

# Kaustabh Paul

[kaustabp@andrew.cmu.edu](mailto:kaustabp@andrew.cmu.edu) | (412) 320-3885 | [www.linkedin.com/in/kaustabh-paul](https://www.linkedin.com/in/kaustabh-paul) | [redtorus.github.io](https://redtorus.github.io)

## Education

### Carnegie Mellon University

Master's of Science in Electrical and Computer Engineering (Advanced Study)

Pittsburgh, PA

May 2025

### Technical University Munich

Bachelor's of Science in Electrical Engineering and Information Technology

Munich, Germany

May 2023

## Research Experience

### Carnegie Mellon University, Robomechanics Lab

Pittsburgh PA

*Design of PRM-Based Global Body Planner for Quadruped Ghost Robotics Spirit 40*

September 2024 - ongoing

- Implemented lazy PRM based global planner using weighted A\* for dynamic obstacle avoidance and sample efficiency inside of the Quad SDK framework in ROS Noetic using C++ with <30ms planning time

### Technical University Munich, Chair of Information-oriented Control (ITR)

Munich, Germany

Bachelor thesis: *Grasp Optimization from Learning-Based Initial Guess*

September 2022-April 2023

- Developed optimization algorithms for robotic grasp based on initial guess from reinforcement learning framework in simulation environment MuJoCo
- Divided into contact position optimization (via force and moment residual control) and force optimization (minimizing grasping wrench while satisfying friction cone and external force constraints)
- Successfully reduced average required force for optimized grasp by 60%

## Internship Experience

### Boardwalk Robotics Inc.

Pensacola, FL

AI Intern

June 2024- August 2024

- Designed reinforcement learning pipeline using PPO for autonomous bi-manipulation tasks for upper body of humanoid robot Alex
- Conducted simulation testing in Isaac Sim to explore and optimize control strategies for manipulation
- Analyzed and interpreted simulation data to refine machine learning models for robust performance
- Achieved successful object handling for pick and push tasks in simulation

### Siemens Healthineers

Forchheim, Germany

R&D Intern in Department: Diagnostic Imaging (DI) X-Ray Products (XP)

September 2021-October 2021, March 2022

Research and Development Hardware (HW) Mechatronics (MEC)

- Analyzed damage on electromechanical components of X-Ray machines through automated testing procedures
- Programmed hardware controller on BeagleBoneBlack microPC for automated testing of prototype

## Projects

### Carnegie Mellon University

Pittsburgh, PA

*Optimizing and testing diffusion based RL*

Spring 2025

- Tuned & benchmarked model free diffusion-based RL algorithms (DIP0 & QVPO) using seven SDE/ODE samplers (DDPM, Heun, PC, DDIM, k-LMS, RK4, DPM-solver), achieving 13% higher return compared to baseline DDPM for HalfCheetah environment and lower variance in other cases
- Designed unified evaluation framework on MuJoCo and D4RL benchmarks to quantify sampler effects on various environments, showed supervised warm-start pretraining cuts actor MSE by ~15%

*Parallelized Convolutional Neural Network Architecture for faster Inference*

Spring 2025

- Implemented hand-tuned CUDA kernels for the game checkers in AlphaZero in team of 2
- Replaced libtorch calls for input, torso and output layers resulting in inference latency reduction of up to 4.9 on NVIDIA Tesla T4 GPUs and 12.7 on CPU
- Designed conflict-free shared-memory tiling & padding schemes unlocking near-peak hardware utilization

*RTAB-MAP SLAM Pipeline Optimization & Evaluation*

Spring 2025

- Developed end-to-end SLAM evaluation pipeline for RTAB-Map in team of 4 using Turtlebot with Intel Realsense RGB-D camera, wheel odometry and IMU in ROS Noetic
- Built ground truth alignment pipeline to validate mapping accuracy (<0.5 mm mean error, 10% RMSE improvement)
- Parallelized RTAB-Maps's Ceres pose-graph solver with OpenMP, reducing average solve time by 17% boosting throughput in large scale mapping scenarios

