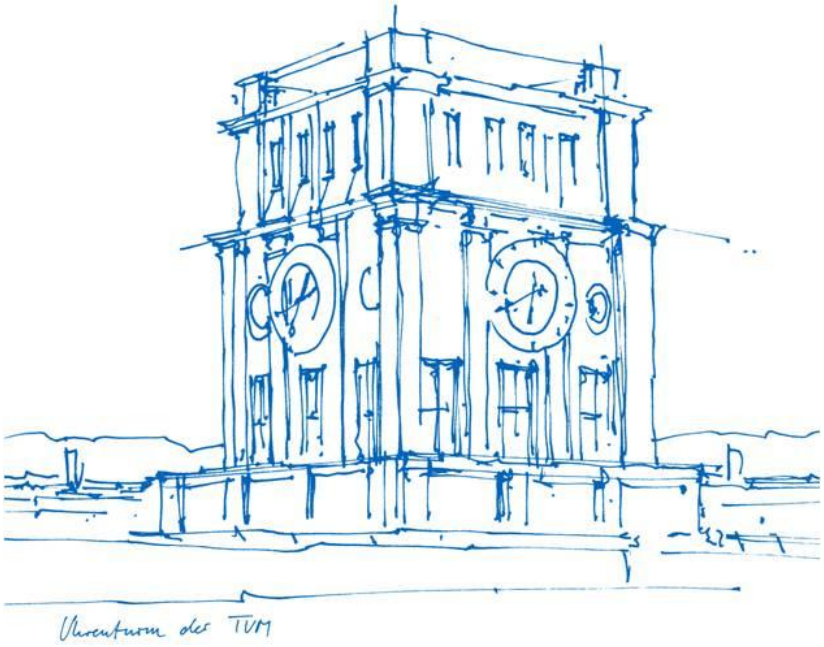
Advanced Deep Learning for Robotics - Midterm

Multimodal Sensor Fusion in Differentiable Bayesian Filters



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Too big? Push it!

Motivation

Taken from [1]

