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Agile and Dynamic Interactions for Mobile Manipulation

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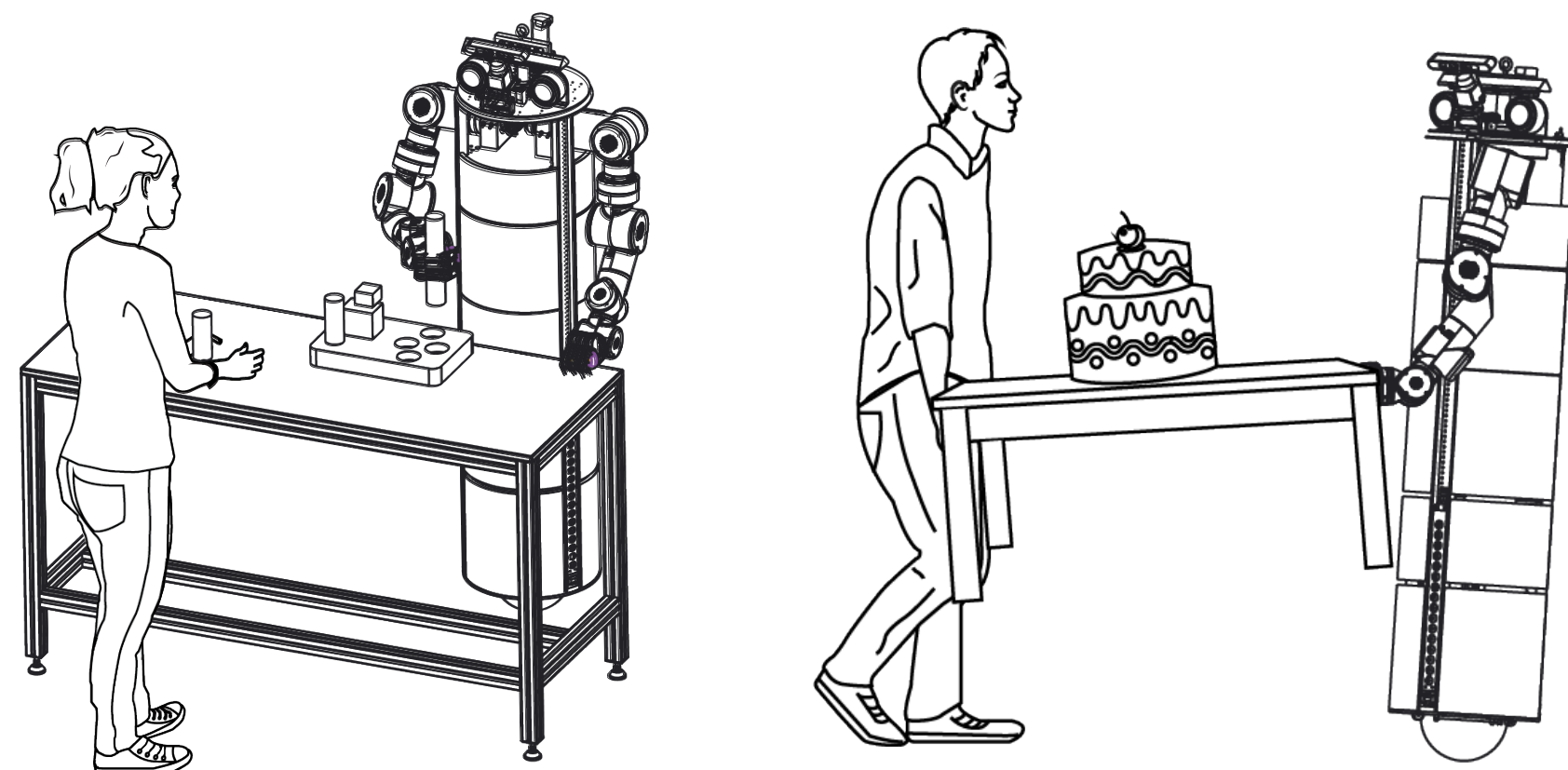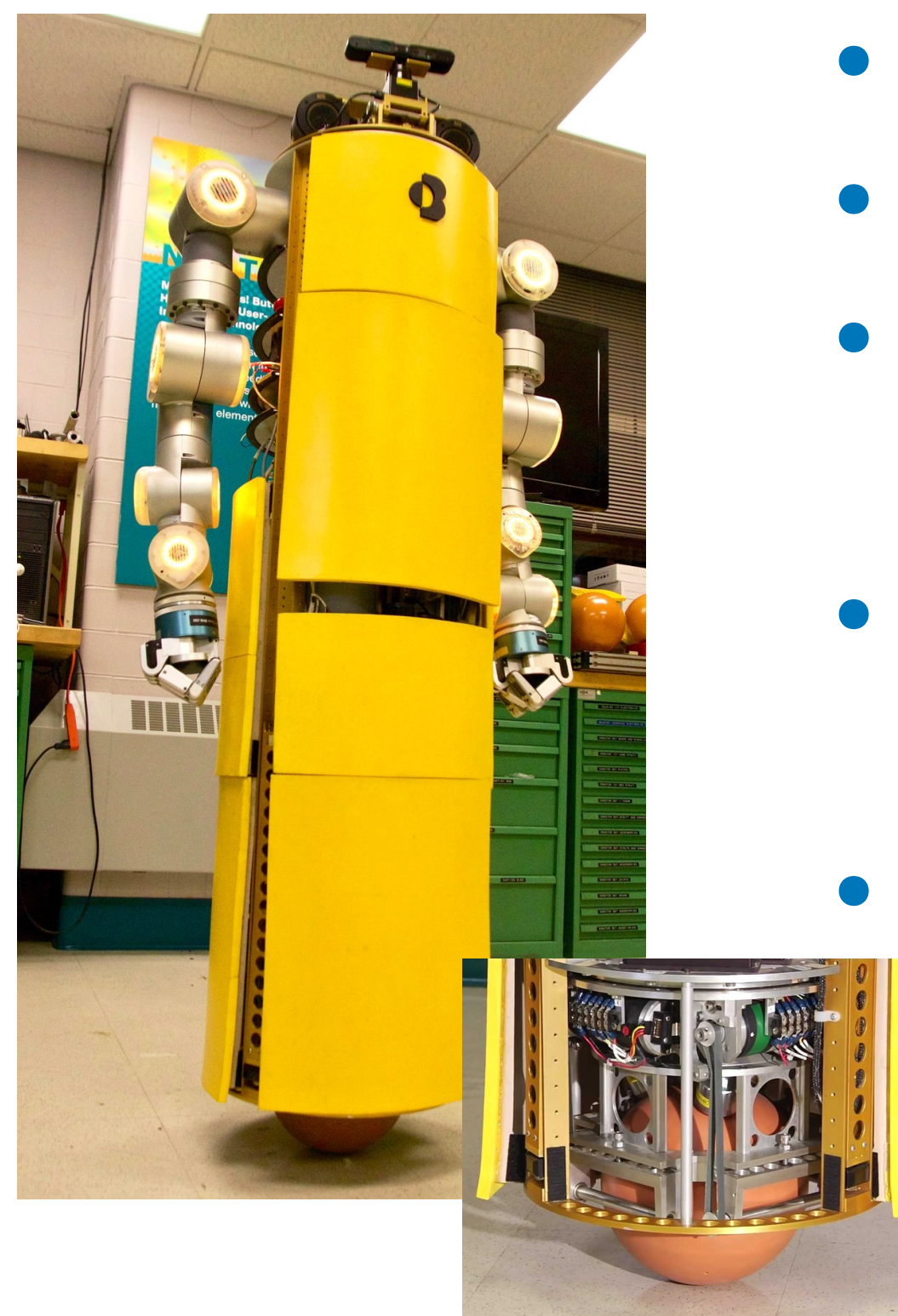https://labs.ri.cmu.edu/iam/agile-and-dynamic-interactions-for-mobile-manipulation/

