Robotics: Introduction to AI in robotics

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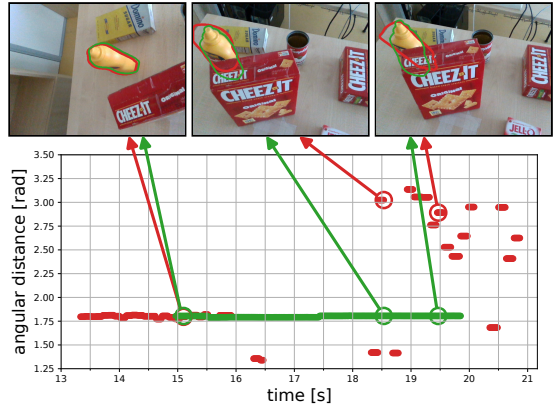
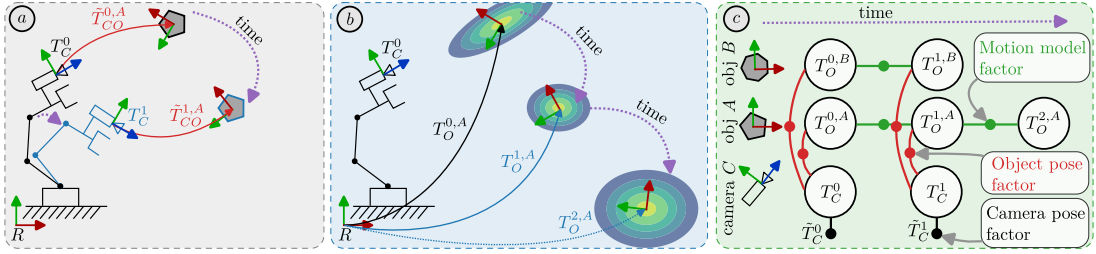
Temporal consistency



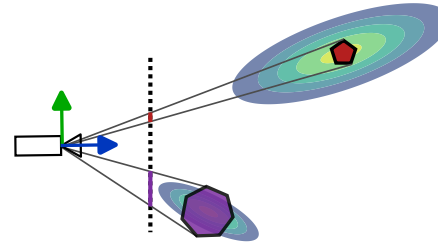
- Use smoothing and mapping with CosyPose to achieve temporal consistency
- Probabilistic smoothing
  - occlusions
  - jumps
- Bachelor Thesis of Vojtěch Přibáň, published in IEEE RA-L journal

Approach



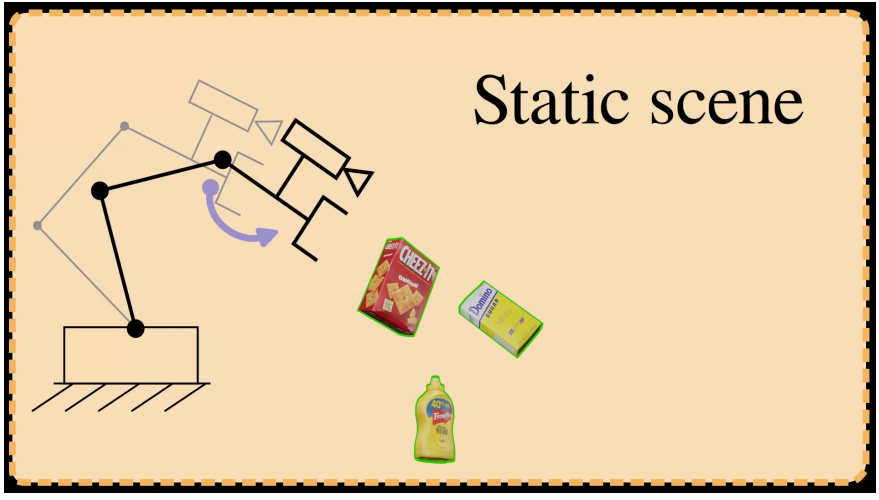
$$\chi^* = \arg\min_{\chi} \underbrace{\sum_{k=\tau-H}^{\tau} \left\| \boldsymbol{r}_C^k \right\|^2_{\boldsymbol{\Sigma}_C}}_{\text{camera pose factors}} + \underbrace{\sum_{i=1}^{N} \sum_{k=\tau-H}^{\tau} \delta^{k,i} \left\| \boldsymbol{r}_O^{k,i} \right\|^2_{\boldsymbol{\Sigma}_O}}_{\text{object pose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

