

Yuer Gao

Robotics Researcher | Marine Autonomy | Simulation-to-Real Systems

Ph.D. Candidate, HKUST(GZ) | Underwater Perception, Planning & Control, Vision-Language Robotics

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RESEARCH PROFILE

I build **real underwater robotic systems** that perceive, plan, and act in visually degraded and hydrodynamically complex environments, spanning robust state estimation, disturbance-aware planning/control, vision-language reasoning, simulation, and close-range inspection.

Selected Research Highlights

- Underwater Perception** (RA-L 2025; CASE 2025): Achieved **5.65 mm** position RMSE at **62 FPS** with tightly coupled vision-optical fusion; proposed **MULoc** with **92%** tracking success under turbidity.
- Disturbance-Aware Autonomy** (TMECH, under review): Exploited 8-thruster actuation redundancy to reduce target-region particle velocity by **67%** and reconstruction RMSE to **1.9 mm**.
- Operator-Guided Coral Inspection** (Ocean Engineering 2026): Developed a vision-based close-range inspection framework with multi-view 3D anchoring for reliable coral-colony inspection.

RESEARCH EXPERIENCE

The Hong Kong University of Science and Technology (GZ) 2023 – Present (PhD Candidate)

Underwater Autonomy, Perception, and Disturbance-Aware Reconstruction

- Developed perception, planning, and disturbance-aware control methods for underwater inspection and reconstruction on an over-actuated ROV.
- Built an **NVIDIA Isaac Sim underwater environment** with marine scenes, coral assets, robotic platforms, programmable sensing, and physics-based simulation.
- Independently developed a **custom ROV ground station** with real-time video/recording, telemetry, depth/attitude monitoring, motion and trajectory control, experiment logging, and E-stop.
- Conducted **440 real-robot trials**, achieving **98.5%** reconstruction success and **1.9 mm** RMSE under visually degraded and hydrodynamically challenging conditions.

Xi'an University of Technology 2021 – 2022 (Lead Researcher)

Underwater Vehicle–Manipulator System (UVMS) Research

Worked on UVMS modeling, motion planning, and obstacle avoidance, and developed a ROS-based simulation platform for autonomous navigation and trajectory optimization.

CORE TECHNICAL SKILLS

Robotics & Simulation: NVIDIA Isaac Sim, ROS/ROS2, RViz, Gazebo, MoveIt, system integration

Programming: C/C++, Python, MATLAB, Linux, GUI / experimental software

Perception / Planning: Visual localization, multi-modal fusion, underwater perception, motion planning, trajectory optimization

Robot Systems: Custom ROV ground station, real-time video/telemetry, STM32, CAN, RS422/RS232, TCP/IP

EDUCATION

- 2023 – 2026

PhD in Smart Manufacturing
The Hong Kong University of Science and Technology (GZ)
Expected: Dec. 2026 • GPA: 3.5/4.0
- 2020 – 2023

Master of Control Science and Engineering
Xi'an University of Technology
GPA: 4.4/5.0
- 2017 – 2021

Bachelor of Engineering in Automation
Xi'an University of Technology
GPA: 4.2/5.0 • Top 3%

SELECTED AWARDS

- 2024

Model Mark — Third Prize
HKUST(GZ), Team Lead
- 2022

National Scholarship (Graduate)
(twice)
China Robotics & AI Competition (1st Prize)
Internet+ Innovation (Bronze/Gold)
- 2021

ACADEMIC SERVICE

Journal & Conference Reviewer

- Ocean Engineering
- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)

Teaching Assistant

- UCMP 6010: Cross-disciplinary Research Methods (HKUST)

Academic Mentoring / Evaluation

- Evaluator / Mentor, Red Bird Challenge:** Selected and evaluated prospective MPhil students during a two-week intensive selection camp at HKUST(GZ).

LEADERSHIP

- Model Mark 2024 Competition**

2024
- Team Leader / Organizer** Represented HKUST(GZ) as a team leader to coordinate and compete in the Model Mark competition. Awarded the **Third Prize** for innovative modeling and technical execution.

