



Multi-Session Ground Texture SLAM in Low-Dynamic Environments

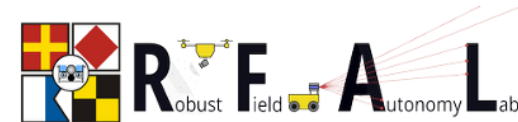
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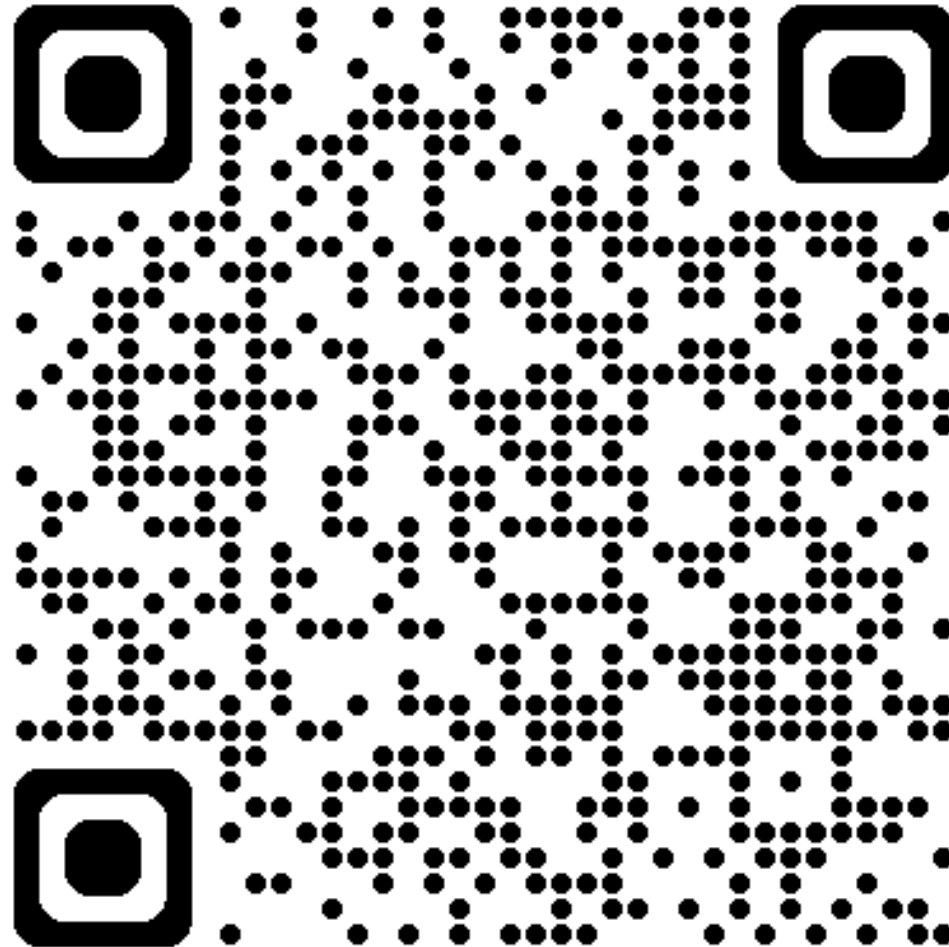
Robotics and Intelligent Systems Engineering Lab, US Navy, New Jersey

