

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

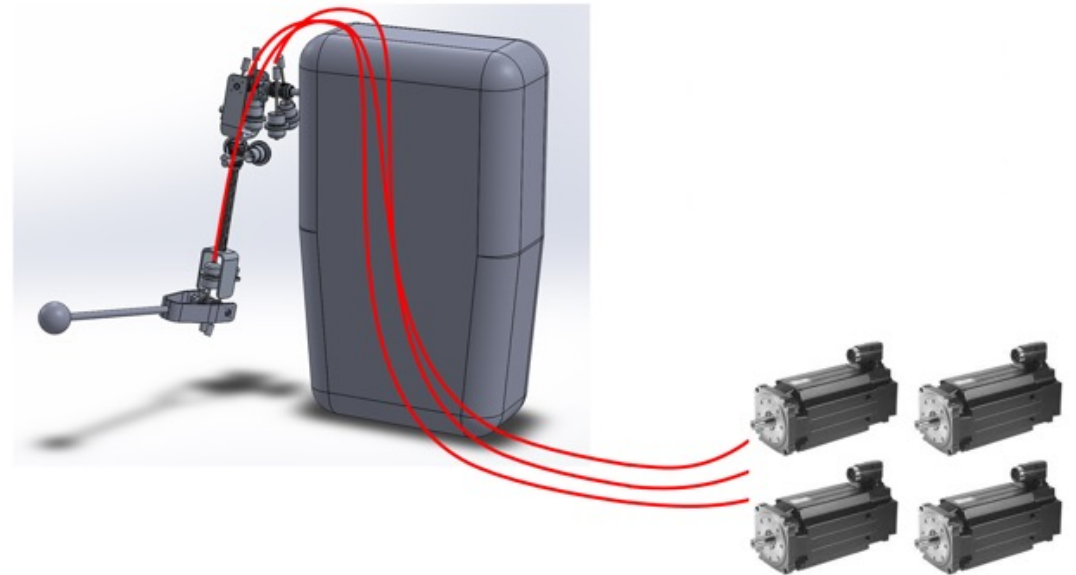
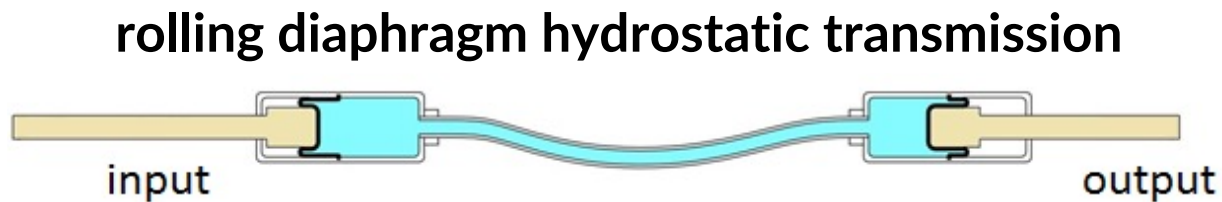
Award Number: 1830425

Peter Whitney and Rob Platt

NRI 2022 PI Meeting

Remote Direct Drive (RDD) Actuation

- Low-friction hydrostatic transmission allows ALL motors in arm to be remotely located—*extremely low moving mass*
- Initial experimental configuration uses a 2-DOF RDD gripper, pending completion of 7-DOF RDD arm
- Fluid pressure measurement allows precise measurement of endpoint contact forces



