



Zewen Xu

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Advisor: Professor Yihong Wu

Research Interests:

Robot localization, pose estimation, 3D reconstruction, AR/VR, etc.



Education

2020.09-2026.01

University of Chinese Academy of Sciences, Institute of Automation
Ph.D. in Pattern Recognition and Intelligent Systems GPA: 3.9/4.0
Beijing Institute of Technology, School of Information and Electronics
B.Eng. in Electronic Information Engineering Rank: 2nd overall

2016.09-2020.09

Projects and Key Publications

2022.11-2025.10

Environment Perception and Virtual Fusion Rendering for AR/MR

Led the design of a novel VIO initialization framework addressing inaccurate or missing camera-IMU spatial-temporal parameters in AR devices and smartphones.

- **Technical Approach:** Rotation-translation decoupled framework with tightly coupled normal epipolar constraint (NEC) using both camera and IMU observations, accounting for **gyro bias**, **extrinsic rotation**, and **time offset**.
- **Challenges Solved:**
 - ✧ Designed fine-grained weighting and iterative reweighted least squares (IRLS) to **reduce linearization errors**.
 - ✧ Developed a “failure detection” module based on chi-square test to **mitigate NEC non-convexity**.
 - ✧ Used IESKF-based rotation optimization to **address pure rotation initialization delays**.
- **Results:**
 - ✧ Developed a VIO initialization method with significantly improved efficiency and accuracy compared to existing approaches—over 30% faster than ORB-SLAM3, OpenVINS, and VINS-Mono.
 - ✧ Achieved 1/5 time offset error and 1/20 rotation error of SOTA methods under realistic AR datasets with large initial errors.
 - ✧ Addressed parameter drift due to deformation in real AR/MR use and eliminated rendering delays.
- **Publications:** ICRA 2025 (oral) [1], TRO (submitted) [2].

2023.07-2025.06 Xiaomi Inc.—Technologies for Indoor Visual Mapping and Localization for Humanoid Robot Navigation
From 03/2025, integrated [2] into humanoid robot navigation system to address extrinsic and gyro bias mismatches, achieving **<1% localization error** on physical tests.

2023.01-2025.12

Stereo-IMU Fusion SLAM Based on Multi-feature Integration

Developed a point-line feature fusion VIO subsystem to improve robustness in man-made environments with poor point features.

- **Technical Approach:** Consistent line observation model (segment as landmark, infinite line as observation), anisotropy-aware weighting, MSCKF observability-constrained updates.
- **Challenges Solved:**
 - ✧ To address the inconsistency in the line feature observation model of existing point-line feature SLAM caused by occlusion and fragmentation of line segments, a new observation model was designed that treats line segments as landmarks and infinite lines as observations.
 - ✧ To handle the anisotropy and non-uniformity of line feature uncertainty, a weighting scheme for line feature observation errors was developed that requires only the measurement of perpendicular uncertainty.
 - ✧ To ensure that line segment landmarks are correctly updated within the MSCKF framework, an update strategy based on observability direction projection for line landmarks was proposed.
- **Results:** By adopting a consistent observation model and reasonably quantifying the uncertainty of the error terms, the trajectory accuracy remained essentially unchanged as the number of line features in MSCKF increased (even when the line features were of low quality). On public datasets, the trajectory accuracy of the proposed point-line fusion VIO improved by more than 13% on average compared to OpenVINS (with a reduced number of point features in OpenVINS).

Compared to PL-VINS, which outperforms its point-based subsystem in 53% of the sequences, the proposed method outperformed OpenVINS in 80% of the test sequences.

- **Publications:** Related work has been accepted to the top robotics conference IROS [4], and one invention patent has been filed.

Internship Experience

2022.03-2022.10

Huawei Technologies Co., Ltd. – Huawei Cloud

Designed VIO backend module for industrial manufacturing and campus scenarios.

Technical Approach: Adopted OpenVINS as the front-end framework and used bundle adjustment (BA) for back-end optimization. The keyframe selection strategy was inspired by ORB-SLAM3. ORB features were additionally extracted on keyframes, and O

- **Technical Approach:** OpenVINS front-end + BA backend, keyframe selection inspired by ORB-SLAM3, ORB feature augmentation, bag-of-words, and multiple matching strategies. Establishing the association between backend features and frontend features through photometric constraints.
- **Results:** 15% trajectory accuracy improvement over VINS-Mono; backend optimization improved accuracy by an additional 9%.

Honors & Awards & Skills

- **Bachelor's:** 2× National Scholarship, multiple “Excellent Student” awards, Beijing Outstanding Graduate, Beijing Outstanding Thesis (top 1%), 2× First Prize in Beijing University Student Mathematical Modeling Contest, 1st place in 2018 National Formula Student Autonomous Competition.
- **Ph.D.:** 2020–2021 UCAS “Outstanding Communist Youth League Member”, “Excellent Student”, 3rd place in 2023 China SLAM Challenge VIO track (team captain).
- **Skills:** Proficient with LiDAR, IMU, RGB-D, and stereo cameras; skilled in extrinsic calibration and data collection. Experienced with vins-mono, opencvins, ORB-SLAM series, LOAM, FAST-LIO, etc.
- **English:** CET-6 502; strong academic reading and writing ability.
- **Personality:** Curious, persevering, team-oriented, perfectionist, values the application of knowledge.

Publications (Citations >100)

Google Scholar: <https://scholar.google.com/citations?user=AhzpLgkAAAAJ&hl=zh-CN>

- Robust VIO Initialization for Robotics and AR (Online Calibration):
 - [1] **Zewen Xu**, Yijia He, Hao Wei, et al. DOGE: An Extrinsic Orientation and Gyroscope Bias Estimation for Visual-Inertial Odometry Initialization[C]. ICRA . 2025 (Oral)
 - [2] Bo Xu*, **Zewen Xu***, Yijia He, et .al A Rotation-Translation Decoupled Solution for Visual-Inertial Initialization and Oline Spatial-Temporal Calibration.[J] TRO, 2025 (submitted)
- Multi-feature Fusion for Pose Estimation:
 - [3] **Zewen Xu** , Zheng Rong, Yihong Wu. A survey: which features are required for dynamic visual simultaneous localization and mapping?[J]. VCIBA, 2021, 4(1): 20.
 - [4] **Zewen Xu**, Hao Wei, Fulin Tang, et al. PLPL-VIO: a novel probabilistic line measurement model for point-line-based visual-inertial odometry[C] IROS. 2023: 5211-5218. (Oral)
 - [5] **Zewen Xu**, Yijia He, Hao Wei, et al. An Accurate and Real-time Relative Pose Estimation from Triple Point-line Images by Decoupling Rotation and Translation. TIP, 2025 (submitted)
 - [6] Hao Wei, Fulin Tang, **Zewen Xu**, et al. A point-line vio system with novel feature hybrids and with novel line predicting-matching[J]. RAL, 2021, 6(4): 8681-8688. (SCI)
 - [7] Hao Wei, Fulin Tang, **Zewen Xu**, et al. Structural regularity aided visual-inertial odometry with novel coordinate alignment and line triangulation[J]. RAL, 2022, 7(4): 10613-10620. (SCI)
 - [8] Haolin Wang, Hao Wei, **Zewen Xu**, et al. RSS: Robust Stereo SLAM with Novel Extraction and Full Exploitation of Plane Features[J]. RAL, 2024. (SCI)

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