Prachit Gupta

github | prachitg@iitb.ac.in | LinkedIn

Education

Indian Institute of Technology Bombay — Mumbai, India
B.Tech. in Mechanical Engineering; ***GPA: 3.67/4.0*** — *Nov 2021 – May 2025 (Expected)*
Minor Degree in Systems and Controls — *July 2022 – May 2025 (Expected)*

The Shishukunj International School — Indore, India
Intermediate; ***GPA: 99.2/100*** — *July 2021*

The Shishukunj International School — Indore, India
Matriculation; ***GPA: 96.5/100*** — *June 2019*

Research Interest

Safety-critical Control, Robotics, Control theory, Optimal control, Multi-agent control, Game theory, Distributive optimization, Learning-based control, Reinforcement Learning, Unmanned Aerial Systems, Quadrupeds, Mobile robotics

Awards & Achievements

- Awarded **fellowship** by **Canadian** Government to pursue research at Queens University, Kingston *('21)*
- Qualified as a **KVPY** Fellow and finished among **top 3 %** of applicants from a pool of **97000+** candidates *('21)*
- Secured All India Rank **917** out of **150,000+** candidates in the **JEE Advanced** Exam *('21)*
- Secured All India Rank **388** in **Joint Entrance Exam Mains** among over **1.4 million** applicants *('21)*

Research Experience

Advanced Safety and Control Systems for Autonomous Vehicles — IIT Bombay, India
Dept. of Systems and Control Engineering | Advisor: Prof. Arpita Sinha — *July 2023 – March 2023*

- Developed a **safety verification system** for autonomous cars using **forward reachability**, ensuring collision-free navigation and generating optimized emergency trajectories using **convex optimization** in **CVXPY**
- Computed **avoid sets** for AVs, realized as the viscosity solution of the **Hamilton-Jacobi PDE** for safe **robot-human interactions**, using the **helperOc** package for **dynamic programming** and optimal controls.
- Integrated reachability-based safety guarantees into a **Model Predictive Controller** for overtaking maneuvers of autonomous vehicles, modeled as a **zero-sum differential game** between the ego and a human lead vehicle.

Safewalk Robotics — Queen's University, Canada
Dept. of Electrical and Computer Engineering | Advisor: Prof. Matthew Pan — *May 24- July 24*

- Developed **ROS** controllers for detection based dynamic object following on **Quadruped Unitree GO1**.
- Crafted **human-following** algorithms in **ROS2** for **Turtlebot4** using **depthai-blazepose** for skeletal detection
- Implemented **SLAM** and **Follow the Gap** based object avoidance using ROS2 and **NAV2** for indoor navigation.
- Designed a hybrid **SL-based RL policy** framework for person-following robots in outdoor environments, robust to occlusions, and detection inaccuracies by training **deep neural networks** on a custom expanded dataset.

Multi-Agent Control with Safety Guarantees — IIT Bombay, India
Dept. of Systems and Control Engineering | Advisor: Prof. Mayank Barnwal — *Aug '24 - Present*

- Developed decentralized neural networks in **PyTorch** to ensure **safe multi-agent** control across varying scales.
- Jointly trained control policies and **barrier functions**, enhancing safety and scalability in complex environments.
- Leveraged **Large Language Models** (LLMs) to intuitively and effectively optimize **Reinforcement Learning** (RL) reward functions for **Deep -Q-Network** agents in an Intelligent driving scenario in a **human-centric** way.

Communication and Control of Autonomous Drones — IIT Bombay, India
Dept. of Aerospace Engineering | Advisor: Prof. Dhwanil shukla — *Feb '22 - Dec' 22*

- **Senior Avionics Engineer** responsible for conducting state-of-the-art research to achieve full aerial autonomy.
- Employed wind data for **barometric compensation**, ensuring stable altitude and preventing sudden drops.
- Customized the **Ardupilot's** autopilot codebase to develop a custom mode enabling immediate motor shutdown.
- Developed **Minimum Snap** trajectories with optimized time segments using **constrained quadratic programming**

