# Kai Gao

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## EDUCATION

**Rutgers, the State University of New Jersey**                    Aug. 2019 – Present
*Robotics PhD Candidate*                                                 Piscataway, USA

- GPA:3.92/4.0
- Related courses: Computer Vision, Machine Learning

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

- Outstanding Graduates(2019)
- Outstanding Student Scholarship (2015-2016) (2017-2018)
- Gold Award of China Undergraduate Mathematical Contest in Modeling in Anhui Province(2017)(1/65 in USTC)
- Related courses: Computer Graphics

## WORK EXPERIENCE

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

- Conducted extensive literature research on object packing problems.
- Developed model-free approaches for efficiently packing irregularly-shaped objects.
- Created a prototype pick-and-pack system with a UR5 robot, integrating the proposed packing strategy and Siemens' advanced grasping technology.
- Created demonstration videos and experimental results of the packing strategy for potential customers to showcase its effectiveness and efficiency.

## RESEARCH EXPERIENCE

**Task and Motion Planning**                                          Mar. 2020 – Present
*Research Assistant*                    Algorithmic Robotics and Control Lab(ARCL), Rutgers University, USA

- Implemented a complete perception-planning-control pipeline utilizing the UR-5e robotic arm.
- Developed efficient algorithms and analyzed structural characteristics with mathematical proofs for various manipulation scenarios.
- Applied deep learning models for perception and employed DQN for push planning tasks.
- Performed extensive experimentation and demonstration utilizing various simulation platforms, including PyBullet, Issac Gym, Drake, and ROS+Gazebo.

**Multi-Robot Path Planning**                                         Jul. 2018 – Sep. 2018
*Research Intern*                       Algorithmic Robotics and Control Lab(ARCL), Rutgers University, USA

- Designed fast algorithms to solve multi-robot path planning problems with different objectives.
- Designed an efficient algorithm to solve the perimeter guarding problem.
- Proved some lemmas and theorems on the efficiency of the algorithms.

**Image Registration**                                                Sep. 2017 – Jun. 2019
*Research Assistant*                      Graphics&Geometric Computing Laboratory(GCL), USTC, China

- Developed a highly efficient non-rigid image registration algorithm that is able to handle noise and outliers effectively, surpassing the state of the arts.
- Implemented the algorithm with C++ and employed OpenGL for visualization.

## PUBLICATIONS

- **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).

- 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).

- **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).

- 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).

## PAPERS UNDER REVIEW

- **K. Gao**, J. Yu, T. S. Punjabi, and J. Yu. "Effectively Rearranging Heterogeneous Objects on Cluttered Tabletops." submitted to 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023).

- Andy Xu*, **K. Gao***, S. W. Feng*, and J. Yu. "Optimal and Stable Multi-Layer Object Rearrangement on a Tabletop." submitted to 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023).

- 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." submitted to 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023).

- R. Wang, **K. Gao**, Y. Miao, J. Yu and K. E. Bekris. "Improving Feasibility, Efficiency and Quality for Rearranging Uniform Objects in Confined Spaces." submitted to IEEE Transactions on Robotics (T-RO).

## INVITED TALKS

**Fast High-Quality Tabletop Rearrangement in Bounded Workspace.** March 2022
*TRIPODS/DATA-INSPIRE Graduate Student Workshop* Virtual

**On Minimizing the Number of Running Buffers for Tabletop Rearrangement** May 2021
*TRIPODS (Transdisciplinary Research in Principles of Data Science) Seminar* Virtual

## SKILLS

**Programming Languages** : Python, Matlab, C++
**Tools** : Git, ROS, PyBullet, Gazebo, OpenCV, PyTorch, Gurobi, Drake, Isaac Gym