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

Ballbot Platform

- Dynamically stable
- Spherical wheel base
- Human-sized torso with small footprint
- Safe omnidirectional compliance controller
- 7 DoF arms with dexterous hands

Push-off Reflexes

- Analyzing how humans utilize surfaces to push-off and change their direction
- Explore how we can apply push-off reflexes to robots
- Model the robot push-off reflexes with optimization techniques
- Applied to bimanual planar hovering robot
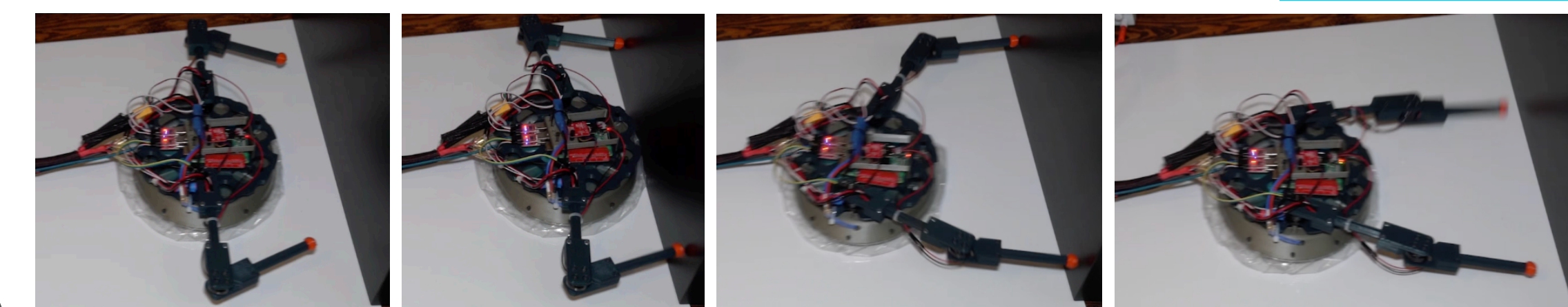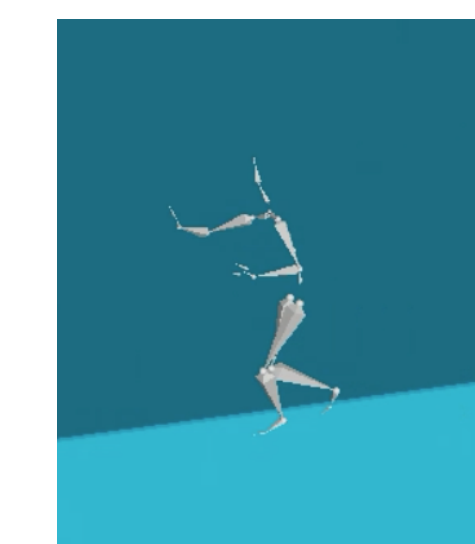
Dynamic Grasping

- Learn composite dynamical behaviors from expert demonstrations
- Reactive and predictive control:
  - operates over switching dynamics
  - anticipates contact interactions
  - reacts to unanticipated contacts
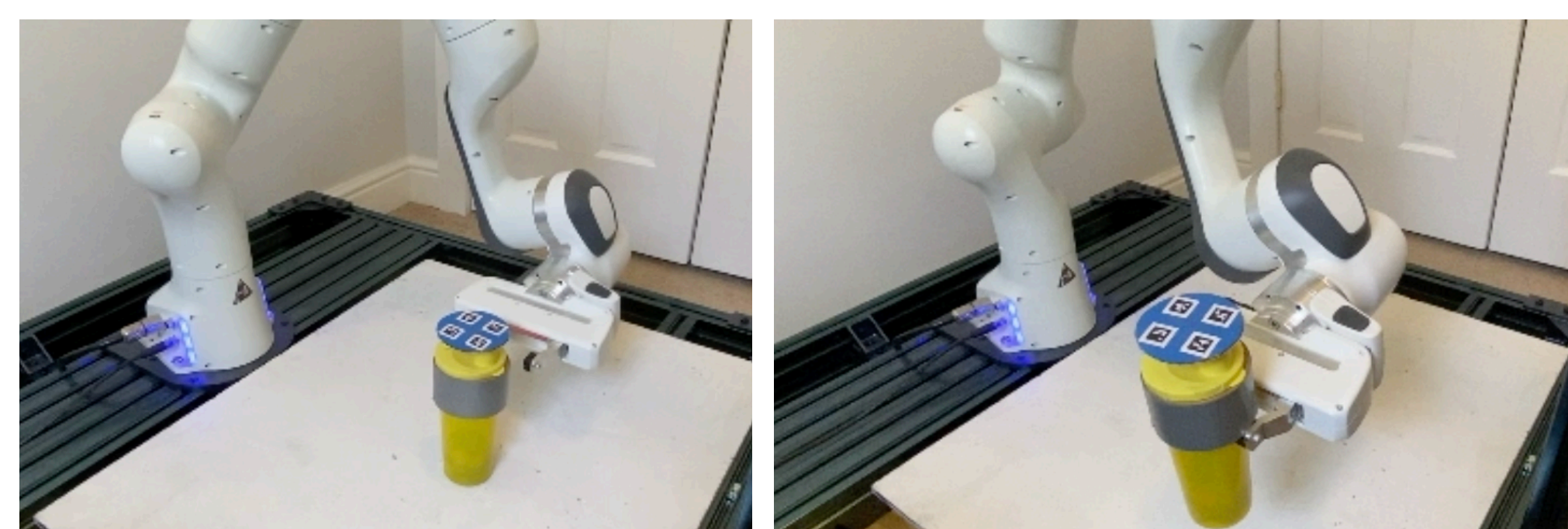
Whole-body Control