Brendan Englot

Robust Field Autonomy Lab, Stevens Institute of Technology, New Jersey

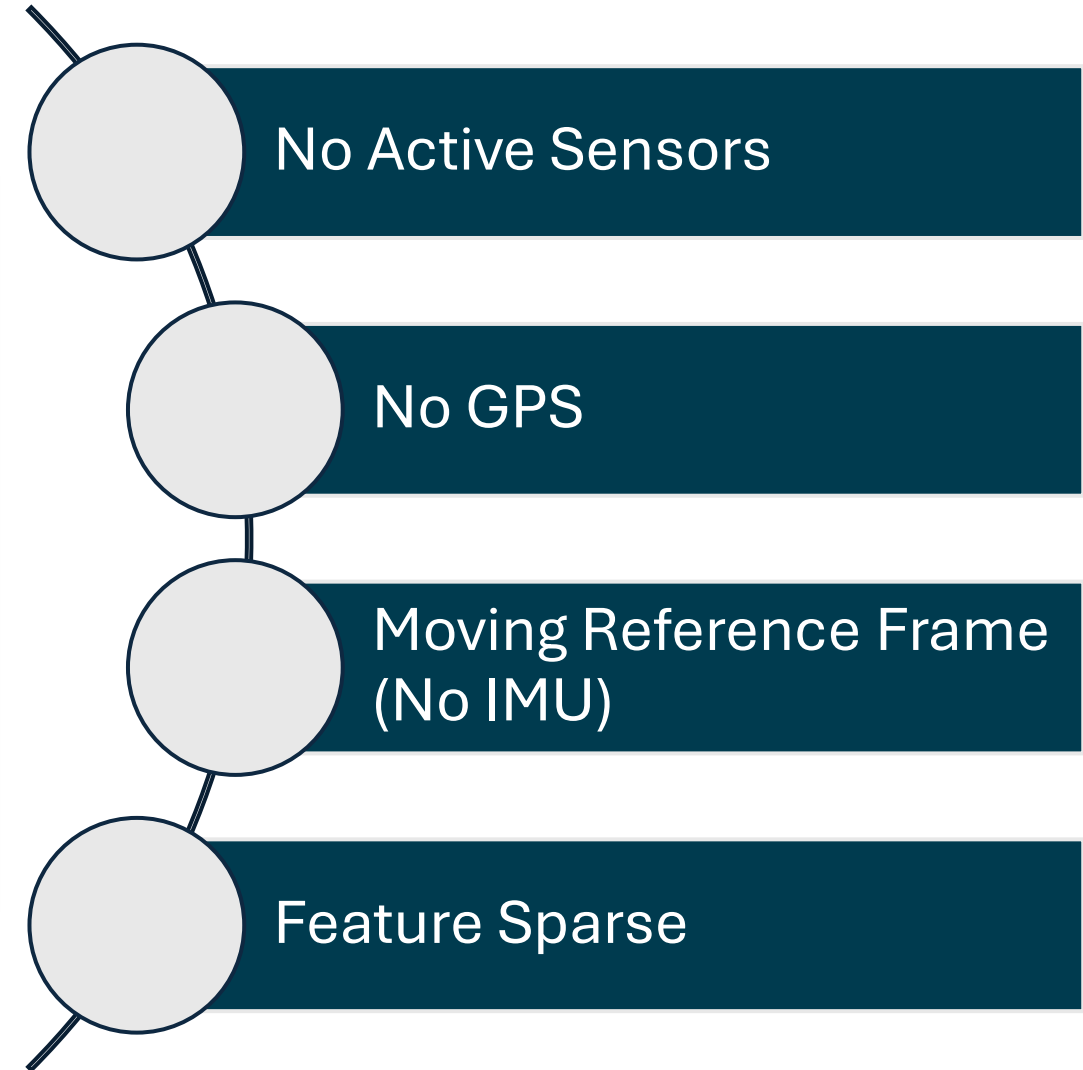


Link to Slides



https://robustfieldautonomylab.github.io/Hart_UR_2026_Presentation.pdf

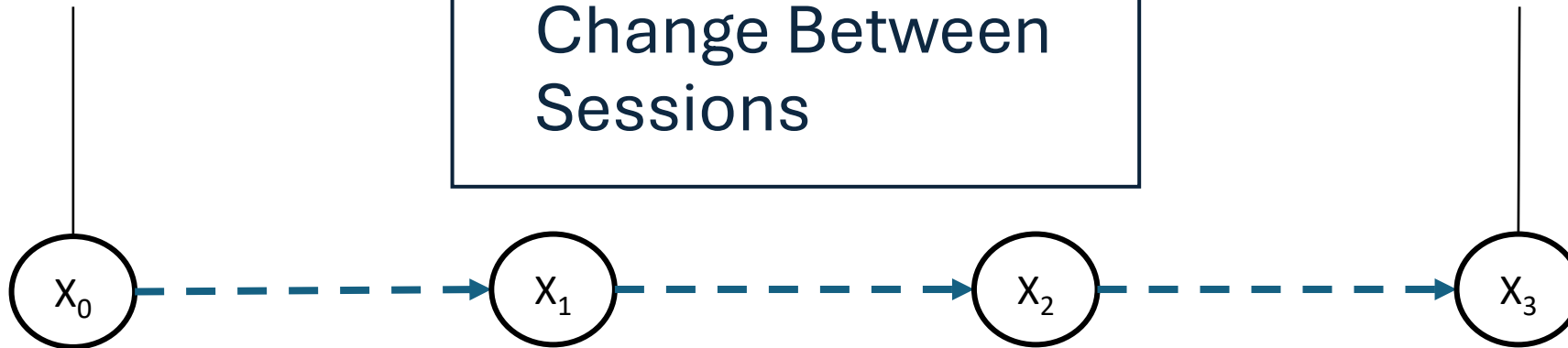
Why Ground Texture?



