SANDEEP SAM ZACHARIAH

Master of Science in Robotics (MSR)
Carnegie Mellon University
Email: sszachar@andrew.cmu.edu, Website: https://sandeepzachariah.github.io/
Phone: +1 (412) 589-4914

RESEARCH AREAS

Mobile manipulation, Assistive robots, Task and Motion Planning, Perception, Generative AI, Task space control, and Image processing.

EDUCATION

Master of Science in Robotics (MSR) August 2024 - Present
Carnegie Mellon University GPA: 4.17/4.0

Bachelor of Technology (B. Tech) July 2018 - May 2022
National Institute of Technology Calicut, India (NIT Calicut) GPA: 9.75/10, Institute Rank 1
Department of Electronics and Communication Engineering
Courses: Robotics, Artificial Intelligence, Computer Vision, Embedded Systems, Signal Processing.

High School (12^{th} Grade) August 2017 - March 2018
St Thomas Residential School, India Grade: 98.5%, Rank 2

EXPERIENCE

Graduate Research Assistant September 2024 - Present
Carnegie Mellon University
Topic: Simultaneous Localization and Mapping

- Design and Integration of sensor suite for drone-based data collection.
- Merging of under-canopy and above-canopy maps for comprehensive forest environment reconstruction.

Project Scientist July 2022 - July 2024
Indian Institute of Technology Delhi, India (IIT Delhi)
Topic: Language-guided mobile manipulation.

- Developed the autonomy stack for the mobile manipulator.
- Task planning in incomplete world knowledge.
- Foundation model based planning and perception for zero-shot generalization to novel scenes.

Project Intern April 2021 - August 2021
Indian Institute of Space Science and Technology, India (IIST)
Topic: Modeling, Control and Simulation of Quadruped robots.

- Closed Loop Inverse Kinematic (CLIK) algorithm for the resolved acceleration control of torso and foot frames.
- Mathematical modeling of quadruped dynamics using Composite rigid body and Recursive Newton-Euler algorithms.
- Joint space and Task space inverse dynamics control with holonomic constraints.

Summer Intern May 2019 - July 2019
Indian Institute of Technology Delhi, India (IIT Delhi)
Topic: Modeling, Control and Simulation of Planar Robotic Manipulator.

- Modeling of manipulator dynamics based on the Euler-Lagrange equations of motion.
- CAD design and structural analysis of the manipulator.
- Joint space and Task space control.

MAJOR PROJECTS

Open-World Scene Graphs for Human-instructed Manipulation Tasks Using Foundation Models November 2023 - May 2023

Indian Institute of Technology Delhi

A scene representation scheme that is both open-set and structured is necessary for sequential robot instruction following. This work focuses on generating such a representation that allows for local updates as the scene evolves. We demonstrate that our method produces superior results compared to previous works in both open-world object detection and relation extraction, even without relying on any priors. Paper

Leveraging Foundation Models for Generalization in Robust Task Planning for Field Robots May 2023 - July 2024

Indian Institute of Technology Delhi

This work focuses on implementing vision language and large language models for perception and planning tasks in a language-guided mobile manipulator designed for outdoor environments. As these models are trained on internet-scale data, this approach equips these systems with the capability to handle novel scenes.

Task Planning in Incomplete World Knowledge July 2022 - July 2023

Indian Institute of Technology Delhi

Mobile robots deployed on the field are often faced with incomplete knowledge about their surroundings. This project focussed on the development of a language-guided mobile manipulation system that contextually spawns exploration goals based on the information extracted from the natural language instructions. The proposed system achieved a Goal Reaching Rate(GRR) of 90%. Draft Paper, Video

Underwater Image Enhancement June 2021 - April 2022

National Institute of Technology Calicut

Autonomous exploration systems capture vast image data to study marine life but these images frequently exhibit distortion and clutter due to fluctuating lighting conditions and suspended particles. To enhance these images, a novel technique based on wavelet fusion of Multiscale Retinex and Dark Channel Prior algorithm was developed. The proposed model showed superior results in both quantitative metrics (UIQM) and qualitative metrics (edge profiles) as compared to deep learning methods such as UNET and CycleGAN. Thesis

Modeling, Control and Simulation of Quadruped Robots Arpil 2021 - August 2021

Indian Institute of Space Science and Technology

This project focussed on the implementation of task space inverse dynamics control to regulate the pose of the floating torso base frame and swing feet of a 12 DOF quadruped robot, while satisfying the holonomic constraints. Video1, Video2

COURSE PROJECTS

Detection of vowels using Variational mode functions September 2021 - November 2021

National Institute of Technology Calicut

Accurate detection of vowel's onset and end points from speech data using variational mode decompositions. The method achieved a detection accuracy of 95.2% even in the presence of $10dB$ noise.

Brain Tumour Detection using ResNets February 2021 - March 2021
National Institute of Technology Calicut
A ResNet CNN model was trained using the 'Brain MRI Images for Brain Tumor Detection' dataset on TensorFlow to detect brain tumors. The model achieved an accuracy of 93%.

Opamp based audio equalizer March 2020 - June 2020
National Institute of Technology Calicut
An opamp-based audio equalizer circuit was designed to individually vary the gain of bass, mid, and treble frequency bands along with features such as distortion detection and master gain control.

Electronic Voting Machine using 8051 microcontroller February 2020 - March 2020
National Institute of Technology Calicut
Implementation of the Electronic Voting Machine (EVM) using 8051 microcontroller interfaced with display for viewing the status of the election.