Pushing is hard though …

- Point of Contact?
- Pushing Angle?
- Material?
- Shape?
- …

Analytical Modelling is difficult

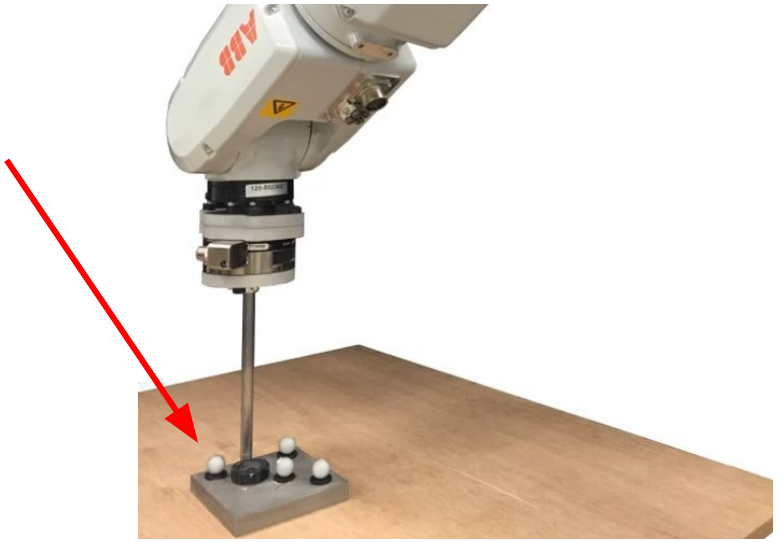
→ Use data-driven model instead

State Estimation with Learned Models

Problem Statement

