

# Xiang (Shawn) Fei

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## EDUCATION

### Carnegie Mellon University

*Master of Science in Robotics* | GPA:4.08/4.0

Pittsburgh, PA

Aug. 2024 - Aug. 2026

### The Chinese University of Hong Kong (Shenzhen)

*Bachelor of Engineering in Computer Science and Engineering* | Major GPA:3.873/4.0

Shenzhen, China

Sept. 2020 - May 2024

### University of California, Berkeley

*Visiting Student, Berkeley Global Access Program* | GPA:4.0/4.0

Berkeley, CA

Jan. 2023 – May 2023

## INTERESTS, SKILLS

**Interests of Research:** Simultaneous Localization and Mapping (SLAM); Deep Learning; Computer Vision; Robotic Manipulation

**Skills:** ROS, Python, C++, C, Matlab, Pytorch, TensorFlow, CUDA, Unreal Engine, Gazebo, PyBullet, Raspberry Pi, Autodesk Fusion, Blender, Linux, Git, Latex

## PUBLICATIONS

**X. Fei\***, Y. Qiu\*, Y. Chen, R. Li, C. Xu, S. Scherer. *MAC-VI-Init: Robust Visual-Inertial Initialization and Calibration with Learning-based Features and Uncertainty*. (Working Paper). [[Website](#)]

\* Equal contribution

**X. Fei**, T. Tian, H. Choset, L. Li. *Bag of Word Groups (BoWG): A Robust and Efficient Loop Closure Detection Method Under Perceptual Aliasing*. 2025 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). [[Paper](#), [Code](#), [Website](#)]

**X. Fei**, H. Zhao, X. Zhou, J. Zhao, T. Shu, F. Wen. *Power System Fault Diagnosis with Quantum Computing and Efficient Gate Decomposition*. Scientific Reports. [[Paper](#)]

Y. Cao, X. Zhou, **X. Fei**, H. Zhao, W. Liu, J. Zhao. *Linear-Layer-Enhanced Quantum Long Short-Term Memory for Carbon Price Forecasting*. Quantum Machine Intelligence. [[Paper](#), [Code](#)]

X. Zhou, H. Zhao, Y. Cao, **X. Fei**, G. Liang, J. Zhao. *Carbon Market Risk Estimation Using Quantum Conditional Generative Adversarial Network and Amplitude Estimation*. Energy Conversion and Economics. [[Paper](#)]

X. Zhou, X. Wang, **X. Fei**, W. Liu, B. Xie, J. Zhao. *Carbon Disclosure Effect, Corporate Fundamentals, and Net-zero Emission Target: Evidence from China*. Under Review. [[Paper](#)]

Data Analysis Team: **X. Fei**, H. Bi, S. Dai, Y. Xu, C. Tao. Carbon Rating Report of China's 100 Overseas Listed Companies. (REPORT) 2022 Global Forum on Sustainable Development. [[Report](#)]

## RESEARCH AREA 1: SLAM; 3D RECONSTRUCTION; ROBOTIC MANIPULATION

### MAC-VI-Init: Robust Learning-based Visual-Inertial Initialization and Calibration

May. 2025 - Nov. 2025

*AirLab, Carnegie Mellon University (Mentor: Prof. Sebastian Scherer)*

- Proposed MAC-VI-Init, a method that leverages learning-based feature matching for robust and accurate VI initialization and calibration.
- Computed metrics-aware covariances (MAC) of visual poses from the learned 3D covariances of feature matching.
- A learning-based IMU model can be further incorporated, providing accurate IMU uncertainties and corrections.
- Conducted comprehensive experiments on challenging scenarios with illumination changes, dynamic objects, occlusions, and fast motions, demonstrating superior performance over traditional methods.
- Preparing a paper as co-first author for submission to Robotics: Science and Systems (RSS) 2026.

### MAC-VIO: Metrics-aware Covariance for Learning-based Stereo Visual-Inertial Odometry

Oct. 2024 - Nov. 2025

*AirLab, Carnegie Mellon University (Mentor: Prof. Sebastian Scherer)*

- Proposed MAC-VIO, a learning-based stereo visual-inertial odometry (VIO) that achieves robust and accurate localization.
- Achieved dense and consistent mapping by leveraging the estimated depth uncertainty.
- Combined learning-based metrics-aware covariance models from both the feature matching and the IMU pre-integration, enhancing the accuracy and robustness.
- Operated reliably in highly challenging environments, such as illumination changes, dynamic objects, occlusions, and fast motions.
- The proposed method can generalize across different environments without tuning the covariance.

