

# Arpit Dwivedi



## Research Interests

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

## Education

**Stanford University, California, USA**

*Master of Science in Aeronautics and Astronautics Engineering*

**[2024 - 2026]**

*GPA: 4/4*

**Indian Institute of Technology Bombay, Mumbai, India**

*Bachelor of Technology with Honors in Mechanical Engineering*

**[2020 - 2024]**

*Minor in Artificial Intelligence and Data Science*

*GPA: 9.43/10*

## Publications

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, Accepted

## Research Experience

**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

**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

**Control Design for Offshore Wind Turbine**

**[May '23 - Jul '23]**

Guides: [Prof. Ryoze 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%

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## Work Experience

### Opendrone Private Limited | Control Systems Intern

[May '24 - Jul '24]

- Implemented a control strategy for deploying the tailsitter's flaps, ensuring a smooth VTOL transition in hardware
- Reduced crabbing effects and enhanced the tailsitter's stability and robustness by effectively enabling weathervaning

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## 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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### 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

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### 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%

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### Intelligent Learning Agents| IIT Bombay

[Aug '22 - Nov '22]

- Implemented  $\epsilon$ -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

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#### 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

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#### 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.
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## Relevant Coursework

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<b>Control &amp; Estimation</b>	Robot Perception, Topics in Advanced Robotic Manipulation, Robot Autonomy, Estimation on Lie Groups, Nonlinear Dynamical Systems, Embedded Controls and Robotics, Microprocessor and Automatic Controls
<b>Artificial Intelligence</b>	Decision Making Under Uncertainty, Reinforcement Learning, Advanced Machine Learning, Online Learning and Optimization
<b>Programming</b>	Data Structure & Algorithms, Computer Programming & Utilization
<b>Mathematics</b>	Convex Optimization, Linear Algebra, Calculus, Numerical Analysis, Ordinary Differential Equations

## Technical Proficiency

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