

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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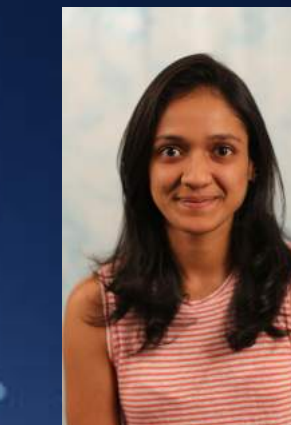
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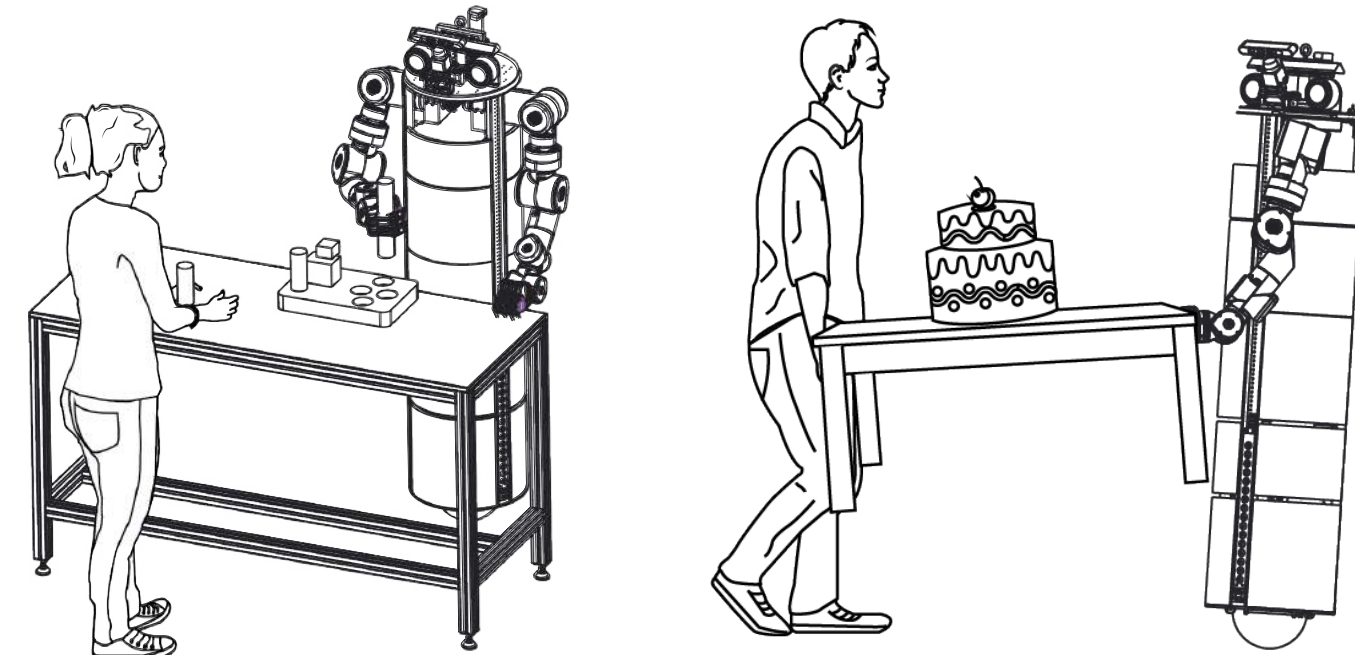
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Problem and Goal

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



Decoupled and Whole-body Control

- Decoupled control for arms and base
 - Position/force/compliance controllers for the arms
 - Base reactively compensates to shifts caused by arm motion
- Whole-body controller for arms and base together
 - Model centroidal dynamics of Ballbot robot
 - Optimize for more coordinated whole-body movements



