Arpit Dwivedi

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Research Interests

○ **Theory** - AI & Robot Learning, Decision Making, Reinforcement Learning, Optimal Control, Nonlinear Systems
○ **Applications** - Space Robots and Systems, Autonomous Ground and Aerial Vehicles, Multi-agent Systems

Education

Stanford University, California, USA   **[2024 - 2026]**
Master of Science in Aeronautics and Astronautics Engineering   *GPA: 3.95/4*

Indian Institute of Technology Bombay, Mumbai, India   **[2020 - 2024]**
Bachelor of Technology with Honors in Mechanical Engineering   *GPA: 9.43/10*
Minor in Artificial Intelligence and Data Science

Publications

A. Dwivedi, H. Hazarika, D. Mukherjee, and D. Pal, **"Decentralized Control Strategy for Path-Following in Snake Robots"**, *International Conference on Control, Decision and Information Technologies(CoDIT)*, 2025, Accepted

Y. Niu, **A. Dwivedi**, J. Sathiaraj, P. P. Lathi and R. Nagamune, **"Floating Offshore Wind Farm Control via Turbine Repositioning: Unlocking the Potential Unique to Floating Offshore Wind"**, IEEE Control Systems, vol. 44, no. 5, pp. 106-129, 2024, doi: 10.1109/MCS.2024.3432342

A. Dwivedi, and C. Pimpalkhare, **"Coverage Maximization for UAV Surveillance on Non-convex Domains using Genetic Algorithm"**, *National Conference on Multidisciplinary Design, Analysis and Optimization*, 2023

Research Experience

Trajectory Optimization Using Language Models| Autonomous Systems Lab   **[Nov '24 - Apr '25]**
Guide*: Prof. Marco Pavone, Department of Aeronautics and Astronautics, Stanford*
Introduction: *Can a sequential optimizer be warm-started for solving non-convex optimal control problems?*
○ Developed and trained a GPT–2–based Decision Transformer to model trajectory-conditioned policies for spacecraft rendezvous, enabling learning-based trajectory optimization
○ Engineered & optimized the S6-Mamba Linear-Time Sequence Model, utilizing selective scanning and hardware-aware design for efficient, domain-informed trajectory prediction in autonomous space missions.
○ Deployed Structured State Space Model (S4D) to generate warm-start solutions for nonlinear trajectory optimization
○ Concluded that Transformer-based architectures outperform SSMs in both feasibility and quality of solutions

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Design and Control of Snake Robot   **[Jul '23 - Jul '24]**
Guide*: Prof. Dwaipayan Mukherjee, Department of Electrical Engineering, IIT Bombay*
Introduction: *ISRO-assigned project of fabricating a snake robot and designing a controller to enable robotic locomotion*
○ Developed a novel decentralized control algorithm for stabilization and precise trajectory tracking for snake robot
○ Designed & fabricated modular snake robots using Dynamixel MX-64R smart actuators with parallel joint axes
○ Formulated dynamics & tested open loop control inputs for the serpentine locomotion of assembled snake robot

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SeDriCa (Self-Driving Car)| Student Research Project   **[Feb '22 - Apr '24]**
Guide*: Prof. Amit Sethi, Department of Electrical Engineering, IIT Bombay*
Introduction: *SeDriCa: A team of 20+ students working on autonomous ground vehicles with participation in IGVC.*

Project*: Is it possible to implement a control architecture that ensures safe and precise tracking on Indian roads?*
- Implemented Non-linear Model Predictive Control (NMPC) with discrete-time dynamic bicycle model for optimal control inputs ensuring smooth driving and communication among modules in Robot Operating System (ROS)
- Improved vehicle path planning & safety tracking by fusing Artificial Potential Fields with Model Predictive Control
- Integrated low-level steering controller for real-time deployment using an Arduino microcontroller, conducted vehicle testing under ideal conditions, and established communication with the drive-by-wire system via the CAN module
- Deployed and tested Pure Pursuit and Stanley controllers for precise lateral control and waypoint tracking

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Control Design for Offshore Wind Turbine [May '23 - Jul' 23]
Guides*: Prof. Ryozo Nagamune, Department of Mechanical Engineering, University of British Columbia*
Introduction: *To design and tune the repositioning controller for maximizing the power output and investigating the integration of Reinforcement Learning-based control strategies.*
- Designed and tuned a PID nacelle-yaw controller for the IEA-15MW semi-submersible offshore turbine, achieving an overall 6.6% fluctuation from mean output power
- Developed a learning control strategy for offshore wind turbines using the deep deterministic policy gradient method

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Swarm Algorithms based Optimization of Rescue Robots [Jan '23 - Aug '23]
Guide: *Prof. Avinash Bhardwaj, Industrial Engineering and Operations Research, IIT Bombay*
Introduction: *Can we architect an autonomous pipeline encompassing sensing, coverage optimization, and task allocation for rescue robots?*
- Developed a 3-stage pipeline for rescue missions, encompassing mapping, sensing, and robotic deployment to enhance mission efficiency
- Proposed a novel framework leveraging Genetic Algorithms with Monte Carlo sampling and direct sensor position encoding to optimize sensor configurations
- Achieved high coverage in complex environments, including non-convex and disconnected domains