PUBLICATIONS

G2TR: Generalized Grounded Temporal Reasoning for Robot Instruction Following by Combining Large Pre-trained Models
Riya Arora, Niveditha Narendranath, Aman Tambi, Sandeep S. Zachariah, Souvik Chakraborty, Rohan Paul
arXiv

Generating Open-World & Multi-Hierarchy Scene Graphs for Human-instructed Manipulation Tasks via Foundation Models
Sandeep S. Zachariah, Aman Tambi, Moksh Malhotra, P. V. M. Rao and Rohan Paul
ICRA 2024: 2nd Workshop on Mobile Manipulation and Embodied Intelligence
Paper, Website

Generalized Grounded Temporal Reasoning with Foundation Models for Language-guided Robot Manipulation
Riya Arora, Niveditha Narendranath, Sandeep S. Zachariah, Aman Tambi, Souvik Chakraborty and Rohan Paul
ICRA 2024: Physical Human-Robot Interaction Workshop
Paper, Website

Incorporating Foundation Model Priors in Modeling Novel Objects for Robot Instruction Following in Unstructured Environments
Moksh Malhotra, Aman Tambi, Sandeep S. Zachariah, P. V. M. Rao and Rohan Paul
ICRA 2024: 3D Visual Representations for Robot Manipulation
Paper, Website

AWARDS AND HONORS

Vikram Sarabhai Ever Rolling Trophy September 2022
National Institute of Technology Calicut
Institute level: Awarded for the Best Outgoing student of the year 2022.

Prof. Allesu Kanjirathinkal Memorial Award September 2022
National Institute of Technology Calicut
Institute level: For having scored the highest CGPA(Rank 1) among all undergraduate programs.

Er M L Bapna Gold Medal September 2022
National Institute of Technology Calicut
Institute level: For having scored the highest CGPA(Rank 1) among all undergraduate programs.

Gold Medal September 2022
National Institute of Technology Calicut
Department level: Outstanding scholastic performance in Electronics and Communication Engineering department(Rank 1) with a CGPA of 9.75/10.

Certificate of Merit February 2019
National Institute of Technology Calicut
For securing the first position among 1050 students in the first-semester exam of the undergraduate program.

Merit Award January 2019
St Thomas Residential School
School 2^{nd} rank among 235 students in the ISC Board exam.

Merit Award August 2018
Vikram Sarabhai Space Centre, Indian Space Research Organization (ISRO)
For procuring 98% in the ISC Board exam.

PROFESSIONAL AND ACADEMIC SERVICES

Robot Fabrication and Integration March 2022 - May 2024
Worked in an interdisciplinary team with IIT Delhi and Nex Robotics Pvt. Ltd. Mumbai, India, to develop an indigenous mobile manipulator designed for outdoor environments.

- Software stack design for the indigenous robotic platform.
- Sensor suite selection - 3D and 2D Lidars, RGBD cameras, microphones, force-torque sensors.
- Hardware design reviewer.

Demonstration and Academic Interaction with Project Sponsors July 2022 - May 2024
Defence Research and Development Organisation, India (DRDO)

- Technology and Know-How Transfer.
- Contribution to technical reports.
- Led robot field experiments for the research agency.

Academic Service August 2025
Reviewed papers and workshop proposals for the IEEE Transactions on Automation Science and Engineering (T-ASE-2025) and IEEE International Conference on Robotics and Automation (ICRA 2024).

Teaching Assistantship August 2023 - November 2023
Indian Institute of Technology Delhi
Participated in the evaluation and development of assignments based on Reinforcement Learning in

collaboration with a Ph.D. student for the COL864 Embodied AI course offered at IIT Delhi.

Involvement in Student Projects July 2023 - Current
Indian Institute of Technology Delhi
Worked with seven undergraduate students and one doctoral student as part of their course projects to develop language and robot skill modules for the mobile manipulator.

PROFESSIONAL SKILLS

Robotics System Experience
Clearpath Husky, UR5e manipulator, Franka Emika Panda Manipulator, Robotiq 3f-gripper, Force-Torque Sensor, Velodyne VLP-16, Hokuyo LiDAR, Intel Realsense and OAK-D cameras, Nvidia Orin.

Programming Languages and Frameworks
Python, C++, PyTorch, Matlab, ROS, Proteus, LTSpice, Solidworks, LaTex, Github, Docker, Microsoft Office.

System skills
Linux, System management for GPU clusters(4 Nvidia A40 cluster), Fine-tuning of Large Language Models, Network setup.

Languages
English, Malayalam, Hindi.

EXTRACURRICULARS AND HOBBIES

Anand Memorial Project Competition October 2018
National Institute of Technology Calicut
The project on 'Sun following solar panel' was shortlisted for the Anand Memorial project competition held as part of the intercollegiate technical fest, Tathva.

Music Band Performance at Ragam, Cultural Fest March 2020
National Institute of Technology Calicut
Won the third prize as a part of a music band in Ragam, south India's biggest intercollegiate cultural fest.

House Captain August 2016 - March 2018
St Thomas Residential School
As the captain of the Red house consisting of over 700 students, I was responsible for organizing different cultural and sports competitions each year.

Playing Musical Instruments (Keyboard and Guitar)
Photography

REFEREES

Prof. Abhisesh Silwal
Assistant Professor, Robotics Institute
Carnegie Mellon University
Email: asilwal@andrew.cmu.edu

Prof. Rohan Paul
Assistant Professor, Department of Computer Science and Engineering
Joint Faculty, Yardi School of Artificial Intelligence
Indian Institute of Technology Delhi
Email: rohan@cse.iitd.ac.in

Prof. P.V.M. Rao
Professor, Dean Alumni Relations
Department of Design & Department of Mechanical Engineering
Indian Institute of Technology Delhi
Email: pvmrao@design.iitd.ac.in

Prof. Praveen Sankaran
Associate Professor, Chairperson Centre for Career Development
Department of Electronics and Communication Engineering
National Institute of Technology Calicut
Email: psankaran@nitc.ac.in