

Muhammad Suhail Saleem

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Education

Carnegie Mellon University

Ph.D. in Robotics

Pittsburgh, PA

Aug 2020 - Present

- **Thesis:** Motion Planning to Leverage Contacts for Manipulation under Uncertainty
- **Advisor:** Dr. Maxim Likhachev
- **Coursework:** Math Fundamentals for Robotics - Introduction to Machine Learning - Probabilistic Graphical Models - Optimal Control - Kinematics, Dynamics, and Control - Computer Vision

Master of Science in Mechanical Engineering - Research

Aug 2018 - May 2020

- **Thesis:** Planning with Selective Physics-based Simulation for Manipulation Among Movable Objects
- **Advisor:** Dr. Maxim Likhachev
- **Coursework:** Planning and Decision Making - Statistical Techniques in Robotics - Artificial Intelligence and Machine Learning - Deep Learning for Engineers - Localization and Mapping - Engineering Optimization - Linear Systems

Research Interests

I am interested in developing and deploying motion planning and decision-making solutions that enable robots to operate robustly in uncertain and unstructured real-world scenarios. My research has leveraged ideas from model-based planning, aided by data-driven techniques, to build frameworks for robotic systems performing contact-rich manipulation, navigation, and other complex interaction tasks.

Experience

Robotics AI Organization, Amazon

Seattle, WA

Research Scientist Intern

May 2022 - Aug 2022

- Built a closed-loop planning framework that uses contact feedback for robust stowing of items into inventory pods.
- Updated beliefs about item geometry and free space from the contact signals, enabling recovery from failed stowing attempts. Validated the framework in both simulation and on the real system.

Search Based Planning Laboratory, Robotics Institute, Carnegie Mellon University

Pittsburgh, PA

Graduate Research Assistant

Aug 2018 - Present

- **Manipulation in the Blind:** Developed frameworks that leverage contact feedback for manipulation in vision-absent environments.
 - Integrated torque-based contact localization, diffusion-based occupancy prediction, and search-based planning to enable manipulators to navigate unknown confined spaces—achieving 2× faster task completion on real-world systems.
 - Developed POMDP frameworks that exploit hierarchical uncertainty representations and experience-based priors to localize objects through contact feedback and complete high-precision insertion tasks, reducing planning time by up to 100×.
 - Developing a hierarchical reinforcement learning framework that integrates navigation and contact-based localization skills to efficiently identify and retrieve target objects without visual feedback in cluttered environments.
- **Planning for Complex Robotic Systems:** Developed planning frameworks for diverse high-dimensional and contact-rich systems.
 - Built a path planner for a 21-DOF snake robot-like manipulator used in turbine inspection, leveraging homotopy heuristics and optimization-based motion primitives to boost success rates by over 90%.
 - Developed physics-aware planners for non-prehensile manipulation in cluttered, interactable environments, that improved planning times by over 20×.
 - Contributed to the development of a constant-time kinodynamic planner enabling a robot manipulator to intercept incoming projectiles in real time (<200 ms), achieving a 78% success rate in hardware experiments.
 - Developed a physics-informed tree search algorithm for generating stable stacks of highly irregular objects.
- **LLMs:** Developing methods that adapt lazy heuristic search techniques to improve inference efficiency and test-time scaling in large language models.
- **Multi-Agent Systems:** Contributed to the development of scalable cooperative path-finding algorithms that leverage short-horizon planning for real-time coordination of up to 350 agents while maintaining strong theoretical guarantees.
- **Graph Search and Planning:** Developed algorithms improving the efficiency of both deterministic and stochastic (POMDP) planning by leveraging learned heuristic functions, reducing memory footprint, and deferring expensive search operations.

