Shadi Haddad

shhaddad@ucsc.edu | shadihdd.github.io | shadi-haddad

Summary

PhD in Applied Mathematics and MSc in Mechanical Engineering focused on uncertain systems, machine learning, and control. A strong mathematical background in optimization and dynamical systems, along with extensive programming experience implementing high-performance numerical simulations, novel neural architectures, and optimization technique.

Education

PhD, Applied Mathematics & Statistics — Sep 2019 – March 2024
University of California, Santa Cruz — *Santa Cruz, CA*

- Applied Mathematics Research Award • Chancellor's Fellowship • Advancement with Honors

MSc, Mechanical Engineering — Sep 2015 – Jan 2018
University of Tehran — *Tehran, Iran*

- Full Tuition Merit Scholarship

Skills

Optimization:	Semidefinite programming (SDP), Constrained optimization
High Performance Computing:	Python (incl. NumPy, SciPy, Jax), MATLAB, JavaScript, CSS, C++
Machine Learning:	Nonlinear regression, Neural networks, Reachability analysis
Control Theory:	Optimal control, Stochastic control, Model predictive control (MPC), Simulink
Software:	SolidWorks, Abaqus FEA, git

Experience

Data Scientist and Analytics Consultant — Sept 2024 – Present
Addidas Combat Sports (OPTAPT LLC) — *Remote, US*

- Product inventory planning using constrained optimization methods
- Statistical analysis of product reviews using open-source Large Language Models (LLMs)

Graduate Student Researcher — Sep 2019 – March 2024
UC Santa Cruz — *Santa Cruz, CA*

- Introduced the sublinear input neural network (ISNN) architecture (output function is sublinear in input data).
- Developed custom algorithms for set-based reachability, improving accuracy by 20-30% over leading methods.
- Proposed a probabilistic learning approach to estimate the reach sets of feedback linearizable systems.
- Devised novel reach set intersection detection methods for feedback linearizable systems.
- Established upper bounds for the expected Hausdorff distance between linear time varying control systems.

Team Leader — Sept 2020 – March 2022
Ford University Research Project, Ford Greenfields Lab — *Palo Alto, CA*

- Proposed a non-parametric stochastic prediction method with 30% runtime speedup over Monte Carlo in an automated driving highway case study.
- Designed a prediction and optimal feedback control framework for stochastic reachability in multi-lane automated driving.

Graduate Student Researcher — Sep 2015 – Jan 2018
Mechanical Engineering, University of Tehran — *Tehran, Iran*

- Designed micro-piezoelectric actuator and performed vibration control.
- Designed an observer-based fault reconstruction scheme using terminal sliding modes to guarantee asymptotic system convergence.
- Derived the analytical solution for a nonlinear model of a functionally graded tapered micro-bridge using the Homotopy-Padé technique.
- Increased axial deflection of micro-beam by 18% and improved model of natural frequency by considering small scale effects, nonlinear mid-plane stretching, and lateral deflections.

PUBLICATIONS

Exact Computation of LTI Reach Set from Integrator Reach Set with Bounded Input.
Shadi Haddad, Pansie Khodary, Abhishek Halder. *IEEE Control Systems Letters*, 2024, URL.

The Curious Case of Integrator Reach Sets, Part I: Basic Theory.
Shadi Haddad, Abhishek Halder. *IEEE Transactions on Automatic Control*, 2023, URL.

Convex and Nonconvex Sublinear Regression with Application to Data-driven Learning of Reach Sets.
Shadi Haddad, Abhishek Halder. *American Control Conference*, 2023, URL.

A note on the Hausdorff Distance between Norm Balls and their Linear Maps.
Shadi Haddad, Abhishek Halder. *Set-Valued and Variational Analysis*, 2023, URL.

Certifying the Intersection of Reach Sets of Integrator Agents with Set-valued Input Uncertainties.
Shadi Haddad, Abhishek Halder. *IEEE Control Systems Letters*, 2022, URL.