Projects

Unmanned Aerial System Competition (UAS) 2023, UK Feb '23 - Jun '22

- Achieved outstanding results, winning 3 awards: **Best Design**; **Scrutineering Award** for meeting supportability goals; **Advancement Award** for highest score among newcomers at Buckminster, UK
- Designed a **7 kg drone** for relief operations, capable of lifting 150,000 of payload & a flight of **20+ min**.
- Leveraged **Lua Scripting**, **Pymavlink**, and **RPI GPIO** interfaces for safe and reliable payload drop actuation
- Simulated the complete mission in **Gazebo** environment using **ROS** with **ArduPilot** as the flight control stack.
- Tested additional **safety features** like datalink loss, GC Fail Safe, and geo-fencing of autopilot for high-speed

International Aerial Robotics Competition (IARC), Norway Aug '22 - Oct '22

- Recognized by the organizers with **Special Mention** for the concept of a system of mother and daughter drone.
- Manufactured and assembled a **15kg** payload drone, Audrey, sized 2m x 2m with **Xavier NX** onboard computer
- Engineered the entire circuitry and developed C code for an autonomous replacement and gripper assembly

Estimation on Lie Groups Jan '24 - Apr '24

- Derived spacecraft attitude estimators and observers using **Wahba**, **Quest**, **Triad** and **Kalman filter** algorithm.
- Authored a review paper on MPC for Invariant Systems on Matrix **Lie Groups**, using **stable embedding** into Euclidean spaces and combining manifold-based motion description with **MPC constraint handling**.

UAV Control Apr '23 - May '23

- Implemented and tuned **Control-Lyapunov** function-based Non-linear **Backstepping coupled Sliding Mode Controller** for better tracking and robust performance against disturbances and changing parameters
- Achieved stable tracking even with an additional **45%** uncertainty in rotary inertia and disturbances.
- Modelled lateral and longitudinal autopilots for a model of **Fixed-wing** aircraft in **Matlab** using **Simulink**.

Inverted Pendulum Sep '24 - Nov '24

- Developed a framework to swing up and balance an inverted pendulum using **energy-based nonlinear** control.
- Implemented **LQR-based** swing-up strategy for **cart-pole** system, achieving stabilization from downward to upward position in **4 seconds**.

Soft Robotic Gripper Sep '24 - Nov '24

- Developed a **soft robotic** compliant two-finger gripper mechanism for high **adaptability** and gentle gripping.
- Implemented a mechanism for adaptive handling of food items using **topological** and **shape optimization**.
- Designed a **3-DOF robotic arm** using servo motors and a solenoid actuator to demonstrate gripper's efficacy.

Autonomous Maze Solver Mar '22 - Jun '22

- Ideated and Developed **CAD** assembly of a **wall climbing bot** with a rocker-bogie like mechanism and a servo gripper to autonomously navigate, locate, and pick colored balls in a given arena using **Solidworks**.
- Crafted python scripts for implementing **bug0, bug1** and obstacle avoidance algorithms using **ROS** and Gazebo.

Mentorship and Teaching Experience

Technical Advisor Team Aerove April 2023 – Present

UMIC aims to facilitate technical start-ups and foster an atmosphere of innovation.
Led training sessions for 15 new recruits in ROS, OpenCV, and drone building.

Solve for society Dec 2023 – Jan 2023

Led projects in Solve-For-Society by Amazon's Innovation Story Foundation.
Guided teams from underprivileged schools to create solutions for people with disabilities

Relevant Coursework and Skills

Systems and Controls: Guidance & Control of UAVs, Signals and Feedback Systems, Linear and Nonlinear Systems, Microprocessors and Automation, Random Processes in Learning and Control, Mathematical Structures for Control

Math and Computing: Games and Information, Estimation on Lie Groups, Introduction to Numerical Analysis, Linear Algebra, Differential Equations, Introduction to Machine Learning, Operations Modeling

Hands-on Courses: Microprocessors and Automatic Control Lab, Mechanical Measurements, Kinematics and Dynamics of Machines, Manufacturing Processes Lab, *Design of Mechatronic Systems, *Machine Design

Programming: C/C++, Python, Arduino, Matlab, Lua, URDF, Xacro

Software Tools: ROS, ROS2, Git, MATLAB, Simulink, Solidworks, Eagle, Gazebo, Arduino, QGC, Mission Planner, CoppeliaSim, X-Plane, Rviz, Mavros, Ardupilot, PX4 LaTeX

Frameworks: Gymnasium, TIVA, Mavros, OpenCv, Scikit-learn, Numpy, Matplotlib, helperOc, CVXPY, CasADI