Nikhil Sobanbabu

MS ECE CMU

Curriculum Vitae

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Education

Carnegie Mellon University — *Pittsburgh, PA*

Master of Science in Electrical and Computer Engineering **GPA: 4.0/4.0** — *Aug 2024 – May 2026 (Expected)*

Coursework: Robot Learning, Optimal Control, Deep Learning for Computer Vision, Optimization, Planning and Decision Making.

Indian Institute of Technology Madras — *Chennai, India*

Bachelor of Technology in Electrical Engineering **GPA: 9.39/10.0** — *Aug 2020 – May 2024*

Coursework: Reinforcement Learning, Motion Planning, Linear Dynamical Systems, Nonlinear System Analysis, Field Robotics

Research Interests

My research goal is to develop physics-aware learning and control frameworks that enable robots to acquire scalable, contact-rich skills and execute them robustly in the real world. I am particularly interested in **Learning-based control** (Agile Locomotion, Loco-Manipulation and Human Motion tracking), **Real2Sim2Real**(System Identification, Dynamics-Aware sim-to-real adaptation, Active Exploration, reality-gap aware benchmarks) and **Multi-Robot coordination** spanning algorithms and training pipelines.

Honors and Awards

2025 **CoRL ORAL**, Top 5.7%

2024 **KC Mahindra Graduate Scholarship**, Selected 90/2354

2023 **IUSSTF–Viterbi Summer Research Internship Program**, Selected 15/400

2020 **All India Rank 286 in JEE Advanced**, 0.2% among 1.2 Million Students

2020 **KVPY Fellow SX**, All India Rank of **243**.

2018 **NTSE Scholar**, State Topper, Stage 1

Publications

Preprints and Under Review

HDMI: Learning Interactive Humanoid Whole-Body Control from Human Videos
Haoyang Weng, Yitang Li, **Nikhil Sobanbabu**, Zihan Wang, Zhengyi Luo, Tairan He, Deva Ramanan, Guanya Shi
Under Review, [Paper]

OGMP: Oracle Guided Multimodal Policies for Agile and Versatile Robot Control
Lokesh Rajan, **Nikhil Sobanbabu**, Quan Nguyen
arXiv preprint, [Paper]

Conference Proceedings

SPI-Active: Sampling-Based System Identification with Active Exploration for Legged Robots
Nikhil Sobanbabu, Guanqi He, Tairan He, Yuxiang Yang, Guanya Shi **(Perfect Score-All Strong Accepts)**
Conference on Robot Learning (CoRL 2025 (Oral)), [Paper]

ASAP: Aligning Simulation and Real-World Physics for Learning Agile Humanoid Whole-Body Skills
Tairan He, Jiawei Gao, Wenli Xiao, Yuanhang Zhang, Zi Wang, Jiashun Wang, Zhengyi Luo, Guanqi He, **Nikhil Sobanbabu**, Chaoyi Pan, Zeji Yi, Guannan Qu, Kris Kitani, Jessica Hodgins, Linxi "Jim" Fan, Yuke Zhu, Changliu Liu, Guanya Shi
Robotics: Science and Systems (RSS 2025), [Paper]

Preferenced Oracle Guided Multi-Mode Policies for Dynamic Bipedal Loco-Manipulation
Prasanth Ravichandar, Lokesh Rajan, **Nikhil Sobanbabu**, Quan Nguyen
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2025), [Paper]

Towards Unstructured MAPF: Multi-Quadruped MAPF Demo
Rishi Veerapaneni*, **Nikhil Sobanbabu***, Guanya Shi, Jiaoyang Li, Maxim Likhachev
International Conference on Automated Planning and Scheduling (ICAPS 2025, Demo Track), [Paper]

Research Experience

Carnegie Mellon University, LeCAR Lab — *Pittsburgh, PA*

Graduate Research Assistant, Advised by Prof. Guanya Shi — *May 2024 – Present*

- Designing a two-stage meta-adaptation pipeline combining forward dynamics learning, domain-aware policy training, and few-shot real-world fine-tuning to maintain policy stability and performance in legged robot sim-to-real transfer.
- Developed a parallelizable **sampling-based system identification (SPI-Active)** framework that identifies inertial and actuator parameters of legged robots by reducing open-loop trajectory prediction error enabling precise locomotion.
- Designed an **active exploration policy** maximizing Fisher Information to enable informative data collection for parameter estimation, and deployed agile RL locomotion policies , improving transfer performance by **42–63%** over baselines.

Carnegie Mellon University, Search-Based Planning Lab (SBPL) *Pittsburgh, PA*
Graduate Research Assistant, Advised by Prof. Maxim Likhachev *Jan 2025 – Present*

- Working on **multi-agent motion planning and coordination** for teams of quadruped robots using Conflict-Based-Search(CBS) and Temporal Graph(TPG)-based planning.
- Developed a waypoint refinement and synchronization pipeline together with custom-trained locomotion policies to enable coordinated navigation of heterogeneous quadruped robots.
- Developed a modular sim-to-real control stack for Unitree quadrupeds, enabling scalable multi-agent deployment and seamless hot-swapping between high-level and low-level controllers.

University of Southern California, Dynamic Robotics and Control Lab (DRCL) *Los Angeles, CA*
Research Intern, advised by Prof. Quan Nguyen *May 2023 – Present*

- Developed a **closed-loop state reference generator(oracle)** using preview control and a centroidal model that generates dynamically feasible state trajectories guiding an RL policy for the biped Hector toward **parkour-style motions** in MuJoCo.
- Extended the framework with a **hybrid automaton–based oracle** that supports multi-mode, whole-body loco-manipulation behaviors such as soccer dribbling and box manipulation across morphologies(HECTOR v1, Berkeley Humanoid, Unitree G1).
- Currently designing a **data-augmentation pipeline** to directly learns oracles from large scale retargeted human motion data to automate oracle design.

