

Kai Gao

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EDUCATION

Rutgers, the State University of New Jersey Aug. 2019 – Present
PhD, Robotics/Computer Science | Advisor: by Dr. Jingjin Yu
Piscataway, USA
• IROS 2023 Finalist of Best RoboCup Paper Award. (Top 6% among accepted papers)

University of Science and Technology of China (USTC) Aug. 2015 – Jun. 2019
Bachelor, Mathematics
Hefei, China

WORK EXPERIENCE

Applied Scientist Co-op Feb. 2024 – Present
Amazon Robotics North Reading, USA

- Led a research project, collaborating with a team of engineers and assigning daily tasks to ensure smooth project execution.
- Designed and trained a transformer-based visuomotor policy for hardware-agnostic skill learning and multi-skill chaining, leveraging a pre-trained robotics foundation model (generalist policy) as the backbone.
- Participated in a project of imitation learning based dexterous object grasping, responsible for deciding on the object set and demonstrated skills for subsequent data collection based on the roll-out performance of trained policies.
- Developed a simulation environment using Nvidia Isaac Sim for multi-step dexterous manipulation tasks, enabling effective demonstration collection and analysis of varying observation types and task descriptions (language prompts or images).

Advanced Robotics Intern May. 2022 – Sep. 2022
Siemens Corporation Berkeley, USA

- Designed and implemented a model-free online algorithm for the bin packing problem with irregularly shaped objects. The method consists of depth-image preprocessing and a gradient-based optimizer for packing pose computation.
- Built a prototype pick-and-pack system utilizing a UR5 robot and RealSense cameras, seamlessly integrating the proposed packing strategy with Siemens' FlexGrasp.

RESEARCH EXPERIENCE

Robot Arm Manipulation Planning Mar. 2020 – Present
Research Assistant Advised by Dr. Jingjin Yu Algorithmic Robotics and Control Lab (ARCL), Rutgers University, USA

- Designed and implemented perception-planning-control pipelines for multiple real-world robotic systems, utilizing UR5 robots in tabletop rearrangement settings and a Baxter Robot for shelf-based object retrieval scenarios.
- Applied deep learning models for precise object segmentation, grasp pose generation, and prediction of object pose stability.
- Designed and constructed simulation scenarios for shelf, tabletop, room environments using physics engines such as PyBullet, Isaac Gym, Drake, ROS+Gazebo, and Moveit.
- Explored dual-arm motion planning through C-space decomposition on MIT Drake and GPU-accelerated motion planning with Nvidia CuRobo.

Language-Guided Semantic Object Rearrangement Mar. 2023 – Sep. 2023
Research Assistant Advised by Dr. Jingjin Yu Algorithmic Robotics and Control Lab (ARCL), Rutgers University, USA

- Explored language-guided manipulation planning strategies in collaboration with Dr. Abdeslam Boularias' team.
- Developed a Monte-Carlo Tree Search based task planner that uses goal state conditions, interpreted by large language models from human language instructions, as input.

Image Registration Sep. 2017 – Jun. 2019
Research Assistant Advised by Dr. Juyong Zhang Graphics & Geometric Computing Laboratory (GCL), USTC, China

- Developed a non-rigid image registration algorithm based on Iterative Closest Points and Quasi-Newton method adept at handling noise and outliers.
- Implemented the algorithm in C++ and utilized OpenGL for enhanced visualization and thorough code testing.

Lab Toolkits Development, and Miscs Jul. 2018 – Present
Research Assistant Advised by Dr. Jingjin Yu Algorithmic Robotics and Control Lab (ARCL), Rutgers University, USA

- Developed camera calibration software to precisely evaluate the perception accuracy of RealSense cameras.
- Created a pose estimation dataset featuring synthesized desktop scenes from diverse camera angles, using Blender.