### Unified Shape Space for Arm Motion Representation and Retargeting

May. 2025 - Nov. 2025

*Biorobotics Lab, Carnegie Mellon University (Mentor: Prof. Howie Choset)*

- Proposed a method that learns a unified shape space to simultaneously represent the poses of multiple robot arms and human arms.
- This unified shape space was learned through dedicated loss design and contrastive learning methods.
- Achieved human-to-robot and robot-to-robot motion retargeting while preserving end-effector poses and skeletal consistency.
- Enabled robots to closely replicate human motions, supporting tasks requiring high motion consistency, such as threading an arm through a narrow hole or pushing a door with the elbow.

## Efficient and Robust Loop Closure Detection Under Perceptual Aliasing

Sept. 2024 - Mar. 2025

*Biorobotics Lab, Carnegie Mellon University (Mentor: Prof. Howie Choset)*

- A definition of word groups exploiting the co-occurrence and proximity of visual words. This representation enriches the discriminative information of images with similar appearance.
- An online word group database is designed and implemented, providing context-specific representation. Through the integration of direct and inverse index tables, our system achieves efficient loop closure detection suitable for large-scale applications.
- Temporal consistency and feature distribution information are incorporated directly into the similarity score calculation, complemented by dedicated temporal and geometrical post-verification modules. These additions further improve the system's precision and recall.
- At a running speed similar to DBoW, our method raises recall on the New College dataset by over 30% at 100% precision.
- First-authored the paper "Bag of Word Groups (BoWG): A Robust and Efficient Loop Closure Detection Method Under Perceptual Aliasing".

## Visual-Laser-Inertial SLAM for Confined Environments

Jun. 2023 - Nov. 2024

*Biorobotics Lab, Carnegie Mellon University (Mentor: Prof. Howie Choset)*

- Extended a compact, low-cost visual-laser-inertial SLAM-based 3D scanner to narrow pipe environments [[Website](#)].
- Achieved confined space scanning by combining structured light with a traditional monocular visual-inertial SLAM system.
- Utilized an alternating-shutter approach to achieve colored 3D reconstruction using a monocular sensor.
- Deployed the implemented algorithms in a simulation environment built with Unreal Engine 4.
- Investigated a compact prototype design that generates a conical laser emission using diffractive optical elements, as well as the ray-casting problem on conical surfaces.
- Proposed a calibration method with sub-millimeter accuracy for visual-laser systems that use a conical laser pattern.

## Collaborative Robotic Arm in Dynamic Workbench Environments

Jun. 2023 - Nov. 2024

*Biorobotics Lab, Carnegie Mellon University (Mentor: Prof. Howie Choset)*

- Designed and built a collaborative robotic arm using modular HEBI actuators.
- Designed and built a synchronized multi-3D camera system for the workbench of Siemens EV Charger assembly plants.
- Achieved real-time obstacle avoidance for the collaborative arm by generating continuous distance and gradient field using 3D cameras.
- The implemented method models dynamic objects, thereby enabling the arm to work effectively in dynamic workbench environments without interfering the normal operations of human workers.

## Photorealistic 3D Reconstruction with Multi-view-Stereo

Feb. 2024 - May. 2024

*Advanced Computational Imaging Lab, CUHKSZ (Mentor: Prof. Qilin Sun)*

- Proposed a new PatchMatch-based photorealistic 3D reconstruction method with multi-view-stereo.
- Proposed Broad Adaptive Checkerboard Sampling, which considers pixels in a wider but shallower region rather than a deeper region in a specific direction, improving disparity propagation in large low-texture areas.
- Introduced Dynamic Multi-Hypothesis Joint View Selection, which dynamically adjusts matching costs to enable more robust and accurate view selection.
- Results show that the proposed method can effectively reconstruct low-texture areas of the overall scene with fewer disparity propagation and refinement iterations, without losing detail.

## RESEARCH AREA 2: QUANTUM SCIENCE AND ENGINEERING

### Quantum Optimization for Quadratic Unconstrained Binary Optimization (QUBO) Problem

Aug. 2022 - May 2023

*Energy Internet Lab, CUHKSZ (Mentor: Prof. Junhua Zhao)*

- Developed a novel framework to tackle QUBO problems using the quantum approximate optimization algorithm.
- Proposed a quantum gate decomposition method, which enhances the efficiency for solving QUBO problems.
- Adapted the proposed framework to power system fault diagnosis task and formulated the Hamiltonian using the Ising model.
- Simulation results indicate that the proposed method achieves accurate optimal outcomes at a faster speed compared to the classical higher-order solver provided by D-wave.
- First-authored the paper "Power System Fault Diagnosis with Quantum Computing and Efficient Gate Decomposition".