Indian Institute of Technology Madras, Control Engineering Laboratory *Chennai, India*
Undergraduate Research Assistant, Advised by Prof. Bharath Bhikkaji *Aug 2022 – May 2024*

- Studied single-pursuer, multi-evader **pursuit–evasion–target** games for my undergraduate thesis, deriving optimal reach–avoid strategies using **HJI-PDE** equations for omnidirectional agents and implemented them on LEGO EV3 platform for three agents.
- Formulated a Multi-agent RL framework using **MAPPO** on a custom **petting-zoo** environment and compared the convergence with nash-equilibrium of analytical solution on a 1v1 game.

Industry Experience

DiFACTO Robotics and Automation *Bengaluru, India*
Robotics Intern *Jun 2024 – Aug 2024*

- Developed a natural-feature navigation and recovery framework for in-house AMRs using ROS NavStack
- Optimized **Fanuc R-1000iA/80H** palletization trajectories, reducing cycle time by **23.6%**.

Skills

Programming	C/C++, Python, Julia, Bash, Git
Frameworks & Tools	PyTorch, TensorFlow, CasADi, NumPy, Pandas, scikit-learn, Docker, GitHub
Simulation & Robotics	Isaac Gym/Sim, MuJoCo, ROS1/2, Gazebo, MoveIt, MATLAB/Simulink
Domains	Reinforcement Learning, Optimal & Adaptive Control, Sim2Real Transfer
Hardware & Electronics	Embedded Systems (STM32, Arduino, Jetson), Altium PCB Design, Sensors & Actuators Integration

Academic Services

Reviewer	ICRA, IROS, RAL, CoRL 2025, ICRA 2026
Teaching Assistant	CMU 18-460 *Feedback Control Systems*, CMU 18-202 *Mathematical Foundations for Electrical Engineers*
Teaching Assistant	EE3004 Control Engineering

Media Coverage

IEEE Spectrum – Video Friday(Evan Ackerman)
OGMP: Oracle Guided Multimodal Policies for Agile and Versatile Robot Control [Link]

Projects and Competitions

Adaptive Force Control for Learned Centroidal Controller *Carnegie Mellon University*
Course Project (Optimal Control and RL) [Github] *Spring 2025*

- Designed a control framework integrating **L1-Adaptive force control** with a **Hierarchical RL and QP-based** low-level controller.
- Achieved **2.5–3x** longer traversal distances in a continuous jumping task via adaptive sim-to-sim transfer enabling real-time payload adaptation for quadruped robots.

Terrain Traversability Analysis with Image Dehazing *Carnegie Mellon University*
Course Project(Deep Learning for CV) [Report] *Fall 2024*

- Integrated a Generative Adversarial Network (GAN)-based dehazing model with a terrain segmentation (GANav) framework improving mIoU by **61.29**%.
- Analysed and compared Physics and Learning based dehazing techniques as an input to the GANav framework.

Motion Imitation with DIAL-MPC *Carnegie Mellon University*
Course Project(Robot Learning)[Report] *Fall 2024*

- Generated reference trajectories for Unitree Go2 using motion retargeting from motion capture data of dogs.
- Implemented a Full-order Sampling based MPC framework enhancing trajectory tracking performance by 22.73%.

Multi-Agent Trajectory Tracking for Crazyflie Quadrotors
IIT Madras
Undergraduate Research Project [Report]
2023

- Worked on **autonomous** control of multiple **crazyflie quadrotors** using custom-built **ROS** packages with modified **Mellinger and PID** controllers under the guidance of Dr.Bharath Bikkaji.
- Created **ROS** meta packages for **safe landing** of the **quadrotors** in the event of loss of communication.

Team Anveshak
IIT Madras
Team Lead
2021 – 2023

- Designed custom **PCBs** utilizing **MPC2515 CAN** controller to facilitate precise control of the actuators in the manipulator of the rover via **Nvidia's Jetson Xavier.**
- Engineered an energy-efficient power distribution and monitoring framework, reducing rover energy consumption to **86**%. Enabled remote monitoring of electrical parameters from a distant base station, enhancing rover performance.
- Led the team of 40+ students and secured a **global 6th** place at the **Anatolian Rover Challenge in Turkey, 2022.**

Swing-up and Stabilization of an Inverted Pendulum
IIT Madras
Course Project (Nonlinear System Analysis)
Spring 2023

- Developed a controller for the **swing-up and stabilization** of a linear inverted pendulum.
- Implemented swing-up control using **energy-based Lyapunov functions** and stabilized via **pole placement** after swing-up.
- Analyzed robustness and performance of a **Sliding Mode Controller** for stability improvement.

Sampling-Based Motion Planning for a Mobile Manipulator
IIT Madras
Course Project (Motion Planning)
Fall 2022

- Implemented sampling-based planners (**RRT*** and **Bi-Directional RRT**) for the KUKA mobile manipulator.
- Integrated motion planning with **A*** and **Traveling Salesman** algorithms for optimal pick-and-place tasks in Gazebo.
- Validated task completion efficiency through simulations with dynamic obstacle configurations.

KrishiBot – Autonomous Agriculture Robot
IIT Madras
Competition Project (EYRC 2022–23)
Oct 2022 – Mar 2023

- Implemented a **wall-following navigation algorithm** using laser scan feedback and a PID controller for warehouse traversal.
- Integrated **color and centroid detection** to identify bell peppers using Intel RealSense depth camera.
- Executed a complete **pick-and-place pipeline** in ROS MoveIt for crop harvesting automation.