- Combine locomotion and manipulation
- Trajectory optimization:
  - Constrain centroid momentum to balance
  - Use robot's centroidal dynamics and full-kinematic constraints
- Use MPC to track motion plans
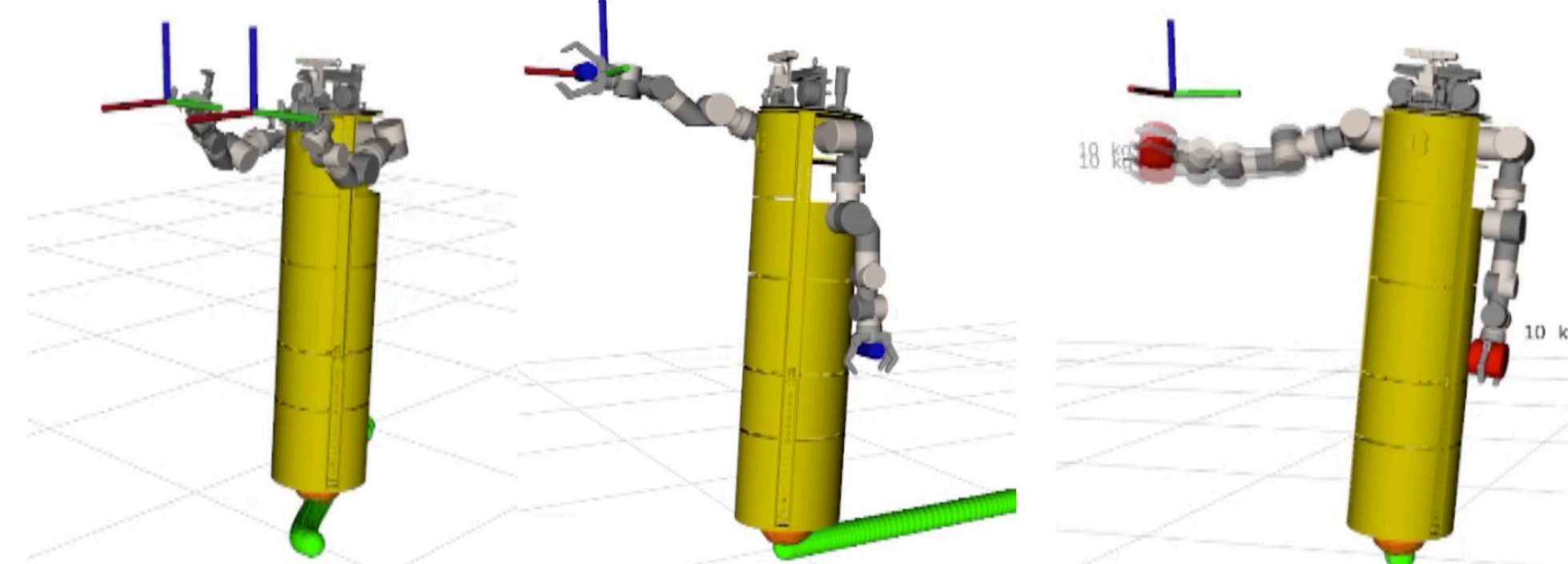
Integrative Tasks

- Pushing wheelchair
- On-the-move grasping
- Dynamic navigation
- Cooperative carrying
- Sit-to-stand support
- Walking support