

# NRI: FND: Controllable Compliance: A New Robotic Arm for Contact-Rich Manipulation

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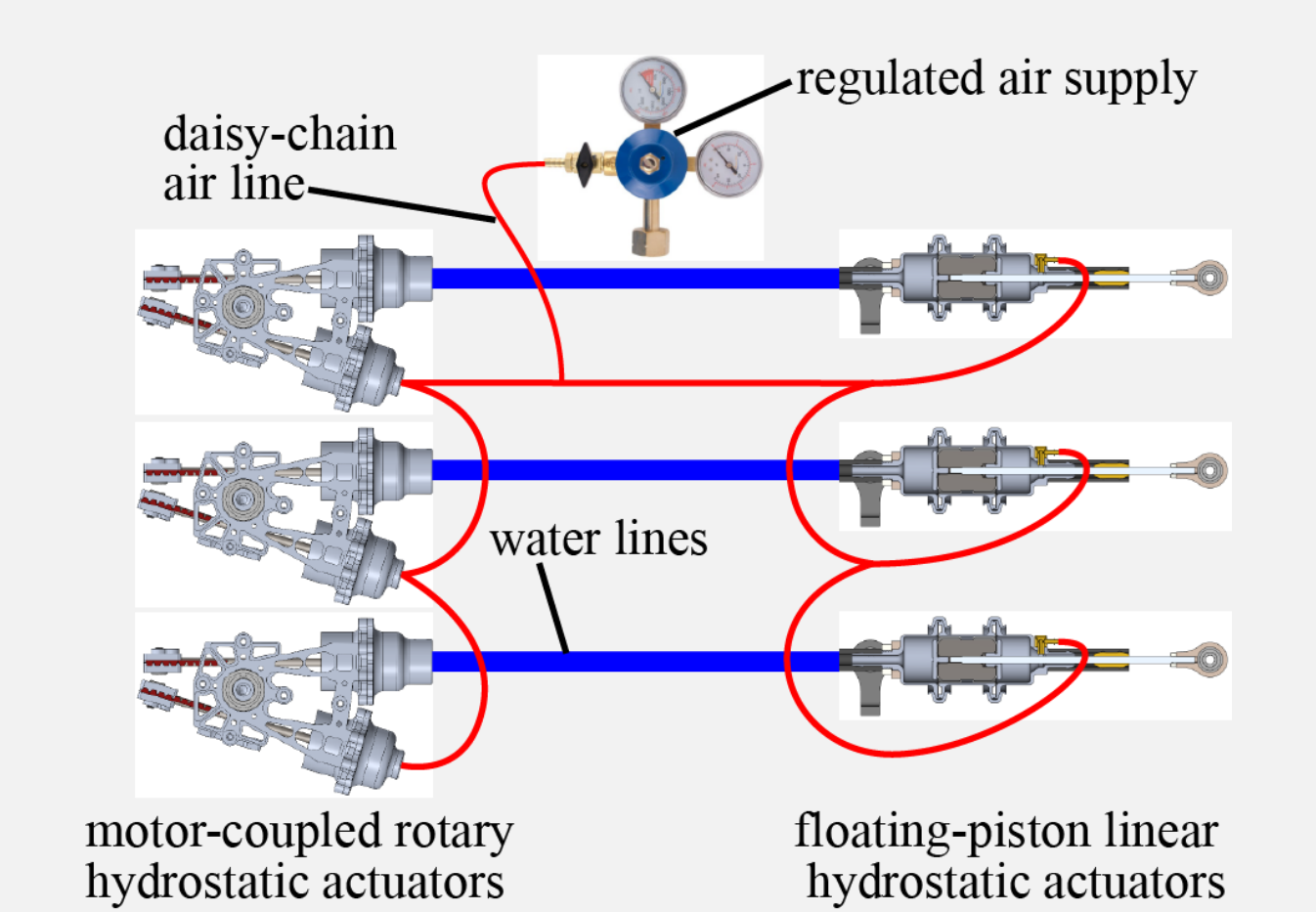
PI meeting video presentation: <https://youtu.be/aJbnsPcWgs> BGN: <https://sites.google.com/view/bgn-pomdp/home>

