Hemanth Raj Tekumalla

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EDUCATION

Northeastern University — ***Sep 2024 - Aug 2026***
Master of Science in Robotics — **Boston, MA**
National Institute of Technology — ***Dec 2020 - Apr 2024***
Bachelor of Technology in Electrical Engineering — **Rourkela, India**

SKILLS

Programming: Python, C++, MATLAB, Bash/Shell
Libraries & Frameworks: ROS 2, PyTorch, OpenCV, Nav2, GTSAM, PCL, SciPy, Simulink, Rviz, Scikit-learn
Tools & Concepts: Linux, Docker, Git, Gazebo, SLAM, State Estimation, Sensor Fusion, Optimization, Path Planning

WORK EXPERIENCE

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

- **Optimized laser scanning efficiency** for Multiphoton microendoscopy by developing a simulation and evaluation framework to analyze spatial resolution and photobleaching across different scan patterns.
- Reduced photobleaching in medical imaging by formulating an **Integer Linear Programming (ILP) optimization** algorithm that strategically disabled redundant laser pulses while ensuring full image coverage.
- Validated the ILP optimizer, achieving **47% pulse reduction while maintaining high image quality** (SSIM ~0.85) and mapped a Pareto frontier showing 80-90% reductions possible for applications tolerating lower quality thresholds.

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

- Integrated a real-time perception system in **ROS 2** using **YOLOv8** and **DeepSORT**, implementing **LiDAR-camera fusion** to combine bounding boxes with **LiDAR** for estimating human pose and improving localization accuracy under **occlusions**.
- Developed a **Sliding Mode Control (SMC)** for trajectory optimization using multi-sensor feedback (odometry, IMU, LiDAR) and integrated a **sliding-mode observer** to detect sensor drift and stealthy system failures without external supervision.
- Deployed the pipeline on a **TurtleBot3 Waffle-Pi** using **ROS 2 Foxy**, validating performance through **Gazebo** simulations to demonstrate autonomous navigation and human-following in dynamic environments with real-time control.

PROJECTS

Monocular 3D Reconstruction via Structure from Motion (SfM) — ***Sep 2025 - Dec 2025***

- Reconstructed 3D geometry from **24 sequential images** in a turntable configuration, employing **SuperPoint** and **SuperGlue** to robustly register **100% of views** by handling perspective shifts and feature occlusions.
- Mitigated initialization errors of **546.32px** by formulating a non-linear least squares problem using **GTSAM Bundle Adjustment** with **Huber loss**, driving the final error down to **0.82px (99.9% reduction)** for sub-pixel precision.
- **Generated** a high-fidelity sparse 3D model containing **6,966 points** with a **mean track length of 2.55 views** by enforcing **100% cheirality constraint satisfaction**, demonstrating physically valid geometry and robust multi-view perception.

Target-less Spatiotemporal LiDAR-Camera Calibration — ***Sep 2025 - Dec 2025***

- Implemented a target-less calibration framework based on semantic consistency, **defining** a bi-directional alignment loss that penalizes reprojection discrepancies between 3D **SalsaNext** segmentation and 2D **DeepLabV3** masks.
- Integrated a temporal offset estimator that leverages **optical flow** and **visual odometry** to synchronize sensor streams, successfully correcting **millisecond-level time delays** in dynamic driving scenarios.
- Executed a robust **non-linear optimization** using Lie Algebra parameterization and L-BFGS-B, validating the 6-DoF extrinsic convergence on the KITTI dataset without physical targets.

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

- Trained reinforcement learning models using PyTorch and OpenAI Gym, implementing PPO and DDPG **actor-critic neural network architectures** with Generalized Advantage Estimation and gradient clipping for stable policy learning.
- Designed a **multi-component reward function** with terms balancing velocity optimization, trajectory alignment, progress tracking, and collision penalties to shape model behavior toward successful task completion and collision-free performance.
- Conducted comparative algorithm analysis demonstrating **PPO outperformed DDPG** with **2x higher cumulative reward at 40% faster speeds** over 3,500 episodes, validating PPO's superior training stability in high-speed control environments.

Dynamic Obstacle Avoidance with D* Lite Path Planning — ***Jan 2025 - Apr 2025***

- Developed a custom **ROS 2 Navigation2 planner plugin** in C++, implementing the **D* Lite algorithm** for real-time replanning in dynamic environments, leveraging incremental search to update only affected graph regions when obstacles appear rather than recomputing entire paths from scratch.
- Integrated dynamic costmap updates with a cell-based **priority queue** and state persistence for incremental search, enabling real-time replanning with minimal computational overhead when obstacles appear in the environment.
- Validated planner using **TurtleBot3** in **Gazebo** across three dynamic obstacle scenarios (sudden, occluded, close-proximity), demonstrating adaptive navigation with **sub-100ms** replanning response times.