performed a comprehensive study of **NN bounding, reachability, and safety verification methods** in open-loop and closed-loop settings, identifying scalability limits and opportunities for control-theoretic structure exploitation.

• Derived and controlled **coupled attitude–orbit dynamics** of a solar sail using center-of-mass manipulation, including trajectory optimization via SNOPT, demonstrating integration of nonlinear dynamics, optimization, and control in a space robotics context.

• Designed and analyzed nonlinear attitude control for an **under-actuated satellite** using only two reaction wheels, addressing actuation constraints and stability in 6-DOF dynamics.

Open-Source Software

nnsector: Python and MATLAB library that computes global and local sector bounds of feedforward neural networks for absolute-stability analysis of neural feedback loops; supports tanh, sigmoid, ReLU, leaky ReLU, and softplus networks and PyTorch models (github.com/hmon91/nnsector).

nnstab: Python and MATLAB library that certifies exponential stability of positive feedback loops with a neural network controller and finds the largest certified region of attraction, using Metzler and Hurwitz tests instead of semidefinite programming (github.com/hmon91/nnstab).

Work Experiences

Northeastern University, Department of Electrical and Computer Engineering**:** **Sep. 2021 - Present**

• Research and teaching assistant.

Safatco, Gas turbine industry: **Dec. 2019 - Oct. 2020**

• Reverse engineering and development of electro magnetic servo valve for fuel control system of industrial gas turbine.

Sharif Technology Services, Satellite-building project: **Apr. 2018 - Oct. 2019**

• Developed code for estimating satellite attitude and position using **EKF** and **UKF**.

• Designed comprehensive **functional test plans** for the satellite's control subsystem, encompassing all testing stages from individual component validation to integrated subsystems assessment and final satellite testing.

• Designed and configured **test beds** for satellite's control subsystems across all testing phases, from single component to integrated subsystems tests.

• Designed **sensor calibration** plans; performed 3-axis magnetometer (ellipsoid fitting), MEMS gyro, and magnetorquer calibrations.

Sharif Technology Services, Aerospace Systems Manufacturing Project**:** **Jan. 2017 - May 2017**

• R&D for a reaction wheel for satellite attitude control; drafted verification & calibration procedure.

Selected Projects

• Installed and calibrated a Quanser autonomous lab environment, configuring multi-camera sensing for real-time pose estimation of drones and ground vehicles, and supporting autonomous flight and driving experiments.

• Safe control learning for a network of quadcopters using my proposed scalable NN feedback loop verification method.

• Safe imitation learning of an MPC controller for an inverted pendulum dynamics.

• Configured two Franka Emika robotic arms and set up a Tic-Tac-Toe game interaction between them.

• Applied Sparse Identification of Nonlinear Dynamics (SINDy) and Sum-of-Squares (SOS) methods to discover governing equations and certify stability properties of nonlinear systems from data.

• Developed data-driven identification pipelines for extracting oceanic transport and flow dynamics from measurements collected by spatially dispersed drifters, modeling oceanic currents as spatiotemporal dynamical systems.

• Designed and analyzed networked epidemic dynamics with cities as nodes and inter-city travel as transport edges; optimized vaccination and intervention strategies to mitigate disease spread in spatially distributed systems.

- Modeling and control of a satellite's attitude considering fuel sloshing effect.
- Modeling and controller-observer design for a quadcopter, and implementation on an Arduino board.
- A priori statistical analysis and control of aircraft encountering clear-air turbulence considering the measurement noise effect.
- Nonlinear momentum transfer control of 6-DOF spacecraft by feedback linearization.
- Fluid Dynamics Simulation of re-entry vehicle using Gambit and Fluent.
- Structural Dynamics Simulation and Analysis of Airplane's Wing Box using Finite Element Method by Abaqus.

Teaching & Student Mentorship

Teaching Assistant: Classical Control (EECE 5580, Spring 2023); Electrical Engineering Class & Lab (EECE 2210 & 2211, Spring 2025); Linear Systems Analysis (EECE 7200, Fall 2025); Embedded Design Enabling Robotics (EECE 2160, Spring 2026), Northeastern University.

Mentorship: "Robotic Gloves for Teaching Piano," Capstone project, Summer 2024, Northeastern University.

Leadership: Founder & President of Northeastern ECE Ph.D. Council, Board Member of Happy Helpers Charity Group.

Presentations & Professional Services

Paper Presentation

- "Crowd Modeling, Guidance, and Control in Mass School Shooting Scenarios," Dec. 2023, The Society for Risk Analysis, Washington, DC, USA.
- "Predator-Swarm-Guide Dynamics: A Hybrid Approach to Crowd Modeling and Guidance in Mass Shooting Scenarios," Jul. 2024, Virtual Presentation for American Control Conference, Toronto, Canada.
- "Ensuring Both Positivity and Stability Using Sector-Bounded Nonlinearity for Systems With Neural Network Controllers," Dec. 2024, Virtual Presentation at Conference on Decision and Control, Milan, Italy.
- "Robust Stability Analysis of Positive Lur'e System with Neural Network Feedback," Sep. 2025 IEEE Conference on Control Technology and Applications, San Diego, CA, USA.
- "Local Stability and Region of Attraction Analysis for Neural Network Feedback Systems under Positivity Constraints," Dec. 2025 IEEE Conference on Decision and Control, Rio de Janeiro, Brazil.
- "Delay Independent Safe Control with Neural Networks: Positive Lur'e Certificates for Risk-Aware Autonomy," May 2026 American Control Conference, New Orleans, LA, USA.

Poster Presentation

- "Stability Verification of AI-enabled System of Systems Subjected to Time Delays," Jul. 2022, Control and Learning Enabled Verifiable Robust AI (CLEVR AI) Project at Multidisciplinary University Research Initiatives (MURI) program Annual meeting, Boston, MA, USA.
- "A Scalable Stability Verification Method for AI-enabled System of Systems under Positivity Constraints" Dec. 2024, Control and Learning Enabled Verifiable Robust AI (CLEVR AI) Project at Multidisciplinary University Research Initiatives (MURI) program Annual meeting, Washington, DC, USA.
- "Integration of Adaptive Identification and Control-Oriented Safe Learning for Networked Systems," May 2025, Northeast Systems and Control Workshop, Washington, DC, USA.
- "Stability Verification of AI-enabled System Under Time Delay and Parametric Uncertainty," Nov. 2025, Control and Learning Enabled Verifiable Robust AI (CLEVR AI) Project at Multidisciplinary University Research Initiatives (MURI) program Annual meeting, Washington, DC, USA.

Reviewer

- IEEE Control Systems Letters CDC 2024.
- IEEE Conference on Decision and Control 2025.
- IEEE American Control Conference 2025.
- IFAC Workshop on Cyber-Physical & Human-Systems 2024.
- IEEE Control Systems Letters ACC 2024.
- IEEE Conference on Decision and Control 2024.
- IEEE American Control Conference 2026 (2 reviews).
- IEEE Conference on Decision and Control 2026.
- IEEE Control Systems Letters 2026 (2 reviews).

Professional Organizations

- Member of Institute of Electrical and Electronics Engineers (IEEE)
- Member of Society for Risk Analysis (SRA)