



Robotics: Introduction to AI in robotics

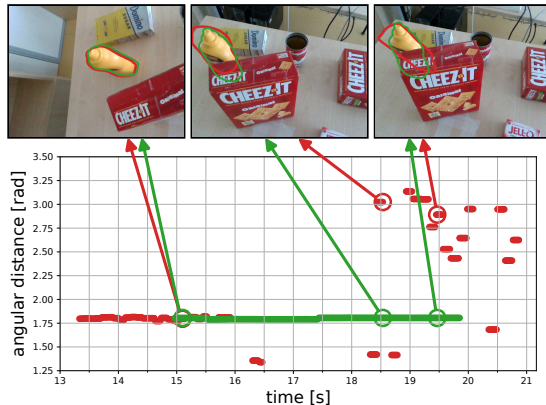
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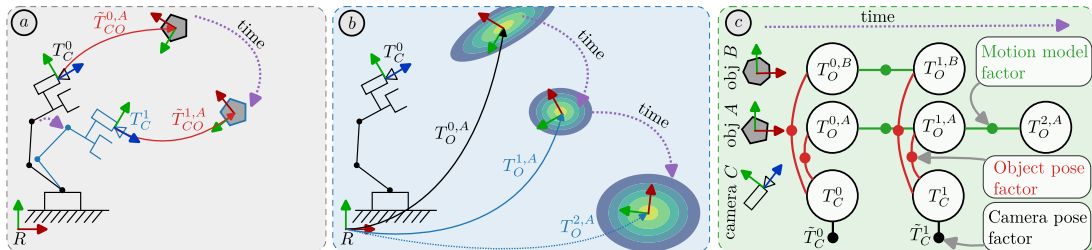
16.12.2024

Temporal consistency

- ▶ Use smoothing and mapping with CosyPose to achieve temporal consistency
- ▶ Probabilistic smoothing
 - ▶ occlusions
 - ▶ jumps
- ▶ Bachelor Thesis of Vojtěch Příbáň, published in IEEE RA-L journal

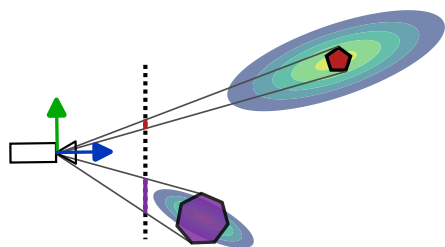


Approach



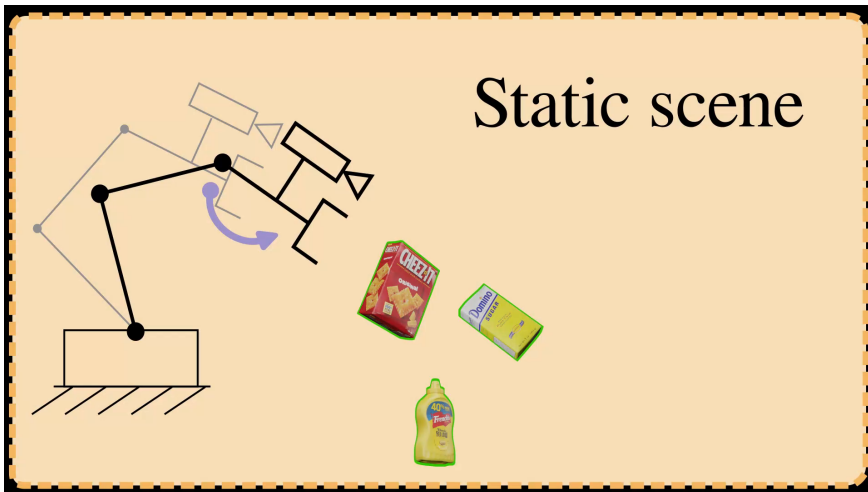
$$\chi^* = \arg \min_{\chi} \underbrace{\sum_{k=\tau-H}^{\tau} \left\| \mathbf{r}_C^k \right\|_{\Sigma_C}^2}_{\text{camera pose factors}} + \underbrace{\sum_{i=1}^N \sum_{k=\tau-H}^{\tau} \delta^{k,i} \left\| \mathbf{r}_O^{k,i} \right\|_{\Sigma_O}^2}_{\text{object pose factors}} + \underbrace{\sum_{i=1}^N \sum_{k=\tau-H+1}^{\tau} \left\| \mathbf{r}_M^{k-1:k,i} \right\|_{\Sigma_M}^2}_{\text{motion model factors}}$$

