


# Meenal Parakh

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## RESEARCH INTEREST

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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

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### 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.

## RESEARCH AND INTERNSHIP EXPERIENCE


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### Graduate Researcher

Jun'22 – Present

*Supervisor: Professor Pulkit Agrawal, Improbable AI Lab*

*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. The performance increased by roughly 6 points on the segmentation AP metric when trained on this dataset as compared to the baselines. 
- 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

*Supervisor: Professor Jonathan How, Aerospace Controls Laboratory*

*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 modifying chordal relaxation initialization technique with robust loss functions (M-estimators) and Truncated Least Squares. The robust initialization returned the same final cost as the outlier-free case, with the baseline returning a suboptimal result depending on the outlier ratio and the pose graph data. 

### Undergraduate Researcher

Sep'21 – May'22

*Supervisor: Professor Nicholas Roy, Robust Robotics Group*

*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.

## MATHEMATICS PROJECTS

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- **Distinct  $n$ -Length Strings in Pascal's Triangle  $\text{mod } p$**

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 recurrence 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 ■.

## EECS PROJECTS

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### 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. ■

## ACADEMIC RESPONSIBILITIES

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- Teaching Assistant for **Computation Structures** course at MIT.
- Lab Assistant for **Computer Systems Engineering** course at MIT.
- Lab Assistant for **Circuits & Electronics** course at MIT.

Fall 2022

Spring 2021

Spring 2020

## TECHNICAL SKILLS

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**Languages:** C/C++, Python, Julia, MATLAB

**Software and Tools:** ROS & Gazebo, PyBullet, Drake, Docker, Git, AutoCAD, Solidworks

## EXTRA-CURRICULAR

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- 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.