

KAIXIN CHAI

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🏛️ MAIN EXPERIENCE

City University of Hong Kong | Research Assistant Sep. 2023 – Jun. 2024

Mobile manipulation, manipulation dataset generation, and wheel-legged robot control

Zhejiang University | Research Assistant Jun. 2022 – Sep. 2023

Perception-aware planning, SLAM, quadrotor control, and relevant commercialized R&D projects

Xi'an Jiaotong University | Bachelor in Energy and Power Engineering Sep. 2018 – Jun. 2022

Average grade: 91.25/100. Participated in multiple competitions and research projects

★ CURRENT FOCUS

Data generation based on foundation models

Current policies for manipulation, such as Behavior Cloning and Reinforcement Learning, are strong enough to enable robots to execute tasks. Besides, recent advancements in language-conditioned multitask policies have shown great promise. However, these powerful models are data-intensive. To my current knowledge, there are primarily three approaches to address data scarcity: expert demonstrations, data auto-aggregation, and data auto-generation. Collecting all potential scenarios a robot might encounter is nearly impossible and often unaffordable for lab research or commercial applications. Therefore, automated data collection and aggregation are crucial for enabling robots to learn new skills over their operational lifespan. I believe that with the proper use of common sense (guided and reflected via LLMs and VLMs) and RL (utilizing real-to-sim to reset environments and the ability to explore and fine-tune skills in parallel), robots can effectively bridge the data gap one day.

🎓 ACADEMIC RESEARCH

Improving Localization Reliability with Path Planning Mar. 2023 – Sep. 2023

Derive a new metric for localization reliability through perturbation analysis and apply the metric to path planning, which enables the robot to avoid degraded areas in advance. Accepted by *IROS2024* [1].

Ground Effect-Aware Modeling and Control for Multicopters Sep. 2022 – Sep. 2023

Set up a mathematical model for ground effect prediction based on flow field simulation and experiments, making the drones fly safer and more stable near the ground. *Submitted to T-RO* [2].

Motion Planning for Car-like Robots on Uneven Terrain Sep. 2022 – Mar. 2023

We propose a planning framework for wheeled robot movement on uneven terrain, which is efficient and allows robots to move safely. Accepted by *IROS2023* [3].

A Deep Sea Turbine Power Generation System (Senior Project) Aug. 2021 – Jul. 2022

Demonstrate a novel energy generation system that maintains the turbine at optimal power conversion efficiency in changing water flow. My undergraduate thesis received an A+ grade ($I^{st} / 25$). Accepted by *Energy* [4].

⚙️ ENGINEERING PROJECT

Build Mobile Manipulation Hardware and Execute Long-Horizon Tasks Jan. 2024 – May. 2024

Build the hardware for a mobile manipulator and develop Inverse Kinematics code to control the arm's movements. Execute long-horizon tasks using pre-trained skills. Additionally, I adjust the robot's initial position at the beginning of each sub-task to better align observations with the skills' training data distribution.

Target Following Framework for Wheel-legged Robot Mar. 2023 – Jul. 2023

Enable a wheel-legged robot equipped with LiDAR and cameras to identify and follow specific targets. This project was completed with Huawei Shenzhen Application Scenario and Innovation Laboratory.

Helium-Assisted Drone for Flight Time Enhancement Dec. 2022 – Mar. 2023

Design a Helium-Assisted drone for floating advertisements in shopping malls. The buoyancy generated by the helium balloon offsets 95% of the weight, extending the flight time from five minutes to one hour.

Motion planning for Drones to Avoid Collisions in Complex Structures Sep. 2022 – Dec. 2022

Build a drone using an onboard computer equipped with HiSilicon chips for Huawei. Deploy obstacle avoidance algorithms enabling the drone to fly safely in complex environments.

Design of An Energy-efficient Heat Loading System

Dec. 2021 – Jul. 2022

Design a new thermal simulation device to generate an even temperature field. To obtain better control strategies, we model the whole heat transfer process and utilize deep reinforcement learning technology.

Automatic detection of Surface Defects in Metal Product

Apr. 2020 – Apr. 2021

We designed a system for a metal processing plant to monitor the production quality of products. With the help of industrial cameras and convolutional neural networks, we achieved a recognition recall rate of 94%.

PUBLICATION

[1] **Chai, K.**, Xu, L., Wang, Q., Xu, C., Sun, H. & Gao, F. (2024). LF-3PM: a LiDAR-based Framework for Perception-aware Planning with Perturbation-induced Metric. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2024). STATUS: Accepted.

[2] Yang, T., **Chai, K.**, Xu, L. & Gao, F. (2024). Ground Effect-Aware Modeling and Control for Multicopters: Enhanced Precision and Energy Efficiency. IEEE/ASME Transactions on Mechatronics (TMECH). STATUS: Under Review.

[3] Xu, L., **Chai, K.**, Han, Z., Liu, H., Xu, C., Cao, Y., & Gao, F. (2024). An Efficient Trajectory Planner for Car-like Robots on Uneven Terrain. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). arXiv preprint arXiv:2309.06115. STATUS: Published.

[4] Zhang, D., **Chai, K.**, Guo, P., Hu, Q., Li, J., & Shams, A. (2024). A novel full-process test bench for deep-sea in-situ power generation systems. Energy, 297, 131341. STATUS: Published.

[5] Chen, Y., Guo, P., Zhang, D., **Chai, K.**, Zhao, C., & Li, J. (2022). Power improvement of a cluster of three Savonius wind turbines using the variable-speed control method. Renewable Energy, 193, 832-842. STATUS: Published.

[6] Yuan, X., Li, R., **Chai, K.**, Qiu, Z. & Sun, X. (2022). Creative Design Based on Arduino —— An Intelligent System of Plant Cultivation. Research and Exploration in Laboratory(02),74-78. doi:10.19927/j.cnki.syyt.2022.02.017. STATUS: Published.

PATENT

[1] Zhou, Z., **Chai, K.**, Qiu, Z., Shu, H., Zhu, Y., Xing, H., Ye, S., Shen, Y. & Liu, B. (2021). A fast and uniform static load heating device and control method for high-speed aircraft. China National Intellectual Property Administration. CN202110462447.0. STATUS: Published.

[2] Guo, P., **Chai, K.**, Wang, J., Yin, Y., Zhang, D. & Chen, Y. (2022). A deep sea power generation system and its control method. China National Intellectual Property Administration. CN202210663338.X. STATUS: Published.

[3] Chen, Y., Li, J., **Chai, K.**, Zhou, J. & Xu, X. (2022). A passively regulated bidirectional tidal current energy generation device. China National Intellectual Property Administration. CN202210545692.2. STATUS: Published.

[4] Zhang, D., Guo, P., Yuan, X., Zhao, Y., Cheng, Y., **Chai, K.**, Yang, L. & Wang, Y. (2021). A Combined Lift and Drag Double Chain Hydraulic Turbine. China National Intellectual Property Administration. CN202110078616.0. STATUS: Published.

[5] Guo, P., **Chai, K.**, Chen, Y., Zhang, D., Wang, J., Qian, Y. & Liu, C. (2022). A land-based test platform and control method for deep sea power generation system. China National Intellectual Property Administration. CN202210662549.1. STATUS: Published.