Covariance model

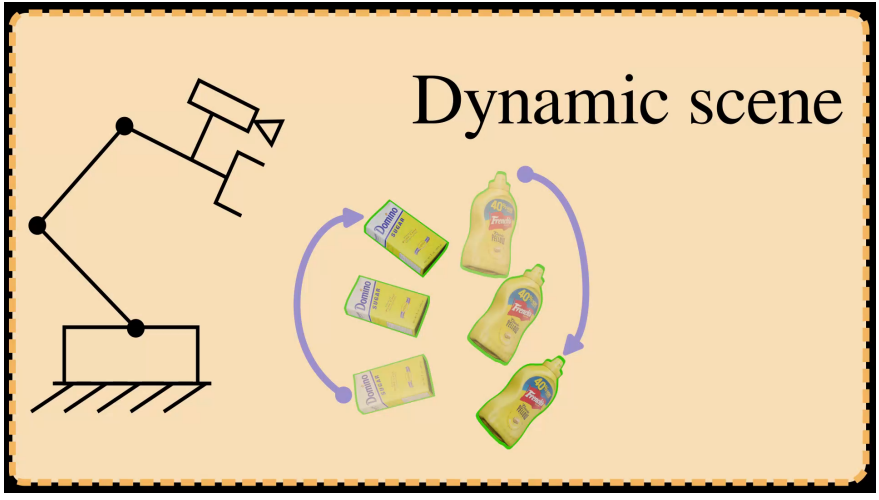


Decoupled	Visibility dependent	frame C'	recall	precision
✓	✓	✓	**0.571**	**0.609**
✓	×	✓	0.570	0.608
✓	✓	×	0.531	0.574
×	✓	N/A	0.483	0.549
×	×	N/A	0.498	0.542