## Challenges:

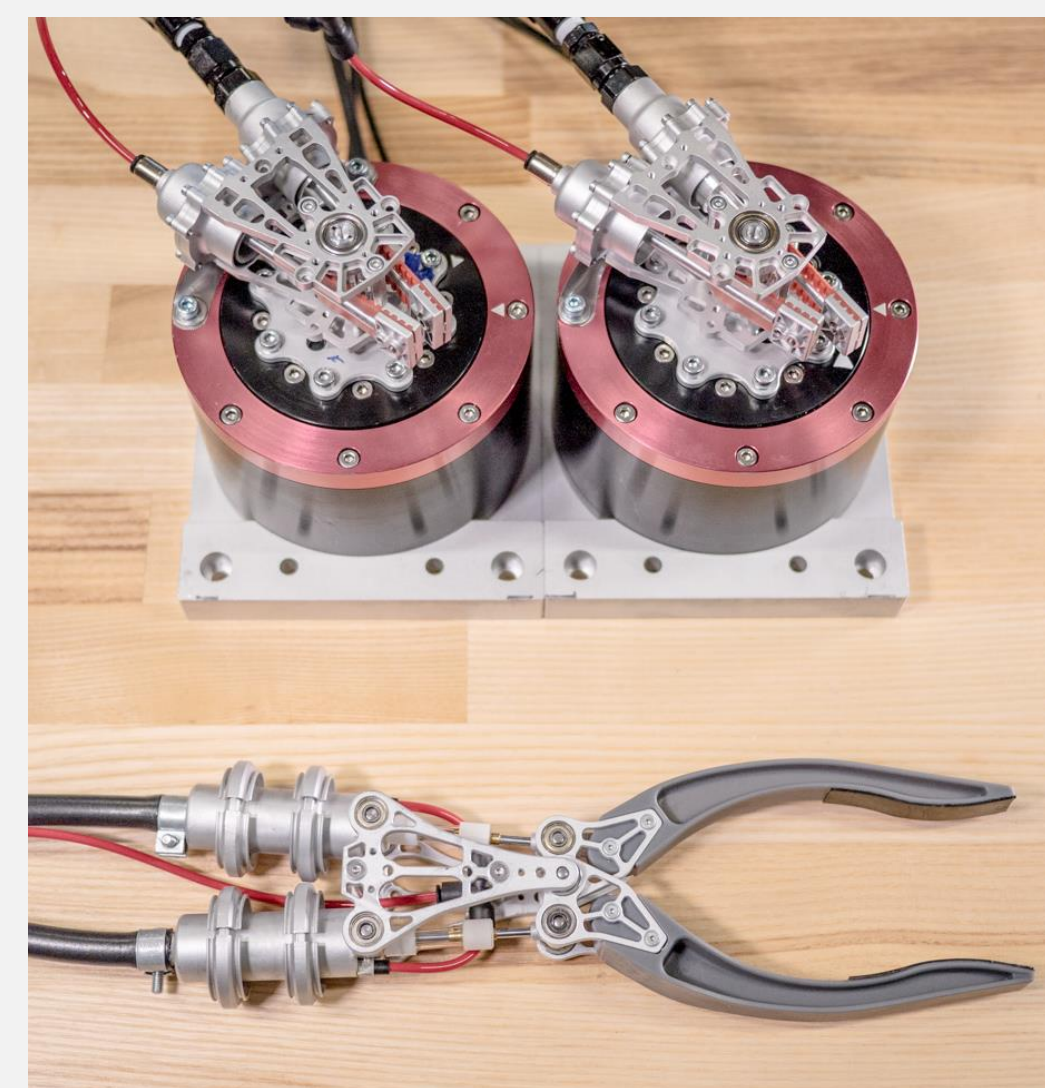
- Building a lightweight arm capable of active high-bandwidth impedance control is hard
- Controlling contact-rich interactions in uncertain environments is hard

## Aims

- Developing a lightweight, low-impedance 7-DOF robot manipulator for research and mass production
- Employ **remote direct drive** (RDD) actuation concept
- Developing process for learning optimal controllers rather than tuning controllers for specific hardware



