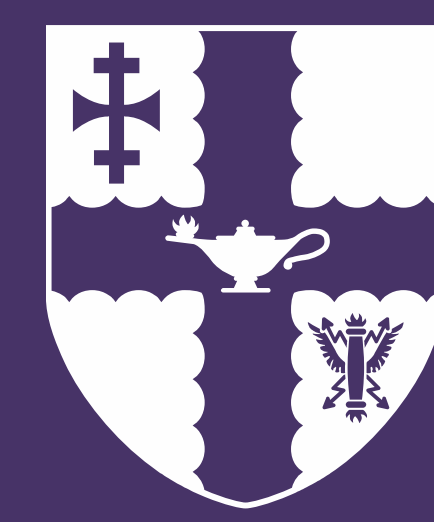


HortiMulti: A Multi-Sensor Dataset for Localisation and Mapping in Horticultural Polytunnels



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Introduction

- **Polytunnels present unique navigation challenges:**
 - perceptual aliasing
 - plant motion
 - illumination instability
 - GNSS unreliability
- **No existing** agricultural dataset (vineyards [1] and corn fields [2]) reproduces polytunnel conditions
- **Aim:** To provide engineers with a real-world multi-sensor dataset to support the development of robust robot localisation and mapping systems for commercial polytunnel environments

