

Karan Nair

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RESEARCH OBJECTIVES

Seeking research opportunities to apply **Reinforcement Learning** and **Model Predictive Control** toward achieving agile, robust control in **quadrupeds**, **manipulators**, and **humanoid robots**.

EDUCATION

BITS Pilani, Hyderabad Campus

B.E., Electronics and Instrumentation | GPA: 8.51/10.0

Minor: Robotics and Automation | GPA: 9.67/10.0

Aug 2023 – Jul 2027

Hyderabad, India

RESEARCH EXPERIENCE

PIP-Loco: Model-Based RL for Blind Quadruped Locomotion

Jan 2026 – Feb 2026

- Engineered the **PIP-Loco framework (ICRA 2025)** from scratch using Genesis and PyTorch, training a Unitree Go2 for robust blind locomotion in 4 hours on an RTX 3050.
- Implemented an **Asymmetric Actor-Critic** architecture with a **No-Latent Model (NLM) Dreamer**, injecting model-based predictive planning into a reactive RL policy to survive 1.0 m/s external perturbations.
- Developed a **Temporal Convolutional Network (TCN)** for proprioceptive velocity estimation, enabling the policy to precisely track command velocities using only a history of onboard sensor data and past actions.
- Formulated a safe RL training pipeline with **strict gradient isolation** across three decoupled optimizers and **quadratic barrier penalties** to enforce torque and velocity limits, ensuring sim-to-real feasibility for the Go2's actuators.

The Semantic Manipulator

Nov 2025 – Jan 2026

- Engineered a localized control stack using **model2vec** and **Logistic Regression** to translate **natural language** commands into robot actions with less than 5ms latency, eliminating cloud API dependencies.
- Implemented a **Finite State Machine (FSM)** middleware to deterministically validate all classifier outputs against physical constraints, filtering out invalid actions.
- Formulated a **monocular perception and calibration pipeline** to segment multi-coloured blocks in HSV space, utilizing pinhole depth projection and an ArUco-based homography transform to map 2D pixel targets to the robotic arm's base frame.

Real-Time Projectile Interception using a 3-DOF Robotic Arm

Jul 2025 – Oct 2025

- Developed a closed-loop **Receding Horizon Control** pipeline in Python to enable a planar 3-DOF robotic arm to intercept ballistic projectiles in simulation.
- Implemented a robust trajectory estimator using **least-squares regression** to predict 3D ballistic paths from noisy observations within a custom PyBullet simulation environment.
- Designed a **Fixed-Time Model Predictive Controller** that pre-calculates the exact interception time, preventing optimization failures and reducing computation time to **under 15ms** for highly accurate real-time tracking.

Beetle: An Autonomous Navigation Testbed

Aug 2024 – Nov 2024

- Developed the software stack for “Beetle,” a 60kg skid-steer AGV powered by **ROS 2 Humble** and **Jetson AGX Xavier** for SLAM and path planning.
- Integrated sensors (YDLIDAR X2, RealSense D435, T265 VIO) and implemented mapping/localization via **SLAM Toolbox** and **RTAB-Map**.
- Configured the **Nav2** stack with custom planners for autonomous indoor navigation and zero-radius turns.

POSITIONS OF RESPONSIBILITY

Secretary – Automation and Robotics Club

May 2025 – Present

- Co-leading a 30+ member technical club focused on robotics, control systems, and autonomous systems.
- Driving club strategy through project advising, resource allocation, and event planning.
- Managing cross-divisional project coordination and documentation to improve team accountability.