Low-friction hydrostatic transmission

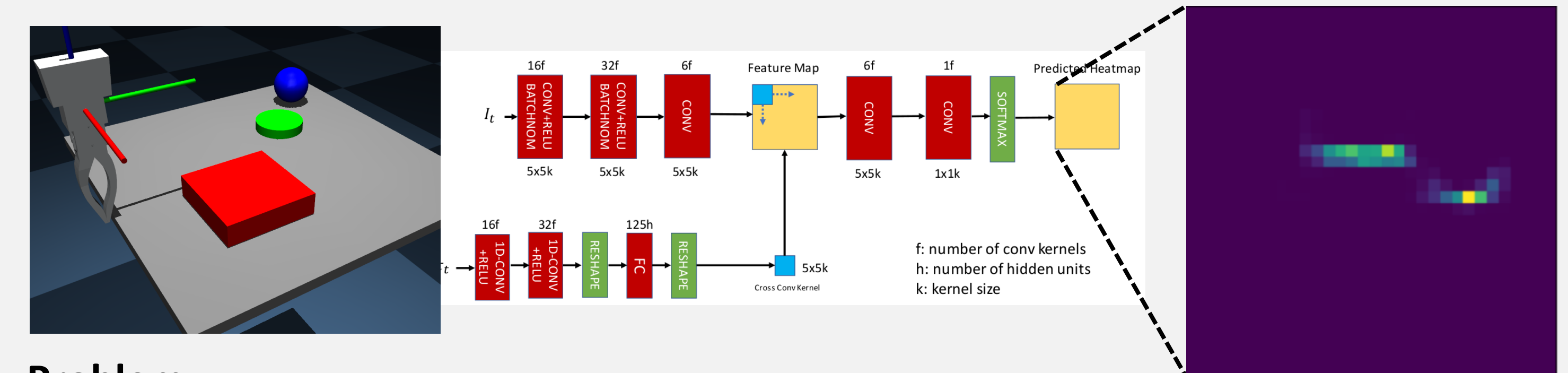


2-DOF gripper, driven by remote direct-drive brushless motors



Under devel. 7-DOF arm, fully remotely actuated

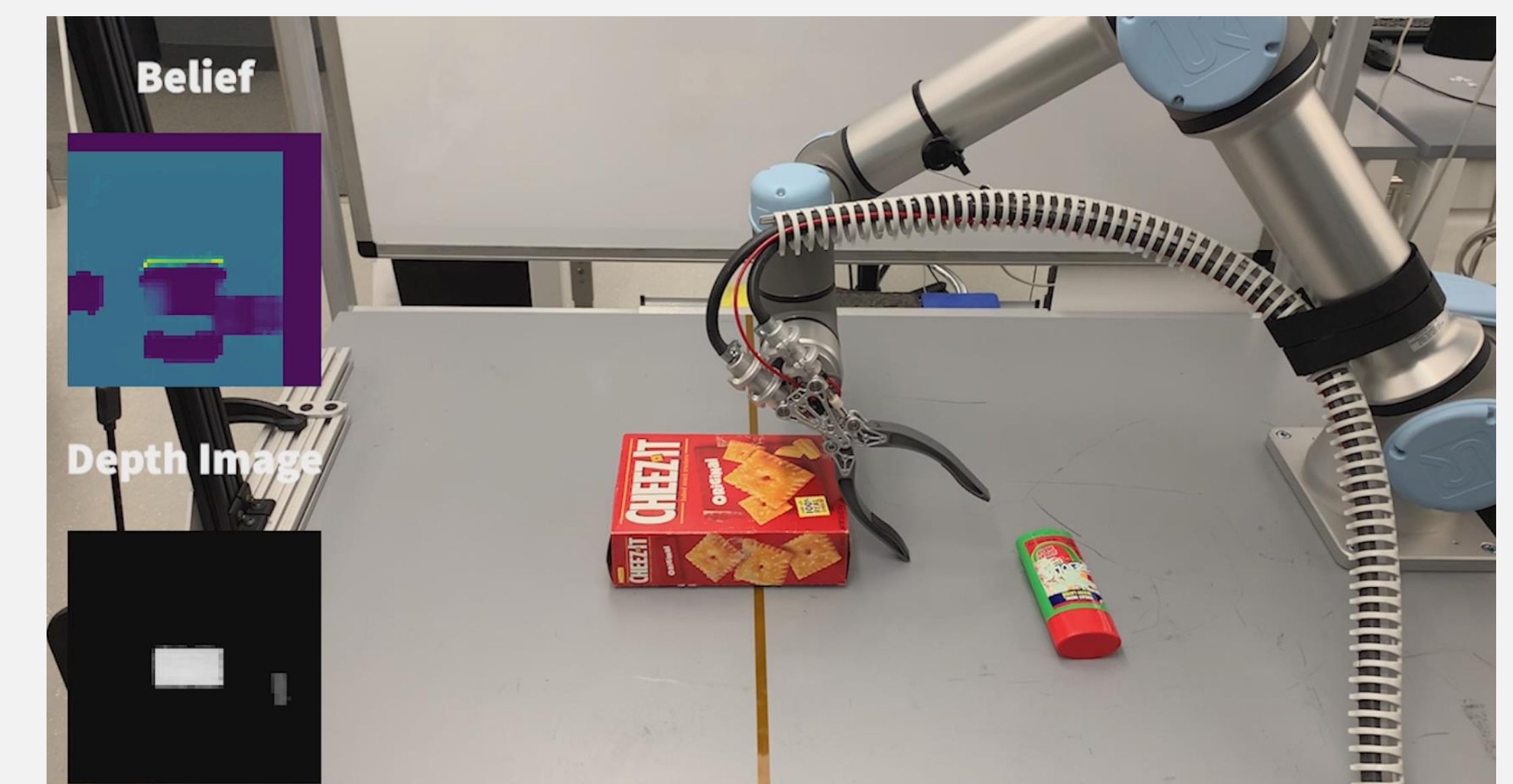
## Localization and mapping using tactile information