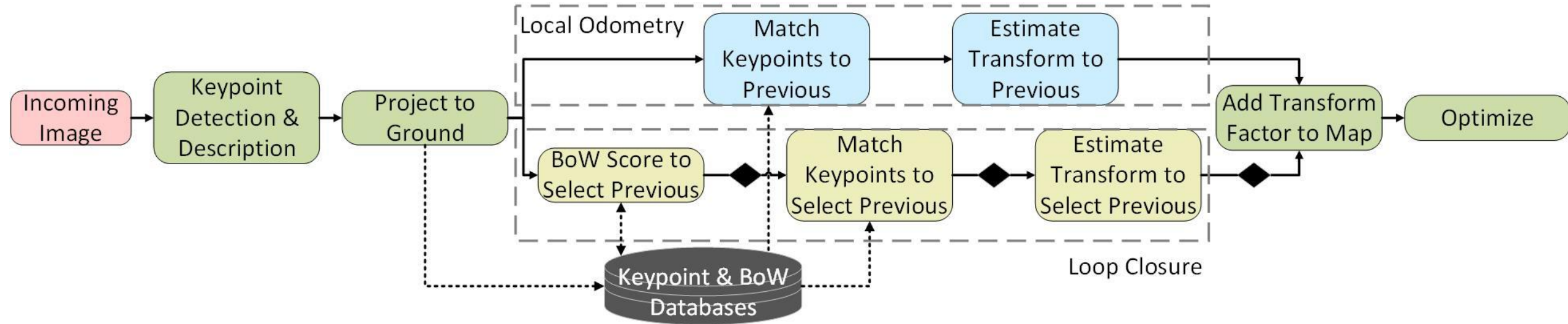
Goal

Visual SLAM with:

- **Only** downward images
- Multiple Sessions
- Low-Dynamic Change Between Sessions



Starting Framework



K. M. Hart, B. Englot, R. P. O'Shea, J. D. Kelly, and D. Martinez, "Monocular Simultaneous Localization and Mapping using Ground Textures", IEEE International Conference on Robotics and Automation, London, United Kingdom, May 2023.