Dataset Overview

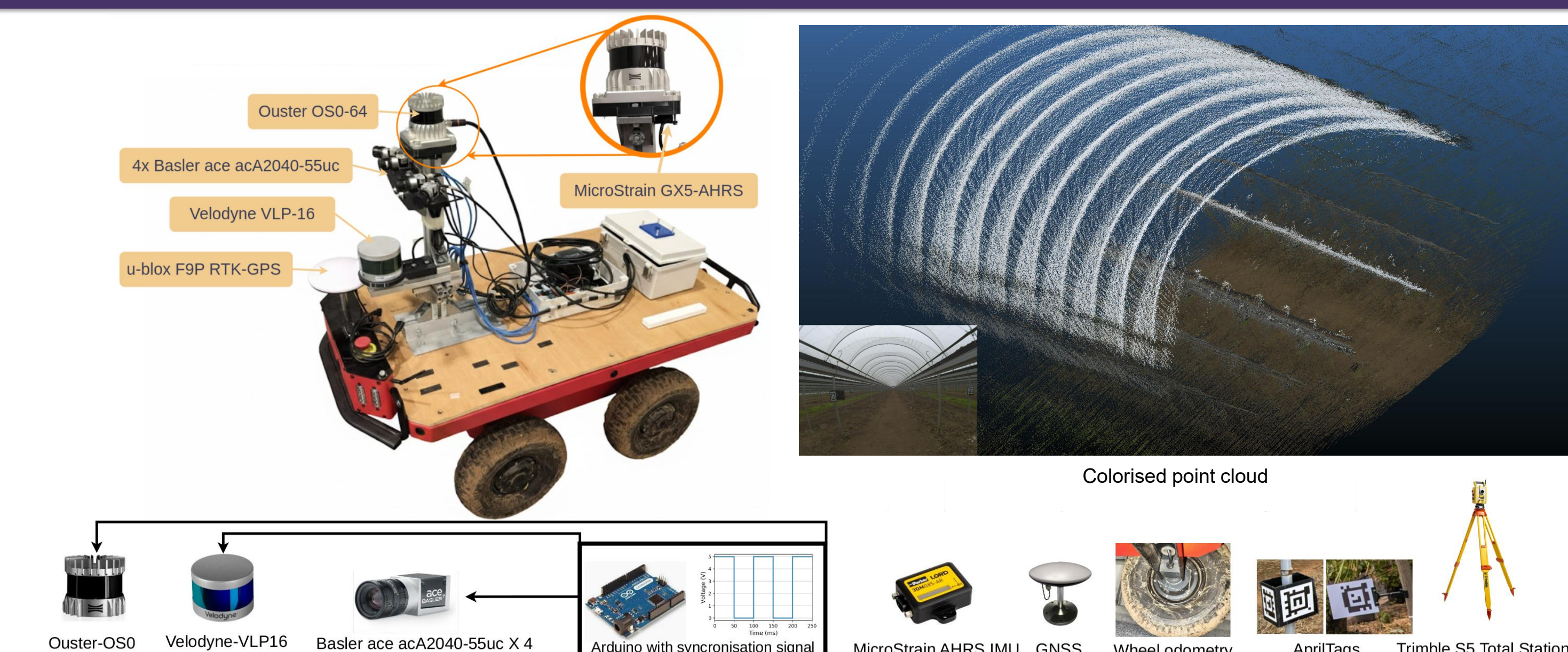


Fig. 1. Data collection platform

- **Platform:** Antobot with Lidar, camera, IMU, GNSS and wheel odometer calibrated and synchronised
- **Environments:** Commercial strawberry & raspberry polytunnels, Gloucestershire, UK
- **Season coverage:** June 2025 – February 2026 (full growing cycle)
- **Total sequences:** 20 sequences, >11 km of trajectories

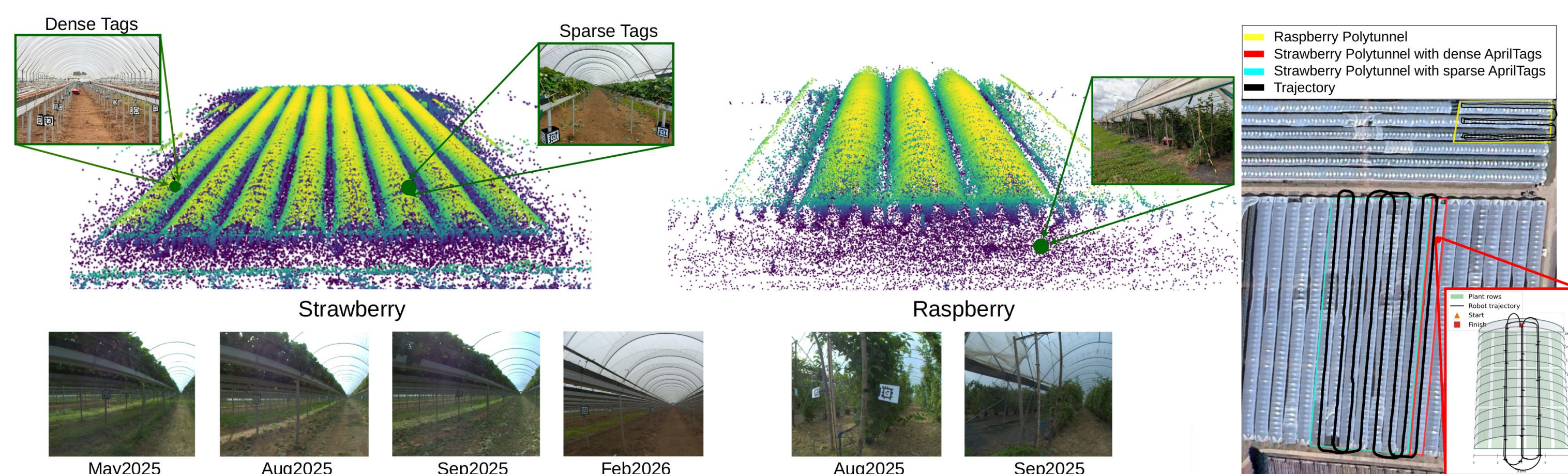


Fig. 2. Data collection environment

Ground Truth Pipeline

- **AprilTags + Total Station**
- **Poly-TagSLAM** [3] fusing LiDAR-inertial odometry + tag detections + surveyed priors

