Aryaman Gupta

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Education

- **Stanford University** — Stanford, CA
  Doctor of Philosophy in Aeronautics and Astronautics — *January 2025 – Present*
- **Indian Institute of Technology (BHU)** — Varanasi, India
  Bachelor of Technology in Electronics Engineering; GPA: 9.42/10 — *November 2020 – May 2024*

Publication

1. **Aryaman Gupta**, Kaustav Chakraborty, Somil Bansal, "**Detecting and Mitigating System-Level Anomalies of Vision-Based Controllers**", *IEEE ICRA'24* *[Link]*
2. Kaustav Chakraborty, **Aryaman Gupta**, Somil Bansal, "**Enhancing Safety and Robustness of Vision-Based Controllers via Reachability Analysis**", *Submitted to IEEE TRO*
3. A.M. Ali, **Aryaman Gupta**, H.A. Hashim, "**Deep Reinforcement Learning for Sim-to-Real Policy Transfer of VTOL-UAVs Offshore Docking Operations**", *Applied Soft Computing Journal* *[Link]*
4. Neha Sharma, **Aryaman Gupta**, Sivala Deepak, Om Jee Pandey, "**Node Fault Prediction Assisted Small-World IoT Networks Using ML Frameworks: Towards Performance Improvement**", *IEEE ANTS'24*

Experience

- **University of Southern California** — Los Angeles, CA
  Research Internship | Prof. Somil Bansal — *May 2023 - August 2024*
  - **Goal:** Provide safety guarantees of vision-based controllers leveraging knowledge of their failure cases.
  - Prepared datasets containing failure samples labelled using **Backward Reachable Tubes (BRTs)**.
  - Trained an **Anomaly Detector** to detect system failures and trigger **Fallback Controller** for safety.
  - BRT failure volume reduced by 40% on testing environments unseen during anomaly detector training.
  - Implemented **Conformal Prediction** to provide confidence guarantees on the anomaly detector.
- **Carleton University** — Ottawa, Canada
  Research Internship | Prof. Hashim Mohamed — *January 2023 - December 2023*
  - **Goal:** Develop docking mechanism for VTOL-UAVs on offshore charging platforms using Deep-RL.
  - Built a custom environment for UAV landing with **JONSWAP** model-based hydrodynamic disturbances(waves) acting on the docking station making it oscillate on the water surface.
  - Implemented **DQN** and **PPO** algorithms to compare performance among value and policy-based agents.
  - Agents successfully learnt to initially accelerate downwards and then decelerate to land safely.
- **Indian Institute of Science** — Bengaluru, India
  Summer Research Internship | Prof. Bharadwaj Amrutur — *May 2022 - July 2022*
  - **Goal:** Develop centralized multi-agent exploration and vision-aided dynamic obstacle avoidance systems.
  - Implemented **RRT-Exploration** and **Map Merge** on multiple ground robots in unseen environments.
  - Performed real-time map updates using **3D Object Detection** with multiple infrastructure cameras and used **First-Order Gradient Descent** for optimizing obstacle's 3D real-world position for avoidance.
  - Developed ROS packages that can be configured and implemented on custom hardware testbeds.
- **Changwon National University** — Changwon, South Korea
  Research Internship | Prof. Oh-Seol Kwon — *March 2022 - July 2022*
  - **Goal:** Develop a deep learning architecture for efficient object detection in low-resolution aerial images.
  - Combined **Faster R-CNN, Edge Enhanced Network,** and **SRGAN** architectures for the joint task.
  - Performed **End-to-End Training** of the entire pipeline, feeding detector's loss to SRGAN network.
  - Obtained testing accuracies of 95.5% on COWC and 83.2% on OGST datasets.

