SRIJAN KUMAR PAL

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EDUCATION

Master of Science in Robotics
University of Minnesota, GPA - 3.91/4.0 [2022 - expected 2025]

Bachelors in Mechanical Engineering
Jadavpur University, GPA - 9.18/10.0 [Converted GPA- 3.92/4.0] [2018 - 2022]

RELEVANT COURSES

Graduate Courses: Feedback Controls, Machine Learning, Analytic and Data-Driven Decision Making, Natural Language Processing, Computer Vision, Robot Vision, Deep Learning.
Undergrad Courses: Programming in C, Optimization Techniques, Brain-Computer Interfacing, Modern Control Theory.

PUBLICATIONS

Srijan Kumar Pal, S. Sharma, N. Krishnakumar and J. Hong, **"Autonomous Drone for Dynamic Smoke Plume Tracking,"** *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA), 2025.* Under Review.

RESEARCH EXPERIENCE

Autonomous Drone for Dynamic Smoke Plume Tracking
- Masters Thesis Project under Prof. Jiarong Hong [May 2023 - Sept 2024]

- Developed a vision-based deep reinforcement learning (DRL) drone controller using Proximal Policy Optimization (PPO) to autonomously track smoke plumes in unsteady wind scenarios for precise plume particle data collection and compared its performance with a purpose-built PID-based controller.
- Created a custom Unreal Engine simulation environment (integrated with AirSim, PX4 SITL, WSL, and ROS) to test algorithm feasibility and train the PPO-based controller in dynamic smoke-wind scenarios.
- Integrated segmentation-based smoke localization within the camera frame, for real-time PID-controlled drone maneuvers within smoke plume to track wind-induced smoke shifts.
- Designed a novel PPO architecture (with optimized CNN, action space, and reward function) integrated with segmentation (using Stable Baselines, OpenAI Gym, and YOLO) for robust and intelligent control. This design enabled seamless Sim2Real policy transfer after training the PPO on diverse simulated smoke-wind scenarios.
- Deployed PPO and PID controllers on a Pixhawk quadcopter equipped with Jetson, to track real-life smoke plumes.
- Achieved 15% improvement in smoke tracking efficiency with PPO over PID in highly unsteady wind conditions, evaluated using custom smoke-tracking performance metrics.

3D Reconstruction of Smoke Plume using Drone Swarm
- Graduate Research Assistant under Prof. Jiarong Hong [Jan 2024 - Sept 2024]

- Developed a synchronized swarm of 4 drones to capture real-time multi-view smoke imaging, enabling adaptive spatial and temporal data collection tailored for reconstructing evolving smoke dynamics in 3D.
- Designed an autonomous algorithm using smoke segmentation to dynamically adjust the swarm's position and orientation based on plume size and movement for efficient data acquisition under varying environmental conditions.
- Deployed a manager-worker swarm architecture with quadrotors equipped with Jetsons for enhanced autonomous operations and simultaneous capturing of real-life smoke images optimized for 3D reconstruction.
- Leveraged COLMAP for camera pose estimation and Nerfacto for high-fidelity 3D volumetric models of plumes.
- Achieved 1-second temporal resolution by overlapping time segments to generate smooth and continuous 3D reconstructions of the transient smoke plume.

Drone Swarm for Forest Fire Smoke Particle Mapping
- Graduate Research Assistant under Prof. Jiarong Hong [Jan 2024 - Present]

- Developed a swarm of 4 drones equipped with Digital Inline Holography (DIH) sensors to map real-time volumetric smoke particle dispersion in a real-life wildfire.
- Implemented a master-worker configuration, with the master drone generating segmentation-based 2D waypoints from the top view and mapping these to 3D coordinates to ensure the optimal smoke coverage by worker drones.
- Integrated Jetsons for waypoint generation, real-time DIH image capture, and live sensor data transmission.
- Successfully deployed the swarm in a large-scale prescribed burn, enabling detailed mapping of smoke particle dispersion and gaining critical insights into the spatial distribution and particle morphology within volumetric space.

