Maulik Bhatt

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Education

University of California, Berkeley (UCB) [Jan'24 - Present]
Ph.D. student in the Department of Mechanical Engineering
Advsior: Prof. Negar Mehr
GPA: N/A(Transferred from UIUC starting Spring 2024)

University of Illinois Urbana-Champaign (UIUC) [Aug'21 - Dec'23]
Ph.D. student in the Department of Aerospace Engineering
Advsior: Prof. Negar Mehr
GPA: **3.91/4.0**

Indian Institute of Technology Bombay [Jul'16 - May'21]
Interdisciplinary Dual Degree Program

- Bachelor of Technology(with Honors) in the Department of Aerospace Engineering
- Master of Technology in the Department of Systems and Control Engineering

GPA : **8.96/10**

Research Interests

Motion Planning and Safe Autonomy using Game Theory, Reinforcement Learning, Stochastic Control and LLMs

Publications and Preprints

- **Maulik Bhatt** and Negar Mehr, "Strategic Decision-Making in Multi-Agent Domains: A Weighted Potential Dynamic Game Approach", submitted to **IEEE Transactions on Robotics (T-RO)**. (arXiv2308.05876)
- **Maulik Bhatt**, Yixuan Jia, and Negar Mehr, "Efficient Constrained Multi-Agent Trajectory Optimization Using Dynamic Potential Games," 2023 IEEE/RSJ **International Conference on Intelligent Robots and Systems (IROS)**, Detroit, MI, USA, 2023, pp. 7303-7310. (doi: 10.1109/IROS55552.2023.10342328)
- Yixuan Jia, **Maulik Bhatt**, and Negar Mehr, "RAPID: Autonomous Multi-Agent Racing using Constrained Potential Dynamic Games." In 2023 21st IEEE **European Control Conference(ECC)**. (doi:10.23919/ECC57647.2023.10178387)
- Negar Mehr, Mingyu Wang, **Maulik Bhatt**, and Mac Schwager, "Maximum-entropy multi-agent dynamic games: Forward and inverse solutions", **IEEE Transactions on Robotics (T-RO)**, 2023. (doi:10.1109/TRO.2022.3232300)
- **Maulik Bhatt**, Ayberk Yaraneri, and Negar Mehr, "Efficient constrained multi-agent interactive planning using constrained dynamic potential games", **RSS-2022 workshop** in Close Proximity Human-Robot Collaboration. (arXiv:2206.08963v1)
- **Maulik Bhatt**, Srikant Sukumar, Amit K Sanyal, "Rigid body geometric attitude estimator using multi-rate sensors." In 2020 59th IEEE **Conference on Decision and Control (CDC)**, pp. 1511-1516. IEEE, 2020. (doi:10.1109/CDC42340.2020.9304059)
- **Maulik Bhatt**, Srikant Sukumar, Amit K Sanyal, "Discrete-time Rigid Body Pose Estimation based on Lagrange-d'Alembert principle", **Journal of Nonlinear Science**, 2022. (doi:10.1007/s00332-022-09848-z)
- **Maulik Bhatt**, Amit K Sanyal, Srikant Sukumar, "Asymptotically Stable Optimal Multi-rate Rigid Body Attitude Estimation based on Lagrange-d'Alembert Principle", **Journal of Geometric Mechanics**, 2022. (doi:10.3934/jgm.2023004)
- Anant Joshi$^{\uparrow}$, **Maulik Bhatt**$^{\uparrow}$, Arpita Sinha, "Modification of Hilbert's Space-Filling Curve to Avoid Obstacles: A Robotic Path-Planning Strategy", Sixth **Indian Control Conference (ICC)**, Hyderabad, India, 2019, pp. 338-343. (doi:10.1109/ICC47138.2019.9123166) ($^{\uparrow}$ equal contribution)

Key Research Projects

Multi-Agent Interactive Planning using Dynamic Games | Advisor: Negar Mehr [Sep'21-Jul'23]

- Designed a fast and efficient **multi-agent constrained trajectory planner** using dynamic potential games
- Developed a real-time multi-agent trajectory planner that is **20 times faster** than the state-of-the-art
- Implemented the algorithm on **hardware** to demonstrate its real-time capabilities

Multi-Agent Autonomous Racing using Dynamic Games | PhD Research [Jun'22-Dec'22]