Projects

- **Multi-Agent Warehouse Cleaning**
  - **Goal:** Develop a Multi-Agent Coverage and Cleaning system for unknown terrains using ground robots. *[Link]*
  - Built a swarm of **Omnidrive Robots** and mapped the terrains using **RRT-based Multi-Robot Exploration**.
  - Distributed terrain among multiple agents by computing **Voronoi Cells** using **Fortune's Algorithm**.
  - Used a polygon planner for computing **Boustrophedon Paths** for each agent for complete coverage.
- **UAV Swarming**
  - **Goal:** Develop UAV Position Control using PID controller and implement Swarm Motion of multiple drones. *[Link]*
  - Used ArUco marker and Time of Flight (TOF) Lidar sensor for pose estimation with Kalman Filter for correction.
  - Implemented **Cascaded PID** for 3D position control and Python-based socket communication for manual control.
  - Used **Flocking Algorithm** for a swarm motion of drones in PyBullet simulation software.
- **Multi-Purpose Household Robot (Supervised by Prof. Shyam Kamal, IIT BHU)**
  - **Goal:** Design a Compact Ground Robot that can perform household tasks like Cleaning and Child-Care. *[Link]*
  - Designed a **CAD** model and integrated ROS pckages for **Exploration, Navigation**, and **Coverage**.
  - Used **Computer Vision** for tasks like threat detection and child following for child care in households.
  - Developed prototype with **Jetson Nano** and **STM Microcontroller** and using **Intel Realsense** for perception.
- **UAV Guided UGV Navigation**
  - **Goal:** UAV-assisted Exploration of mountainous terrains and UGV Navigation in snow-covered roads. *[Link]*
  - Performed UAV Localization by fusing IMU and GPS data using **Extended Kalman Filtering**.
  - Used **U-Net** for segmenting roads and **Frontier Exploration** on UAV for mapping using RGBD data.
  - Obtained UGV odometry using UAV camera feed and traversed the terrains through waypoint following.
- **Small World IoT Networks (Supervised by Prof. Om Jee Pandey, IIT BHU)**
  - **Goal:** Introduce Small-World Phenomenon in Wireless Sensor Networks and Detect Faulty Sensor Nodes. *[Link]*
  - Implemented **Actor Critic** methods for introducing long-range links in network (topology optimization).
  - Prepared faulty sensory nodes dataset and used **DBSCAN** algorithm for detection during data routing.
  - Performed data routing and observed increased network lifetime and throughput with reduced latency.

Skills and Interests

- **Areas of Interest**: Safety Critical Control, Robotics, Self Driving, Reinforcement Learning, Computer Vision
- **Languages and Libraries**: Python, C++, MATLAB, OpenAI Gym, PyTorch, Tensorflow, X-Plane, Carla
- **Technologies**: ROS, ROS2, Deep Learning, Machine Learning, AutowareAI, Linux, Git, LaTeX

Relevant Coursework

- **Academic Courses**: MA-101(Real Analysis), MA-102(Linear Algebra), MA-202(Probability and Statistics), CSO-102(Data Structures and Algorithms), CSO-332(Ubiquitous Computing), CSO-458(Soft Computing)
- **Online Courses**: ML and DL Fundamentals by Andrew NG, RL Specialization by UoA, Computer Vision by Stanford

Achievements

- Awarded the **Best Undergraduate Thesis Title** among 146 students in ECE department at IIT BHU.
- Among **Top-15** students selected among 400 applicants nationwide for the **IUSSTF-Viterbi Scholarship 2023** to pursue a fully-funded summer research internship at the USC Viterbi School of Engineering.
- Awarded **DAAD-WISE Scholarship 2023** to pursue Research Internship in German Public Institutes.
- Awarded **Mitacs GRI Scholarship 2023** to pursue Research Internship in Canadian Institutes.
- Awarded **Honourable Mention** for my technical achievements and contribution in organizing competitions and workshops and mentoring students by the Science and Technology Council of IIT BHU.
- Stood **Second** in **All Indian Institutes of Technology Robotics Association 2021 Challenge** among all prestigious institutions in India for maximum coverage of warehouse using multiple agents.
- Among **Top-10** winners in **National Robotics Competition** for developing innovative household robot.