Antareep Singha

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RESEARCH EXPERIENCE

International Institute of Information Technology, Hyderabad (IIITH) **Jan, 2024 – June, 2025**
Researcher @ RRC-(Autonomous Wheelchair) Optimal Control, Deep Learning

- Built a novel **MPC pipeline using CasADi** integrating polygonal SDF for dynamic actors, and deployed it IRL.
- Ported the MPC to Facebook's **Theseus Lirary** to make it differentiable for E2E learning.
- Built a local planner to function in dense crowds using VQ-VAE **(CrowdSurfer)**, conditioned on real-world semantics.
- Migrated the entire wheelchair stack from ROS Noetic to ROS2 including the open-source Voronoi Global Planner.

Indian Institute of Technology, Madras (IITM) **May 2023 – July 2023**
Summer Fellow - (SFP 2023) FPGAs, RTL and Digital Design

- Developed and implemented a **novel Verilog based Data Acquisition(DAQ)** module on a **RedPitaya STEMlab 125-10** that reads 10-bit ADC data, runs a peak detection algorithm, and stores the output on its Block RAM.
- Generated Gaussian peaks using **PYNQ** Overlay on Zynq-7010 SoC to simulate the Verilog based DAQ module.

Indian Institute of Technology, Hyderabad (Remote) **May 2023 – July 2023**
Project Intern - Embedded Systems, Systems Engineering

- Worked on the Hardware Security R&D team of the **"Smart Meter" project** funded by Directorate of Science and Technology and developed Python based security models according to the existing **ITSAR** standards.

EDUCATION

Nanyang Technological University, Singapore **Aug 2025 – Dec 2026(expected)**
MSc. in EEE(Computer Control and Automation)

Puducherry Technological University, Puducherry **Aug 2020 – May 2024**
B.Tech in Mechatronics Engineering — First Class with Distinction *CGPA: 9.08/10*

PUBLICATIONS

CrowdSurfer: Sampling Optimization Augmented with Vector-Quantized Variational AutoEncoder for Dense Crowd Navigation
Naman Kumar*, **Antareep Singha***, Laksh Nanwani*, Dhruv Potdar, Tarun R, Fatemeh Rastgar, Simon Idoko, Arun Kumar Singh, K. Madhava Krishna
IEEE International Conference on Robotics and Automation(ICRA), 2025

An FPGA based Real-Time Video Processing system on Zynq 7010

Antareep Singha*
IEEE Second International Conference on Advances in Computational Intelligence and Communication (ICACIC), 2023

PROJECTS

Social Navigation on an Autonomous Wheelchair **Source Code**

- Developed a custom **MPC** pipeline using **CasADi**. Constraints to the MPC are dynamic agent velocities, and static obstacle positions as an SDF function.
- Built a **novel local planning algorithm** for generating multi-modal trajectories in **dense crowds** using **generative modeling and Sampling Optimization**. A VQ-VAE is used to generate a trajectory distribution to be used for warm-starting a sampling optimizer. Improved success rates by 40% against SOTA DRL-VO planner.

Visually Conditioned Diffusion Policy for Socially Compliant Navigation(in-progress) **Source Code**

- Learning to generate **scene-specific trajectories** using Diffusion, in social spaces.
- A **Transformer encoder** is to used to encode semantically-segmented RGB images and Human body poses to a **context vector** that in turn is used to condition a Diffusion policy.

- Trajectories are diffused in a parameterized space and then converted back to Cartesian space at run-time. Additionally, diffusion policy might be guided by a cost function namely, goal reaching cost to ensure goal-directed trajectories.

Differentiable Model Predictive Control **Source Code**

- Implemented a differentiable version of the MPC-based local path planner using **Facebook's Theseus library**.
- Created custom differentiable cost functions for both acceleration and velocity commanded MPCs.

Real-Time Human Body Pose Estimation using RTMO **Source Code**

- Built a real-time body pose estimation pipeline using RTMO and depth data, used in deployment of CrowdSurfer. RTMO provides keypoints on the shoulder and face. The points are **deprojected to 3D** using camera extrinsics and the **cross-product of the keypoints** are computed for the real-time human body pose.
- This pipeline was used to provide body pose information on which a VQVAE model (a version of CrowdSurder) was trained to learn social behavior.

Temporal-RRT Path Planner **Source Code**

- Developed a novel 3D temporal RRT planner capable of determining simultaneous shortest paths for multiple sets of start and end points within a discrete 3D grid.
- Implemented collision avoidance within the temporal RRT framework to ensure that no two independently computed paths occupy the same grid point at any given time step.

TECHNICAL SKILLS

Relevant Courses: Industrial Robotics, Control System, Mechatronics, Modelling & Simulation
Languages: Python, C, C++, Verilog
Frameworks and Tools: PyTorch, Jax, ROS/ROS2, OpenCV, CasADi, Theseus, Git, Docker
Areas of Interest: Optimization & Control, Deep Learning, Computer Vision, Reinforcement Learning

TEACHING & MENTORING

- Being the president of the robotics club, held seminars on Mobile Robotics, ROS and Introduction to Machine Learning as a part of **RoboVed Summer School** at Puducherry Technological University.
- Worked as a Teaching Assistant**(TA)** under Dr. R. Elansezhian for the graduate-level course **MT213 Industrial Robotics**, arranging assignments and designing coursework.
- Designed MCQ questionnaires, hosted learning webinars online for over 60 courses for **L&T EduTech** on Machine Learning, Data Analytics and Time Series, as a freelancer.

HONOURS & AWARDS

- Awarded **Best Paper Award** at PTU Genesis 2023, a National Level Technical Symposium. Presented my research ***An FPGA based Real-Time Video Processing System on Zynq 7010*** to jury of 5 members.
- Received the prestigious monetary **Summer Fellowship Award** for the May-July 2023 internship season from Indian Institute of Technology, Madras (IITM).
- State-level Cricketer at **Cricket Association of Bengal(CAB)**. Played several state-level U-14 tournaments and won several accolades.