Tejash Raj
Systems & Control Engineering
Indian Institute of Technology Bombay

25M2010
M.Tech.
Gender: Male
DOB: 15/02/2003

Examination	University	Institute	Year	CPI / % Credits
Post Graduation	IIT Bombay	IIT Bombay	2027	null Core: | Total:
Graduation	IIEST Shibpur	IIEST Shibpur	2025	7.82
Graduation Specialization: Aerospace and Applied Mechanics				
Intermediate	CBSE	Delhi Public School	2021	90.40%
Matriculation	ICSE	St. Teresa's School	2019	92.30%

AREAS OF INTEREST

• Control System • Robotics • Autonomous Drone System • Reinforcement Learning • Computer Vision

PUBLICATIONS

Optimized Last-Mile Delivery: Integrating Drones with Carrier Vehicles using Team-Restricted Multiagent Rollout
Tejash Raj, Arpita Sinha | Conference Paper — AIAA SciTech 2027 (Submitted)

- Developed a **multiagent rollout-based , battery-aware dispatch framework** for multi-drone–carrier last-mile delivery.
- Demonstrated **scalable sequential drone assignment** with complexity linear in fleet size and evaluated performance under varying customer spread and fleet size.

M.TECH THESIS

Autonomous Quadrotor Navigation, Perception and Control | *M.Tech Thesis* [May'26 – Present]

Guide: Prof. Arpita Sinha, Systems and Control, IIT Bombay

Objective: Develop an autonomous quadrotor **navigation and control framework** for traversing racing gates, and extend it to **onboard stereo vision-based navigation** through previously unknown openings, eliminating reliance on external motion-capture systems.

Completed Work - Learning-based control for autonomous quadrotor gate navigation.

- Developed a **learning-based control framework** using Proximal Policy Optimization (PPO) for autonomous quadrotor navigation through a sequence of racing gates, with the policy generating control actions from gate-relative state information.
- Formulated the navigation problem using a **kinematic quadrotor model**, enabling the vehicle to regulate its motion based on its relative position and orientation with respect to the target gate.
- Incorporated **actuation and state-estimation delays** into simulation to model the real-world sensing, estimation, and control pipeline, and applied **domain randomization** to improve robustness and sim-to-real transfer.
- Deployed and experimentally evaluated the trained controller on a **Crazyflie 2.0**, using **Qualisys motion capture and the Crazyflie EKF** for real-time state estimation and autonomous flight.

Ongoing Work - Onboard Stereo Vision-Based Navigation:

- Developing an **onboard perception and state-estimation system** using **drone-mounted stereo cameras** to eliminate reliance on external motion-capture systems and enable autonomous navigation in unknown environments.
- Developing a **gate and opening detection pipeline** from **stereo-based depth observations** to identify candidate passages and estimate their relative position, orientation, and geometry with respect to the quadrotor.
- Extending the navigation framework from predefined racing gates to **arbitrary openings and gaps**, enabling the quadrotor to identify feasible passages in previously unknown environments.
- Applying **largest-rectangle fitting** to detected openings to determine the largest feasible passage region and extract its geometric properties.
- Converting the estimated opening geometry into **opening-relative state information** for the controller/RL policy, enabling the quadrotor to navigate through previously unknown passages.

COURSE PROJECTS AND SELF PROJECTS

Autonomous Mobile Robot Motion Planning and Navigation | *Course Project* [Jan'26 - Apr'26]

Course: *SC 627* | *Motion Planning & Coordination of Autonomous Vehicles* | *Prof. Arpita Sinha*

- Generated a **2D occupancy grid map** using **SLAM** and formulated the robot's **configuration space (C-space)** by inflating obstacles with the robot radius and safety margin.
- Implemented **A*** path planning from scratch using a **priority queue** and **Euclidean heuristic**, along with an alternative planner for comparative trajectory generation.
- Deployed the planning framework on a physical **TurtleBot**, integrating **AMCL** and tuning costmap and path-following parameters; evaluated planners through **simulation and hardware experiments** .

Receding Horizon Control for Autonomous Crazyflie Navigation | *Course Project* [Jan'26 - Apr'26]

Course: *SC 627* | *Motion Planning & Coordination of Autonomous Vehicles* | *Prof. Arpita Sinha*

- Formulated the **Crazyflie navigation problem** as a **double-integrator optimal control problem** and generated collision-free trajectories using **trajectory optimization** with obstacle constraints.
- Implemented **open-loop trajectory execution** in Gazebo and developed a closed-loop **Receding Horizon Controller** using **MPC** for real-time trajectory re-planning based on state and obstacle information.
- Deployed the controller on a physical **Crazyflie** and analyzed the **sim-to-real gap** through simulation and hardware trajectory comparisons.

Autonomous Navigation in Fire Environment using Drone | *Course Project* [Jul'25 - Nov'25]

Course: *SC 662* | *Robotics Capstone Project* | *Prof. Leena Vachhani*

- Simulated **indoor fire scenarios** with multi-room and multi-corridor layouts using the **FDS solver in PyroSim**, and developed a **ROS2-based closed-loop control architecture** for autonomous fire-source localization using temperature data.
- Implemented and evaluated **Hill Climbing** and **Multi-Armed Bandit** approaches, including **Greedy, ϵ-Greedy, and UCB** strategies, for fire-source localization in unknown environments.

Real-Time Decision-Making Agent (Microchess AI) | *Self Project* [Jul'25 - Nov'25]

Technologies: *Python, Minimax, Reinforcement Learning*

- Designed and implemented **game-tree search agents** (**minimax** with handcrafted state-evaluation functions) making sequential decisions under **hard per-action latency budgets (5–200ms)**, analogous to real-time planning constraints in robotic control loops.
- Built a **reinforcement learning agent** via **self-play** to learn a decision policy directly from state representations, without hand-engineered heuristics, outperforming a random baseline by 50+/100 in evaluation.
- **Designed** a compact **state-action representation** using **bitboard encoding** and **tensorized board states**, optimizing memory efficiency and enabling real-time decision-making for **robotics RL**.

RELEVANT COURSES *Ongoing

- Systems Theory **SC 625**
- Control of Nonlinear Dynamical Systems **SC 602**
- Intelligent Feedback Control **SC 645**
- Robotics - Capstone Project **SC 662**
- Estimation on Lie Groups* **SC 651**
- Optimization **SC 607**

TECHNICAL SKILLS

Languages: C++, C, Python, XML (for ROS)
Hardware: Raspberry Pi, Arduino, ESP32, Qualisys Motion-Sensing Cameras, Turtlebot, Crazyflie, Big Quad Deck, Stereo Camera
Software: MATLAB, Simulink, Gazebo, Visual Studio Code, MS-Office
Tools: ROS-2, ROS-2 Control, RViz, Linux, LaTeX, Arduino IDE, Git

SCHOLASTIC ACHIEVEMENTS

- Secured "AA" grade in two courses **Robotics - Capstone Project** and **M.Tech Seminar**.

EXTRA-CURRICULAR ACTIVITIES AND HOBBIES

- Enthusiast of **Table Tennis** and **Pool**.