An Evaluation of Particle Filters for Contact-SLAM Problems

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Contact-SLAM Problem

• Design filter to track:
  • Object Pose
  • Contact Locations
  • Physical Parameters, such as coefficient of friction.

• Research goal:
  • To understand the design trade-offs of particle filter.
Evaluation of Particle Filters for Contact-SLAM

• We studied the case of a robot making contact with an object with its end-effector.

• Four models were studied:
  (a) two contact models: Rigid and Compliant
  (b) two noise models: Noise added to input and output
• Different methods of filtering were tested.
Filtering Methods

Noisy State Particle Filter

State Transition Function

Deterministic Model: Rigid/Compliant

Output

Input

Measurement Model

Noise
Filtering Methods

Noisy Input Particle Filter

Input → State Transition Function → Deterministic Model: Rigid/Compliant → Output → Measurement Model

Noise
Filtering Methods

Projected Particle Filter

Input → State Transition Function → Output

Deterministic Model: Rigid/Compliant

Measurement Model

Calculate Additional Weights

Noise
Filtering Methods

Force State Particle Filter

- Input
- State Transition Function
  - Deterministic Model: Rigid/Compliant
  - Noise
- Output
- Measurement Model

Input Force Transition Function
Results

We tested all our methods in both simulation experiments and physical experiments.

Result Conclusions:

- Different noise models with proper choice of noise levels perform similarly on tracking.
- Adding noise to the input performs the best for contact prediction.
- Rigid body and compliant body models show no big differences for contact prediction in physical experiments while compliant body model is a better option for contact prediction in simulation experiments.