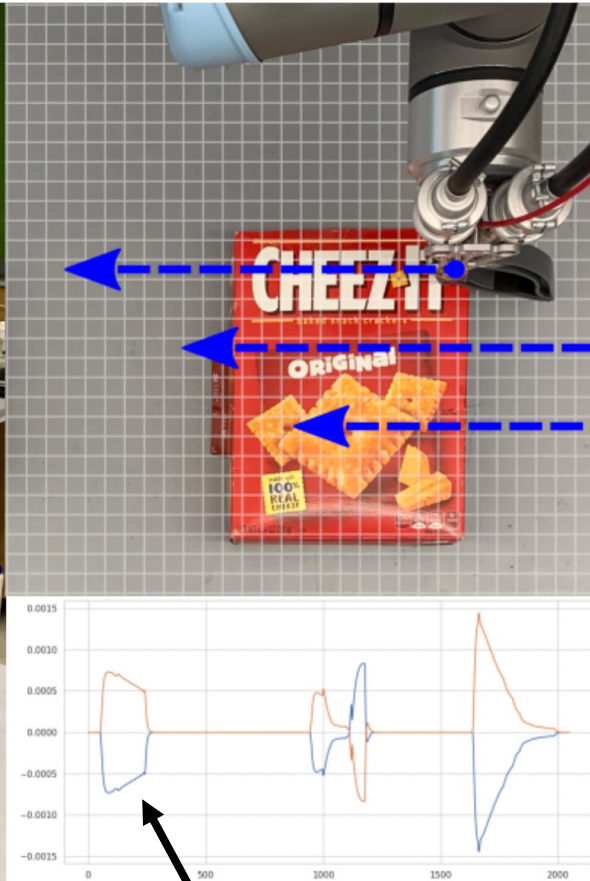
2-DOF gripper



Spec's:

