Anant A. Joshi

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Summary

- As a control theorist and applied mathematician by training, I aim to understand and solve current problems in reinforcement learning, machine learning, diffusion models, and optimization through the lens of optimal control and filtering.
- I have a background in optimal control and filtering, stochastic differential equations, optimal transport and differential geometry.
- My current research focuses on simulation based reinforcement learning algorithms for continuous space control systems and Markov chains, and studying filter stability for the same systems.

Publications

- **Anant A. Joshi**, Amirhossein Taghvaei, Prashant G. Mehta, Sean P. Meyn„ "Controlled interacting particle algorithms for simulation-based reinforcement learning,", Systems & Control Letters, Volume 170, 2022, 105392, ISSN 0167-6911.
- **Anant A. Joshi**, Debasish Chatterjee, Ravi N. Banavar, "Robust Discrete-Time Pontryagin Maximum Principle on Matrix Lie Groups", IEEE Transactions on Automatic Control, vol. 67, no. 7, pp. 3545-3552, July 2022.
- **Anant A. Joshi**, D.H.S. Maithripala, Ravi N. Banavar, "A bundle framework for observer design on smooth manifolds with symmetry", Journal of Geometric Mechanics, 2021, 13(2): 247-271..
- **Anant A. Joshi**, Debasish Chatterjee, Ravi N. Banavar, "Robust Discrete-Time Pontryagin Maximum Principle on Matrix Lie Groups", 2020 59th IEEE Conference on Decision and Control (CDC), Jeju, Korea (South), 2020, pp. 1086-1091.
- **Anant A. Joshi**, Kamesh Subbarao, "Uncertainty Quantification and Analysis of Dynamical Systems with Invariants", AAS-19-368, 29th AAS/AIAA Space-Flight Mechanics Meeting, Maui, HI, January, 2019.
- **Anant A. Joshi**, Maulik C. Bhatt, Arpita Sinha, "Modification of Hilbert's Space-Filling Curve to Avoid Obstacles: A Robotic Path-Planning Strategy", 2019 Sixth Indian Control Conference (ICC), Hyderabad, India, 2019, pp. 338-343.

Education

Ph.D. in Mechanical Science and Engineering, UIUC (Advisor: Prof. Prashant Mehta)

Jan. 2021 - present

- Awarded the prestigious Grainger Engineering Graduate Fellowship

B.Tech. in Mechanical Engineering, M.Tech. in Systems and Control Engineering

Aug. 2015 - July 2020

- Best student paper award at the 29th AAS/AIAA Space-Flight Mechanics Meeting, Maui, HI, January, 2019 for work with Prof. Kamesh Subbarao.

Research Experience

Particle Systems for Simulation Based Reinforcement Learning

UIUC

- Considered the problem of reinforcement learning for continuous time and continuous state systems. Proposed a simulation based algorithm based on the Ensemble Kalman filter, which leverages duality between optimal control and filtering
- Proposed algorithm directly approximates the optimal control law bypassing the need to solve the HJB equation which makes our approach up to two orders of magnitude more computationally efficient than competing approaches.

Filtering for Linear Gaussian systems and Markov Chains (current work)

UIUC

- Investigating stability of ensemble Kalman filter and non-linear filter for discrete state Markov chains via duality formalisms.

Robust Discrete-Time Pontryagin Maximum Principle on Matrix Lie groups

IIT Bombay, India

Master's Thesis with Prof. R. N. Banavar and Prof. D. Chatterjee — *Jan. 2016 - Jun. 2017*

- Proposed an extension of the Pontryagin maximum principle for discrete-time optimal control with bounded disturbances on matrix Lie groups.
- Verified the analytical solution by simulation it on the Lie Group of 2 dimensional rotations.

Lie Group Symmetry in Observer Design on Smooth Manifolds

IIT Bombay, India

Research Project with Prof. R. N. Banavar and Prof. D. H. S. Maithripala — *Aug'18 - Jul'19*

- Highlighted the decomposition of observer design problem into 2 smaller subsystems under Lie group symmetry and leveraged this structure to propose an observer for the total system.

Uncertainty Quantification in Dynamical Systems with Invariants

University of Texas at Arlington, USA

Research Internship with Prof. K. S. Subbarao — *Jan. 2013 - Feb. 2013*

- Investigated dynamical systems that possess conserved quantities (invariants) when perturbed by Gaussian white noise. Characterized the temoporal evolution of the statistical moments of invariants. Theoretical results agreed closely with Monte Carlo simulation.
- For rigid body dynamics showed that the mean of kinetic energy evolves linearly in time and obtained a computationally tractable form for covariance. For the two body problem, established bounds on the mean and variance of angular momentum.

Application of Hilbert's Space Filling Curve to Robotic Exploration

IIT Bombay, India

Research Project with Prof. A. Sinha — *Dec. 2011 - Feb. 2012*

- Used Hilbert's space filling curve to plan a path for an autonomous agent to fully explore a given region with obstacles. Presented an online strategy, assuming no apriori knowledge of the location of obstacles to implement the path.

Skills and Coursework

Coursework: Real Analysis, Probability Theory, Stochastic Differential Equations, Partial Differential Equations, Optimization in Vector Spaces, Optimal Control, Stochastic Control, Machine Learning for Signal Processing

Skills: Python, MATLAB, C++