

Prachit Gupta

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EDUCATION

University of Illinois Urbana Champaign

Urbana, IL

Master of Science in Mechanical Engineering; **GPA: 4.0/4.0**

Aug 2025 – May 2027 (Expected)

Indian Institute of Technology Bombay

Mumbai, India

B.Tech. in Mechanical Engineering; **GPA: 3.67/4.0**

Nov 2021 – May 2025

Minor Degree in Systems and Controls

July 2022 – May 2025

RESEARCH INTEREST

Safety-Critical Control, Formal Verification, Multi-Agent Systems, Motion Planning, UAVs, Foundation Models

AWARDS & ACHIEVEMENTS

- Awarded **fellowship** by the **Canadian Government** to pursue research at Queen's University, Kingston ('24)
- 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

Statistical Contraction for LLM based UAV Planners 🧠

UIUC, Illinois

Aerospace Engineering Department | Advisor: Prof. Hiroyasu Tsukamoto

Jan 26 - Present

- Derived **probabilistic safety bounds** using **conformal prediction** for a fine-tuned **LLaMA-8B** based UAV planner, certifying **incremental exponential stability** to an optimal trajectory via **contraction theory**.
- Integrated the certified planner into a **closed-loop control** architecture, coupling LLM-based **intuitive language communication** and **semantic scene awareness** with real-time trajectory tracking.
- Demonstrated natural-language task execution via probabilistic tubes with guaranteed **safety radius of 0.24m** calibrated at **90% coverage** over **2000** samples, on **Starling2** in **real-world cluttered indoor environments**.

Diffusion-based Graph Control Barrier Functions for Multi-Agent UAVs 🧠

UIUC, Illinois

Mechanical Science and Engineering Department | Advisor: Prof. Naira Hovakimyan

Aug 25 - Present

- Jointly trained a **GNN-based actor** and **graph control barrier certificates** (GCBF+) within a **diffusion-based** multi-agent framework for decentralized safe UAV control.
- Leveraged the **GCBF+** formulation to achieve **scalability** and **generalizability** across varying agent numbers, topological configurations, and system dynamics with an empirically derived **safety rate of 99%**
- Deployed the framework on hardware with **8 Crazyflie UAVs** via **Crazyswarm**, successfully demonstrating symmetric **position-swap** exchanges where traditional **QP-based** controllers encountered deadlock.

Robust Adaptive Control for Quadrotors 🧠

UIUC, Illinois

Mechanical Science and Engineering Department | Advisor: Prof. Naira Hovakimyan

Aug 25 - Present

- Developed an **augmented LQR + L_1 adaptive controller** for a planar quadrotor, achieving **decoupled adaptation and robustness**, improved tracking, while guaranteeing bounded away from zero time-delay margin.
- Implemented a safe heterogeneous multi-robot coordination operation involving **multi-drone rendezvous**, where multiple **Crazyflie UAVs** autonomously tracked and maintained relative hover above a moving Jackal UGV.

Full-Stack Autonomy Pipeline for the Polaris GEM e2 🧠

UIUC, Illinois

Dept. of Electrical and Computer Engineering | Advisor: Prof. Sayan Mitra

Jan 26 - Present

- Formulated a moving-lookahead **Frenet-frame Model Predictive Controller with OSQP obstacle constraints**, validated in closed-loop simulation for real-time obstacle avoidance on the **Polaris GEM e2**.
- Deployed the full hardware stack on the vehicle testbed, integrating lane perception, Pure Pursuit/PI control, and **PACMod drive-by-wire** into an end-to-end **perception-to-control pipeline**.

Leveraging LLMs for RL Agents in Intelligent Driving Scenarios 🔗

IIT Bombay, India

Dept. of Systems and Control Engineering | Advisor: Prof. Mayank Barnwal

Nov 24 - May 25

- 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.
- Distilled LLM driving judgments into reward shaping** and an action surrogate with **93.7%** held-out accuracy and showed that policies learned human-like speed selection, safe merging, and restrained lane changes.

Safewalk Robotics 🔗

Queen's University, Canada

Dept. of Electrical and Computer Engineering | Advisor: Prof. Matthew Pan

May 24- July 24

- Developed ROS2 perception and control stacks for **socially aware person following** on a **Unitree GO1 quadruped** and TurtleBot 4 testbeds, using pose and depth cues for responsive human-robot interaction.
- Designed a hybrid **Supervised Learning based RL policy** framework for human-following robots, robust to occlusions and detection inaccuracies, trained on a custom expanded dataset.