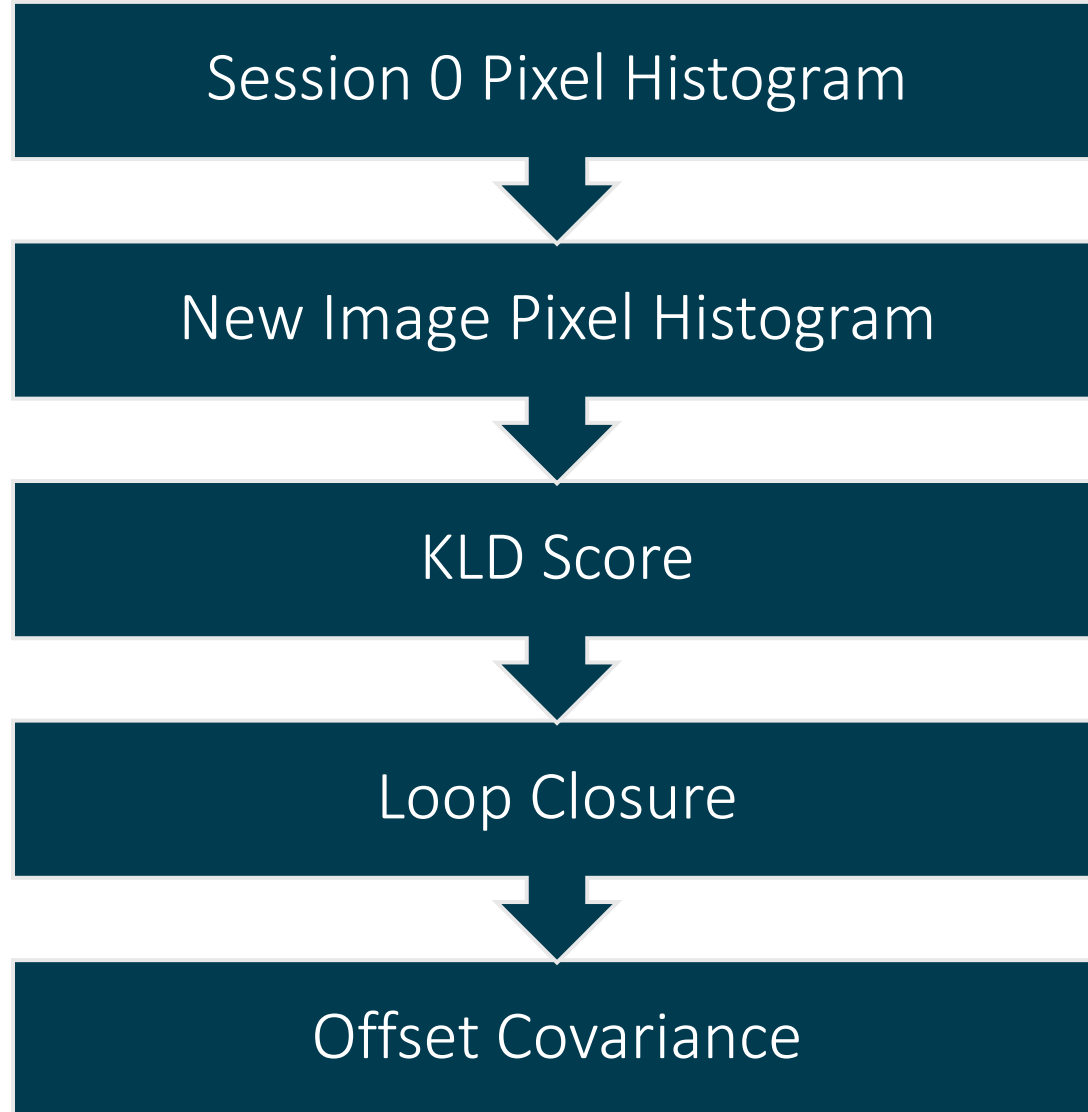
Possible Approaches

Kullback-Leibler Divergence

Visual Overlap

Joint Intensity Histogram

Kullback-Leibler Divergence



$$Score = \frac{1}{3} \sum_{c=\{r,g,b\}} \sum_0^{255} p_c \log \frac{p_c + \epsilon}{q_c + \epsilon}$$

$$\Sigma^* = \Sigma \cdot (Score + 1)$$

Visual Overlap

Estimate Poses



Estimate Field of View



Exclude Non-Overlapping

Joint Intensity Histogram

$$\mathbf{H} = \begin{bmatrix} I(0,0) & \dots & I(0,255) \\ \vdots & \ddots & \vdots \\ I(255,0) & \dots & I(255,255) \end{bmatrix}$$

$$\mathbf{H}_{sym} = \frac{1}{2}(\mathbf{H} + \mathbf{H}^T)$$

$$\mathbf{H}_{anti} = \frac{1}{2}(\mathbf{H} - \mathbf{H}^T)$$

$$Score = \frac{1}{2} \left(\frac{|\mathbf{H}_{sym}| - |\mathbf{H}_{anti}|}{|\mathbf{H}_{sym}| + |\mathbf{H}_{anti}|} + 1 \right)$$