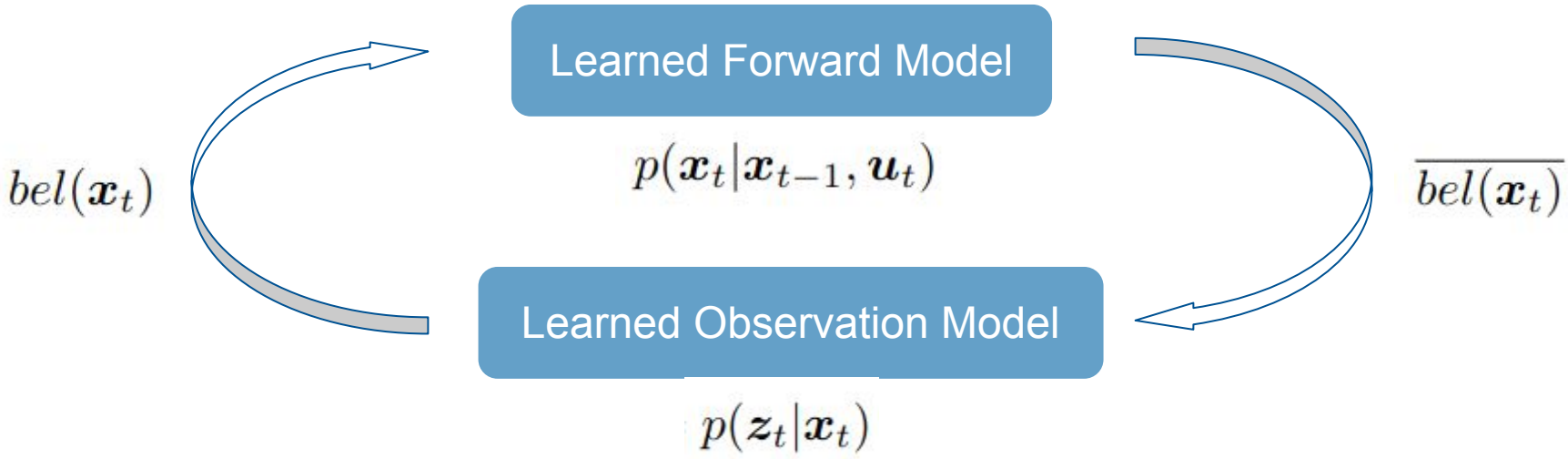
Goal: estimate pose of pushed object

$$bel(\boldsymbol{x}_t) = p(\boldsymbol{x}_t | \boldsymbol{z}_{1:t}, \boldsymbol{u}_{1:t})$$



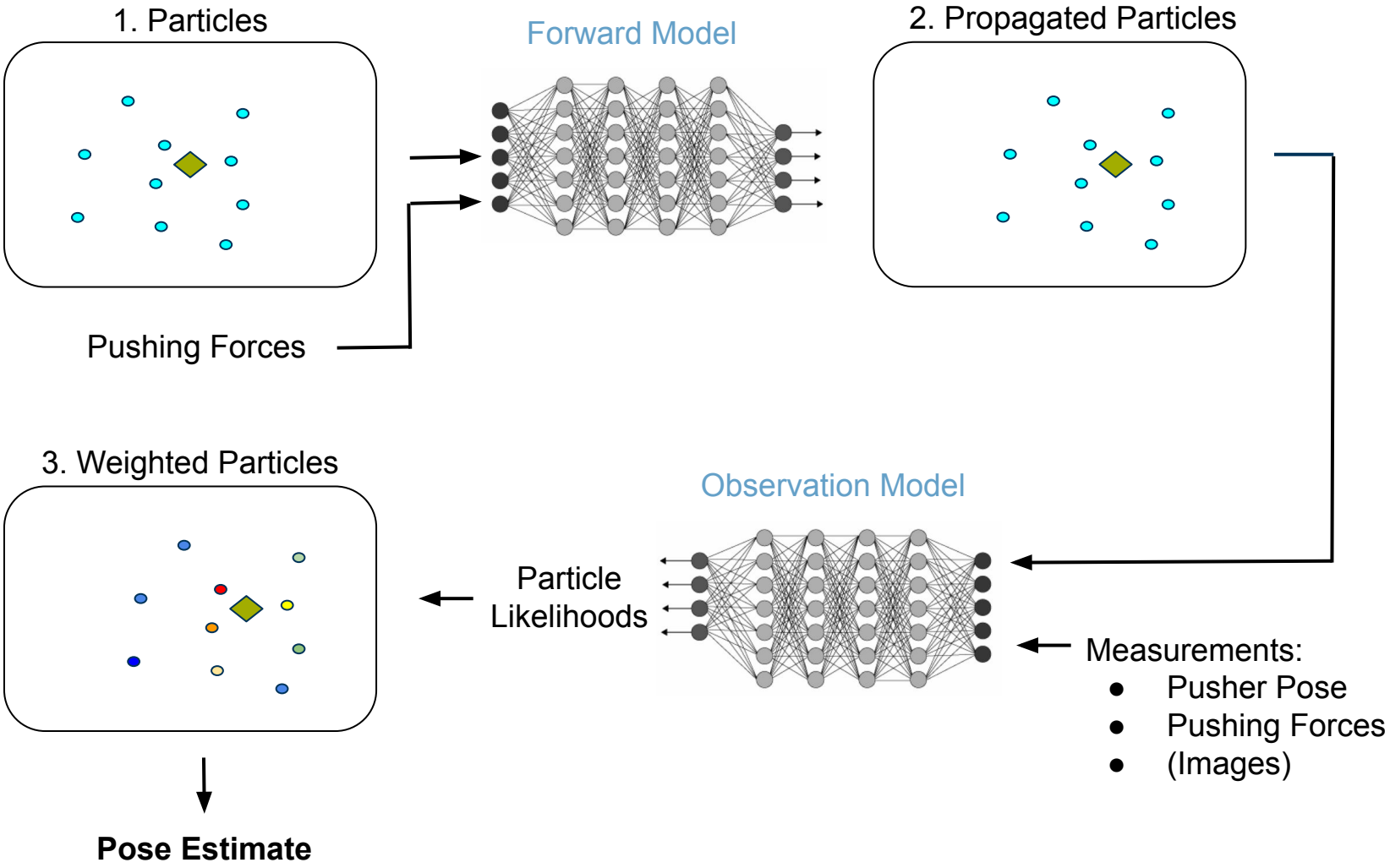
https://web.mit.edu/mcube//push-dataset/