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

- Computed **reach-avoid** sets for autonomous vehicles via **Hamilton Jacobi reachability** based **formal verification** methods ensuring safe overtaking of human-driven vehicles
- Integrated formally verified reachability-based safety guarantees into a **Model Predictive Controller** for overtaking maneuvers, modeling **human-robot interaction** as a **zero-sum differential game**.

Communication and Control of Autonomous Drones

IIT Bombay, India

Dept. of Aerospace Engineering | Advisor: Prof. Dhwanil shukla

Feb '23 - Dec '23

- Worked as **Senior Avionics Engineer** overseeing assembly and testing of custom-build autonomous drones.
- 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.

PROJECTS

Unmanned Aerial System Competition (UAS) 2023, UK ▶

Feb '23 - Jun '24

- 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

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.
- Oversaw manufacturing and assembly of a **15kg** payload drone, Audrey, sized 2m x 2m
- Engineered the entire circuitry and developed C code for an autonomous replacement and gripper assembly
- Designed and successfully fabricated a **custom PCB** board using **EAGLE** software to ensure compact circuitry

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 Model Predictive Tracking Control for Invariant Systems on Matrix **Lie Groups**, embedding manifold-based motion into Euclidean space for **MPC constraint handling**.

UAV Control

Apr '23 - May '23

- Implemented **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.
- Designed a **state-feedback** control system to balance the pendulum at its vertical upward position using **LQR**.
- Implemented the **LQR-based** swing-up strategy on a **TIVA** microcontroller, 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.

TEACHING EXPERIENCE

Teaching Assistant | Fluid Lab, TAM335

Instructor: Prof. Blake Everett Johnson

UIUC, Illinois

Aug 2025 – Present

- Solely managed TAM335 for 50+ students during summer and served as TA for **three consecutive semesters**.
- Independently ran three lab sections: taught, supervised experiments, graded reports, and managed operations.

Teaching Assistant | Makerspace, MS101

Instructor: Prof. Ankit Tiwari

IIT Bombay, India

Jan 2025 – May 2025

- Monitored and evaluated AutoCAD labs for 100+ first-year students.
- Mentored 20+ students in designing and building an RC drone from the ground up.

TECHNICAL SKILLS

Programming: C/C++, Python, Matlab, Lua, JAX, PyTorch, NumPy, Scikit-learn, OpenCV, CVXPY, CasADi

Software Tools: ROS, ROS2, Git, MATLAB, Simulink, Solidworks, Gazebo, Rviz, QGroundControl, Mission Planner, CrazySwarm2, Mavros, ArduPilot, PX4, PACMod, L^AT_EX

Frameworks/Hardware: Gymnasium, helperOC, TIVA C, Raspberry Pi, ZED2, Vicon

RELEVANT COURSEWORK

AI and Autonomy: Principles of Safe Autonomy, LLM Reasoning for Engineers, Guidance & Control of UAVs, Reinforcement Learning, Introduction to Machine Learning

Systems and Controls: Control Systems Theory, Robust & Adaptive Controls, Signals and Feedback Systems, Linear and Nonlinear Systems, Control of Nonlinear Systems

Math and Computing: Distributed Optimization, Random Processes, Games and Information, Estimation on Lie Groups, Numerical Analysis

EXTRACURRICULAR ACTIVITIES & LEADERSHIP

Technical Advisor, Team Aerove (UMIC, IIT Bombay)

Apr 2023 – Apr 2025

- Recruited and mentored students in foundational robotics tools and algorithms
- Led training sessions for 15 new recruits in ROS, OpenCV, and drone building.

Volunteering

Aug 2025 – Apr 2026

- A Rotaract: Food Donation drive/ Menstrual Hygiene Awareness drive/ Salt & Light NGO
- Habitat for Humanity: Helping in expanding access to safe and affordable housing
- Moderator for oral sessions at the UIUC STEM Symposium coordinating speakers and audience discussions
- Service Learning UIUC – devised lesson plans and delivered introductory drone-building lessons with interactive activities for middle school students.

REFERENCES

Prof. Hiroyasu Tsukamoto

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Prof. Matthew Pan

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