SELECTED CERTIFICATES & AWARDS

IROS 2023 Finalist of Best RoboCup Paper Award.	IROS, Oct 2023
Gold Award of China Undergrad. Math. Contest in Modeling in Anhui Province (1/65 in USTC)	2017
Reinforcement Learning Specialization.	Coursera, July 2023
Outstanding Graduates (2019)	USTC, Jun. 2019
Outstanding Student Scholarship (2015-2016) (2017-2018)	USTC, 2016, 2018

SKILLS

Programming Languages : Python, C++, Matlab

Tools : Git, ROS, Docker, PyBullet, Gazebo, OpenCV, PyTorch, Gurobi, Drake, Isaac Gym, Unreal Engine, Blender

INVITED TALKS

Fast High-Quality Tabletop Rearrangement in Bounded Workspace.	March 2022
<i>TRIPODS/DATA-INSPIRE Graduate Student Workshop</i>	Virtual
On Minimizing the Number of Running Buffers for Tabletop Rearrangement	May 2021
<i>TRIPODS (Transdisciplinary Research in Principles of Data Science) Seminar</i>	Virtual

PUBLICATIONS

Published First-Author

- **K. Gao**, J. Yu, T. S. Punjabi, and J. Yu. "Effectively Rearranging Heterogeneous Objects on Cluttered Tabletops." 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023) (**Finalist of Best RoboCup Paper Award.**).
- Andy Xu*, **K. Gao***, S. W. Feng*, and J. Yu. "Optimal and Stable Multi-Layer Object Rearrangement on a Tabletop." 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023).
- **K. Gao**, S. W. Feng, B. Huang, and J. Yu. "Minimizing Running Buffers for Tabletop Object Rearrangement: Complexity, Fast Algorithms, and Applications." The International Journal of Robotics Research (IJRR).
- **K. Gao**, and J. Yu. "On the Utility of Buffers in Pick-n-Swap Based Lattice Rearrangement." 2023 IEEE International Conference on Robotics and Automation (ICRA 2023).
- **K. Gao** and J. Yu. "Toward Efficient Task Planning for Dual-Arm Tabletop Object Rearrangement." 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022).
- **K. Gao**, D. Lau, B. Huang, K. E. Bekris and J. Yu. "Fast High-Quality Tabletop Rearrangement in Bounded Workspace." 2022 IEEE International Conference on Robotics and Automation (ICRA 2022).
- **K. Gao** and J. Yu. "Capacitated Vehicle Routing with Target Geometric Constraints." 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021).
- **K. Gao**, S. W. Feng, and J. Yu. "On Minimizing the Number of Running Buffers for Tabletop Rearrangement." 2021 Robotics: Science and Systems (RSS 2021).
- R. Wang*, **K. Gao***, D. Nakhimovich*, J. Yu, and K. E. Bekris. "Uniform Object Rearrangement: From Complete Monotone Primitives to Efficient Non-Monotone Informed Search." 2021 IEEE International Conference on Robotics and Automation (ICRA 2021).

Published Co-Author

- H. Chang, **K. Gao**, K. Boyalakuntla, A. Lee, B. Huang, H. U. Kumar, J. Yu, and A. Boularias "LGMCTS: Language-Guided Monte-Carlo Tree Search for Executable Semantic Object Rearrangement." Submitted to IROS 2024.
- E. R. Vieira, **K. Gao**, D. Nakhimovich, J. Yu and K. E. Bekris. "Effective and Robust Non-Prehensile Manipulation via Persistent Homology Guided Monte-Carlo Tree Search" the 18th International Symposium on Experimental Robotics (ISER 2023).

- E. R. Vieira, D. Nakhimovich, **K. Gao**, R. Wang, J. Yu and K. E. Bekris. “Persistent Homology for Effective Non-Prehensile Manipulation” 2022 IEEE International Conference on Robotics and Automation (ICRA 2022).
- R. Wang, **K. Gao**, J. Yu and K. E. Bekris. “Lazy Rearrangement Planning in Confined Spaces.” the 32nd International Conference on Automated Planning and Scheduling (ICAPS 2022).
- S. W. Feng, **K. Gao**, J. Gong, and J. Yu. “Sensor Placement for Globally Optimal Coverage of 3D-Embedded Surfaces.” 2021 IEEE International Conference on Robotics and Automation (ICRA 2021).
- S. W. Feng, S. D. Han, **K. Gao**, and J. Yu. “Efficient Algorithms for Optimal Perimeter Guarding.” 2019 Robotics: Science and Systems (RSS 2019).