GRADUATE COURSE PROJECTS

Instant-NGP-based Autonomous 3D Reconstruction of Target Object [Oct 2024 - Dec 2024]

- Developed an autonomous drone algorithm that detects and autonomously circles the target object in optimal paths, capturing high-resolution images for 3D reconstruction.
- Built a 3D reconstruction pipeline using Instant-NGP, integrating COLMAP-generated camera poses and drone-captured images to produce high-fidelity models of dynamic environments.
- Implemented automated image sorting based on blurriness, target cropping, and optimized hash grid encoding in Instant-NGP by tuning n_levels and log2_hashmap_size to capture finer and spatial details in reconstruction.

3D Semantically Segmented Reconstruction [Oct 2023 - Dec 2023]

- Developed a 3D semantic reconstruction pipeline combining COLMAP-generated point clouds and U-Net segmentation masks, integrating majority voting and kNN classification.
- Achieved a 0.75 IoU in multi-class semantic segmentation using a U-Net-inspired CNN model, classifying 29 object classes, with the segmentation data contributing to semantic reconstruction.
- Generated semantically segmented 3D point cloud by integrating majority voting on sparse point cloud with U-Net segmentation on 2D images, and a kNN classifier for dense point cloud labeling.

Path Planning and Communication in Multi-agent Systems [Feb 2023 - May 2023]

- Deployed a multi-agent system of Turtlebots, using a centralized ROS master, to map an unknown environment, containing static and dynamic obstacles, with 2D LiDAR SLAM.
- Implemented A*, Dijkstra's, and RRT* algorithms for path planning, enabling efficient navigation of Turtlebots.
- Integrated SLAM data from two Turtlebots to construct a unified map and identify optimal paths from start to goal.

UNDERGRADUATE PROJECTS [Projects Page]

Autonomous Stair Climbing Robot [July 2020 - Jan 2021]

- Designed a custom stair-climbing robot using SolidWorks and simulated its autonomous functionality in Webots.
- Implemented depth-based stair detection using a Kinect sensor to detect and climb stairs autonomously.
- Simulated a linear actuator-based payload stabilization, improving the robot's safety while climbing stairs.

Robotic Arm-based Automated Pin Insertion System - Intern at IIT Indore [June 2021 - Aug 2021]

- Developed a robotic arm system for automated sorting and inserting industrial pins.
- Simulated the industrial automation in Webots using an IPR robotic arm.
- Implemented a fast image-processing algorithm to detect pin orientation for precise autonomous grasping.

Electrohydraulic Actuation with Feedforward-PID Controller [Oct 2021 - April 2022]

- Simulated an electrohydraulic actuator plant in Simulink for precise motion control.
- Designed the controller combining a PID and feedforward control for controlling the plant under diverse loadings.

TECHNICAL SKILLS

Programming	Python, C++, C, MATLAB, Simulink, R
Software	ROS, Linux, Git, AirSim, Unreal Engine, Gazebo, Webots, SolidWorks, 3D Printing
Libraries	NeRFs, PyTorch, OpenCV, NumPy, YOLO, Gym, Stable Baselines, MAVROS, Scikit-learn
Hardware	NVIDIA Jetsons, Arduino, Pixhawk, GPS, Arducam

TEACHING EXPERIENCE

Teaching Assistant – Business Statistics in R [Carlson School of Management, UMN, Fall 24, upcoming Spring 25]

- Assisted in teaching statistical methods to analyze business problems and R programming to a class of 105 students.
- Graded assignments and supported lab sessions, to ensure proficiency in applying statistical concepts using R.

CREDENTIALS

- Top 5 national finalists in **Airbus-Day Innovation Challenge** as part of the undergrad robotics team.
- Top 9 national finalists in **Philips Code to Care** as part of the undergrad robotics team.
- Top 30 national finalists in **Flipkart Grid 2.0 Robotics Competition** as part of the undergrad robotics team.
- **DST - Inspire Internship** : top 1% of the students in the secondary examination.

EXTRA-CURRICULAR ACTIVITIES

Jadavpur University Motorsports Club

- Contributed to the Formula SAE student design team, working on Go-Kart and Supra, utilizing SolidWorks and Ansys.