

Nikhil Sobanbabu

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Research Interests

Passionate in the fields of **Controls, Dynamics, and Reinforcement Learning**, particularly in the context of **legged locomotion and space robotics**.

Education

- **Indian Institute of Technology Madras** Aug 2020 - May 2024
Bachelor of Technology in Electrical Engineering (Honors) Department Rank-6/155 **CGPA: 9.37/10**

Publications

- **RSS 2024** OGMP: Oracle Guided Multimodal Policies for Agile and Versatile Robot Control
(Under Review) Lokesh Rajan, Nikhil Sobanbabu, Quan Nguyen [[Webpage](#)][[Arxiv](#)]

Research Experience

- **Dynamic Robotics and Control Laboratory USC** (*Prof. Quan Nguyen*) (May'23- Present)
 - Developed a task-driven planner for an RL policy to solve high-level locomotive tasks by selecting behaviours encoded as latent modes, using **Monte-Carlo** Roll-outs in a **Receding-Horizon** approach. This solved the tasks while ensuring **robust recovery** from disturbances.
 - Developed a novel **Preview Controller** for a **centroidal model** of a **biped**, enabling the generation of dynamically feasible reference trajectories. This controller played a crucial role in supporting a **Multi-Modal Reinforcement Learning (RL) policy**, operating in a closed-loop manner, to achieve **parkour-inspired** motions.
- **Control Engineering Laboratory - IIT Madras** (*Prof. Bharath Bhikkaji*) (Oct'23-Present)
 - Developed an **MAPPO** framework for a modified **MPE-Petting Zoo** environment to solve a **pursuit-evasion-target scenario**.
 - Developing a **Mutli-agent RL framework** guided by the analytical solutions of a simple **omnidirectional reach-avoid model** to solve the pursuit-evasion target problem with differential drive robots.
- **Research Intern - Robert Bosch Centre for Cyber-Physical Systems** (Jan'23-Apr'23)
 - Worked with **Dr. Shishir Kothalya** and **Mr. Amith Somanath** on the Implementation of **vision-based algorithms** for localization for the quadruped robot in association with **ARTPARK**.
 - Applied **PCA**-based plane detection to **Intel RealSense RGB** images, focusing on regions of interest identified through open-source stair detectors utilizing CNNs.
 - Successfully correlated these ROIs with corresponding regions in a 3D point cloud of the staircase and subsequently mapped them with **LiDAR** point cloud data.
- **Team Anveshak - Mars Rover Team of IIT Madras** (May'21- Present)
 - Created a **Frontier-Based** algorithm leveraging 3D point cloud data from the terrain to construct an extended traversability map. Employed the **A*** algorithm on this map to calculate the rover's optimal obstacle-avoiding path, contributing to the **International Rover Design Challenge 2021**.
 - 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.
 - Developing RL-based obstacle avoidance policy for the leo-rover to transverse an uneven Martian terrain using a custom-implemented **PPO** framework.

Scholastic Achievements [↗](#)

- Secured a highly competitive spot as one of the top **15** out of over **400** applicants for the **IUSSTF-Viterbi Summer Research** Internship Program.
- Secured **All India Rank 286** in **JEE¹ Advanced 2020** ranking in top **0.2** percentile out of **1.2 million** students in all over India.
- **NTSE² Scholar 2018** being **State Topper** in **Stage 1** out of **50,000+** students in the state of **Tamil Nadu**.
- **KVPY³ Fellow SX 2020** and secured an **All India rank** of **243**.

¹ Joint Entrance Examination ² National Talent Search Examination ³ Kishore Vaigyanik Protsahan Yojana

Projects and Competitions

- **Simultaneous beamforming and trajectory tracking in a multi-agent formation** [↗](#) (May'22-Nov'22)
 - 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.
 - This project was credited as part of **Undergraduate Research Credits** and presented in front of the entire department.
- **Team Anveshak** [↗](#) (May'21- Present)
 - 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**.
 - Developed a software stack that leverages **bitmask encoding** to transmit **16 bit** information through the **8 bit** MPC2515 for manipulator control.
 - Played a pivotal role in the team's outstanding performance, securing a **global 6th** place at the **Anatolian Rover Challenge in Turkey, 2022**.
 - Led a team of 3 students in implementing a PID-based control and spiral search algorithm-based path planning framework for traversal between arrow markers that helped the team win the **Excellence award for autonomous** task in the **International Rover Challenge 2024**.
- **EYRC - KrishiBot** [↗](#) (Oct'22- Mar'23)
 - Implemented **Wall following** Algorithm through laser scan feedback and a **PID controller** for autonomous navigation of the robot around the warehouse setup.
 - Integrated colour and centroid detection techniques to identify bell peppers within images captured by an Intel RealSense depth camera and executed a pick-and-place workflow using **ROS MoveIt**.
- **Multi-agent Game theoretic framework for security of critical infrastructure** (Jan'23-April'23)
 - Worked under **Dr. Bharath Bikkaji** and **Dr. Vishwananda Reddy** on ROS implementation of a **Receding Horizon** based multi-agent **LQR** controller on **TAD** game theoretical framework.
 - Developed a simulation stack based on Turtlesim, which uses pose feedback of all the agents using a centralized ROS node and subsequent velocity control under this framework.

Course Projects

Non-Linear System Analysis ↗	<ul style="list-style-type: none">• Developed a controller for Swing-up and Stabilisation of a linear Inverted Pendulum.• Implemented swing up using Energy control by designing a suitable Lyapunov function and stabilisation after swing up using Pole placement technique.• Analysed the stability of sliding mode control for stabilization in this system.
Intro to Motion Planning ↗	<ul style="list-style-type: none">• Implemented Sampling-based motion planning algorithms RRT* and Bi-Directional RRT for the KUKA Mobile Manipulator.• Integrated these algorithms with an A* and Traveling salesman-based Navigation algorithm for the most optimal pick and place task of scattered objects in a Gazebo Environment.
PLC & SCADA ↗ (MOOC)	<ul style="list-style-type: none">• Implemented timers and counters in IEC-61131-3 PLC ladder logic and Interfaced Scada/HMI system for remote control of industrial process units.

Technical Skills

Courses: Reinforcement Learning | Linear Dynamical Systems | Non-linear System Analysis | Intro to Motion Planning
Linear Algebra | Synthesis of Control Systems.

Programming Languages: C, C++, Python, MATLAB

Tools & Frameworks: Git, Mujoco, Isaac Gym, Robot Operating System(ROS), Eagle, Latex, Pytorch, Tensorflow.

Key Competencies : Controls, Deep Reinforcement Learning, Optimisation, Diagnosis and Debugging of Electronics.

Extracurriculars and Mentoring Experience

- **Teaching Assistant** for the course **EE3004 Control Engineering** under **Prof. Bharath Bikkaji**.
- Elevated to the role of **Team Lead** for **Team Anveshak**, serving from July 2022 to July 2023.
- Coordinated **Tech and Innovation Fair** with **500+** participants which aims to convert a Project to a **Minimum Viable Product** in **Shaastra**, the Annual Tech Festival of IIT Madras.
- Conducted Workshop with a Hands-on Session for 30+ students on **ROS** and **Gazebo**.
- Member of the **Dance Contingent** of IIT Madras and conducted Workshops for the General Student Body.