Meenal Parakh

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Research Interest

I am broadly interested in robotics and perception. I am interested in solving challenging problems in mobile manipulation for home environments while focusing on the perception abilities of the robot. I aim to develop algorithms capable of handling significant variations in objects and scenes.

Education

Massachusetts Institute of Technology *Cambridge, MA*

■ Master of Engineering in Artificial Intelligence Jun'22 - Present

- *GPA: 5.0/5.0*
- *Thesis Supervisor: Professor Pulkit Agrawal*

■ BS in Electrical Engineering & Computer Science, and Mathematics Aug'19 - May'22

- *GPA: 4.9/5.0*

Key Courses: Computational Sensorimotor Learning • Underactuated Robotics • Optimization for Machine Learning • Robotic Manipulation • Principles of Autonomy and Decision Making • Computer Vision • Inference • Statistics, Computation & Applications • Parallel Computing • Machine Learning • Algorithms • Embedded Systems

Indian Institute of Technology *Mumbai, India*

■ Bachelor of Technology in Computer Science Jul'18 - Jul'19

- *GPA: 9.78/10.00*
- Transferred to MIT in 2019.

Academic Responsibilities

- Teaching Assistant for **Computation Structures** course at MIT. *Fall 2022*
- Lab Assistant for **Computer Systems Engineering** course at MIT. *Spring 2021*
- Lab Assistant for **Circuits & Electronics** course at MIT. *Spring 2020*

Research and Internship Experience

Graduate Researcher Jun'22 – Present

Improbable AI Lab, Professor Pulkit Agrawal *CSAIL MIT, Cambridge*

- To improve the **far-range object segmentation** in real-world images, developed a novel approach for collecting labeled real-world data using a self-supervised approach.
- Currently working on incorporating the above data collection approach for the downstream robotic task of fetching objects using a mobile base robot.
- Built a PyBullet-based simulation for **LoCoBot**, a mobile base manipulator, implementing low-level controls for the robot arm and the base, a motion and path planner, and an RGBD-based obstacle detector.

Undergraduate Researcher Sep'20 – May'21

Aerospace Controls Laboratory, Professor Jonathan How *MIT, Cambridge*

- Used multi-threading for parallelizing the **Distributed Pose Graph Optimization** algorithm. Observed an improvement of approximately 25% in run-time for a synthetic dataset.
- Worked on **Robust Initialization** for Pose Graph problem by using chordal relaxation initialization technique with robust loss functions (M-estimators) and Truncated Least Squares.

Undergraduate Researcher Sep'21 – May'22

Robust Robotics Group, Professor Nicholas Roy *CSAIL MIT, Cambridge*

- For the toy task of throwing objects to target distances, where objects vary in different unseen properties, such as friction coefficients and air drag, implemented a method that simultaneously learns object and task parameters from a given dataset of example throws.
- Used the above approach to adjust to unseen test objects by retraining only the object-specific parameters but keeping task parameters constant.
- Modeled the toy task of throwing objects as a multi-task learning problem, considering the different target distances of the throw as different tasks. Solved using **Gaussian Processes** with **Deep Kernel Learning**.

Embedded Software Engineering Intern Jun'21 – Aug'21

Advanced Imaging Group, JADAK *Remote*

- Tested Medley Software Development Kit, a camera library, on the Nvidia Jetson platform. Medley SDK is originally designed for Windows and controls different functions of Jadak machine vision cameras.
- Built a Python wrapper for the Medley camera library, given the low-level C++ API containing over 100 different functions.

EECS Projects

Trajectory Optimization with Iterative Learning Apr'22 – May'22
Underactuated Robotics *MIT, Cambridge*
- Implemented an optimization model which, given a geometric path and uncertainty bounds for task parameters (such as friction coefficients), computes a time parameterization for the geometric path.
- Implemented iterative learning approach by performing a binary search over uncertain parameters.

Solving Sokoban using Deep Q Learning Apr'22 – May'22
Sensorimotor Learning *MIT, Cambridge*
- Applied Deep Q Learning for training an agent to solve Sokoban in fixed-size grid environments. Tested the algorithm for 5x5 and 6x6 grids with 1 and 2 movable boxes each.
- Implemented Topological Experience Replay buffer to obtain faster convergence in the sparse reward game.

High Performance Sparse Pose Adjustment Nov'20 – Dec'20
Parallel Computing and Scientific Machine Learning *MIT, Cambridge*
- Implemented Sparse Pose Adjustment algorithm, which uses Levenberg-Marquardt (LM) non-linear optimizer, to solve the 2D Pose Graph Optimization problems. The implementation is multi-threaded.

Robust Parameter Estimation Mar'21 – May'21
Optimization for Machine Learning *MIT, Cambridge*
- Performed a literature survey on the various methods of robust parameter estimation, with special attention to problems of Pose Estimation, Fundamental Matrix Estimation, and Deep Neural Networks.
- Modified the original Neural Radiance Field model to use a general and adaptive loss function and trained the Neural Radiance Field network for different outlier rates.

Deformable Object Manipulation Oct'21 – Dec'21
Robotic Manipulation *MIT, Cambridge*
- Experimented with a hand-crafted policy to align a given cable of beads to the desired shape. The desired shape can be any open polygon with an appropriate length.
- Used Proximal Policy Optimization with discrete action space to obtain a policy for the same task, assuming access to key points on the beaded cable for pick action.

PSoC Image Editor Apr'20 – May'20
Microcomputer Project Laboratory *MIT, Cambridge*
- Built a platform for editing an image using Programmable System on Chip (PSoC), providing the user with features of changing brightness, blurring the image and adding a watermark and a noise removal feature for salt-pepper noise. The image is viewable on a TFT display.

Mathematics Projects

- **Distinct n-Length Strings in Pascal's Triangle *mod* p**
  Investigated $a_n(p)$, the number of distinct strings of length n that occur consecutively in Pascal's triangle mod p, where p is prime. Found closed-form expressions for $a_2(p)$ and $a_n(2)$ and the asymptotic behavior of $a_n(p)$ using recursion relations.
- **How Languages Grow?**
  Investigated how the number of n-length words grows with n. Developed a graphing technique for words in the language. Based on graph structures, identified when languages have polynomial or exponential growth rates.
- **Metric Spaces and Embeddings**
  On the topic, wrote an article for a magazine, and course notes for Math majors.

Technical Skills

Languages: C/C++, Python, Julia, MATLAB
Software and Tools: ROS & Gazebo, PyBullet, Drake, Docker, Git, AutoCAD, Solidworks

Extra-Curricular

- Designed *Mural*, an activity in which people in a community (such as a dorm) can learn about each other by exchanging anonymous notes through a public board kept in the community.
- Volunteer in tutoring Mathematics to K-12 grade students through Mastery Learning Hour.
- Completed a year-long course at the college level in Fine Arts. One of my works was shown in *Kaladarsharn*, an annual exhibition for Photography and Fine Arts, at IIT Bombay.