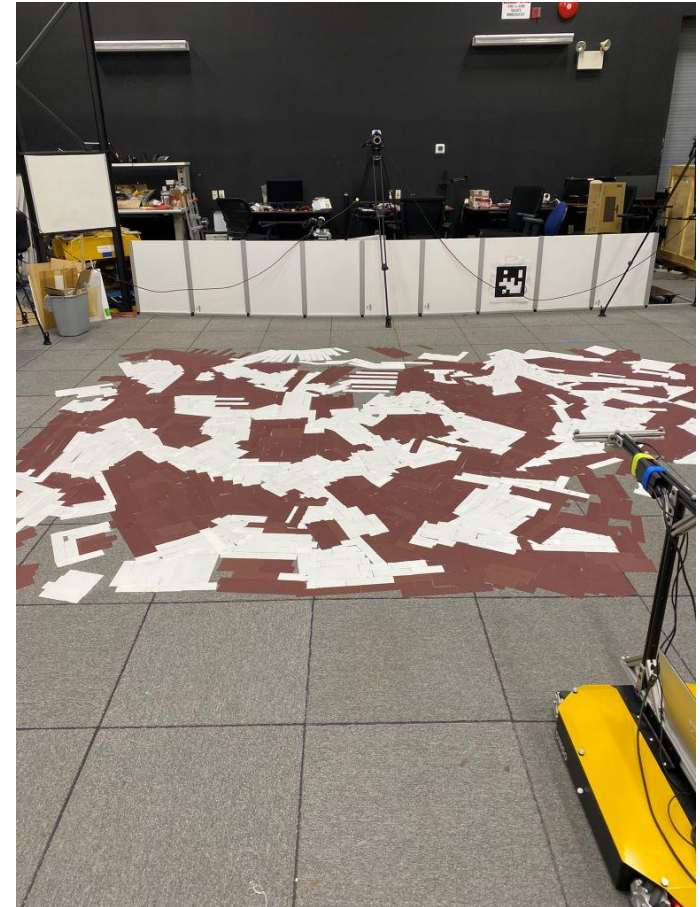
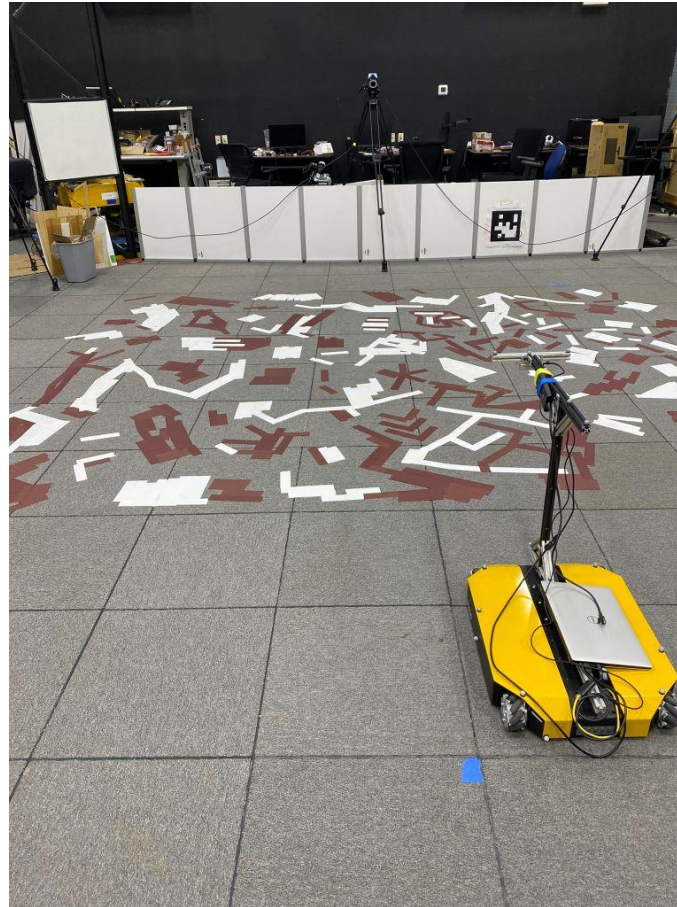
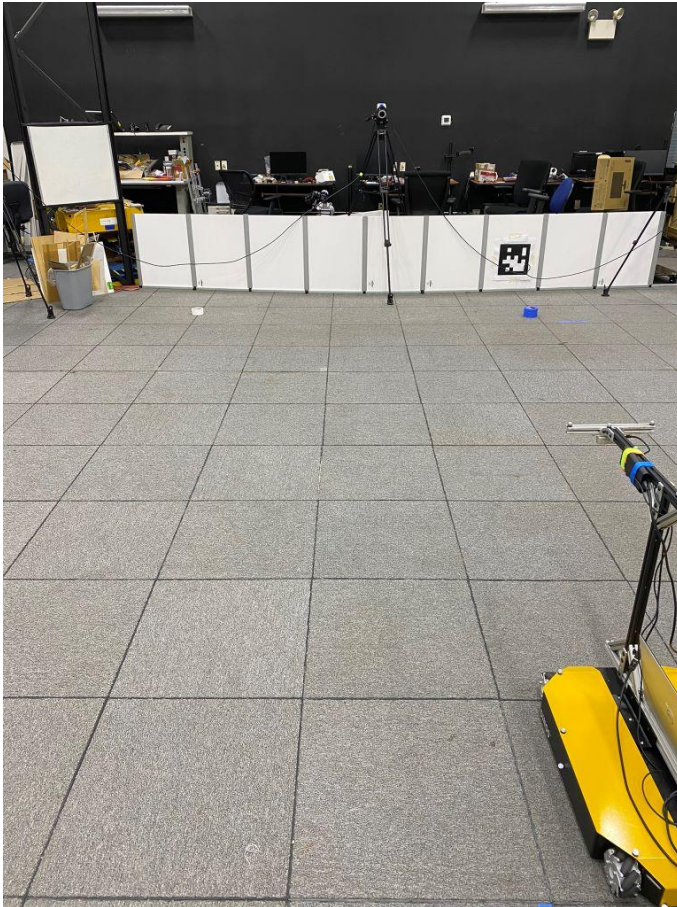
$$\Sigma^* = \Sigma \cdot \frac{1}{Score + \varepsilon}$$