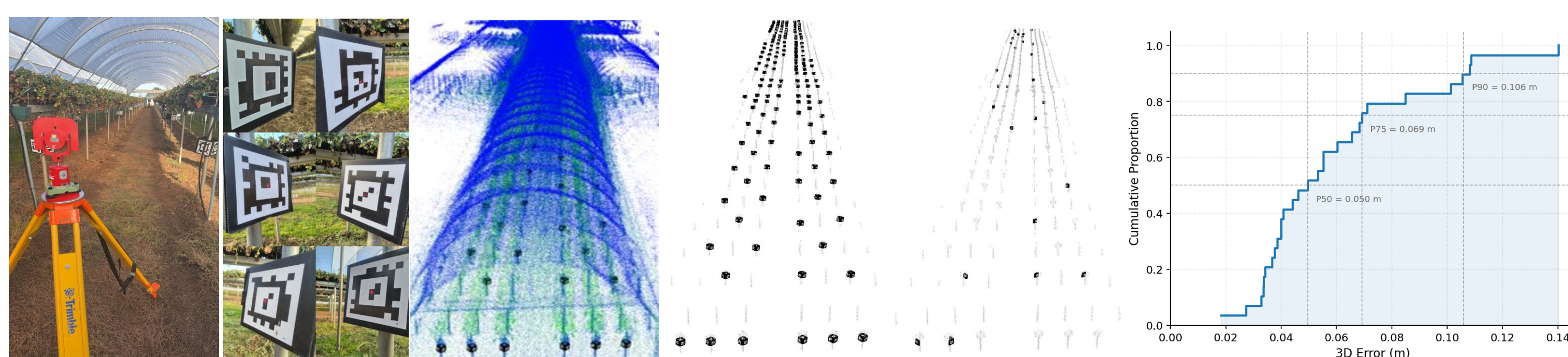


Fig. 3. Ground truth data collection process

SLAM Results

- **Visual methods:** mostly fail
- **LiDAR-only:** metre-level drift on longer sequences
- **LiDAR-visual-inertial:** failed on all sequences
- **LiDAR-inertial:** most robust — best RPE 0.64%, ATE 0.044 m