Use Structure of Bayes' Filter:



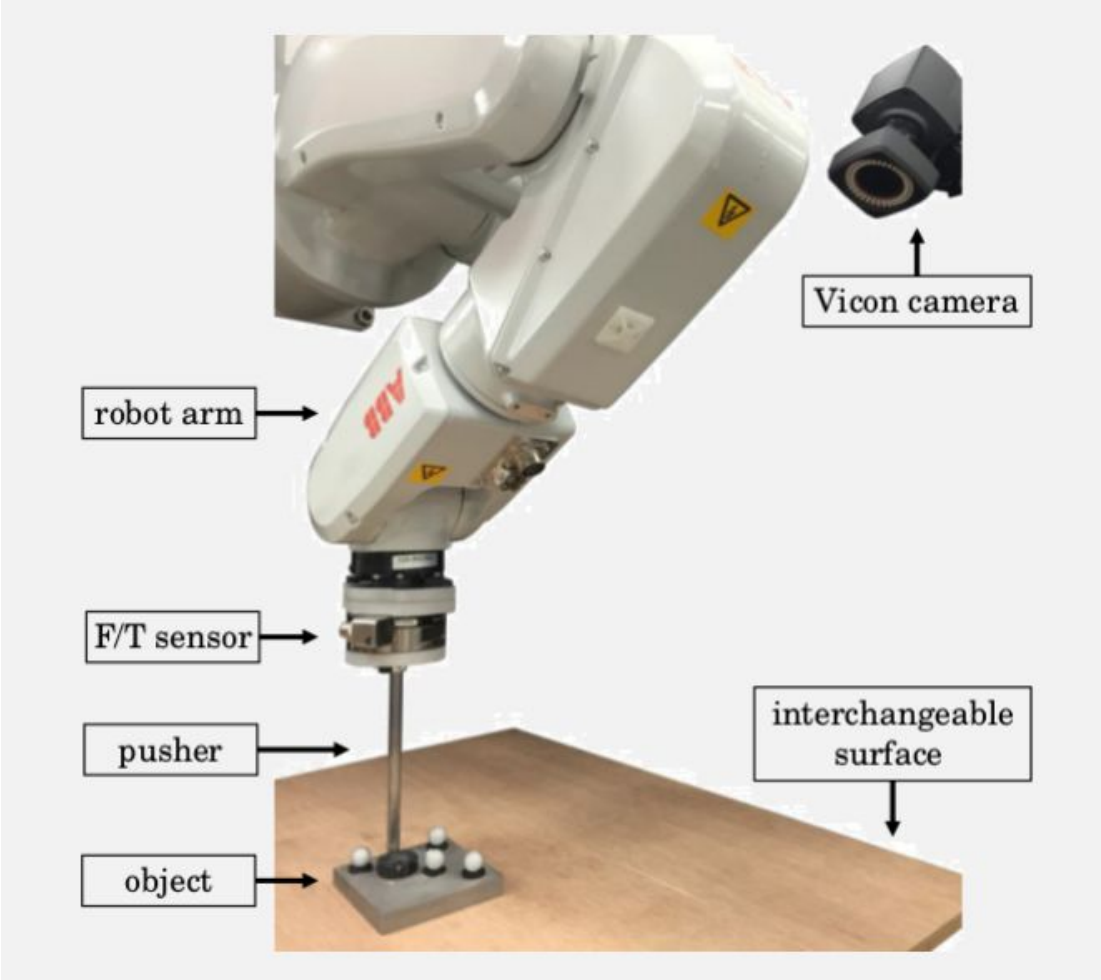
Differentiable Particle Filters

Methods



More than a million ways to be pushed

Methods



https://web.mit.edu/mcube//push-dataset/

MIT Push dataset:

- 11 objects
- 4 surface materials
- 250 Hz sampling rate

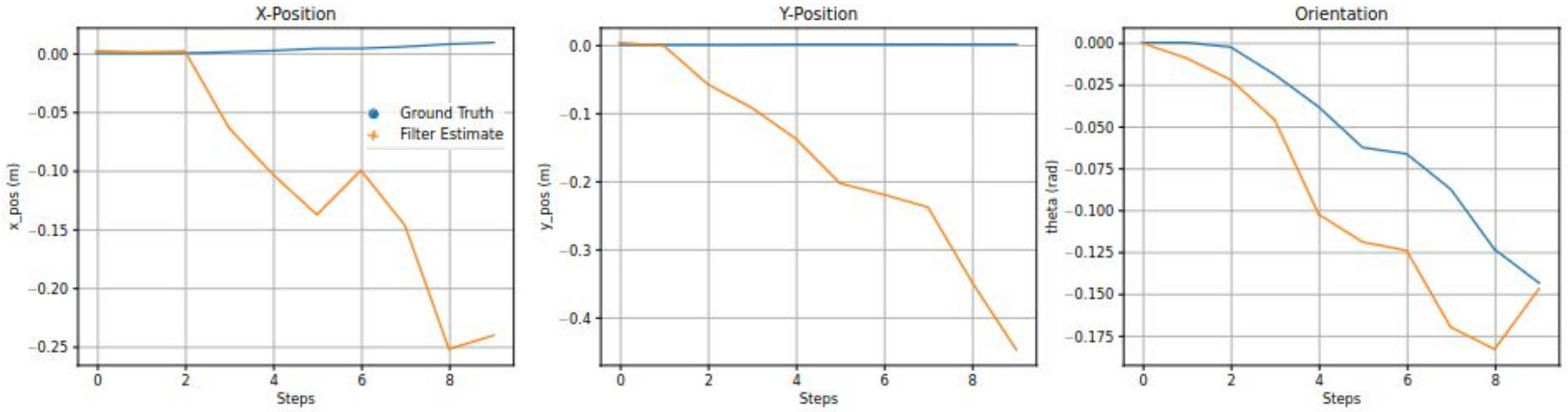
→ more than a million pushes

Use subset for training/testing:

- rectangular shape on plywood
- v = 100 mm/s, a = 0 mm/s²
- downsample to 50 Hz

Pushing is hard (revisited)

First Results



Room for Improvement:

- Resampling
- Training: minimize multi-step error

What next?

Next Steps

Done

- Data Preprocessing
- Simple Differentiable Particle Filter
- End-to-end training on single step predictions

Future work

- Resampling + train for longer predictions
- Incorporate images
- Estimate physical parameters (friction, etc.)
- Compare to RNNs

References

[1] Mericli, Tekin & Veloso, Manuela & Akin, H. Levent, “Achievable push-manipulation for complex passive mobile objects using past experience”, in 12th International Conference on Autonomous Agents and Multiagent Systems 2013, AAMAS 2013, pp. 71-78.

[2] K. T. Yu, M. Bauza, N. Fazeli, and A. Rodriguez, “More than a Million Ways to Be Pushed: A High-Fidelity Experimental Data Set of Planar Pushing”, in 2016 IEEE/RSJ Internation Conference on Intelligent Robots and Systems (IROS), 2016, pp. 30–37.

Backup

Backup: Additional Figure