*Drone Controller for Wind Robustness*

Fall 2024

- Implemented various onboard controllers (PID, SMC and LQR) for wind rejection for drone crazyflie 2.0 in group of 4
- Designed dynamics model for cascaded SMC and PID controller and simulation environment in ROS2 + Gazebo
- Achieved stable hovering for three controllers and acceptable performance for wind rejection and trajectory tracking

*Imitation Learning for Bipedal Walker Control*

Fall 2024

- Successfully implemented and compared imitation learning methods (Behavior Cloning, DAgger and Diffusion Policies) for training a bipedal walker (BipedalWalker-v3) in OpenAI Gym and achieved training loss less than 0.04
- Leveraged expert trajectories supplied by PPO

*Sampling-Based Planners for multi DoF Robotic Arm*

Fall 2024

- Implemented and evaluated sampling-based planners (RRT, RRT-Connect, RRT\* and PRM) to plan motion of a high degree of freedom robotic arm in an 2D environment with static obstacles in C++
- Achieved planning times under 80ms and success rates up to 100% for 4 DoF arm

*Sketch to Image Latent Diffusion Model*

Spring 2024

- Designed text conditioned latent diffusion model framework using DDIM with PyTorch in group of 3
- Designed edge-map based dataset augmentation for sketch-image dataset and various training pipelines using

different results to achieve image generation

- Generated high-quality images with potential for significant improvement given more compute resources

*Implementation of Decision Transformer for Existing RL Environment*

Spring 2024

- Incorporated online decision transformer into TDMP2 algorithm of RL framework of humanoid robot unitree H1
- Achieved 54% reduction in training time with randomly initialized weights and 27% reduction in training time with pretraining, along with smoother and more natural joint movements in MuJoCo

*Autonomous Vehicle Controller Design*

Fall 2023

- Implemented PID and LQR controller with EKF SLAM and A\* planning for autonomous vehicle in Webots
- Achieved 20% faster track speed over PID with < 3.5 meter average distance from road median

*Design of Reaction Time Game on Embedded System*

Fall 2023

- Designed reaction time game on STM32 that communicates with mechatronic system to read player signals
- Implemented sensor circuit on KiCAD and low level BDC motor control

**Technical University Munich**

Munich, Germany

*SLAM for Sound-Source Localization*

Spring 2023

- Simulated search and rescue mission in ROS2 on unknown map in group of 3
- Attempted to reach signal source points while creating map of the environment using SLAM toolbox and avoiding collisions using real-time collision monitoring

*Self-balancing and Trajectory Following Robot*

Spring 2022

- Implemented digital controller on ATmega8 microcontroller for balancing and trajectory following
- Utilized various sensors and components (e.g. accelerometer, gyroscope, ADC, encoder)
- Tasks: robot modelling, sensor communication via SPI, sensor data fusion, designed flatness based controller for trajectory following, designed interrupts for special cases

*Self-balancing and Trajectory Following Robot*

Spring 2022

- Implemented digital controller on ATmega8 microcontroller for balancing and trajectory following
- Utilized various sensors and components (e.g. accelerometer, gyroscope, ADC, encoder)
- Tasks: robot modelling, sensor communication via SPI, sensor data fusion, designed flatness based controller for trajectory following, designed interrupts for special cases

*Design of Controller for Buck-Boost Converter*

Winter 2021

- Designed digital and analog controller for buck-boost converter to ensure stable and regulated output voltage during load change
- Implemented analog controller using OpAmp circuits and digital controller on microcontroller
- Simulated and designed buck-boost converter, modulator and noise filter circuits using LT Spice

**Skills**

Programming Languages: MATLAB, C/C++(OpenMP, CUDA, ROS, embedded), Python (PyTorch, Tensorflow, Keras, Jax), Julia

Software: LT-Spice, SolidWorks, MSC Adams, KiCad, Linux, Git, Simulation (ROS, MuJoCo, Isaac Sim, Gazebo), AWS (E2C), Docker

Hardware: ATmega5, STM32, Raspberry Pi, BeagleBoard

Languages: German, English, Hindi