Behrad Rabiei

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Education

University of California - San Diego *Sept 2023 – June 2024*
MS in Electrical Engineering - Intelligent Systems, Robotics, and Controls

- GPA: 3.744/4.0

University of California - San Diego *June 2020 – June 2023*
BS in Electrical Engineering - Machine Learning and Controls

- GPA: 3.618/4.0

Research Interests

- Simultaneous Localization and Mapping (SLAM), Novel Environment Representations, Sensor Fusion for SLAM, LLM equipped Planning and Navigation
- Autonomous Robot Exploration, Perception-aware Planning and Control, Active SLAM, Model-based and Model-free Active Target Tracking
- Multi-robot Systems, Distributed Estimation and Planning
- **Relevant Fields:** Robotics, Machine Learning, Computer Vision, Distributed Optimization, Automation

Experience

Graduate Researcher *San Diego, CA*
Existential Robotics Laboratory (UCSD) *July 2024 – Present*

- Implementing a custom A* path planning algorithm with heuristic for LTL-based planning using semantically annotated 2D maps
- Implemented ROS1 nodes for A*, trajectory tracking, and differential drive control on Jackal UGV and TurtleBot 4, tested and validated the trajectories in Gazebo
- Working on building real-time semantically annotated OctoMap from depth and semantic segmentation data using the Semantic Shannon Mutual Information (SSMI) Library
- Used Spot to generate automata from LTL formulas based on natural language queries

Software Engineer *San Diego, CA*
PMAT *April 2024 – Present*

- Debugged issues in software for Navy ships written in C++ and Java in a 40-year-old codebase
- Rebuilt and validated code, ensuring fixes meet performance and operational standards
- Wrote test procedures for engineers to verify software fixes
- Utilized version control to manage changes across a large, legacy codebase

Machine Learning Intern *Manhattan, NY*
NASA *June 2024 – August 2024*

- Developed a data retrieval system for CMIP 6, managing 30PB of climate data
- Created an efficient parser to filter datasets from over 13.6 million entries
- Integrated LangChain and OpenAI APIs to build a dynamic user-driven analysis engine
- Designed a Streamlit UI for a conversational, intuitive data analysis experience
- Submitted the project to the AGU 2024 and NeurIPS 2024 conferences for presentation

Machine Learning Intern *San Diego, CA*
RoboCoach *May 2023 – May 2024*

- Designed an open-source project that generates Python code from natural language
- Integrated LangChain and OpenAI APIs to enable code generation via multiple LLMs
- Developed custom prompts and used regex to extract code from plain text

- ○ Created a chatbot-like web interface using Streamlit for a seamless user experience

System Architecture Co-Op *North Reading, MA*
Amazon Robotics *July 2022 – Sept 2022*

- ○ Designed test plans to match exit criteria for Amazon's autonomous robot, Proteus
- ○ Initiated cross-team collaboration to validate metrics and automate logging
- ○ More than doubled facility throughput by expanding test scenarios and maps (from 6 to 15)
- ○ Wrote Python scripts to extract real-time test data from AWS databases using SQL queries

Reliability Engineer Intern *Glendale, CA*
Takeda *June 2021 – Sept 2021*

- ○ Liaised between Takeda and the vendor to shift from preventive to predictive maintenance
- ○ Coordinated sensor installations, balancing vendor and production needs
- ○ Secured approvals for shutdowns to enable smooth sensor deployment
- ○ Helped draft a proposal that secured funding for expanded sensor installations
- ○ Highlighted operational redundancies, showing continued production capability during installations and potential equipment failures
- ○ Performed cost analysis, outlining the benefits of predictive maintenance adoption

Manufacturing Intern *Hawthorne, CA*
SpaceX *July 2020 – Sept 2020*

- ○ Optimized the solenoid valve manufacturing process to boost production and quality
- ○ Increased production rate by 114%, from 70 to 150 valves/day
- ○ Added two new assembly steps to reduce assembly time
- ○ Identified root causes of valve failures, addressing around 60 daily failures
- ○ Created a corrective action guide for technicians to resolve production losses

Publications

Data PAL: Scientific Data Analysis through Conversational AI *PDF* ↗ *Fall 2024*

Anonymous Author(s)

Submitted and in review to NeurIPS 2024 Workshop FM4Science

Climate PAL: Climate Analysis through Conversational AI *PDF* ↗ *Fall 2024*

Anonymous Author(s)

Submitted and in review to NeurIPS 2024 Workshop ML4PS

Projects

Infinite-Horizon Stochastic Optimal Control *Link* ↗ *Spring 2024*

- ○ Developed trajectory tracking algorithms for differential-drive robots using CEC and GPI
- ○ Implemented CEC for real-time trajectory tracking, optimizing control inputs using CasADi
- ○ Applied GPI for adaptive policy iteration, position/orientation error, and control effort
- ○ Designed control policies ensuring safe navigation through environments with obstacles
- ○ Evaluated performance of both algorithms, showing CEC's efficiency and GPI's robustness

Motion Planning *Link* ↗ *Spring 2024*

- ○ Developed motion planning algorithms for 3D environments with obstacles
- ○ Implemented A* and Bi-Directional RRT for path planning in 3D spaces
- ○ Designed and tested collision detection using PyBullet for obstacle avoidance
- ○ Evaluated algorithm performance in structured and unstructured environments
- ○ Demonstrated A*'s effectiveness in complex environments and RRT's in simpler settings

Dynamic Programming *Link* ↗ *Spring 2024*

- Utilized a dynamic programming algorithm for navigation in a ”Door and Key” environment
- Designed a Markov Decision Process (MDP) for navigation in stochastic environments
- Implemented dynamic programming to compute optimal paths while minimizing costs
- Developed policies for both known and random environments, adapting to unknown layouts
- Validated algorithm performance through simulations in complex navigation scenarios

Visual-Inertial SLAM *Link* ↗ *Winter 2024*

- Developed an EKF-based VI-SLAM system using stereo camera and IMU data
- Integrated IMU/stereo camera data for real-time localization using Extended Kalman Filter
- Mapped landmarks via stereo image triangulation and EKF refinement
- Iteratively updated robot trajectory and map in real time
- Synchronized visual and IMU data for accurate state updates

LiDAR-Based SLAM *Link* ↗ *Winter 2024*

- Developed SLAM algorithms for differential-drive robots using Lidar/IMU/RGBD data
- Implemented Dead Reckoning using IMU and Encoder data to estimate robot trajectory
- Applied ICP to Lidar scans for refining trajectory estimates from Dead Reckoning
- Developed occupancy grid maps using Lidar data and Bresenham’s algorithm
- Generated texture maps by combining RGBD camera data with occupancy grids
- Used GTSAM for factor graph optimization, incorporating loop closure for better accuracy

Orientation Tracking *Link* ↗ *Winter 2024*

- Tracked camera orientation using IMU data and generated 3D panoramas
- Calibrated IMU data to correct biases and errors using VICON data
- Tracked camera orientation over time using quaternion kinematics and IMU data
- Generated panoramic images by stitching camera frames based on estimated orientation

Technologies

Hardware: Intel RealSense, 3D LiDARs, VectorNav, Nvidia Jetson, Raspberry Pi

Robots: F1 Tenth, Jackal UGV, Turtlebot4, DJI Custom Drones, Amazon Differential Drive Robots

Software: Python, C++, C, ROS, Open3D, PyTorch, JAX, GTSAM, Spot, LLMs (LangChain, LangFlow)

Tools: Git, Linux, Docker, Kubernetes, Gazebo