- Worked on developing a fast and efficient multi-agent racing planner using dynamic games
- Formulated the problem as a dynamic potential game, which resulted in a highly competitive racing algorithm

Maximum-Entropy Multi-Agent Inverse Dynamic Games | PhD Research [May'22-Aug'22]

- Studied the problem to learn the objectives of multiple interacting agents from trajectory demonstrations.
- Worked on comparison of inverse dynamics games with state-of-the-art inverse optimal control solvers on synthetic and highway data to figure out that considering game theoretic interactions results in better algorithm

Coordination in Noncooperative Multi-agent Dynamic Games | PhD Research [Dec'23-Present]

- Working on efficient computation of multi-modality in multi-agent dynamic games and coordination

Estimation of Observation Space in Partially Observable Games | PhD Research [July'23-Present]

- Working on the estimation of observation space of agents through trajectory data in partially observable games

Multi-agent Deep Reinforcement Learning for Pursuit Game | RL Course Project [Feb'23-May'23]

- Implemented Independent Q-Learning(IQL) for cooperative multi-agent RL for multi-agent pursuit games.

TranDynaMo: Dynamics Modeling using Transformers | Deep Learning Course Project [Feb'23-May'23]

- Formulated dynamics modeling as a sequence modeling problem and employed Transformers capabilities to model dynamical systems and achieved as good performance as baselines like RRNs and GRUs.

Optimal Discrete-time Rigid Body Pose Estimation | Master's Thesis [Aug'20-Jun'21]

- Designed an **almost globally asymptotically stable** discrete-time pose estimation algorithm using Lagrange-d'Alembert principle and Lyapunov analysis

Autonomous Landing of Drones on Moving Ground Vehicles | Research Internship [May'19-Jul'19]

- Implemented a **Dynamic Image-Based Visual Servo Control** technique for autonomous landing
- Designed a **hybrid controller** to correct for the singularity so that a safe landing is guaranteed

Hilbert's Space-Filling Curve for Robotic Exploration | Supervised Learning Project [Jul'18-May'19]

- Developed an **online strategy** using Hilbert's space-filling curve to cover a region while **avoiding obstacles**
- Validated the strategy on a ground robot using **ROS** and **VICON Motion Capture system**

Software Skills

Programming	C/C++, Python, Julia, ROS, Simulink, MATLAB, LaTeX
Libraries	PyTorch, Pandas, Numpy, SciPy, JAX
Simulation & CAD	AutoCAD, SolidWorks, Gazebo, Ansys, XFLR5

Key Courses

Learning	Machine Learning, Deep Learning for Computer Vision, Markov Decision Processes(MDPs), Reinforcement Learning(RL),
Dynamics & Control	Stochastic Control, Analytical and Geometric Dynamics, Linear Systems Theory for PDEs, Differential Geometric Methods in Control, Multivariable Control
Applied Mathematics	Optimal Control, Probability and Random Processes, Games and Information, Optimization, Matrix Computations, Applied Linear Algebra, Tensors.

Leadership and Service

- **Teaching:** E178 - Statistics and Data Science for Engineers [Jan'24-Present]
- **Organizer:** Robotics Seminar@Illinois, UIUC [Aug'22-Aug'23]
- **Reviewer:** Transactions on Robotics(T-RO), Robotics and Automation Letters(RA-L); International Conference on Robotics and Automation(ICRA); International Conference on Intelligent Robots and Systems (IROS); Automatica; Conference on Decision and Control(CDC); Journal of Guidance, Control, and Dynamics
- **Mentor:** Institute Student Mentor and Department Academic Mentor at IIT Bombay [Jul'18-Ju'20]
- **Student Representative:** Annual General Meeting of Aeronautical Society of India [Oct'16]

Achievements and Awards

- Honoured with **Undergraduate Research Award** (awarded by IIT Bombay to select undergraduate students for exceptional effort towards research) for the work on Hilbert's Space-Filling Curve ['18]
- Amongst **2** out of 50+ students to be awarded the Institute Gymkhana Award **Technical Hostel's Commendation** for an extraordinary contribution towards technical activities ['19]
- Amongst **30 students** selected for **Panasonic Scholarship Program** from all over India's 23 IITs ['16]
- Ranked in the **top 0.7%** in **IIT JEE-Advanced** examination among 0.15 million aspirants ['16]