Rajdeep Singh

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Education

University of Pennsylvania — Philadelphia, PA
Masters of Science in Robotics (GPA: 3.9/4.0) — *Aug. 2025 – May 2027*

- **Relevant Coursework**:
  * Optimization based Controls | F1/10th autonomous racing | Discrete Generative Models (audit)
  * Deep Reinforcement Learning | State Estimation for Robotics | Controls for Adaptive and Reactive Robots
  * Mathematics for Robotics | Machine Learning | Introduction to Robotics | Principles of Deep Learning (audit)

Guru Gobind Singh Indraprastha University — Delhi, India
Bachelor of Technology in Computer Science and Engineering — *Aug. 2014 – May 2018*

Projects and Research

[Ongoing Research] Learning based MPC for Underwater Manipulator

- Formulated underwater trajectory tracking as a residual dynamics learning problem, modeling buoyancy, hydrodynamic drag, and other unmodeled fluid forces as unknown residual in the MPC forward dynamics model.
- Extended **KNODE-MPC** to model continuous-time underwater dynamics using Neural ODEs, combining learned dynamics with physics-based models for MPC-based trajectory tracking.
- Developed the end-to-end software stack for a **custom 4-DoF manipulator**, integrating Dynamixel actuators, ros2_control, Pinocchio, Ruckig, and MoveIt2 for real-time hardware control, motion planning, and execution.
- Integrated an underwater motion capture system for real world trajectory and dynamics data collection.
- **Tools:** Acados, CasADi, MoveIt2, ros2_control, C++, Pinocchio, MuJoCo, PyTorch, JAX, Sim2Real

[Ongoing Early Stage Research] Online RL for Flow-Based VLA Policies

- Exploring online RL methods for improving flow-based VLA policies across multi-task manipulation settings.
- Investigating recent flow-based RL approaches and their possible extensions with privileged critics for real-world VLA generalization without supervised fine-tuning for sim-to-real deployment.
- **Tools:** Isaac Lab, Pi 0.5

[Competition 2025-26] DARPA Abstract Planning and Semantic Understanding challenge

- Led a multi-institutional team for a DARPA challenge under the TIAMAT program with Prof. Antonio Loquercio (Penn), Prof. Yunzhu Li (Columbia) and Prof. Dhruv Shah (Princeton).
- Integrated **VLFM (Yokoyama et al.)** for language guided semantic navigation and **ReMEmbR (Anwar et al.)** for long-horizon spatio-temporal memory within our autonomous quadruped agent.
- Replaced VLFM's default **PointNav policy** for a simpler **A* based planner**. Built fully containerized deployment and evaluation infrastructure for the other teams to test and integrate their work.
- Resulting manuscript submitted to **ICRA 2027**, decision pending.
- **Tools:** Isaac Sim, Habitat Sim, ROS2

Autonomous Drone Racing using Reinforcement Learning: Youtube

- Placed in the **top 7 (out of 40 teams)** in both the Simulation and Sim2Real competitions as part of a two-person team. Competition submissions: Simulation and Sim2Real.
- Built the rewards and training infra for curriculum based drone racing pipeline in simulation **(trained in Isaac Lab)** followed by successful sim-to-real transfer onto **Crazyflie hardware** for real-world autonomous racing.
- Implemented **Proximal Policy Optimization** from scratch, with significant focus on system-level design including observations engineering, reward shaping for speed, and robust domain randomization for improved transferability.

Work Experience (6 Years)

Scalable Autonomous Robots Lab (ScalAR), University of Pennsylvania — Philadelphia, PA
Graduate Research Assistant — *May 2026 – Present*

- Advised by Prof. M. Ani Hsieh on learning based MPC for residual dynamics for underwater manipulators.
- Developing software infrastructure, simulation environments, and learning-based methods.

DREAM Lab, Indian Institute of Science — Bangalore, India
Senior Research Associate — *May 2024 – June 2025*

- Extensively worked with **ROS 2**, **Gazebo**, and **PX4** for simulation, with real-world validation on Jetson Orin Nano and Tello drones, leveraging C++ and Python.
- Developed a a hardware-agnostic, declarative programming model for UAVs with native support for **ML driven workloads across the edge-cloud continuum**. This work is published this at **IEEE ICWS 2025 (Core A Ranked)**.
- Evaluated the framework using real-time vision pipelines built with **OpenCV, MediaPipe, and YOLO**.

- Collaborated with **IBM India** on hybrid FaaS platforms across private and public clouds using Apache OpenWhisk, Docker, and Kubernetes; built upon the XFaaS orchestration framework.

Loco: Esports Streaming Platform Bangalore, India

Software Development Engineer III - Data Engineering *Nov. 2018 – Nov. 2023*

- Built and led the Data Engineering and MLOps team from the ground up, partnering with the CTO to productionize machine learning systems at the scale of **1.2 Million daily active users**.
- Architected end-to-end **core ML infrastructure and Data pipelines** for personalization and recommendation, integrating **Spark and Kafka** based data processing with offline training and online inference, scaling clips traffic from **7% to 35%**.
- Built a multi-tier **bronze–silver–gold data lake** and downstream **data warehouse** to support reliable feature engineering, model training, and analytics at scale.
- Designed, trained, and deployed production ML models, supporting real-time ranking, feed personalization, and onboarding optimization.
- Reduced feature and label freshness latency from **3 hours to 15 minutes** by building unified **real-time + batch ETL pipelines**, enabling faster experimentation and model iteration.
- Led ML-driven product improvements including personalized Search (**+25% CTR**), recommendation ranking, and large-scale analytics pipelines (Spotify-style year-end wrap processing **TBs of data**).
- Established scalable **MLOps infrastructure** using EMR, Airflow, and Redshift for model training, evaluation, monitoring, and reproducibility across multiple production ML systems.

Publications & Presentations

- Hu Y., Zheng Z., Zha L., Xing C., **Singh R.**, Hossain O., Loquercio A., Shah D. "RAVEN: Long-Horizon Reasoning & Navigation with a Visuo-Spatio-Temporal Memory" - arXiv preprint **(Under Review)**.
- S. Raj, **R. Singh**, K. Astu and Y. Simmhan, "AeroDaaS: An Application Programming Platform for Drones-as-a-Service," in **IEEE International Conference on Web Services (ICWS) 2025**.
- "Differentiation Engines: The Elves behind the AI Christmas", remote talk at **PyConZA 2024 (South Africa)**

Technical Skills

Languages: Python, C++, Go, SQL (PostgreSQL), Bash
Robotics: PyDrake, ROS2, MoveIt2, ros2_control, OMPL, Isaac Sim & Lab, Meta Habitat Sim & Lab, Mujoco
Machine Learning & Data: PyTorch, Keras, Scikit-learn, XGBoost, NumPy, Pandas, Matplotlib
Distributed Data Systems: Spark (PySpark), Kafka, AWS EMR, AWS Glue
MLOps & Cloud: Docker, Kubernetes, Git, Linux, AWS SageMaker, MWAA (Airflow), Kinesis
Backend & APIs: Flask, ExpressJS, RESTful services
Cloud Infrastructure: AWS Lambda, Step Functions, S3, EC2, DynamoDB