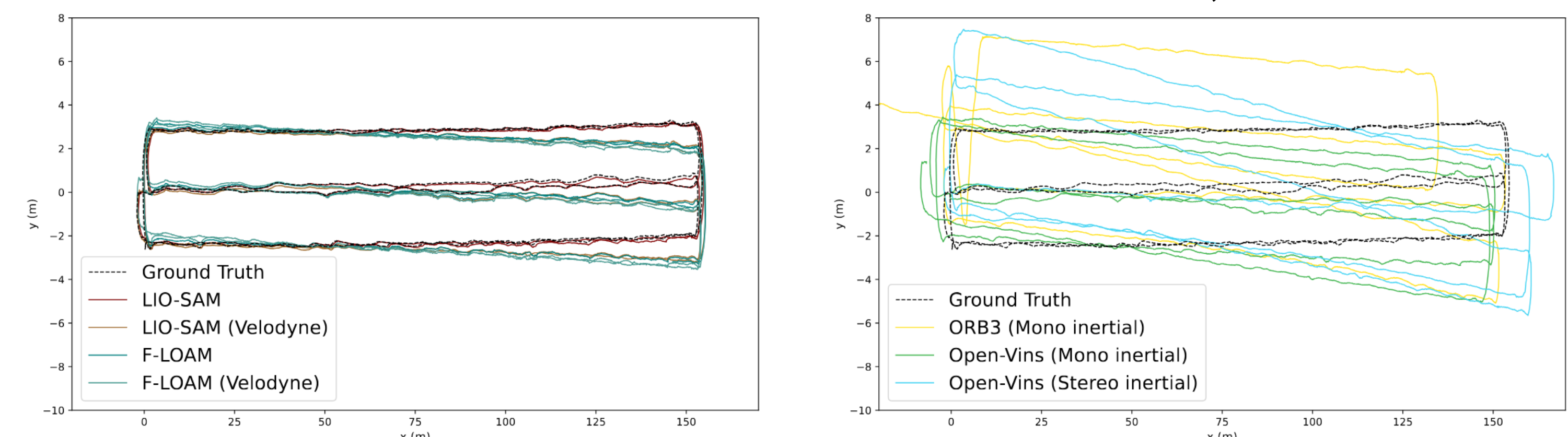


Fig. 4. Trajectory comparison of sequence 1, Feb 2026

Table. 1. Localisation performance comparison

Stat/Sequence (Feb2026/Strawberry_)	1		2		3		4	
	RPE (%)	ATE (m)	RPE (%)	ATE (m)	RPE (%)	ATE (m)	RPE (%)	ATE (m)
DSO (Mono)	×	×	32.07	10.2568	43.53	14.1276	22.84	2.2490
ORB3 (Mono)	×	×	×	×	19.42	0.4920	11.16	1.5589
ORB3 (Mono Inertial)	15.05	10.7027	18.27	10.7716	3.37	22.7727	5.63	2.1896
ORB3 (Stereo)	×	×	×	×	8.00	0.9066	184.37	23.9799
Open-Vins (Mono Inertial)	5.74	4.5396	×	×	15.60	9.0245	4.65	0.6653
Open-Vins (Stereo Inertial)	9.50	5.9612	10.67	2.7691	5.60	0.6526	×	×
VINS-Fusion (Mono Inertial)	×	×	×	×	41.29	17.5131	×	×
VINS-Fusion (Stereo Inertial)	×	×	×	×	9.32	1.5009	20.99	3.9202
FLOAM	3.79	0.8587	10.64	1.6054	3.58	0.2879	4.10	0.2045
FLOAM (Velodyne)	4.04	0.8763	25.80	8.9257	3.77	0.2460	4.22	0.2075
LIO-SAM	1.64	0.4308	9.24	0.7189	0.64	0.0440	1.66	0.3850
LIO-SAM (Velodyne)	3.01	0.8048	9.81	1.0408	2.71	0.1856	3.22	0.3442

Place Recognition Results

- **Handcrafted:** fails due to repetitive row patterns
- **Learning-based:** outperform handcrafted but still insufficient for reliable recall

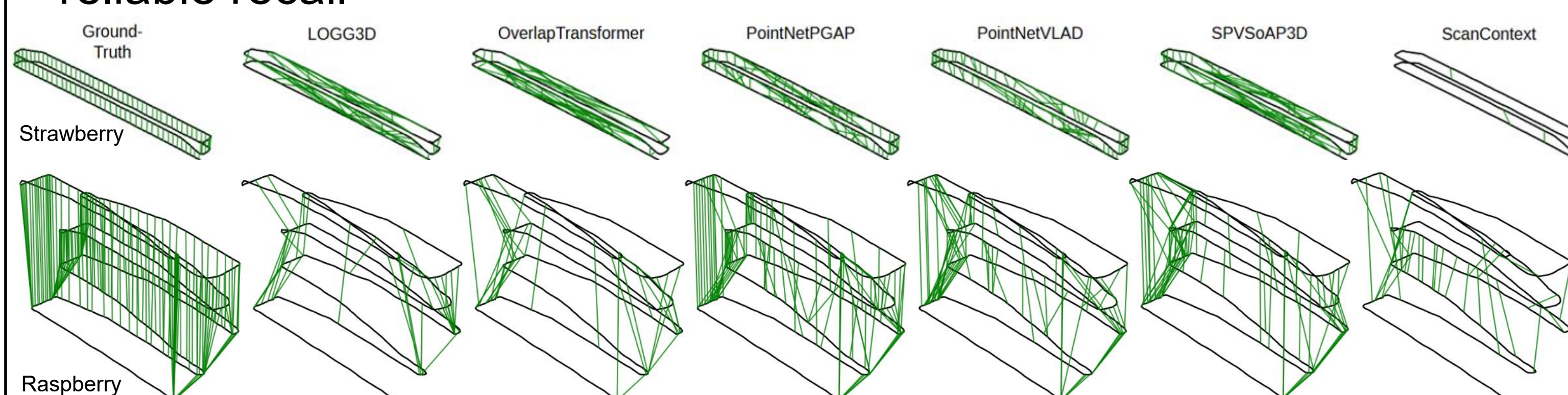


Fig. 5. Illustration of top-1 true positive predictions within a 10m range

Conclusion

Summary:

- First multi-sensor, multi-season dataset targeting commercial polytunnels
- Sub 7 cm ground truth
- Current state-of-the-art methods are insufficient for reliable polytunnel deployment
- **Dataset available at:** <https://github.com/shuoyuanxu/HortiMulti>
- **Preprint:** <https://doi.org/10.48550/arXiv.2603.20150>

Future Research Directions:

- Expand dataset with new seasons, crops, and tunnel configurations
- Open challenges for the community:
 - Achieving reliable visual SLAM in polytunnels
 - Mitigating LiDAR drift over long-term deployments
 - Developing robust place recognition methods to repetitive structure of polytunnel environments

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