- +/- 45N @ 10cm
- 120° range-of-motion
- 220 grams total mass

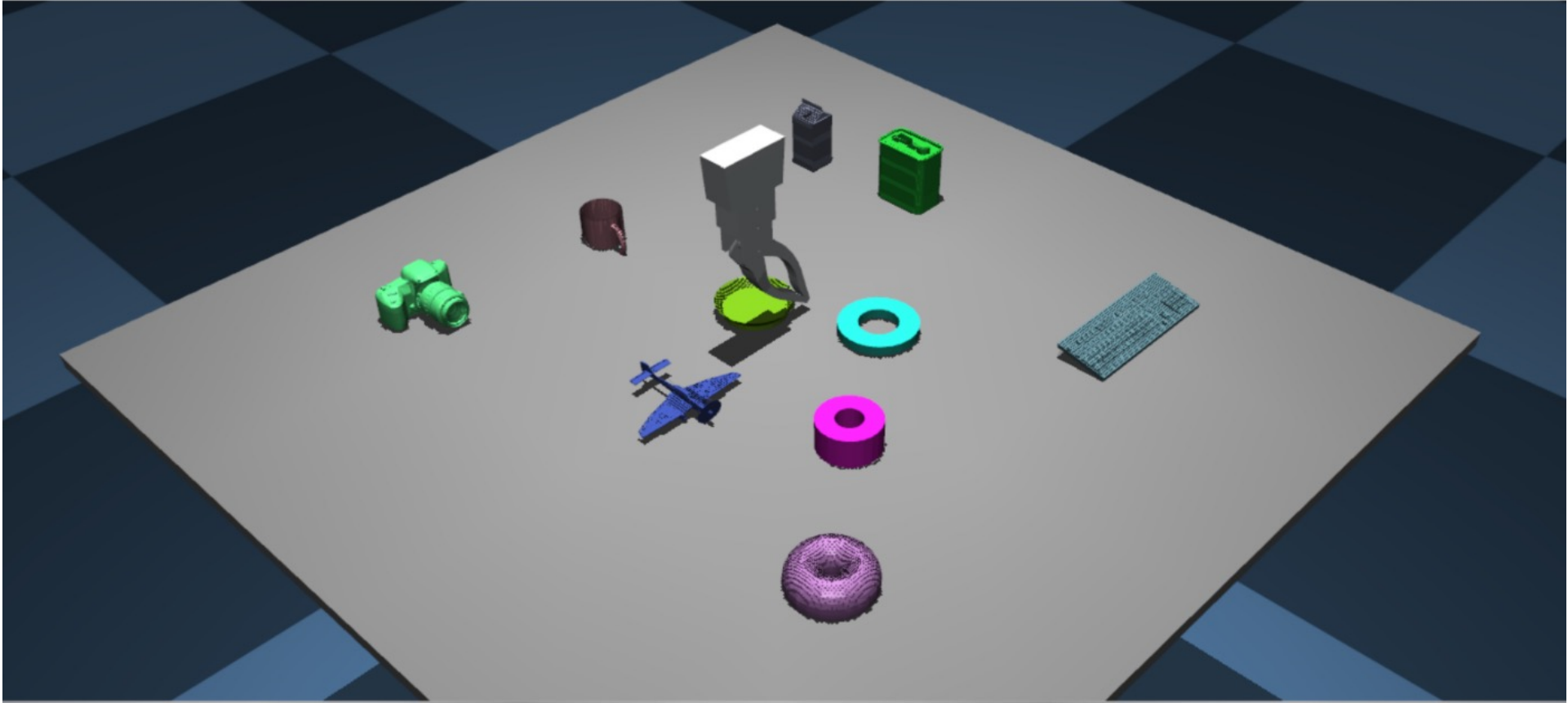
Tactile Localization



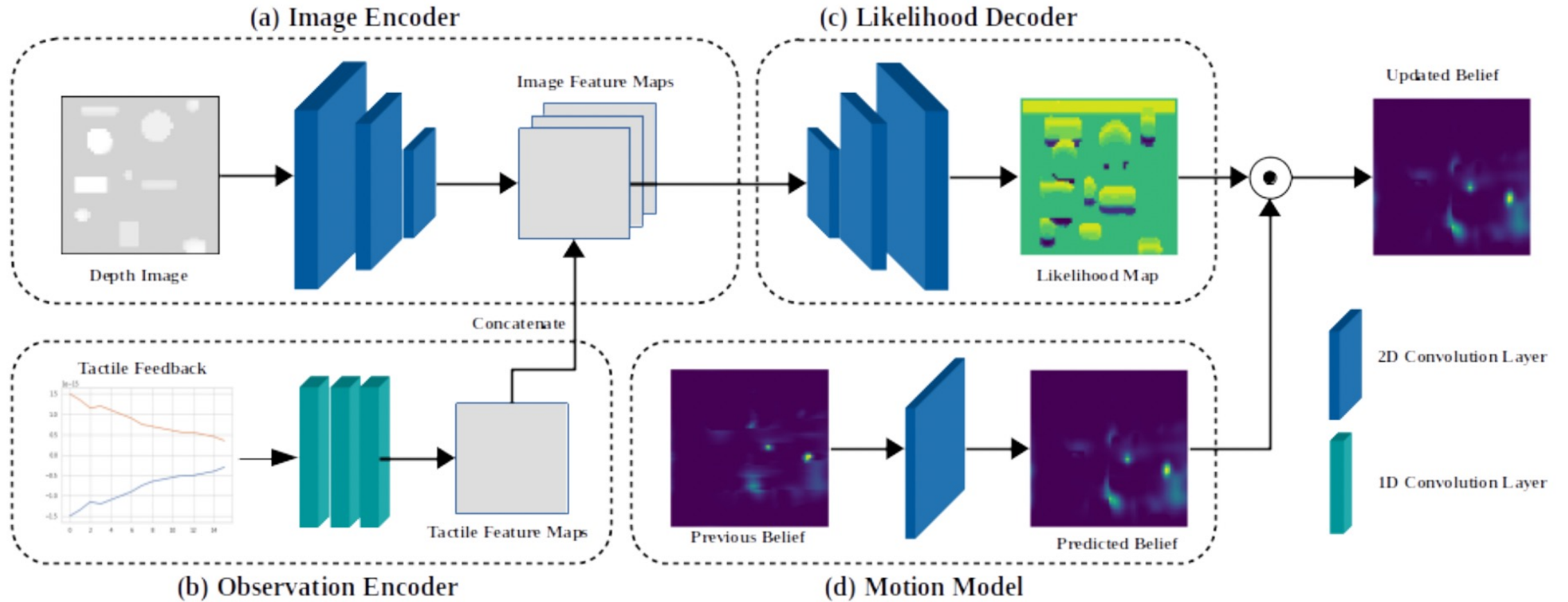
- Differential Bayes filter + deep RL
- Fuses single depth image with continuous tactile force feedback
- System modeled as MOMDP
- Backdriveable fingers lightly brush against objects, set to minimal impedance (stiffness)

