

Saumya Saxena

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EDUCATION

Carnegie Mellon University, Pittsburgh

Ph.D. student, Robotics Institute, School of Computer Science

Pittsburgh, PA

Aug 2019 – May 2025 (expected)

Carnegie Mellon University, Pittsburgh

Master of Science - Research in Mechanical Engineering; QPA: 4.0/4.0

Pittsburgh, PA

Aug 2017 – May 2019

Indian Institute of Technology (IIT) Kanpur

B.Tech. M.Tech. Dual Degree B. Tech. CPI: 8.0/10.0 M. Tech. CPI: 9.3/10.0

Kanpur, India

2010 – 2015

RESEARCH STATEMENT

My research lies at the intersection of **modern control theory**, **robot learning** and **multimodal foundation models for robotics**, with a focus on developing generalist robotic agents capable of performing complex long-horizon dynamic and interactive tasks in unstructured environments. I am particularly interested in leveraging multimodal foundation models for **semantic scene understanding** to perform embodied tasks in novel environments, as well as to ensure adherence to **semantic safety** constraints in dynamic and interactive settings. My long-term goal is to build general-purpose robots capable of lifelong and reliable operations in open-world settings enabling collaboration with humans in assistive and caregiving roles.

Keywords: robot learning, foundation models for robotics, semantic safety, dynamic manipulation, semantic navigation, embodied AI, scene graphs, switching systems, graph neural networks, differentiable control.

PUBLICATIONS

- **S. Saxena**, A. Bajcsy and O. Kroemer. Vision-Language Guided Safe Dynamic Manipulation via Object-Centric Transformers. **2025**. (Under review) [Paper]
- **S. Saxena**^{*}, B. Buchanan^{*}, C. Paxton, et al. **GraphEQA**: Using 3D Semantic Scene Graphs for Real-time Embodied Question Answering. arXiv, **2024**. (Under review) [Website]
- **S. Saxena**^{*}, M. Sharma^{*} and O. Kroemer. **MResT**: Multi-Resolution Sensing for Real-Time Control with Vision-Language Models. Conference on Robot Learning (**CoRL**) **2023**. [Website]
- **S. Saxena**, and O. Kroemer. Dynamic Inference on Graphs using Structured Transition Models. *International Conference on Intelligent Robots and Systems (IROS)* **2022**. [Paper]
- J. Liang, M. Sharma, A. Lagrassa, S. Vats, **S. Saxena**, and O. Kroemer. Search-based task planning with learned skill effect models for lifelong robotic manipulation. *International Conference on Robotics and Automation (ICRA)* **2022**. [Paper]
- **S. Saxena**, A. LaGrassa, and O. Kroemer. Learning reactive and predictive differentiable controllers for switching linear dynamical models. *International Conference on Robotics and Automation (ICRA)* **2021**. [Paper]
- J. Liang, **S. Saxena**, and O. Kroemer. Learning Active Task-Oriented Exploration Policies for Bridging the Sim-to-Real Gap. *Robotics: Science and Systems (RSS)* **2020**. [Paper]
- N. Zevallos, A. Srivatsan Rangaprasad, H. Salman, L. Li, J. Qian, **S. Saxena**, M. Xu, K. Patath, and H. Choset. A real-time augmented reality surgical system for overlaying stiffness information. *Robotics: Science and Systems (RSS)* **2018**. [Paper]
- N. Zevallos, A. Srivatsan Rangaprasad, H. Salman, L. Li, J. Qian, **S. Saxena**, M. Xu, K. Patath, and H. Choset. A surgical system for automatic registration, stiffness mapping and dynamic image overlay. *International Symposium on Medical Robotics (ISMR)* **2018**. [Paper]

MASTER'S DISSERTATION

Motion planning under uncertainty and sensing limitations using exploration versus exploitation.

[Report]

Advised by Prof. H. Choset and Prof M. Travers, Robotics Institute, CMU

Aug 2018 - May 2019

- Developed a novel sampling-based planner (**Particle Filter based Affine Quadratic Tree: PF-AQT**) that explores the environment, and plans to reach a goal with minimal uncertainty.
- The output trajectory from PF-AQT was then used to initialize an optimization-based planner that finds a locally optimal trajectory that minimizes control effort and uncertainty.