Covariance model

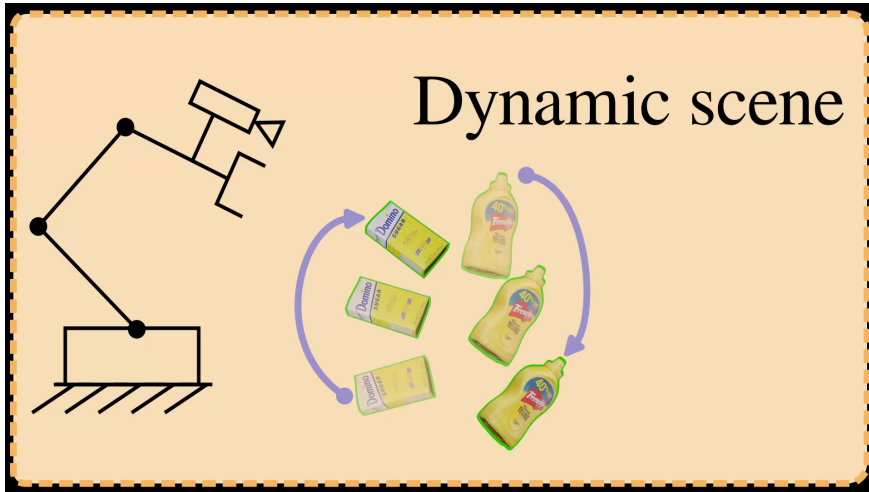


Decoupled	Visibility dependent	frame C'	recall	precision
✓	✓	✓	0.571	0.609
✓	×	✓	0.570	0.608
✓	✓	×	0.531	0.574
×	✓	N/A	0.483	0.549
×	×	N/A	0.498	0.542

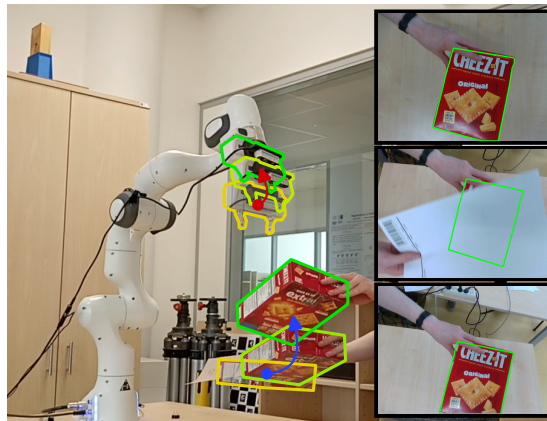
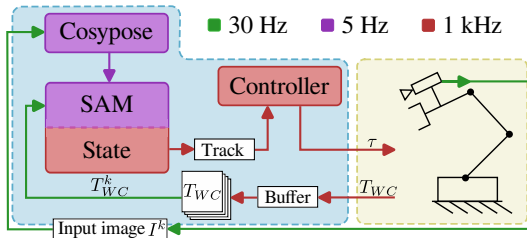
Qualitative static objects tracking

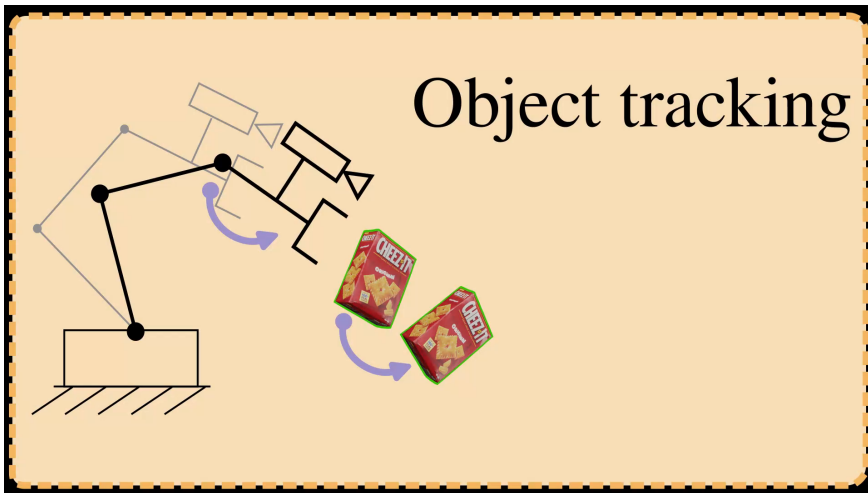


Qualitative dynamic objects tracking



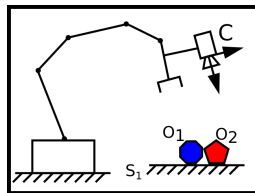
Robot control architecture





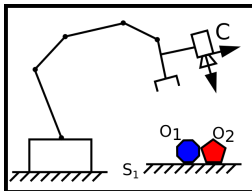
Geometrical consistency for object pose estimation from images

