Manav Vora

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EDUCATION

University of Illinois Urbana-Champaign **Champaign, IL**
M.Sc. in Aerospace Engineering - Thesis Track, GPA: 3.83/4.0 Aug 2022 - May 2024 (expected)

- Advisor: Prof. Melkior Ornik
- Relevant Coursework : MDPs and Reinforcement Learning, Optimization in Aerospace Systems

Indian Institute of Technology Bombay (IIT Bombay) **Mumbai, IN**
B.Tech (with honors) in Aerospace Engineering, Minor in Systems and Controls Jul 2018 - Aug 2022

- Ranked 4^{th} out of 60 students in the department of aerospace engineering
- Recipient of **Chanakya Research Fellowship** awarded for research on autopilot design for delivery drone

SELECTED WORK EXPERIENCE

Constrained Multi-Agent Optimization | *Advisor: Prof. Melkior Ornik* | *LEADCAT Group, UIUC* Aug 2022 - Present

- Solving the problem of **multi-agent optimization** of large state space factored POMDPs via **Monte Carlo Tree Search**
- Developed an **optimal budget distribution** algorithm to decompose a multi-component budget-constrained POMDP into smaller independent POMDPs and make the optimal policy computationally feasible and efficient
- Created a novel **Budgeted-POMDP** model to facilitate budget constraint satisfaction during optimal policy computation
- Implemented a **POMCP** solver in **Julia** for optimal policy synthesis of a Budgeted-POMDP and obtained the optimal budget split among multiple Budgeted-POMDPs by solving a convex optimization problem using **CVXPY**
- Performed simulations using real life infrastructure management data and outperformed the policy currently used in practice

Reinforcement Learning for Optimal Trajectory Synthesis | *Course Project* Aug 2022 - Dec 2022

- Analyzed and compared performance of **DQN, SARSA, Q-Learning and Monte Carlo** RL algorithms for optimal landing of a lunar lander on the surface of the moon in the presence of external disturbances.
- Visualised the performance of all algorithms on the spacecraft by creating animations using the **Python Gym Environment**
- Obtained the final trajectories of the lunar lander from the animations, using object tracking in **OpenCV**

RiP - Risk Aware Planner | *Personal Project* Aug 2022 - Dec 2022

- Created a **reachability-based** path planning algorithm for generating minimum risk paths in presence of obstacles
- Minimized the risk associated with a path by assigning risk boundaries around obstacles and optimizing for length and risk
- Achieved a **90%** decrease in risk as compared to non-risk aware RTD planners in the presence of adverserial obstacles

Lie Algebra Based Neural ODE | *Advisor: Prof. Pratik Chaudhari* | *GRASP Lab, UPenn* Apr 2021 - Feb 2022

- Implemented **Hamiltonian-based Neural ODE** on pendulum and quadrotor to understand its structure and working
- Worked on incorporating **Lie Algebra** in Neural ODE architecture to increase dynamics prediction accuracy
- Achieved validation error under **5%** on CIFAR-10 dataset via design and implementation of a **16x4 Wide ResNet**
- Implemented different deep neural networks like **LeNet, ResNet, AlexNet, GoogleNet** on the fashion MNIST dataset
- Executed **RRT-star** algorithm on Dubins' Car with 2 nearest neighbor search heuristics to understand Lie Algebra

Control of Agile Tethered Drone Attached to Moving Vehicle | *Bachelor's Thesis* Jan 2021 - May 2022

- Developed a **ROS controller package** and merged with PixHawk to achieve trajectory tracking with less than **3%** error
- Created a novel **Gazebo** model of a quadrotor UAV tethered to a fixed support via a flexible tether

- Developed a Gazebo **control force plugin** using C++ to apply external force to the system for dynamics simulation

Autopilot Design for Delivery Drone | *Advisor: Prof. Arnab Maity* Jul 2020 - Jan 2022

- Conceptualised a novel **Hamiltonian Neural ODE** network based adaptive controller to maintain system performance in the presence of dynamic uncertainties like payload imbalance, motor failure and distrubances
- Designed an **e–modification** based adaptive controller and achieved an accuracy of **98%**
- Formulated the dynamics and performed stability analysis of a drone carrying unbalanced grasped payload
- Compared the performance of various flight control techniques like **PID, Dynamic Inversion and Backstepping**

Adaptive Control of an Aircraft With Actuator Faults | *Course Project* Jan 2021 - May 2021

- Examined the problem of controlling the longitudinal dynamics of an aircraft having a stuck elevator
- Analysed stability of the **hybrid longitudinal dynamics** of an aircraft using linear systems theory
- Formulated and implemented a Linear Quadratic Regulator (**LQR**) to stabilise the closed loop dynamics
- Incorporated actuator faults in the dynamics and designed and implemented a **Model Reference Adaptive Controller with Sigma Modification** to achieve **97% tracking accuracy** in presence of these faults

Dynamic Modelling of a Kangaroo | *Course Project* Nov 2020 - Dec 2020

- Created a novel **abstraction** taking references from the literature and videos of hopping of kangaroo
- Researched in detail about the role of static friction force in the entire hopping process of kangaroo
- Calculated the energy expended by the leg muscles and tendons of the kangaroo and frictional force per cycle of hopping of kangaroo matching the experimental results within an error margin of **6%**

Cooperative Load Transportation Using Helicopters | *Undergraduate Research Project* Apr 2020 - Dec 2020

- Simulated the dynamics of a helicopter carrying a suspended point mass payload using Python
- Re-derived the dynamical equations of the helicopter plus payload system using **Lagrangian mechanics**
- Learned about important concepts pertaining to nonlinear systems and **rotational dynamical systems**

Collision Risk Analysis for Autonomous Car | *Advisor: Prof. Ashwini Ratnoo* | *IISc Bangalore* May 2021 - Jul 2021

- Obtained realistic bounds on the reachable set of the system, to be used for an **approximate risk analysis**
- Implemented an algorithm to compute and visualise the reachable set of a point mass system
- Performed a literature survey on sensors to get an idea about available parameters of the traffic participant

Control Systems Engineer | *ExoFly, IIT Bombay* Aug 2019 - Sep 2021

- Created a state space model of a **2D vehicle with acceleration and steering** and simulated it in MATLAB
- Designed **PD controller** to track forward velocity with an accuracy of approximately **98%**

TECHNICAL EXPERIENCE

Languages	Python, Julia, C++, C, MATLAB
Tools & Frameworks	ROS, Pytorch, Apache MXNet, Numpy, SciPy, sklearn, Gym, OpenCV, Pandas, Compyle, Gazebo, Simulink, LaTeX, Mayavi, git, CVXPY

TEACHING EXPERIENCE

Teaching Assistant | *Guide: Prof. Arnab Maity* | *Control Theory* Jul 2021 - Dec 2021

- Worked in a **team of 6** students to help the professor in smooth day-to-day conduction of the course
- Responsible for curation of a comprehensive compendium of the course for **80+** students in the department