Ashutosh Gupta

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EDUCATION

M.S. Robotics (AI Minor) — Oregon State University, Corvallis, OR **Expected Dec 2025**

*Master's Thesis: "**Reinforcement learning** for robust and adaptive legged locomotion"*

B.E. Electronics and Communication — BITS Pilani, Goa, India **Jun 2023**

*Undergraduate Thesis at Carnegie Mellon University: "**Optimisation-based trajectory planning** using robot perception"*

TECHNICAL SKILLS

Programming: Python, C++, C, MATLAB, LaTeX
Core Expertise: Reinforcement Learning, Deep Learning, Multi-Agent Systems, Simulation-to-Real Transfer, Computer Vision, Robot Control, Robot Kinematics
Frameworks: PyTorch, TensorFlow, ROS (ROS1/ROS2), Open3D, PCL, RSL-RL, IsaacLab, Git, Linux
Simulation & Tools: MuJoCo, IsaacSim, Gazebo, RViz, MATLAB/Simulink
Hardware: Nvidia Jetson, Arduino, ESP32, Raspberry Pi
Robots : Unitree Go2, Agility Robotics Cassie and Digit, Boston Dynamics Spot, Universal Robots UR3e
Relevant Coursework: Reinforcement Learning, Learning-Based Robot Control, Multi-Agent Systems, Deep Learning, Natural Language Processing, Robot Kinematics & Dynamics, Nonlinear Dynamics

WORK EXPERIENCE

Graduate Research Assistant **Jun 2024 – Present**

DRAIL Lab, Oregon State University (OSU) — Supervisor: Prof. Alan Fern *Corvallis, OR*

- Led research on **reinforcement learning for quadruped and humanoid locomotion**, training and deploying policies in IsaacLab + RSL-RL with successful sim-to-real transfer on Unitree Go2 and Digit robots.
- Co-authored a **CoRL 2024 publication** on decentralized multi-biped control, designing positional encodings, and running large-scale simulation experiments scaling to 100 robots and 1000 kg payloads.
- Extended research to rough terrain locomotion (slopes, stairs, debris), achieving **90% success rates** with blind decentralized controllers.

Research Intern **Jun 2022 – May 2023**

Biorobotics Lab, Carnegie Mellon University (CMU) — Supervisor: Prof. Howie Choset *Pittsburgh, PA*

- Implemented a **3D surface reconstruction pipeline** in C++ (PCL + ROS1) for a robotic ultrasound system with UR3e + RealSense. Achieved **0.05 mm Chamfer distance** vs CT scans and improving scan quality (ICRA 2023).
- Developed a semi-automated **void detection pipeline** using Open3D + COLMAP SfM for Surfside collapse rubble dataset. Correctly identifying **11/12 expert-labeled voids** (IROS 2023).
- Built 3D vascular meshes from CT/ultrasound data and set up FEM simulations in SOFA for **vascular tissue deformation modeling**, enabling calibration of material properties (ICRA Workshop 2023).
- Engineered locomotion gaits for **modular snake robots** (slithering, rolling, sidewinding, pole climbing).

Remote Research Collaborator **Jul 2021 – Jan 2022**

Sheffield Robotics, The University of Sheffield — Supervisor: Dr. Robert Worley *Remote*

- Collaborated with the **Pipebots project** on acoustics-based SLAM for pipe inspection. Formulated and implemented **acoustic solver models** for higher-order reflections to improve echo-based localization.
- Supported integration of simulation workflows in **ROS2 + Gazebo**, enabling testing of acoustic sensing strategies.

Robotics Intern **Jun 2021 – Jul 2021**

Peppermint Robotics — Supervisor: Harshal Deshpande *Pune, India*

- Prototyped a low-level **PID controller** in C++/ROS1 for path tracking on an autonomous scrubber robot.
- Co-developed a custom **RViz plugin in PyQt** to streamline AMCL localization setup and visualization, later adopted by operators during robot deployment.

Remote Research Intern **May 2021 – Jul 2021**

CSIR – National Institute of Oceanography — Supervisor: Sh. Gajanan Navelkar *Remote*

- Developed a video-processing pipeline in **Python + OpenCV** to detect white lines/ropes from recorded underwater ROV footage, enabling improved feature extraction for line-following tasks.
- Explored integration of the **BlueROV2 platform in ROS–Gazebo with ArduSub**, preparing a baseline simulation environment for testing autonomous line-following controllers.

RELEVANT PROJECTS

Reinforcement Learning for Quadruped Locomotion

- Trained locomotion policies in **IsaacLab + RSL-RL (PPO)** with reward shaping (gait regularization, foot clearance, body tilt, height adaptation), enabling robust whole-body quadruped control.
- Integrated privileged critics with terrain height scans to improve **terrain-aware learning**, successfully transferring policies from simulation to **Unitree Go2 hardware**.
- Extended generalization across diverse environments (stairs, slopes, varying friction, debris) with demonstrations on Go2 hardware and Spot simulation.

Language-Conditioned Quadruped Locomotion using LLMs

- Developed a **hierarchical control policy** in IsaacLab + RSL-RL, mapping LLM-generated delta-position commands to low-level locomotion.
- Integrated **GPT-4o outputs** with trained high-level controllers, enabling natural language instructions to be executed as interpretable motion goals for the Unitree Go2 quadruped in simulation.
- Demonstrated feasibility of **language-grounded motion control**, bridging natural language and robot locomotion.