finger tactile force timeseries

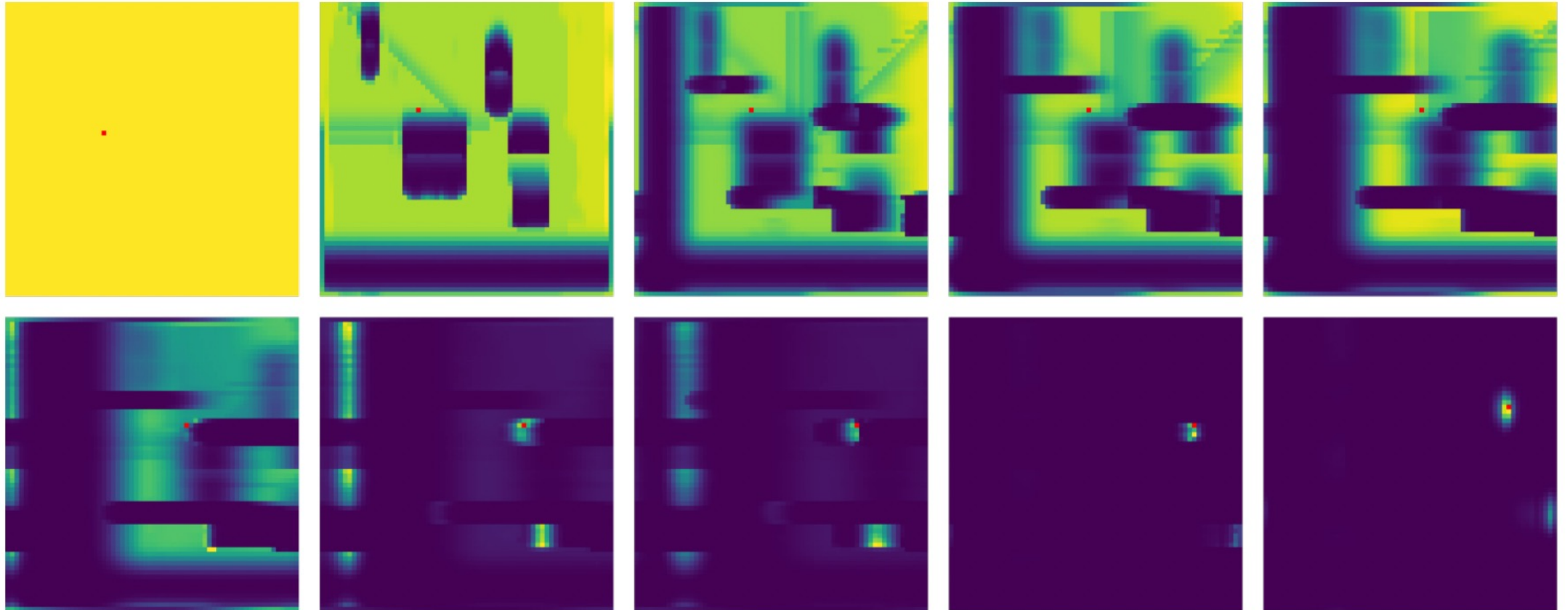
Tactile Localization



Tactile Localization

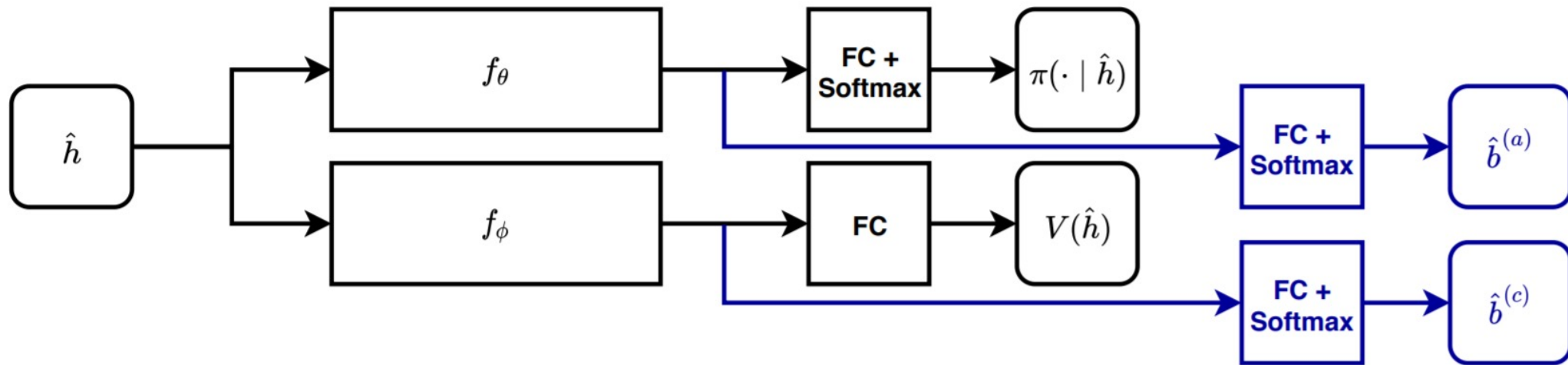


Tactile Localization

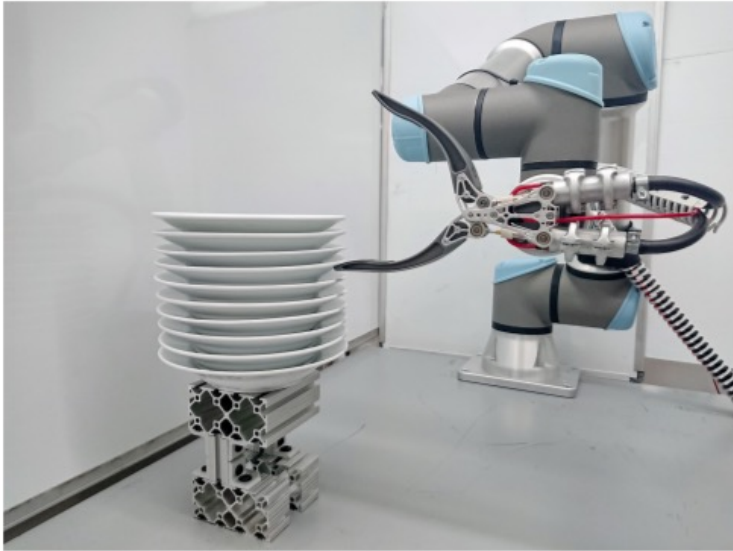


Belief Grounded Network (BGN)

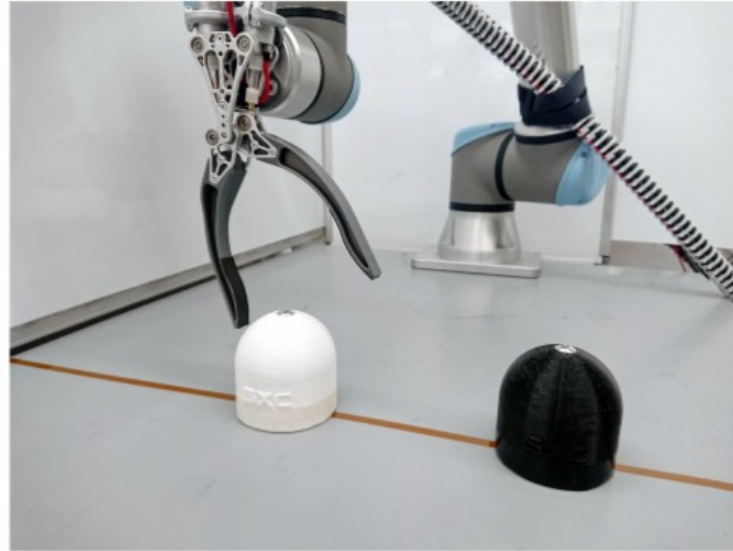
- We introduce a new model called the Belief Grounded Network (BGN) where we add a belief-reconstruction loss to a deep reinforcement learning agent during simulated training.
 - Sync Advantage Actor Critic (A2C) + history summaries
 - MuJoCo training environment



