Manoj Reddy Manchala

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Education

University of California San Diego **Sept 2023 - Jun 2025**
- Master of Science in Mechanical Engineeirng (Specialized in **Robotics**)
- **Key Courses:** Planning & Learning Robotics, Sensing & Estimation in Robotics, Safety for Autonomous Systems

Indian Institute of Technology, Bombay **July 2017 - May 21**
- Bachelor of Technology in Mechanical Engineering

Experience

Graduate Student Researcher - Existential Robotics Laboratory **Mar 2024 - Present**

Mobile Manipulation - Ongoing:
- Integrating RGB data into current GNN-based perception framework enabling **semantic awareness** of the agent, combining perception, manipulation, and navigation into a **unified reinforcement learning policy**.

GNNs for Enhanced Spatial Understanding:
- Implemented a **graph neural network** (GNN)-based feature extractor, modeling **point clouds as structured graphs** to enhance 3D object classification and spatial reasoning, significantly improving scene understanding.
- Achieved a **23%** increase in navigation speed and a **17% reduction in collision rates** in simulation by replacing CNN-based perception with a GNN-driven spatial feature extractor, leading to superior scene understanding.

Vision Guided Autonomous Navigation:
- Engineered a CNN-based Deep Reinforcement Learning framework(**PPO/SAC**) for autonomous navigation of an Ackermann-drive vehicle, enabling efficient maneuvering in complex, obstacle-rich environments.
- Developed a physics-based custom simulation environment with **MuJoCo/DM Control** for realistic training.
- Designed a **3D convolution-based feature extractor** for depth image processing, enabling **spatiotemporal** feature learning across sequential frames, outperforming 2D CNNs in capturing motion dynamics.
- Deployed PyTorch models onto **NVIDIA Jetson TX2** (F1tenth car) by converting them to **ONNX** & **TensorRT**.

Research Assistant - IIT Bombay **Apr 2022 - Jan 2023**
- Supervised the development of a land-moving pesticide sprayer ensuring structural integrity through Fusion 360 & ANSYS.
- Developed a comprehensive Simulink model of the EV, simulating crucial parameters such as range, power, and torque.

Business Leadership Trainee - FARE Labs Private Limited **Jul 2021 - Feb 2022**
- Created a repository of segment segregated clients through detailed Market Research, optimizing targeted outreach.
- Executed innovative marketing strategies, boosting revenue by **15%**, securing clients worth **$250k** in projected revenue.

Research Internship - Varroc Tech Center **Nov 2019 - Dec 2019**
- Simulated & Evaluated multiple state-of-charge estimation techniques for Li-ion batteries, prioritizing model-based approaches like PI observers, **Sliding Mode observers**, and **Kalman filters**.

Projects

Localization and Mapping :
- Developed a **Visual-Inertial SLAM** system via an Extended Kalman Filter (EKF) prediction, integrating IMU & stereo camera data to accurately estimate the robot's trajectory & landmarks.
- Crafted a LiDAR-based SLAM system for differential-drive bot, performed point cloud registration via **Iterative Closest Point** & **Pose Graph Optimization** enhancing trajectory accuracy, generating detailed occupancy & texture maps.

Motion Planning :
- Formulated a **dynamic programming** approach for a 'Door & Key' navigation, formulating the task as a Markov Decision Process, demonstrating effective path planning for both known and random maps.
- Implemented **A*** & **RRT** to solve navigating through various complex 3D environments with static obstacles.
- Engineered a trajectory tracking control system for a differential-drive robot using **Generalized Policy Iteration** & **Certainty Equivalent Control** with minimal trajectory deviations while avoiding obstacles.

MPC for Uneven Terrains :
- Engineered a **Model Predictive Control** formulation for ground robots, enabling safe navigation on complex terrains with friction and elevation variations based on a customized dubins car model.

Comma.ai Calibration Challenge :
- Devised a **Conv-LSTM network** integrating **optical flow** features with RGB images to predict vehicle pitch & yaw from monocular camera inputs, achieving **MSE of 21.72%** & robust to varying environmental conditions.

Mobile Manipulator :
- Developed a control system for a mobile manipulator robot in MATLAB & **CoppeliaSim**, implementing kinematics simulation, **trajectory generation**, PI control strategy for precise autonomous navigation & **object manipulation**.

Technical Skills

Programming	Python, ROS, Linux, Pandas, Numpy, OpenCV, MATLAB, R, Arduino, LaTeX
Tools/Frameworks	MuJoCo, CUDA, ONNX, TensorRT, Git, PyTorch, TensorFlow, Simulink, Fusion 360, ADAMS