Numerical investigation of Indian plucked musical instruments

[Thesis]

Advised by Prof. Anurag Gupta, Dept. of Mechanical Engineering, IIT Kanpur, India

May 2014 - July 2015

- Developed a general numerical approach to model plucked instruments like tanpura which have a curved bridge.
- Captured model dynamics using a dissipative model, which allowed energy transfer from strings to resonator.
- Demonstrated the occurrence of precursor waves that are responsible for the characteristic buzzing sound.

TECHNICAL SKILLS

- **Languages:** Python, C/C++
- **Numerical Computation:** PyTorch, TensorFlow, Matlab, Ansys

KEY COURSES

- Statistical techniques for robotics
- Planning in Robotics
- Probabilistic Graphical Models
- Machine Learning
- Convex optimization
- Robot Design and Experimentation
- Underactuated robotics
- Computer Vision
- AI and ML for Engineering Design

EXPERIENCE

Bosch Center for Artificial Intelligence

Research Intern

Renningen, Germany

May 2023 - August 2023

- Worked on vision-language navigation in unseen multi-room indoor environments using the RxR dataset.
- Developed a method that leverages a VLM-based planner to translate RxR instructions into low-level subtasks, which are then executed using a pretrained language-conditioned multi-task navigation policy.

General Electric Aviation

Edison Engineer, Combustor Design and Technology

India Technology Center, Bangalore, India

July 2016 - July 2017

- Worked on a high power (**70MW**) **aero-derivative gas turbine engine** (LM9000) for industrial applications.
- Achieved **low NOx (< 15 ppm)** and high-performance for the flexible-fuel combustor using CFD.

General Electric Aviation

Edison Engineer, High Pressure Compressor Design

India Technology Center, Bangalore, India

July 2015 - July 2016

- Worked on **GE9X**, the largest and most powerful commercial aircraft engine in the world, which will power Boeing 777X.
- Designed critical 3D features of high pressure compressor like airfoils, lock slots and bolted joints.

Smart Materials, Structures and Systems Lab

Intern, advised by Prof. Bishakh Bhattacharya

IIT Kanpur, India

May 2012 - July 2012

- Designed a PID-based closed loop feedback controller in LABVIEW to actuate **shape memory alloy wires** that drive a 5-link mechanism for trajectory plotting using inverse kinematics.

ACADEMIC PROJECTS

Contact detection and localization using particle filters for collaborative robots

Biorobotics lab, CMU

May 2018 - July 2018

- Worked on a particle filter based approach to, in real time, estimate the contact location and force based on only joint position and torque readings.
- The estimated contact location and force converges to within 10% of the actual values in 0.3sec for a 6 DoF arm.

Inertial reorientation of a freely falling cat using non-holonomic motion planning

[Report]

Robot Design and experimentation course project, CMU

Jan 2018 - May 2018

- Worked in a team to **design, build, and control an inertial-reorienting robot**, mimicking the cat-righting reflex.
- Generated feed-forward trajectories in simulation for the motion plan of an underactuated system with non-holonomic constraints modelled as two rigid bodies connected by a universal joint.
- Successfully dropped the robot from a height of 1.65 m and attained full maneuver in 0.58 sec.

Coverage using graph-based planning for autonomous exploration of non-uniform environments

[Report]

Planning and Decision-making in Robotics course project, CMU

Jan 2018 - May 2018

- Developed a graph-based planning algorithm for coverage of a non-uniform information map which can be useful for mapping of dynamic environments and search and rescue operations.
- Developed an iterative planner with Multi-Goal A* in the loop which takes the robot to the nearest unexplored node with highest information gain till the entire map is sufficiently explored.
- Planner performs well for large graphs of size 50m×50m with 10cm discretization and plans for the full map in 2 mins.

Surgical system for automatic registration, stiffness mapping and dynamic image overlay

Paper

Biorobotics lab, CMU

Aug 2017 - Oct 2017

- Worked in a team to develop a surgical system using the **da Vinci research kit (dVRK)** that is capable of autonomously searching for tumors and dynamically displaying the tumor location using **augmented reality**.
- Worked on state-of-the-art methods in **registration, force sensing and tumor localization** and incorporated them in a unified surgical system.

Regenerative braking system for bicycles

Awarded the Jayesh Memorial **award for Best Undergraduate Project** in ME department, IIT Kanpur

Aug 2013 - Nov 2013

- Built a system to store the kinetic energy otherwise lost during braking using a spiral torsional spring.
- Stored energy assisted in acceleration from halt. Derailleur switched between energy storage and release modes.