Agile and Dynamic Interactions for Mobile Manipulation


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https://labs.ri.cmu.edu/iam/agile-and-dynamic-interactions-for-mobile-manipulation/


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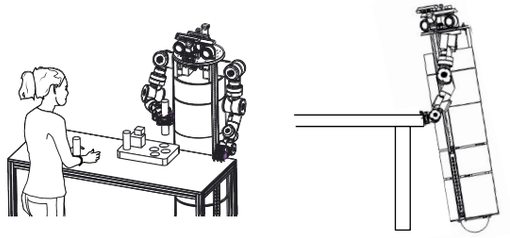
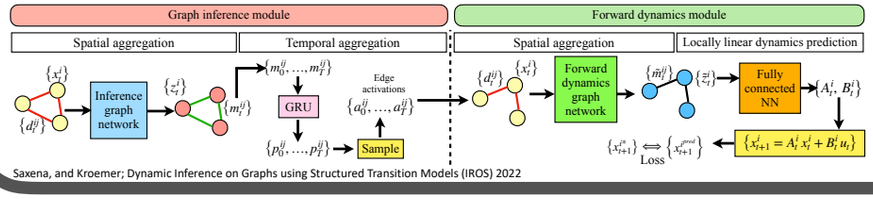
Problem and Goal

We are developing robots that can safely and efficiently work to support people in cluttered and unstructured spaces. To perform tasks efficiently, robots will need to reason about and exploit dynamic interactions with the environment

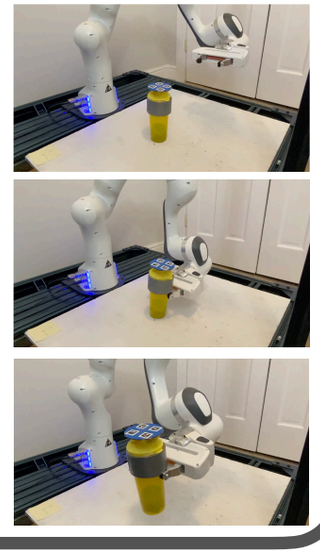


Dynamics Model Learning for Planning and Control

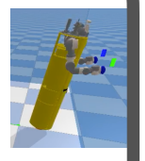
- Learn transition model using dynamic graph NN
  - Handle variable numbers of objects
  - Infer edges at each step during execution
  - Incorporate observations for increased robustness
- Mode transitions captured by switching edges
  - Exploring graphs as subgoals for planning



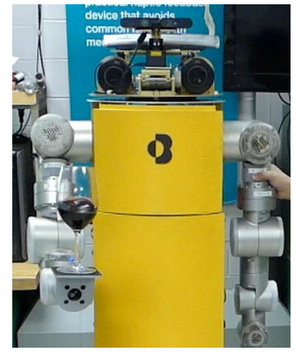
Saxena, and Kroemer; Dynamic Inference on Graphs using Structured Transition Models (IROS) 2022



Ballbot Robot



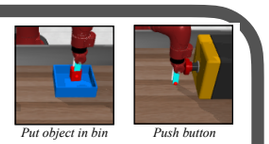
- Robot balances on ball
- Bullet simulation of ballbot
- Exploring hand-ball controllers



Shu; Development of an Agile and Dexterous Balancing Mobile Manipulator Robot, Thesis 2022

Learning Multi-skill Visuomotor Policies

- Learn closed-loop visumotor policies with language inputs
- Explore effect of pretraining and fine-tuning on generalization
- Evaluate multi-skill policies on multi-task domains
- Working on transferring to Ballbot robot - whole-body control

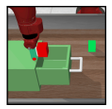

Put object in bin

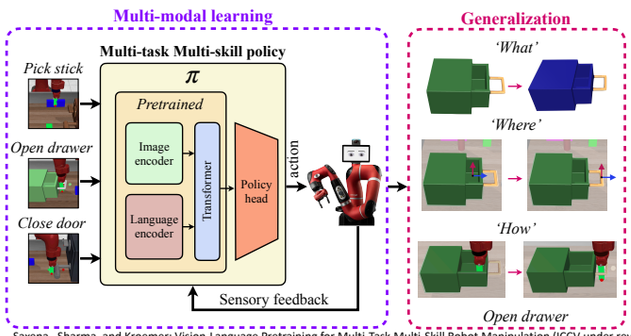
Push button

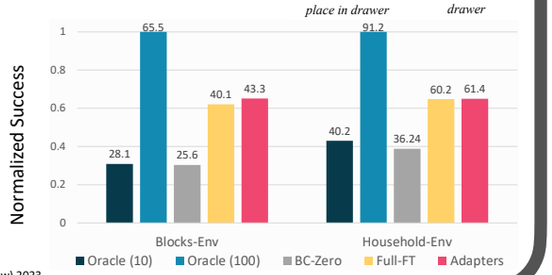

Use stick to close door


Put nut inside door


Pick blue block and place in drawer


Push block inside drawer

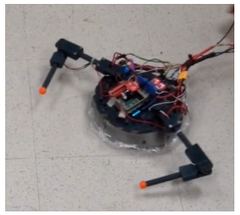


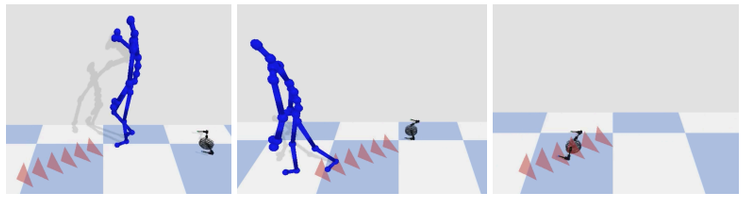


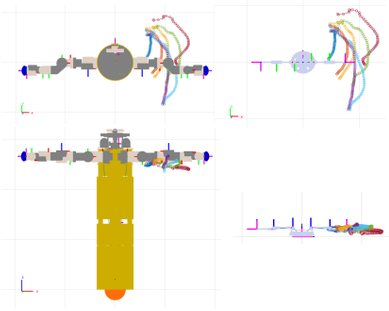
Saxena, Sharma, and Kroemer; Vision-Language Pretraining for Multi-Task Multi-Skill Robot Manipulation (ICCV under review) 2023

Transferring Push-off Behaviors from Human to Robot

- Record human push-offs using Vicon motion capture
- Model pushing behavior as EE trajectory relative to CoM
  - Implicitly encode forces as offsets (impedance)
  - Allow rotation and scaling of push trajectories
- Reflex controller triggered upon contact with wall
- Approach transferable between different robots







Bauer, et al., and Pollard; Learning to Navigate by Pushing (ICRA) 2022

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