Xiang (Shawn) Fei

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Education

Carnegie Mellon University — **Pittsburgh, PA**
Master of Science in Robotics | **GPA:4.08/4.0** — Aug. 2024 - Aug. 2026

The Chinese University of Hong Kong (Shenzhen) — **Shenzhen, China**
Bachelor of Engineering in Computer Science and Engineering | **Major GPA:3.873/4.0** — Sept. 2020 - May 2024

University of California, Berkeley — **Berkeley, CA**
Visiting Student, Berkeley Global Access Program | **GPA:4.0/4.0** — 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; Robot Motion and Manipulation

MAC-VI-Init: Robust Learning-based Visual-Inertial Initialization and Calibration — May. 2025 - Nov. 2025

AirLab, Carnegie Mellon Univeristy (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 Univeristy (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 Univeristy (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 Univeristy (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 Univeristy (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.

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 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; Energy and Sustainability

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".

The Impact of Carbon Disclosure on Company Financial Performance Jan. 2022 - Dec. 2022

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

- Developed a difference-in-differences model to examine carbon disclosure behavior's impact on indicators of companies.
- Investigated the correlation between company stock market performance, carbon disclosure behavior, and the implementation of national/regional emission trading systems (ETS) in China.
- Extracted quantitative carbon emissions data from ESG reports using web crawler and OCR techniques.
- Authored a paper "Carbon Disclosure Effect on Listed Companies under the Net-zero Emission Target: The Case of China".

Carbon Rating Report of China's 100 Overseas Listed Companies Aug. 2021 - Jun. 2022

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

- Contributed to design an innovative method for calculating carbon scores.
- Proposed a new set of metrics capable of accurately measuring corporate carbon scores.
- Conducted energy disclosure data collection and analysis for China's 100 overseas listed companies.
- Published a comprehensive research report at the 2022 Global Forum on Sustainable Development.

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