Multi-point control



Glass Carrying



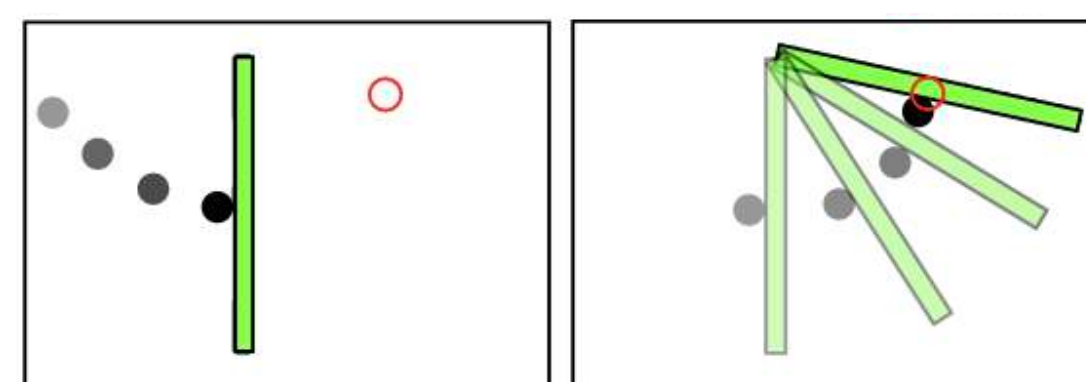
Next Steps

- Integrate model learning with Ballbot and existing control library
- Explore visual servoing for Ballbot to interact with objects
- Explore dexterous manipulation on the Ballbot platform



Model Learning

- Learn transition models using dynamic graph neural networks
 - Switching edge activations capture different modes
 - Learn linearized dynamics for applying optimal control MPC
- Learn high-level Skill Effect Models (SEMs) for planning
 - Allow for a wide range of skill representations
 - Learn from plans to provide faster planning over time



Heavy Door Opening (Sim)

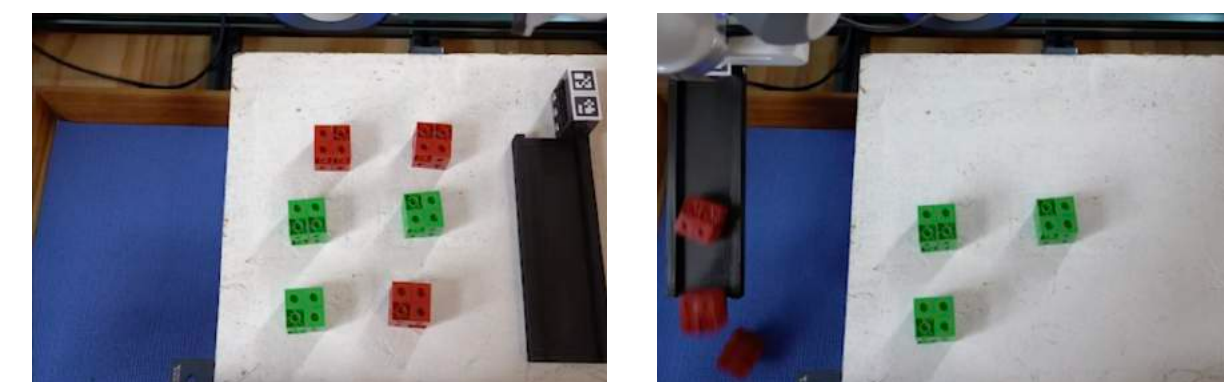
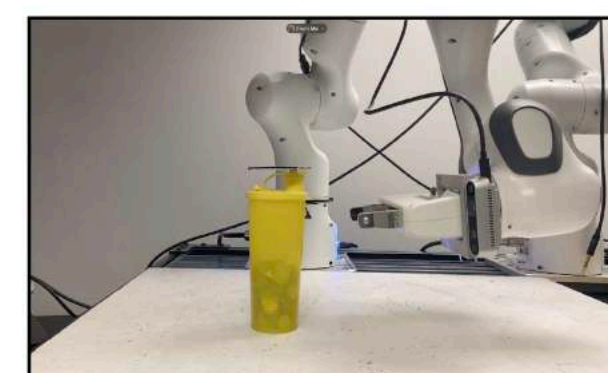


Table Clearing



Dynamic Grasping

Learning to Push Off

- Robot learns reflex strategies for pushing off surfaces
 - Reflexes are triggered by contact with push-off surface
 - Parameters of reflex models learned using reinforcement
 - Learn families of reflex motions for different goal regions