Density-Based Stochastic Reachability Computation for Occupancy Prediction in Automated Driving.
Shadi Haddad, Abhishek Halder, and Baljeet Singh. *IEEE Transactions on Control Systems Technology*, 2022, URL.

Boundary and Taxonomy of Integrator Reach Sets.
Shadi Haddad, Abhishek Halder. *American Control Conference*, 2022, URL.

Anytime Ellipsoidal Over-approximation of Forward Reach Sets of Uncertain Linear Systems.
Shadi Haddad, Abhishek Halder. *CPS IoT Week Workshop*, 2021, URL.

Prediction and Optimal Feedback Steering of Probability Density Functions for Safe Automated Driving.
Shadi Haddad, Kenneth F Caluya, Abhishek Halder, Baljeet Singh. *IEEE Control Systems Letters*, 2020, URL.

The Convex Geometry of Integrator Reach Sets.
Shadi Haddad, Abhishek Halder. *American Control Conference*, 2020, URL.

Observer Based Fault Reconstruction Schemes Using Terminal Sliding Modes.
Mohammad Mousavi, Mostafa Rahnavard, **Shadi Haddad**. *International Journal of Control*, 2018, URL.

Analytical Study on Nonlinear 3D Coupled Deformations of Tapered FG Micro-beams Accounting for Size Effects.
Shadi Haddad, Mostafa Baghani, M.R. Zakerzadeh. *Iranian Journal of Science and Technology*, 2018, URL.

HONORS & AWARDS

Applied Mathematics Research Award.
University of California at Santa Cruz, 2022.

Student Travel Award.
IEEE Control Systems Society, American Control Conference, 2020-2022.

Advancement to Ph.D Candidacy with Honors.
University of California at Santa Cruz, 2022.

Chancellor's Fellowship.
University of California at Santa Cruz, 2019.

Full Tuition Merit Scholarship.
University of Tehran, 2015.

Ranked top 1% among more than 20,000 applicants in nationwide universities entrance exam for Mechanical Engineering graduate studies.
Iran, 2015.

Ranked top 1% among more than 340,000 applicants in nationwide universities entrance exam for undergraduate studies.
Iran, 2011.

Instructional Experience

Teaching Assistant, UC Santa Cruz
Computational Methods and Applications, Winter 2024 (Undergrad)
Nonlinear Dynamical Systems, Fall 2023 and Fall 2021 (Grad & Undergrad)
Convex Optimization, Fall 2022 (Grad)

- Designed and delivered weekly lectures on supplementary course materials.
- Guided students with course concepts.
- Designed and evaluated students assignments.

Mathematics Instructor, Iran

- Prepared students for entry into Exceptional Talent High Schools, 2016-2018

Talks & and Professional Activities

Convex and Nonconvex Sublinear Regression with Application to Data-driven Learning of Reach Sets.
American Control Conference, San Diego, CA, 2023.

Certifying the Intersection of Reach Sets of Integrator Agents with Set-valued Input Uncertainties.
IEEE Conference on Decision and Control, Cancún, Mexico, 2022.

Boundary and Taxonomy of Integrator Reach Sets.
American Control Conference, Atlanta, GA, 2022.

Prediction and Optimal Feedback Steering of Probability Density Functions for Safe Automated Driving.
American Control Conference, Virtual, 2021.

The Convex Geometry of Integrator Reach Sets.
3rd NorCal Control Workshop, Virtual, 2021.

The Convex Geometry of Integrator Reach Sets.
American Control Conference, Virtual, 2020.

Understanding the Geometry of Integrator Reach Sets for Robotics Applications.
Bay Area Robotics Symposium, University of California at Berkeley, 2019.

Reviewer for Journal of Systems and Control Letters, 2024, 2023.

Reviewer for Journal of Optimization Theory and Applications, 2023.

Reviewer for American Control Conference, 2023, 2022.

Reviewer for IEEE Control Systems Letters, 2023, 2021.

Reviewer for IEEE Conference on Decision and Control, 2022, 2021, 2020.