A Panoramic Visual-Inertial SLAM in HILTI SLAM Challenge 2026

Yiyang Wu, Qingsong Yan, Yanjin Du, Xiaohu Zhang, Xiangpeng Xu

***Abstract*—This report presents our panoramic visual–inertial SLAM used to complete the HILTI SLAM Challenge 2026. Our method takes stitched panoramic ERP images and IMU measurements as input, and integrates hybrid feature extraction, panoramic loop closure, and panoramic optimization to achieve 360 VI-SLAM.**

I. Method

Our method [1] is modified based on the framework of [2], and introduces hybrid feature extraction, panoramic initialization, improved IMU integration, panoramic optimization, and panoramic loop closure [3]–[7].

Similar to existing SLAM methods that leverage panoramic equirectangular projection (ERP) images stitched from dual-fisheye inputs [3], [8]–[10], our method integrates a panoramic ERP projection model into the framework of [2] and correspondingly adapts the Jacobians in the back-end optimization to enable panoramic optimization [8]–[10]. To further enhance the robustness of feature tracking under challenging lighting conditions, we introduce hybrid feature extraction that combines both hand-crafted and learned features [5]. Additionally, we incorporate the improved IMU integration from [6] along with the initialization method described in [4] to strengthen the system's tracking performance. Finally, to correct accumulated errors, we extend the framework of [2] with loop closure detection and optimization for ERP panoramic image inputs, thereby improving the global consistency of the estimated poses. Overview of the proposed method is shown in Fig. 1.

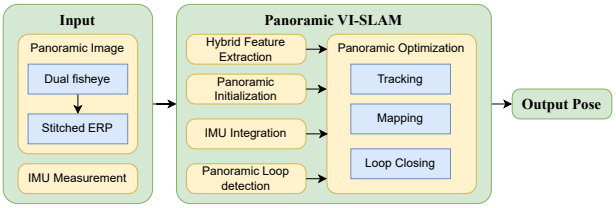

Fig. 1. Overview of the proposed method

II. Results

We run our method using the ERP image stitching program provided in the official GitHub repository, together with the intrinsic and extrinsic parameters of the cameras and IMU. The extrinsic parameters of the ERP camera are approximated using the cam0-to-IMU extrinsics. The best results on the 30 sequences are shown in Fig. 2.

Yiyang Wu, Yanjin Du, Xiaohu Zhang, Xiangpeng Xu are with the School of Aeronautics and Astronautics, Sun Yat-sen University, Guangzhou 510275, China. (e-mail: {wuyy239,duyj36}@mail2.sysu.edu.cn, {zhangxiaohu,xuxp39}@mail.sysu.edu.cn)

Qingsong Yan is with XGRIDS LIMITED, Shenzhen, China. (email: qsyan@xgrids.com)