SELECTED FIRST-AUTHOR PUBLICATIONS

Y. Gao, J. Luo, Y. Cai. “A Vision-Based Operator-Guided Framework for Close-Range ROV Inspection of Coral Colonies via Multi-View 3D Anchoring.” *Ocean Engineering*, 2026. doi:10.1016/j.oceaneng.2026.127297

Y. Gao, T. Xu, Y. Cai. “Real-Time Millimeter-Accurate Underwater Pose Estimation via Tightly-Coupled Fusion of Vision and Optical Tracking.” *IEEE Robotics and Automation Letters (RA-L)*, 2025. doi:10.1109/LRA.2025.3641116

Y. Gao, T. Xu, Q. Liu, Y. Cai. “Disturbance-Aware Motion Planning for Over-Actuated Underwater Vehicles Exploiting Actuation Redundancy for High-Fidelity 3D Reconstruction.” *IEEE/ASME Transactions on Mechatronics (TMECH)*. Under review

Y. Gao, Y. Cai. “Bidirectionally Coupled Global–Local Path Planning for 3D Underwater Navigation in Ocean Currents.” *IEEE Journal of Oceanic Engineering (JOE)*. Under review

Y. Gao, Y. Cai. “MULoc: Robust Monocular Visual Localization for Underwater Robots via Multi-modal Feature Fusion.” *IEEE International Conference on Automation Science and Engineering (CASE 2025)*.

Y. Gao, Y. Zhao, Y. Cai. “CoralVLM: A Task-Oriented Vision-Language Benchmark Toward Underwater Embodied Coral Reef Inspection.” *IEEE Robotics and Automation Letters (RA-L)*. Submitted

Y. Gao, X. Zhang, et al.. “UVMS Task-Priority Planning Framework for Underwater Task Goal Classification Optimization.” *Frontiers in Neurorobotics*, 2022.

Y. Gao, T. Xu, and Y. Cai. “Minimum-Snap Trajectory Optimization for Underwater Manipulator.” *Proceedings of the 2024 International Conference on Advanced Robotics and Mechatronics (ICARM)*, 2024.

SELECTED CO-AUTHOR PUBLICATIONS

Z. Liao, W. Wei, L. Zhang, **Y. Gao**, Y. Cai. “An Augmented Reality-Enabled Digital Twin System for Reconfigurable Soft Robots: Visualization, Simulation and Interaction.” *Computers in Industry*, 2025.

Q. Liu, T. Xu, F. Zhan, **Y. Gao**, Z. Liao and Y. Cai. “Autonomous Magnetically Reconfigurable Soft Gripping System for Adaptive Manipulation in Smart Manufacturing.” *Computers & Industrial Engineering*, 2026.

T. Xu, **Y. Gao**, and Y. Cai. “AI-Based Structural Feature Recognition for Robotic Grasping of Additive Manufacturing Parts.” *Proceedings of the International Conference on Flexible Automation and Intelligent Manufacturing (FAIM)*, 2024.

Y. Gao, X. Zhang, **Y. Gao**, T. Shang, and Q. Yang. “Underwater Manipulator Control Based on Neural Network and Fuzzy Compensation.” *Computer Engineering and Applications*, vol. 58, no. 15, pp. 317–323, 2022. (Chinese Core, CSCD Expanded, EI indexed)

J. Wang, X. Zhang, X. Ma, and **Y. Gao**. “An Improved Model-Free Adaptive Control Algorithm with Differential Element.” *Proceedings of the 2022 China Automation Congress (CAC)*, pp. 684–689, 2022.

X. Guo, M. Xiao, **Y. Gao**, Q. Wang, and Y. Wan. “Fix-Frequency Robust Power Model Predictive Control Method for Three-Phase PWM Rectifiers under Unbalanced Grid Conditions.” *Journal of Power Electronics*, vol. 20, no. 5, pp. 1283–1294, 2020. (SCI/EI indexed)

ADDITIONAL LEADERSHIP EXPERIENCE

Guangzhou Qiwu Intelligent Technology Co., Ltd.
2023 – 2024 (Co-Founder)
Led cross-functional collaboration on AI-related product development and deployment, gaining experience in technical leadership, team coordination, and prototype-to-delivery execution.

SELECTED TECHNICAL KEYWORDS

Marine robotics; underwater autonomy; disturbance-aware planning and control; operator-guided inspection; multi-view 3D anchoring; robust perception; visual localization; state estimation; over-actuated ROVs; NVIDIA Isaac Sim; custom ROV ground-station software; real-robot validation.

SELECTED REFERENCES

	Dr. Yi Cai
TITLE	Assistant Professor / PhD Supervisor
EMPLOYER	The Hong Kong University of Science and Technology (GZ)
POSITION	Cyber-physical Interaction Lab
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	Dr. Jun Ma
TITLE	Assistant Professor / PhD Supervisor
EMPLOYER	The Hong Kong University of Science and Technology (GZ)
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