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Heat Transfer in Jet Impingement [May '22 - Aug '22]
Guide*: Prof. Rajendra P Vedula, Department of Mechanical Engineering, IIT Bombay*
Introduction: *The project involved the prediction of convective heat transfer coefficients in eccentric and concentric jet impingement scenarios on a conical surface's apex region.*
- Validated trends in Nusselt number with in-house experimental data for conical wall of included angle 30° and 70°
- The maximum deviation for the peak Nusselt number between experimental and computed results was observed to be 6.8% for flat wall and 16.3% (concentric) and 14% (eccentricity 0.5) for conical wall surfaces
- Assessed shift in peak of Nusselt number due to reshaping the vertex of cone into hemisphere with different radii
- Surveyed computational procedures for impingement over flat wall surfaces and validated existing literature data
- Concluded with $k - \omega$ SST model best for modelling impingement with maximum Nusselt number error 11.4%

Key Projects

Multirobot Navigation Under Uncertainty| *Stanford University* [Sep '24 - Dec '24]
- Implemented an Extended Kalman Filter (EKF)-based state estimator for improving multi-robot navigation accuracy
- Deployed a multi-agent control strategy by adapting POMCP double progressive widening algorithm to solve the Partially Observed Markov Decision Process formulated

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Vision based Pick and Place| *Stanford University* [Sep '24 - Dec '24]
- Achieved 96% mIoU in object detection with U-Net-based segmentation for precise feature delineation in 2D images
- Trained an end-to-end grasping algorithm using grasping affordance maps for enhanced object manipulation

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Generative AI for Molecular Design | *IIT Bombay* [Jan '24 - Apr '24]
- Trained a GAN model to generate novel molecular structures from SMILES for photovoltaic efficiency optimization
- Preprocessed SMILES data through tokenization, and embeddings for scalable generative model training
- Conducted molecular data analysis and integrated chemical constraints to ensure validity of generated compounds

Pose Estimation and Feedback Control| *IIT Bombay* **[Jul '23 - Nov '23]**
- ○ Estimated probabilistic pose of differential drive robots through belief propagation and velocity motion models
- ○ Deployed Lyapunov analysis based non-linear feedback for stabilization and trajectory tracking of unicycle robots

Adaptive Control of Spacecraft Attitude| *IIT Bombay* **[Sept '22 - Nov '22]**
- ○ Developed a Control Lyapunov Function (CLF) based controller to stabilize the pre-defined attitude dynamics
- ○ Utilized adaptive integrator backstepping for precise trajectory tracking under initial inertia offset of 30%

Intelligent Learning Agents| *IIT Bombay* **[Aug '22 - Nov '22]**
- ○ Implemented ϵ -greedy, UCB, KL-UCB and Thompson Sampling for stochastic multi-armed bandits
- ○ Computed optimal policy of MDP using Value Iteration, Policy Iteration, and Linear Programming algorithms
- ○ Modelled the last wicket in a game of cricket as MDP and planned optimal policy for a batter chasing target

Flexible and Extendable Manipulator| *IIT Bombay* **[Jul '23 - Nov '23]**
- ○ Designed a woodpecker's-tongue-inspired manipulator that can extend in length and flex in a desired direction
- ○ Manufactured, assembled and demonstrated capability of the manipulator by maneuvering through a duct

Bayesian Switchpoint Analysis & Image Denoising| *IIT Bombay* **[Jan '23 - Apr '23]**
- ○ Implemented advanced MCMC algorithms **(Metropolis-Hastings, RWM, NUTS)** for Bayesian inference on probabilistic models, effectively capturing posterior distributions of switch points and disaster rates
- ○ Attained highest ESS score for **NUTS** (Switchpoint: **905.61**, Early Disaster Rate: **223.02**, Late Disaster Rate: **644.74**), demonstrating superior exploration of posterior distributions over HMC and RWM
- ○ Utilized **Gibbs sampling** and **Metropolis-Hastings** algorithms for solving complex image restoration problems.

Achievements and Awards

1) NSF Scholar (Narotam Sekhsaria Foundation): UG Engineering Scholarship Program **[2024]**
2) MITACS Globalink Research Scholar: Awarded fellowship by Canadian Government to pursue research internship at Control Engineering Laboratory, University of British Columbia, Vancouver **[2023]**
3) Achieved **100** percentile in Mathematics in JEE-MAINS amongst **1.1** million candidates appeared **[2020]**

Relevant Coursework

Control & Estimation	Robot Perception, Topics in Advanced Robotic Manipulation, Optimal and Learning based Control, Saftey-Critical Autonomy, Robot Autonomy, Estimation on Lie Groups, Nonlinear Dynamical Systems, Embedded Controls and Robotics, Microprocessor and Automatic Controls
Artificial Intelligence	Deep Learning for Computer Vision, Decision Making Under Uncertainty, Reinforcement Learning, Advanced Machine Learning, Online Learning and Optimization
Programming	Data Structure & Algorithms, Computer Programming & Utilization
Mathematics	Convex Optimization, Linear Algebra, Calculus, Numerical Analysis, Ordinary Differential Equations

Technical Proficiency

Programming Languages	C++, Python, MATLAB
Softwares & Tools	ROS, Linux, Gazebo, Git, RViZ, SolidWorks, ANSYS, Simulink, Arduino, XEP100
Libraries & Packages	PyTorch, OpenCV, PyBullet, CVXOPT, roscpp, rospy, NumPy, Pandas, SciPy, Matplotlib, Seaborn, Plotly, Keras