Ali Vaziri

Kansas, USA

Ph.D. Student — Mechanical Engineering (Control, Estimation, Deep Learning)

Email — Website — LinkedIn — Google Scholar

Education

- **University of Kansas** — Lawrence, KS
  Ph.D., Mechanical Engineering (GPA: 3.97/4.00) — *2023 – Present*
  - Thesis: *Optimal Inferential Control of Machine Learning Models.*
- **University of Kansas** — Lawrence, KS
  M.Sc., Mechanical Engineering (GPA: 3.97/4.00) — *2023 – 2025*
  - Thesis: *Heavy-Tailed Bayesian Inferential Motion Planning for Autonomous Vehicles.*
  - Developed digital twin frameworks for autonomous vehicles using real-world driving data; integrated GRU/ResNet dynamics with Bayesian inference for robust motion planning.
- **Sharif University of Technology** — Tehran, Iran
  B.Sc., Marine Engineering (GPA: 3.55/4.00) — *2016 – 2021*
  - Thesis: *Collision-Free Marine Waste-Collection Robot.*

Summary

I develop safe and computationally efficient optimal control frameworks for complex systems governed by neural-network dynamics. My work blends optimal control and Bayesian inference with GPU-accelerated inference to achieve real-time, robust decision-making in high-dimensional, nonlinear dynamical systems (e.g., autonomous vehicles, soft robots, and thermo-fluid systems).

Research/Teaching and Industry Experience

- **Mitsubishi Electric Research Laboratories (MERL)** — Cambridge, MA
  Research Intern — Machine Learning and Optimization — *Summer 2024*
  - Extended digital twin concepts to HVAC by building real-time Neural ODE/GRU simulators, enabling efficient system forecasting, delivered PyTorch toolkit for MERL researchers.
  - Improved forecasting accuracy and runtime efficiency via data-efficient training and GPU acceleration.
- **University of Kansas** — Lawrence, KS
  Graduate Research Assistant — *2023 – Present*
  - Continuous-time MPC via Bayesian inference for Neural-ODE–based soft-robot manipulators; achieves 10× accuracy gains and 200× faster solve times versus CasADi + IPOPT.
  - **IEEE T-RO 2025** (Paper): Developed learning-based vehicle dynamics models (GRU, ResNet) for AV trajectory planning; validated on real-world driving datasets. GRU models were subsequently applied in MPC benchmark evaluations (CasADi + IPOPT).

- **ACC 2025** (Paper): Heavy-tailed Bayesian motion planning with Student's-t priors for improving exploration; sequential Monte Carlo ensemble Kalman-t smoother for robust inference; validated on neural-network-based vehicle dynamics.
- Constructed digital twins of autonomous vehicles from real-world datasets, linking GRU/ResNet dynamics models with Bayesian motion planning frameworks. Validated on highway driving data with robustness to uncertainty.
- **ACC 2025** (Paper): MPC of convolutional neural networks using gradient-free CUDA-based matrix-variate ensemble Kalman smoothing; achieved 20× faster computations and 12× higher memory efficiency in large-scale neural networks.
- Reinforcement-learning–driven sensor placement for persistent monitoring, optimizing estimation-error covariance for robust coverage.
- Tensor-variate GPU-compatible ensemble Kalman smoother for optimal control of neural-network–modeled high-dimensional systems (3D, and 2D Navier–Stokes & Burgers' PDEs), enabling millisecond-scale optimal control where classical solvers fail.
- Physics-constrained Neural-ODE-GRU for HVAC modeling; achieved 14% accuracy improvement and 5.7× faster runtime with data-efficient training.

- **Sharif University of Technology** Tehran, Iran
  Undergraduate Researcher *2020 – 2022*
  - Built a mobile robot with a SCARA arm for sea-surface plastic collection; integrated hybrid path planning (RRT, Dijkstra, potential fields) with PID control.
  - Modeled mechanisms and ran simulations in MATLAB/Simulink; created CAD in SolidWorks for rapid prototyping.

- **Sharif University of Technology** Tehran, Iran
  Teaching Assistant — Structure Analysis (Prof. M. R. Tabeshpour) *Spring 2018 – 2019*
  - Led problem-solving sessions, graded assignments/exams, and provided office-hour support to students.

Publications

First-Authored:

- **Ali Vaziri**, et al. "Continuous-Time Optimal Control of Neural ODEs via Bayesian Inference", Under review.
- **Ali Vaziri**, et al. "Optimal Inferential Control of Machine Learning Models", Under review.
- **Ali Vaziri**, et al. "Physics-Constrained Neural ODEs for HVAC: Scalable, Efficient, and Physically Consistent Modeling", Under review.
- **Ali Vaziri**, et al. "Bayesian Inferential Motion Planning Using Heavy-Tailed Distributions", In 2025 *American Control Conference (ACC)*, (Paper).
- **Ali Vaziri**, et al. "Optimal Inferential Control of Convolutional Neural Networks", In 2025 *American Control Conference (ACC)*; Best Student Paper nominee (Paper).

Co-Authored:

- Iman Askari, **Ali Vaziri**, et al. "Model Predictive Inferential Control of Neural State-Space Models for Autonomous Vehicle Motion Planning", *IEEE Transactions on Robotics (T-RO)*, 2025, (Paper).

Selected Undergraduate Projects in Sharif (2018-2021)

- AUBO-i5 (6R) collaborative robot: forward/inverse kinematics (Robotics Toolbox), Simscape model, Jacobian & singularity analysis; Newton–Euler dynamics with PD control (MATLAB/Simulink).
- Surgical needle navigation GUI (MATLAB): collision-free path planning with RRT.
- SCARA robot: DH-based forward/inverse kinematics; SimMechanics verification.

Certifications

Reinforcement Learning Specialization (Link) — University of Alberta & AMII (Coursera).
Topics: TD learning, Monte Carlo, SARSA, Q-learning, Policy Gradients, Dyna, function approximation.

Skills

- **Control and Estimation**
  - Optimal Inferential Control; MPC via Bayesian inference, NMPC/MPPI; Optimal control of Neural ODE/PDE systems
  - Kalman Filtering and Smoothing (KF/EKF/UKF/EnKF; tensor/matrix-variate EnKF and EnKS); Particle filters
  - Robust filtering and smoothing; inference with Student's-t distribution
- **Machine Learning and Dynamical Modeling**
  - Digital Twins, Generative AI, Neural ODE/PDEs, CNNs, GRU/LSTM, physics-informed ML, time-series forecasting
  - System identification; dynamic programming and reinforcement learning fundamentals
- **Optimization**
  - Gradient-based methods
  - Gradient-free methods; ensemble Kalman inversion for NN training and system identification
  - Constrained nonlinear optimization: CasADi + IPOPT integration, benchmarking, sensitivity analysis
  - Large-scale linear algebra and convex optimization (QP, SQP)
- **Programming**
  - Languages: Python, MATLAB, C/C++, LaTeX
  - Libraries/Tools: PyTorch, TensorFlow, NumPy/SciPy, CUDA GPUs, cuDNN

Awards, Grants and Honours

"Challenge Seeker" Outstanding Student Award, University of Kansas 2025
Student Travel Award, American Control Conference (ACC) 2025
Wyatt Memorial Scholarship (Top 1% of graduate students) 2023
Best Publication Award (MIC) 2022
Excellent Student Award: 3rd Rank, Sharif Marine Engineering 2019
Top 0.4% in Iran Nationwide University Entrance Exam 2016

References available upon request.