Nehar Poddar

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Research Profile

Robotics researcher at the intersection of **reinforcement learning, classical control, perception, and embodied AI**, focused on enabling humanoid robots to maintain balance, adapt to their environment, and coordinate diverse behaviors through **learning-based whole-body control**.

Research combines learned policies with structured representations of **dynamics, balance, contacts, and 3D environment geometry**, including the composition of walking, recovery, and environment-assisted interaction into unified, perception-conditioned behavior. Broader interests include **physical intelligence, skill reuse, policy composition, and perception-to-action learning** for robust interaction with the physical world.

Education

PhD in Robotics – IHMC & University of West Florida Jan 2024 – Present

- Advisor: **Prof. Robert Griffin**
- Research: Humanoid balance and recovery using **reinforcement learning, classical control, and perception**, with emphasis on physics-informed learning and environment-assisted physical interaction.

MSc in Applied Mathematics – Northeastern University Aug 2019 – May 2021

BSc in Mechanical Engineering – NMIMS, Mumbai Jun 2015 – May 2019

Research Experience

PhD Researcher – IHMC / University of West Florida Jan 2024 – Present

- Led *Bounce Back*, a perception-guided framework that **composes walking, recovery, and environment-assisted interaction**, enabling a humanoid to detect and transiently exploit nearby walls and tables as physical supports.
- Built a **perception-conditioned mixture-of-experts policy** by initializing trainable experts from independently trained walking, get-up, and bracing specialists, then combining them through a learned softmax gate conditioned on **3D occupancy and proprioception**.
- Trained the unified policy with **PPO, advantage-weighted imitation, and entropy-regularized gating**, using frozen specialists as imitation targets and privileged critic inputs while learning residual corrections for adaptation beyond specialist behaviors.
- Designed a **physics-informed asymmetric actor–critic** incorporating center-of-mass dynamics, capture point, and centroidal momentum as privileged training signals while retaining deployable observations for the actor.
- Developed a **success-gated curriculum** spanning standing, falling, ankle and hip recovery, stepping, and multi-contact stand-up, enabling a single reference-free policy to generalize across body configurations and disturbance magnitudes.
- Achieved **93.4% recovery success across 10,000 trials** on the Unitree H1-2 in simulation, with evaluation across MuJoCo and Isaac Lab, five initial configurations, and **0–500 N perturbations**.
- Demonstrated **zero-shot deployment on H1-2 hardware at 50 Hz**, recovering from supine, seated, kneeling, and crouched configurations using proprioceptive sensing.
- Conducted controlled ablations isolating the contributions of **privileged learning, physics-informed reward structure, and curriculum design** to recovery performance.

Industry Experience

Research Engineer – DEKA Research and Development Corp. Jan 2021 – Jan 2024

Autonomous Delivery Robot – FedEx ROXO

- Developed **multimodal perception** for an autonomous delivery robot, fusing LiDAR, radar, monocular, and stereo cameras into unified **3D occupancy and drivability representations**.
- Built RGB-D semantic segmentation, stereo depth completion, surface-normal estimation, and 3D reconstruction pipelines for **environment and terrain understanding**.
- Engineered **active-learning and uncertainty-estimation pipelines** spanning data collection, model training, evaluation, and deployment on autonomous robotic systems.
- Deployed semantic segmentation for surface classification with **84% performance** and self-attention-based scene-text recognition with **94% performance** on a production robotic platform.
- Implemented **RANSAC, PnP, ICP, and sensor-calibration pipelines in ROS/C++**, reducing calibration time from **60 minutes to 3 minutes**.

Medical Devices

- Modeled insulin dynamics using coupled differential equations and explored **reinforcement learning for adaptive control under partial observability**.
- Developed vision-based flow estimation and temporal signal processing for medical infusion monitoring.

Publications

- **[Work in Progress]** N. Poddar et al., *"Bounce Back: Perception-Guided, Environment-Assisted Humanoid Skill Resumption,"* submitted to *IEEE Robotics and Automation Letters*, 2027.
- N. Poddar et al., *"Embedding Classical Balance Control Principles in Reinforcement Learning for Humanoid Recovery,"* submitted to *IEEE-RAS International Conference on Humanoid Robots*, 2026. [arXiv]
- N. Poddar et al., *"Accelerating Classical Path Planning via Learned Search Space Reduction," AIAA SciTech Forum*, 2026. **Nominated for Best Student Paper**.

Technical Skills

- **Learning & Control:** Reinforcement Learning, PPO, Actor–Critic Methods, Model-Based Control, Optimal Control, Curriculum Learning, Sim-to-Real Learning
- **Humanoid Robotics & Control:** Whole-Body Control, Balance, Multi-Contact Interaction, Centroidal Dynamics, Capture Point, Contact Modeling, Stability and Recovery
- **Perception & Spatial Understanding:** 3D Occupancy Maps, Depth Estimation, Surface Normals, Semantic Segmentation, Sensor Fusion, LiDAR, Radar, Stereo Vision, RGB-D
- **Robotics Systems:** Isaac Lab, Isaac Sim, MuJoCo, PyTorch, CUDA, ROS/ROS2, Linux
- **Programming:** Python, C++, MATLAB, NumPy, OpenCV, Scikit-Learn