Humanoid RL Locomotion

- Trained locomotion policies for the Digit humanoid in **MuJoCo (custom PPO)** and IsaacLab + RSL-RL, exploring reward shaping for running and terrain locomotion.
- Achieved **3 m/s forward speed in simulation** and transferred policies to Digit hardware at 1.8 m/s, demonstrating successful sim-to-real deployment.
- Developed terrain-aware policies using feet-airtime rewards, enabling blind locomotion on slopes and uneven terrain.
- Validated robustness on slopes up to **20°**, achieving stable locomotion without explicit terrain input.

Multi-Agent RL for Scalable Payload Transport

- Configured scalable experiments in **VMAS (Vectorized Multi-Agent Simulator)** to study decentralized multi-agent payload transport under resource and sensing constraints.
- Designed reward functions combining global success, distance shaping, and energy penalties, enabling stable **policy learning without communication**.
- Trained agents with Independent PPO (CTDE), demonstrating emergent cooperative strategies with **zero-shot scalability from 2 to 50 agents** without retraining.

Multi-Biped Control for Payload Transport

- Developed a **decentralized RL controller** in PyTorch + MuJoCo, scaling from 1 to 100 Cassie bipeds transporting payloads up to 1000 kg without retraining.
- Deployed policies on 1–3 real Cassie robots with Nvidia Jetson, demonstrating **simulation-to-real transfer**.
- Designed a **positional encoding scheme** for robot configuration, enabling generalization across robot formations and payload shapes.
- Extended experiments to rough terrain locomotion (stairs, slopes, debris), achieving 90% success rates with blind controllers and benchmarking against transformer-based centralized policies.

Robotic Ultrasound System

- Implemented a real-time 3D surface reconstruction pipeline in **C++ with PCL + ROS1**, processing RealSense camera data from a UR3e robotic arm.
- Achieved high-fidelity phantom reconstructions with **0.05 mm Chamfer distance** vs CT scans.
- Developed optimization-based trajectory planner, improving ultrasound scan quality (ZNCC 0.861 vs 0.791 baseline).
- Demonstrated robustness under occlusions and scene variation, reliably isolating the leg surface for scanning.

Void Detection with 3D Perception

- Developed a 3D perception pipeline in **Open3D + COLMAP SfM** to reconstruct rubble point clouds from quadrotor imagery.
- Reduced registration error by **82%** and reconstructed high-fidelity scenes with only 1.7% outliers.
- Implemented void detection methods that **identified 11/12 expert-labeled voids** while reducing false positives by 66% between the two implemented methods.
- Processed real field data from the Surfside, FL building collapse (1,400+ images over 4 days), demonstrating applicability to search-and-rescue.

Deformable Object Simulation using FEM

- Constructed 3D vascular meshes from CT and ultrasound data using **3DSlicer, Blender, Gmsh**, enabling FEM simulations in SOFA.
- Generated phantom and porcine vessel models to calibrate material properties, optimizing for Young's modulus and Poisson's ratio.
- Aligned FEM deformation with ultrasound observations, achieving up to **0.79 IoU** overlap between simulated and real deformed vessels.

Articulated Modular Snake Robots

- Developed a unified **Python/ROS1 + PyBullet codebase** for three modular snake robot platforms (standard, large-module, and series-actuated).
- Implemented and fine-tuned locomotion gaits, including slithering, sidewinding, rolling, and pole climbing.
- Built a joystick-based teleoperation interface for real-time gait switching. Achieved demonstrations such as **tree climbing** by wrapping the snake in a helical configuration.

SpiderBot – Symmetric Hexapod

- Initiated and led the design of an 18-DOF hexapod robot, applying fundamentals of legged kinematics, dynamics, and gait control.
- Developed simulations in **Simulink** for CPG gait analysis and extended modeling in the Coppelia simulator.
- Built a hardware prototype with 3D-printed parts, custom electronics, and Arduino-based motor controllers.
- Directed a project team from simulation to hardware, overseeing motor selection, electronics integration, and testing.

EchoSLAM – Localization using Acoustic Echoes

- Explored **acoustic-based SLAM** for mapping and feature detection in environments such as pipes and closed rooms.
- Prototyped algorithms in Python with **pyroomacoustics**, simulating robot echo responses in confined spaces.
- Collaborated with the Pipebots team to integrate acoustic sensing with **ROS2 + Gazebo**, enabling simulated robot-mounted sensors.

Klann Mechanism Walking Robot

- Designed a walking robot based on the Klann linkage, using **MATLAB** for kinematic analysis and CAD + 3D printing for fabrication.
- Implemented Arduino-based motor control with Bluetooth connectivity, enabling mobile app teleoperation.
- Demonstrated **stable walking** on flat, sloped, and uneven terrain as a proof-of-concept alternative to wheels.

PUBLICATIONS

- B. Pandit, **A. Gupta**, M. Gadde, A. Johnson, A. Shrestha, H. Duan, J. Dao, and A. Fern, "**Learning Decentralized Multi-Biped Control for Payload Transport**," *Conference on Robot Learning (CoRL)*, Munich, Germany, 2024.
- A. Bal, **A. Gupta**, P. Goyal, D. Merrick, R. Murphy, and H. Choset, "**Towards Automated Void Detection for Search and Rescue with 3D Perception**," *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Detroit, USA, 2023.
- A. Bal, **A. Gupta**, F. Abhimanyu, J. Galeotti, and H. Choset, "**A Curvature and Trajectory Optimization-based 3D Surface Reconstruction Pipeline for Ultrasound Trajectory Generation**," *IEEE International Conference on Robotics and Automation (ICRA)*, London, UK, 2023.
- A. Bal, **A. Gupta**, C. Morales, A. Dubrawski, J. Galeotti, and H. Choset, "**3D Deformation Simulation for Vascular Tissue with 2D Medical Imaging**," *ICRA Workshop on Representing and Manipulating Deformable Objects*, London, UK, 2023.