### Quantum Machine Learning for Time Series Forecasting

Apr. 2022 - Sept. 2022

*Energy Internet Lab, CUHKSZ (Mentor: Prof. Junhua Zhao)*

- Proposed and implemented a hybrid quantum computing-based time series forecasting framework called Linear-Layer-Enhanced Quantum Long Short-Term Memory (L-QLSTM).
- Implemented parameter sharing between linear and variational layers, reducing parameters and enhancing learning performance.
- Applied the proposed L-QLSTM to the carbon price forecasting task.
- Results show that the proposed L-QLSTM method greatly improves the learning accuracy compared to the QLSTM method.
- Authored the paper "Linear-layer-enhanced quantum long short-term memory for carbon price forecasting".

Quantum Conditional GAN and Amplitude Estimation for Distribution Learning and Measuring

May 2023 - Oct. 2023

Energy Internet Lab, CUHKSZ (Mentor: Prof. Junhua Zhao)

- Proposed a quantum computing-based distribution learning and measuring framework that utilizes quantum conditional generative adversarial networks-quantum amplitude estimation (QCGAN-QAE) to enhance the estimation accuracy and efficiency.
- Improved the circuit structure of the quantum generator in QCGAN by reordering the data entanglement layer and data rotation layer, while introducing the quantum fully connected layer before rotation operations.
- Incorporated the binary search approach into QAE to bolster the computational efficiency.
- Applied the proposed framework to carbon market risk estimation task. Simulation results show that the proposed framework largely enhances the efficiency and precision of Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR) compared to the existing methods.
- Authored a paper “Carbon Market Risk Estimation Using Quantum Generative Adversarial Network and Amplitude Estimation”.

PROFESSIONAL EXPERIENCE

Winning Health Technology Group Co., Ltd.

Shanghai, China

Algorithm Engineer Intern (Computer Vision Track)

Jul. 2022 - Sept. 2022

- Took on the role of initiating the monocular endoscope 3D reconstruction project and implemented a sophisticated 3D reconstruction technique for the gastrointestinal tract [Project Report].
- Utilized the sparse reconstruction and camera pose obtained by Structure from Motion with SIFT descriptors as self-supervised signals to train a designed two-branch Siamese network to achieve dense depth estimation and feature descriptors.
- Reconstructed a watertight triangle mesh surface of the gastrointestinal tract with high accuracy by using marching cubes method.

Shenzhen Teabreak Network Technology Co., Ltd.

Shenzhen, China

Leader of the Software Backend Development Department

Jul. 2022 - Sept. 2022

- Played a key role in the development of more than 5 products, contributing to the backend program development, product strategy, requirements gathering, feature prioritization, and successful execution [Code].
- Successfully organized and executed Halloween promotion activities for JD.com, Inc. at CUHK(SZ), effectively engaging the target audience and driving participation and sales during the festive season.
- Received recognition as the top 1-performing entrepreneurial team at the school’s incubation base in 2021.

EXTRACURRICULAR ACTIVITIES

Teaching Assistant of the Discrete Mathematics Course at CUHKSZ

- Conducted tutorial courses to assist students in their understanding of complex mathematical concepts and course material.
- Developed homework assignments for students and provided timely and constructive feedback through grading.
- Offered guidance and clarification to students, addressing their questions and concerns to enhance their learning experience.

Peer Advisor of the School of Data Science at CUHKSZ

- Organized orientation activities to help freshmen acclimate to university life and foster a sense of community.
- Facilitated communication between freshmen and professors, ensuring they had access to the necessary support and resources.
- Provided advice on study strategies and overall student life, helping freshmen navigate their university experience.

COMPETITION & AWARDS

- National University Student Energy Economy Academic Creativity Competition	
• 2023 National Outstanding Award of Graduate Group (National Top 10)	May 2023
• 2022 National Outstanding Award of Undergraduate Group (National Top 5)	May 2022
- 2022 CCF “Sinan Cup” Quantum Computing Programming Competition	
• National Second Prize (National Top 18)	Aug. 2022
- 2022 Mathematical Contest in Modeling	
• Meritorious Winner (Global Top 7%)	May 2022
- 2020-2023 Dean’s List Honor of School of Data Science, CUHKSZ	Sept. 2021 - 2023
- 2021-2022 Academic Performance Scholarship of CUHKSZ	Dec. 2022
- Undergraduate Research Award of CUHKSZ	Nov. 2022
- 2020-2021 Master’s List Award of Muse College, CUHKSZ	Nov. 2021
- Bowen Scholarship of CUHKSZ	Sept. 2020