- Image based robotic manipulation



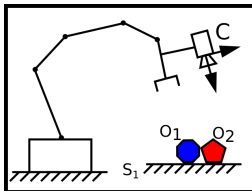
Geometrical consistency for object pose estimation from images

- ▶ Image based robotic manipulation
- ▶ Pose estimation from single RGB image



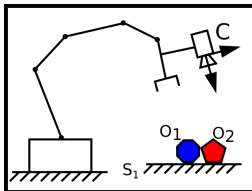
Geometrical consistency for object images

- ▶ Image based robotic manipulation
- ▶ Pose estimation from single RGB image



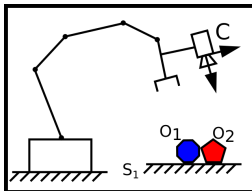
Geometrical consistency for object pose estimation from images

- ▶ Image based robotic manipulation
- ▶ Pose estimation from single RGB image
- ▶ **Physical consistency**



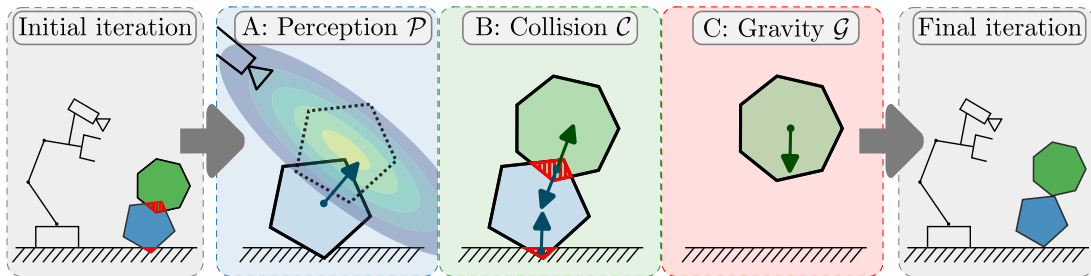
Geometrical consistency for object images

- ▶ Image based robotic manipulation
- ▶ Pose estimation from single RGB image
- ▶ **Physical consistency**
- ▶ Bachelor Thesis of Martin Malenický, submitted to IEEE RA-L journal



Approach

► Gradient descent optimization with derived analytical gradients



Visualization of optimization



Quantitative experiments

- ▶ Real BOP datasets:
 - ▶ YCB-V
 - ▶ HOPE-Video
 - ▶ T-LESS
- ▶ Synthetic datasets:
 - ▶ YCB
 - ▶ T-LESS



Quantitative experiments

► Real BOP datasets:

- YCB-V
- HOPE-Video
- T-LESS

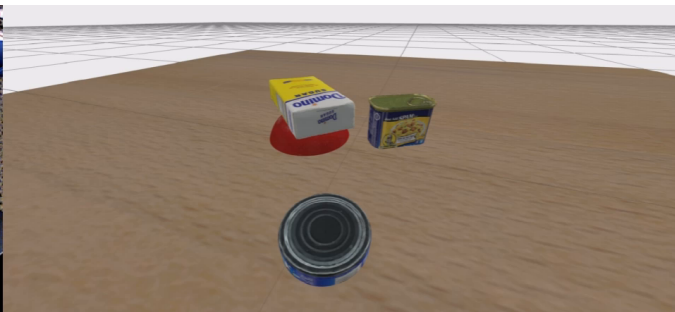
► Synthetic datasets:

- YCB
- T-LESS

	real datasets	synthetic datasets
MegaPose	0.71	0.76
Ours	0.80	0.94
Ours improvement [%]	12.7	23.7



Visualization of optimization



Grasping example



MegaPose

Ours



Summary

- ▶ Temporal consistency is important for control
- ▶ Physical consistency improves accuracy