Current/Candidate Joint Pixel
Intensity Histogram

Symmetry Score

Offset Covariance

Dataset



Simulate
Wear

5 Sessions

Mocap
Ground Truth

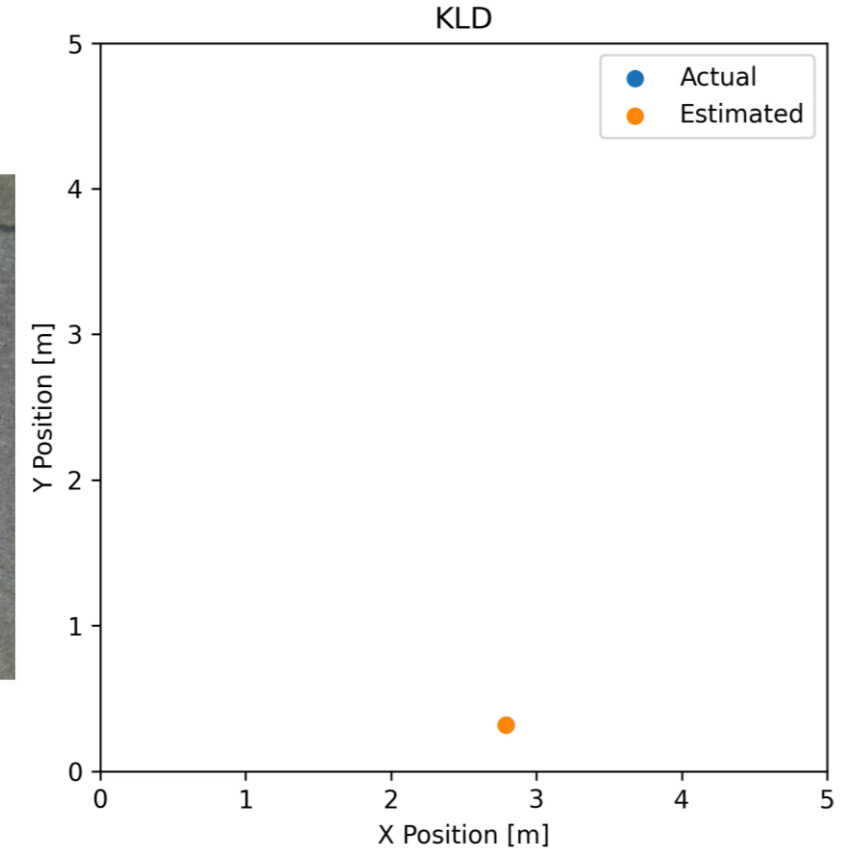
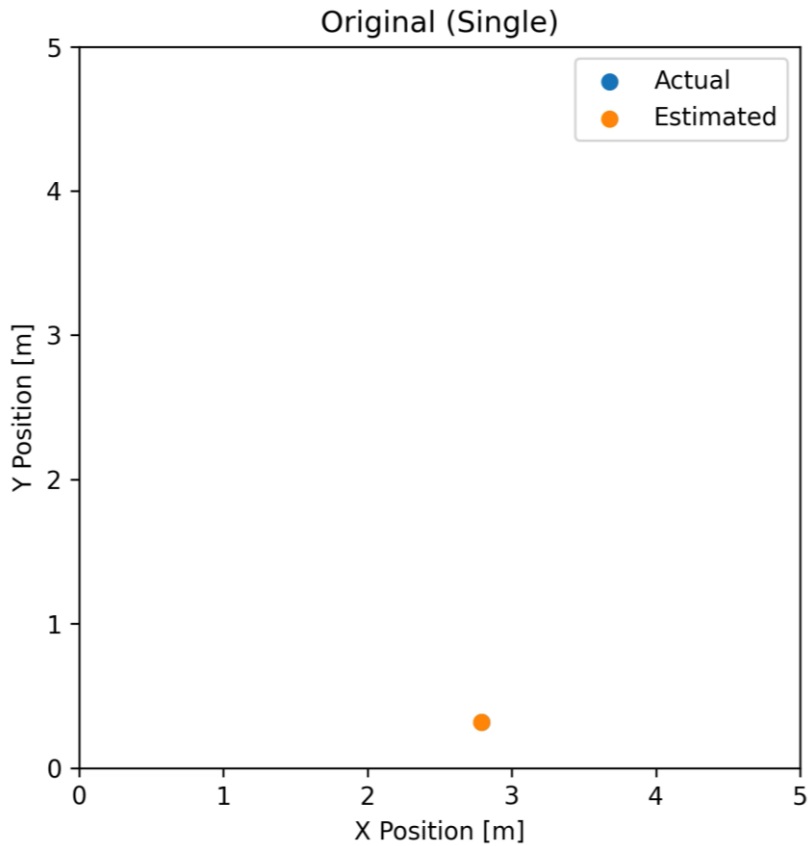
Dataset