Dataset	RMSE (m)	Mean (m)	Max (m)	Min (m)	Coverage (%)	Poses	Exp Score	Status	Notes	Final Score
floor_1_2025-05-05_run_1	0.3055	0.2765	0.5750	0.0391	100.0000	3869	88.2006	Score not included in Challenge		
floor_1_2025-07-07_run_1	0.5762	0.5138	1.6649	0.1364	100.0000	3959	79.4578	Plot is hidden		
floor_1_2025-12-02_run_1	0.5119	0.3983	1.6841	0.0362	100.0000	8172	84.0723			
floor_2_2025-05-05_run_1	0.6567	0.5489	1.2721	0.0136	100.0000	5476	78.7086	Score not included in Challenge		
floor_2_2025-10-28_run_1	0.1687	0.1521	0.3258	0.0159	100.0000	3019	93.2865	Score not included in Challenge		
floor_2_2025-10-28_run_2	0.2608	0.2229	0.6727	0.0141	100.0000	2515	90.4157	Score not included in Challenge		
floor_2_2025-12-02_run_1	0.3510	0.3033	0.8501	0.0468	100.0000	4309	87.2402	Plot is hidden		
floor_2_2025-12-03_run_1	1.2381	1.1068	2.4789	0.0982	100.0000	4416	61.9366			
floor_3_2025-05-19_run_1	0.4068	0.3870	0.5849	0.1313	100.0000	3383	83.8143			
floor_3_2025-12-02_run_1	0.2572	0.2337	0.5853	0.0383	99.6147	3878	89.9065			
floor_4_2025-05-19_run_1	0.7615	0.6775	1.5001	0.0023	100.0000	2616	74.1140			
floor_4_2025-12-02_run_1	0.2953	0.2491	0.7638	0.0057	100.0000	5688	89.3954			
floor_5_2025-12-02_run_1	0.1117	0.1038	0.2456	0.0093	100.0000	4731	95.3479			
floor_6_2025-06-18_run_1	0.1808	0.1597	0.3640	0.0388	100.0000	2029	92.9814			
floor_6_2025-07-07_run_1	0.1148	0.1030	0.2360	0.0080	100.0000	2104	95.3930	Plot is hidden		
floor_6_2025-12-02_run_1	0.1840	0.1429	0.5749	0.0041	100.0000	5041	93.7619			
floor_6_2025-12-02_run_2	0.1676	0.1526	0.4183	0.0235	99.0976	3624	93.2601			
floor_7_2025-12-02_run_1	0.4183	0.3790	0.8357	0.0082	100.0000	3479	84.2584			
floor_7_2025-12-02_run_2	0.2194	0.1945	0.3863	0.0141	100.0000	4539	91.5310			
floor_7_2025-12-03_run_1	0.2103	0.1903	0.4855	0.0036	100.0000	5877	91.6886	Plot is hidden		
floor_EG_2025-10-16_run_1	0.2790	0.2483	0.6586	0.0969	100.0000	7170	89.3442	Plot is hidden		
floor_EG_2025-12-02_run_1	0.1469	0.1335	0.2885	0.0109	99.5957	3695	94.0731			
floor_EG_2025-12-02_run_2	0.0944	0.0810	0.2971	0.0019	100.0000	4788	96.3612			
floor_UG1_2025-05-19_run_1	1.2749	1.1320	2.2958	0.2232	100.0000	6010	61.5853			
floor_UG1_2025-06-18_run_1	0.6199	0.5241	1.2986	0.0957	99.5500	4867	79.4383			
floor_UG1_2025-10-16_run_1	1.4745	1.3635	2.6938	0.0198	100.0000	6014	55.2058	Score not included in Challenge		
floor_UG1_2025-12-02_run_1	1.0532	0.9850	1.8582	0.0569	100.0000	7551	64.4414			
floor_UG1_2025-12-02_run_2	1.2252	1.0643	3.2161	0.0936	100.0000	6502	63.3847			
floor_UG1_2025-12-03_run_1	1.3967	1.1814	2.8568	0.1484	100.0000	3973	61.3122			
floor_UG2_2025-12-02_run_1	0.5587	0.5003	1.4514	0.0777	100.0000	6607	79.9177	Plot is hidden		
Mean Results	**0.5173**	**0.4570**	**1.1140**	**0.0504**	**99.9286**					
Final Score							**2078.0172**			**2078.0172**

Fig. 2. Results of the proposed method.

III. Conclusion And Discussion

Our proposed method achieves stable tracking under challenging lighting conditions and corrects the accumulated drift during long-term tracking, yielding reasonable performance.

However, the method does not explicitly consider occlusion, which may degrade the performance in challenging scenarios. Adapting methods such as [11] or [12] to ERP panoramic images [13] may provide a more effective way to handle occlusions and dynamic objects. In addition, combining learning-based ERP panoramic SLAM approaches [10], [14] with more robust IMU integration [15] and learning-based loop closure [16] may further improve the robustness and accuracy of the system.

As noted in the official repository, the single optical center approximation adopted in the ERP projection of the dual-fisheye camera may introduce geometric distortions, which could also affect the tracking accuracy. Compared with the single continuous ERP representation, directly using the original dual-fisheye images may achieve higher geometric accuracy.

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