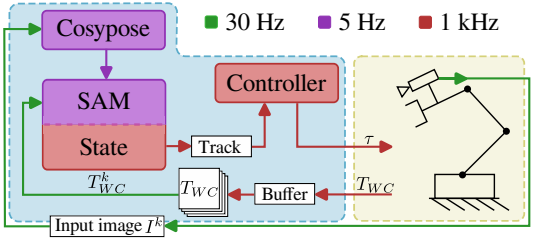
Qualitative static objects tracking

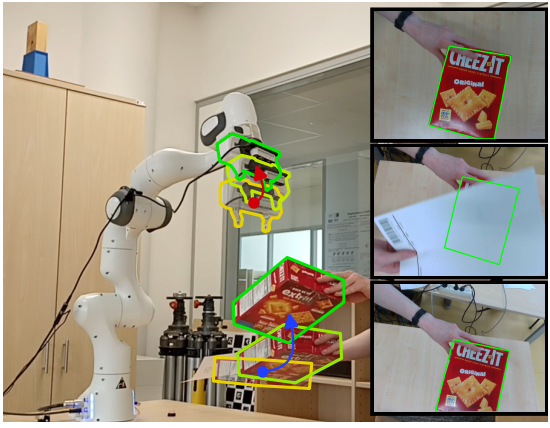


Qualitative dynamic objects tracking

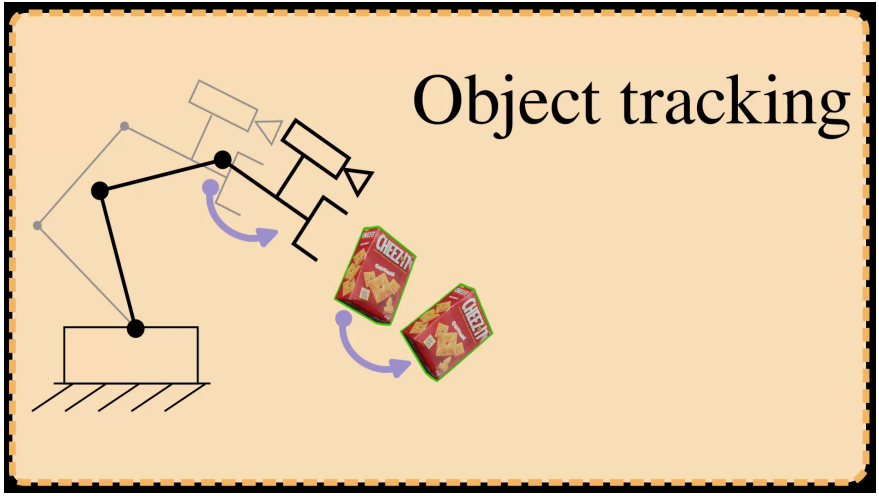


Robot control architecture

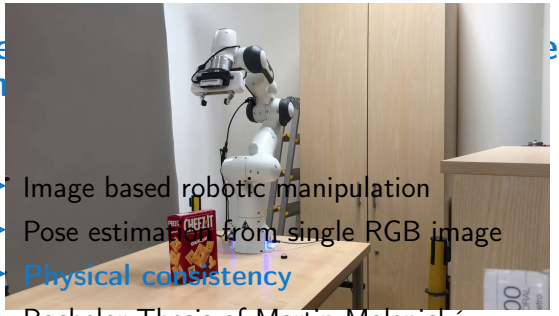




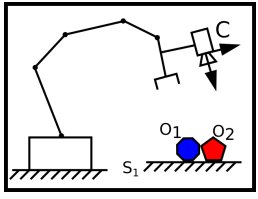
Qualitative robot tracking



Ge… im…

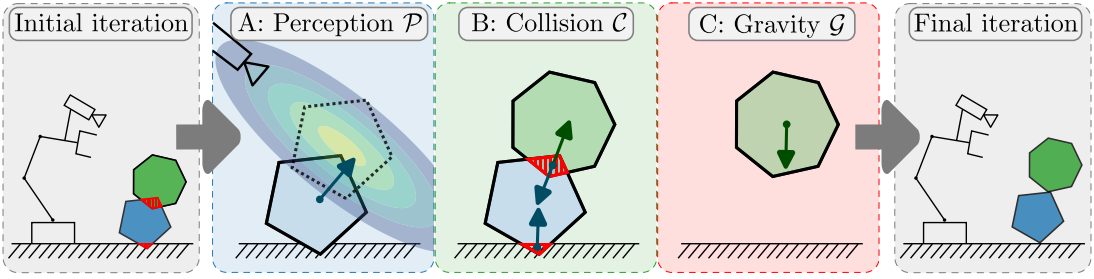


- Image based robotic manipulation
- Pose estimation from single RGB image
- Physical consistency
- Bachelor Thesis of Martin Malenický, submitted to IEEE RA-L journal



Approach

- Gradient descent optimization with derived analytical gradients

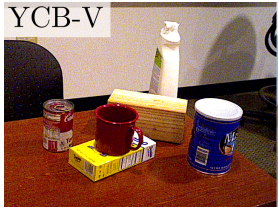


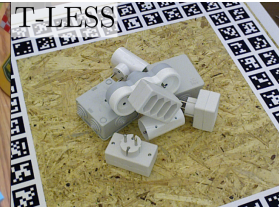
Visualization of optimization

Quantitative experiments

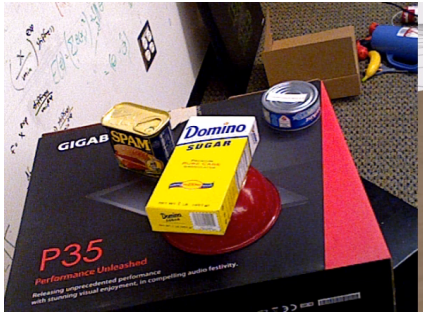
- Real BOP datasets:
  - YCB-V
  - HOPE-Video
  - T-LESS
- Synthetic datasets:
  - YCB
  - T-LESS

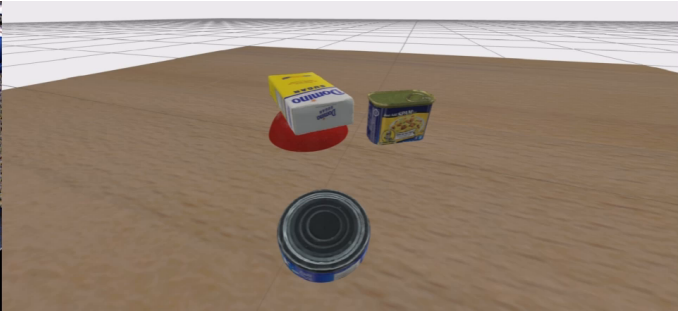
	real datasets	synthetic datasets
MegaPose	0.71	0.76
Ours	0.80	0.94
Ours improovement [%]	**12.7**	**23.7**





Visualization of optimization





Grasping example

MegaPose Ours

Summary

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