Hemanth Raj Tekumalla

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EDUCATION

Northeastern University *Sep 2024 - Aug 2026*
Master of Science in Robotics **Boston, MA**
Relevant Coursework: Robot Mechanics and Control, Robotics Sensing and Navigation, Mobile Robotics, Reinforcement Learning, Autonomous Field Robotics.

National Institute of Technology *Dec 2020 - Apr 2024*
Bachelor of Technology in Electrical Engineering **Rourkela, India**
Relevant Coursework: Control Systems, Embedded Systems, Digital Signal Processing

SKILLS

PROGRAMMING	Python, C++, MATLAB, Prolog, Bash/Shell
LIBRARIES & FRAMEWORKS	ROS 2, PyTorch, OpenCV, YOLO, Scikit-learn, NumPy, Pandas, Matplotlib
TOOLS & PLATFORMS	Simulink, Linux, Git/GitHub, TurtleBot3, F1TENTH Gym, Gazebo, RTAB-Map, Raspberry Pi

WORK EXPERIENCE

Embedded Systems Laboratory, Northeastern University *Nov 2024 - Present*
Research Assistant **Boston, MA**
Advisor: Dr. Gunar Schirner

- Developed a custom **simulation framework** to model fiber optic laser scanning in multiphoton microendoscopy, enabling quantitative analysis of spatial resolution, pulse coverage, and photobleaching distribution.
- Engineered a **Gaussian-based evaluation framework** to characterize laser pulse contributions at the pixel level, benchmarked five scanning patterns, and identified spiral scanning as most effective with **14% higher resolution** than alternatives.
- Formulated a global **Integer Linear Programming (ILP) optimization algorithm** using evaluation-derived weights to disable redundant pulses, reducing total enabled pulses from **65% to 45%** while maintaining full coverage.
- Validated the ILP optimizer against a greedy baseline, achieving a **28% reduction in mean pulse-per-pixel**, improved illumination uniformity, and lower photobleaching intensity in simulated scan outputs.
- Designed the evaluation-optimization pipeline for modular integration into **real-time imaging systems**, with extensibility toward reinforcement learning–based adaptive control.

Centre for Robotics and Security in Internet of Things, IIIT Pune *May 2023 - July 2023*
Research Intern - Robotics **Pune, India**
Advisor: Dr. Ranjith Ravindranathan Nair

- Designed and deployed a real-time **deep learning–based perception system** (YOLOv8 + DeepSORT) with **OpenCV preprocessing** and integration into the **ROS 2** pipeline.
- Implemented **LiDAR–camera sensor fusion** to estimate human pose relative to the robot, improving localization accuracy and robustness under occlusion in **Cyber-Physical System environments**.
- Developed a closed-loop **Sliding Mode Control (SMC)** algorithm using odometry, IMU, and LiDAR feedback to enable smooth **trajectory tracking** in real time.
- Integrated a **sliding-mode observer (SMO)** with adaptive thresholding for anomaly detection, enhancing **fault tolerance** by identifying sensor drift and stealthy failures.
- Validated the full **control–perception pipeline** in **Gazebo** and deployed on **TurtleBot3 Waffle-Pi** using **ROS 2 Foxy** and Linux tools, ensuring stable and safe navigation in dynamic environments.

PROJECTS

Beacon-Based Localization for Multi-Sensor Fusion SLAM *Sept 2024 - Dec 2024*

- Adapted a beacon-based localization method into a multi-sensor fusion SLAM framework using **ROS 2** and **RTAB-Map** to address GNSS-denied environments through beacon-based global pose correction.
- Implemented and optimized a **particle filter** to fuse odometry and beacon distance measurements, improving real-time pose estimation and robustness in feature-sparse scenarios.
- Evaluated system performance in **Gazebo** and **RViz** with **TurtleBot3**, comparing mapping accuracy and trajectory alignment against LiDAR-only SLAM (Cartographer).

Deep Reinforcement Learning for Autonomous Racing in F1TENTH Gym *Jan 2025 - Apr 2025*

- Trained autonomous racing agents using **PPO** and **DDPG** in the **F1TENTH Gym** simulator with a 275-dimensional state space (LiDAR readings and vehicle kinematics) and a continuous action space for steering and speed.
- Designed a multi-term reward function incorporating speed, alignment, lap progress, and collision avoidance, enabling the PPO agent to **consistently complete laps without collision at speeds up to 7 m/s**, while learning to follow the **racing line**.
- Benchmarked training over **3,500 episodes**, comparing PPO and DDPG in terms of **learning stability and policy consistency**; released full implementation with training pipeline and visualization tools on GitHub.