Selected Publications

- **Muhammad Suhail Saleem**, Lai Yuan, and Maxim Likhachev. “A Contact-Driven Framework for Manipulating in the Blind.” (Under review)
- **Muhammad Suhail Saleem**, Rishi Veerapaneni, and Maxim Likhachev. “Lazy Heuristic Search for Solving POMDPs with Expensive-to-Compute Belief Transitions.” In Proceedings of International Symposium on Combinatorial Search (SoCS), 2025.
- Alvin Zou, **Muhammad Suhail Saleem**, and Maxim Likhachev. “Attractor-based Closed List Search: Sparsifying the Closed List for Efficient Memory-Constrained Planning.” In Proceedings of International Joint Conference on Artificial Intelligence (IJCAI), 2025.
- Rishi Veerapaneni, **Muhammad Suhail Saleem**, Jiaoyang Li, and Maxim Likhachev. “Windowed MAPF with Completeness Guarantees.” In Proceedings of the AAAI Conference on Artificial Intelligence, 2025.
- Nayasha Gandotra, Rishi Veerapaneni, **Muhammad Suhail Saleem**, Daniel Harabor, Jiaoyang Li, Maxim Likhachev. “Anytime Single-Step MAPF Planning with Anytime PIBT.” Arxiv preprint, 2025.

- Rishi Veerapaneni, Jonathan Park, **Muhammad Suhail Saleem**, and Maxim Likhachev. “A Data Efficient Framework for Learning Local Heuristics.” In Proceedings of the International Symposium on Combinatorial Search (SoCS), 2024.
- **Muhammad Suhail Saleem**, Rishi Veerapaneni, and Maxim Likhachev. “A POMDP-based hierarchical planning framework for manipulation under pose uncertainty.” Arxiv preprint, 2024.
- Ramkumar Natarajan, Hanlan Yang, Qintong Xie, Yash Oza, Manash Pratim Das, Fahad Islam, **Muhammad Suhail Saleem**, Howie Choset, and Maxim Likhachev. “Preprocessing-based kinodynamic motion planning framework for intercepting projectiles using a robot manipulator.” In Proceedings of IEEE International Conference on Robotics and Automation (ICRA), 2024.
- **Muhammad Suhail Saleem**, Rishi Veerapaneni, and Maxim Likhachev. “Preprocessing-based planning for utilizing contacts in semi-structured high-precision insertion tasks.” In Proceedings of IEEE Robotics and Automation Letters (RA-L), 2023.
- Rishi Veerapaneni, **Muhammad Suhail Saleem**, and Maxim Likhachev. “Learning local heuristics for search-based navigation planning.” Proceedings of the International Conference on Automated Planning and Scheduling (ICAPS), 2023.
- **Muhammad Suhail Saleem**, Raghav Sood, Sho Onodera, Rohit Arora, Kanazawa Hiroyuki, Maxim Likhachev. “Search-based Path Planning for a High Dimensional Manipulator in Cluttered Environments Using Optimization-based Primitives.” In Proceedings of IEEE International Conference on Intelligent Robots and Systems (IROS), 2021.
- Dhruv Mauria Saxena*, **Muhammad Suhail Saleem***, and Maxim Likhachev. “Manipulation planning among movable obstacles using physics-based adaptive motion primitives.” In Proceedings of IEEE International Conference on Robotics and Automation (ICRA), 2021.
- **Muhammad Suhail Saleem**, and Maxim Likhachev. “Planning with selective physics-based simulation for manipulation among movable objects.” In Proceedings of IEEE International Conference on Robotics and Automation (ICRA), 2020.
- Ramkumar Natarajan*, **Muhammad Suhail Saleem***, William, Xiao, Sandip Aine, Maxim Likhachev, and Howie Choset. “A-mha*: Anytime Multi-Heuristic A*.” In Proceedings of the International Symposium on Combinatorial Search (SoCS), 2019.

Skills

Programming Languages: C++, Python, Linux Scripting
 Application Software: ROS, PyBullet, Isaac, Mujoco, Gazebo, OpenCV, Arduino IDE
 Hardware Platforms: UR10e, Willow Garage PR2, Kuka Youbot, UBTEch Walker, Single-board computers (Arduino, Beagle Bone)

Honors

- Recipient of the Uber Presidential Fellowship for doctoral students for the year 2021.
- Recipient of the best Master’s Thesis award at the Carnegie Mellon Mechanical Engineering Graduate Research Symposium 2020.

Academic Engagement

- Mentored 15+ undergraduate and master’s students on research projects in motion planning and manipulation.
- Teaching Assistant for Planning and Decision Making (16-782) at Carnegie Mellon University (2020, 2021).
- Referee for conferences and journals including AIJ, JAIR, WAFR, ICRA, IROS, IJCAI, SoCS, AAAI, and IEEE RA-L.
- Served in the research qualifier committee of multiple PhD students.