Results

Method	Position Error [m]	Orientation Error [deg]
<i>KLD</i>	0.086	1.572
<i>KLD (Grayscale)</i>	0.085	1.530
<i>Visual Overlap</i>	0.212	8.153
<i>Joint Intensity Histogram</i>	0.324	19.629
<i>ORB-SLAM3</i>	Failed	Failed
<i>Original (Single)</i>	0.540	27.013
<i>Original (Many)</i>	0.266	14.963
<i>Visual Odometry</i>	0.210	7.244

Results

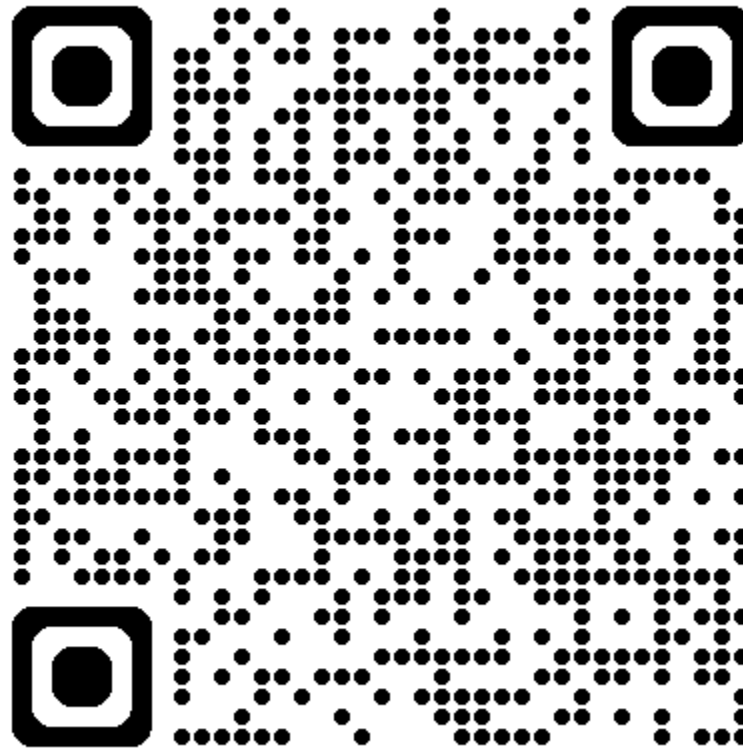


Video is not real time

Thank You

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Code/Data



<https://gitlab.com/riselab/multi-session-ground-texture-slam>