### Problem:

Map objects in a scene and localize robot finger using:

- Initial single coarse depth image
- Continuous finger force measurement

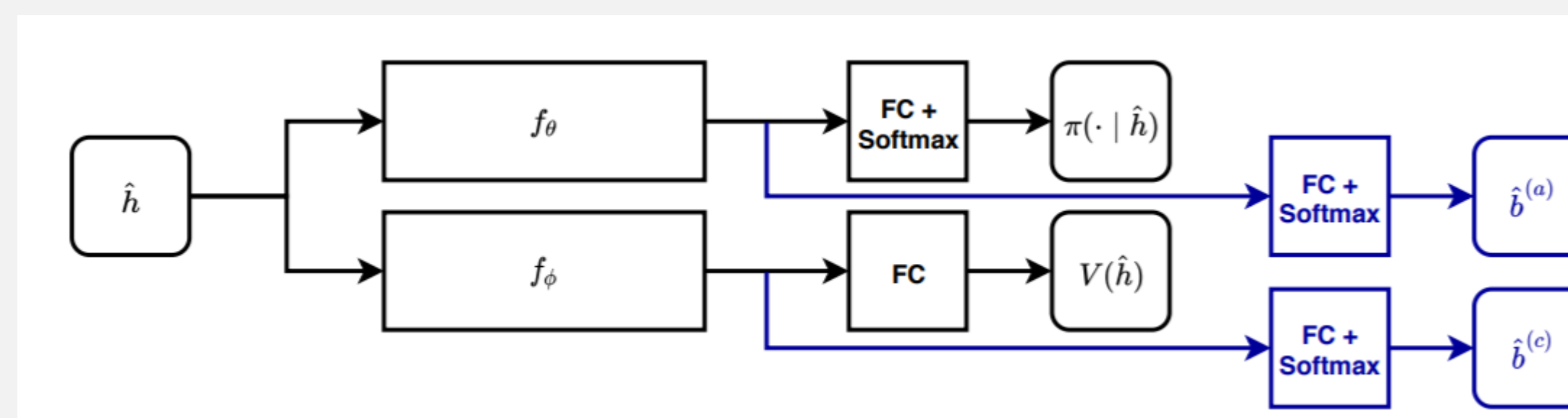


Testing on UR5e + 2-DOF RDD tactile gripper

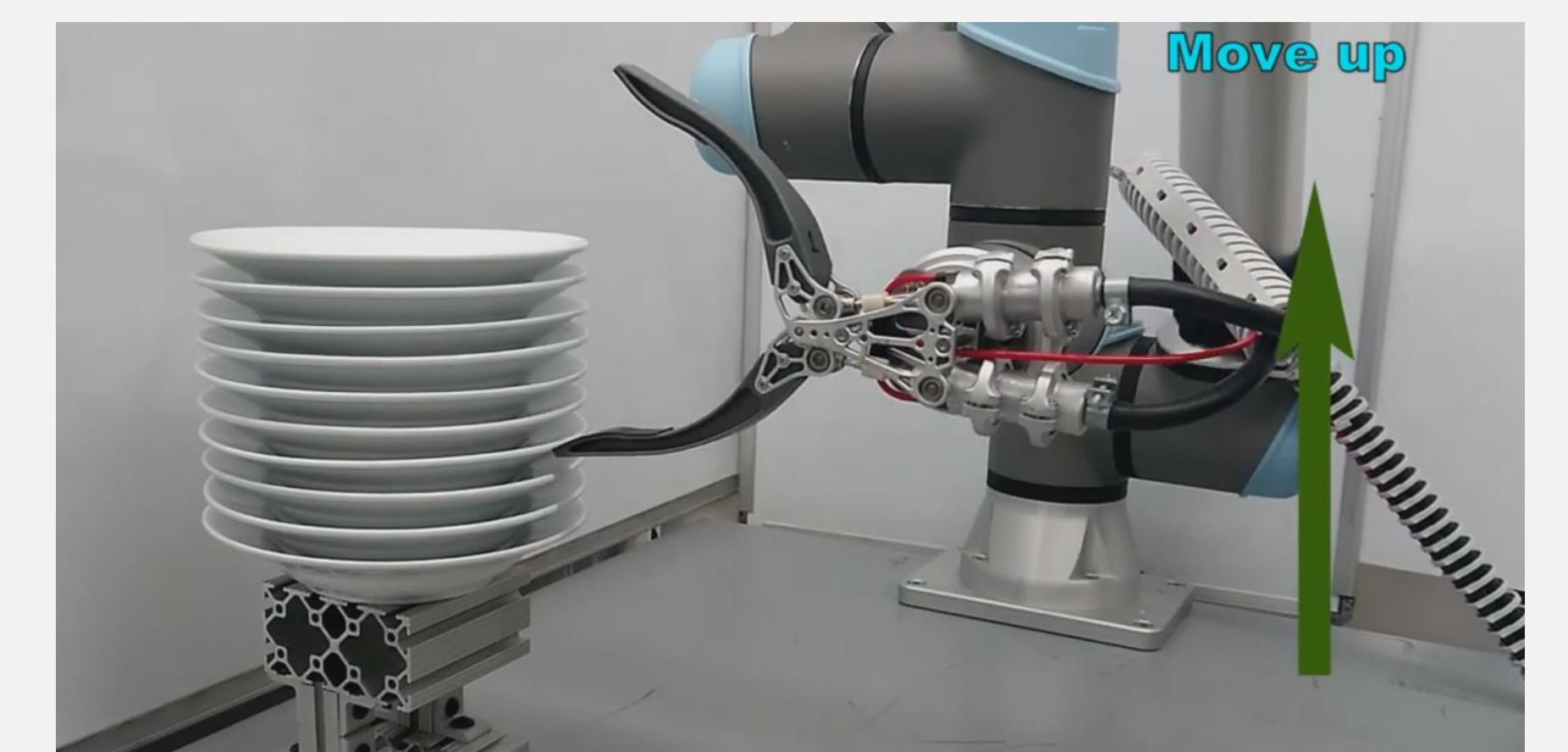
## Force-aware manipulation using Belief Grounded Networks (BGNs)



3 different tasks, all training offline



BGN combined with A2C. The belief state is reconstructed from partial observations during training. The resulting policy is history, not belief based, so we forego calculating belief state during runtime.



In "TopPlate" task, plates are counted by touch alone, and the top plate is grasped automatically. No online training of the BGN is employed.