Belief Grounded Network (BGN)



TopPlate

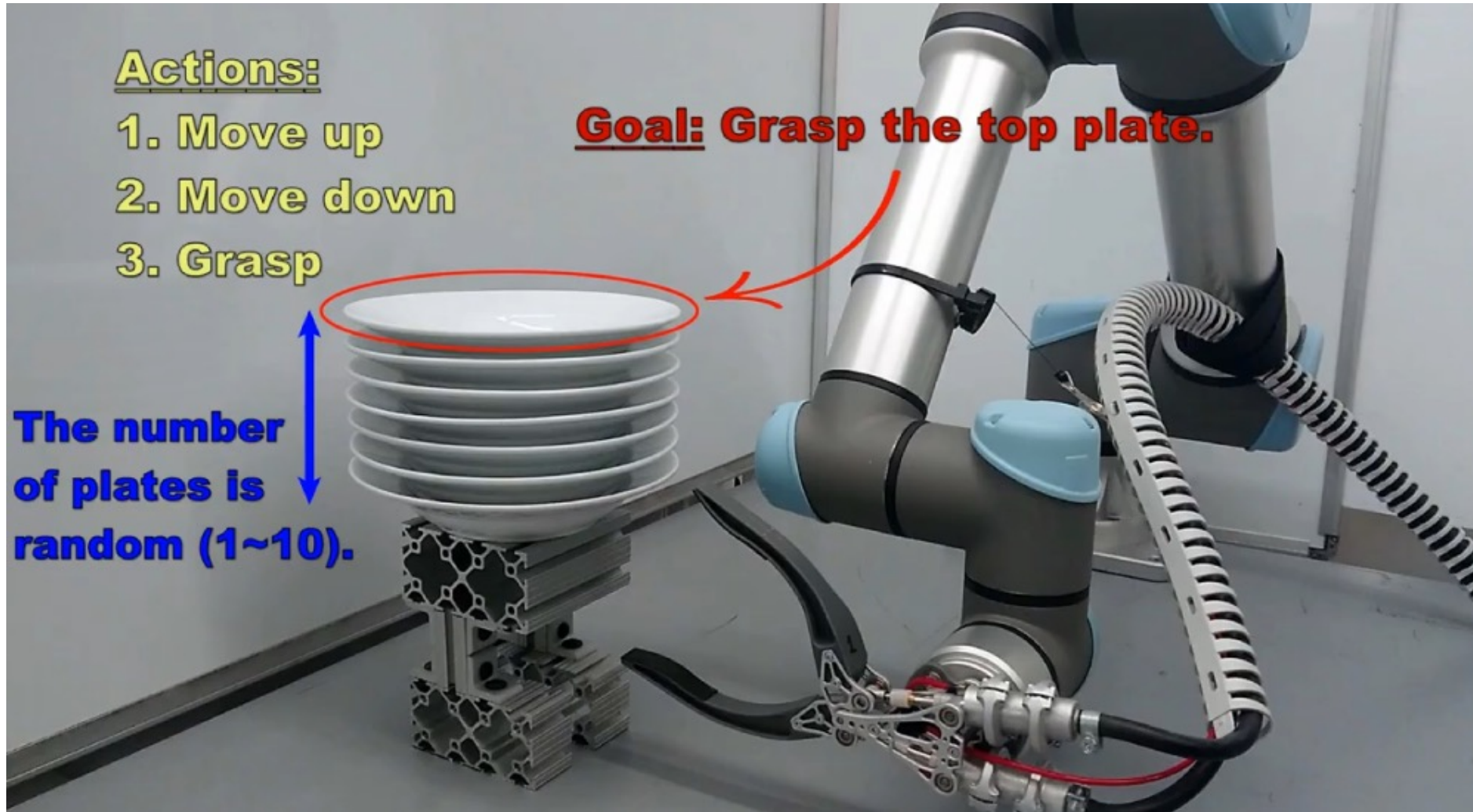


Bumps-1D



Bumps-2D

TopPlate (BGN)

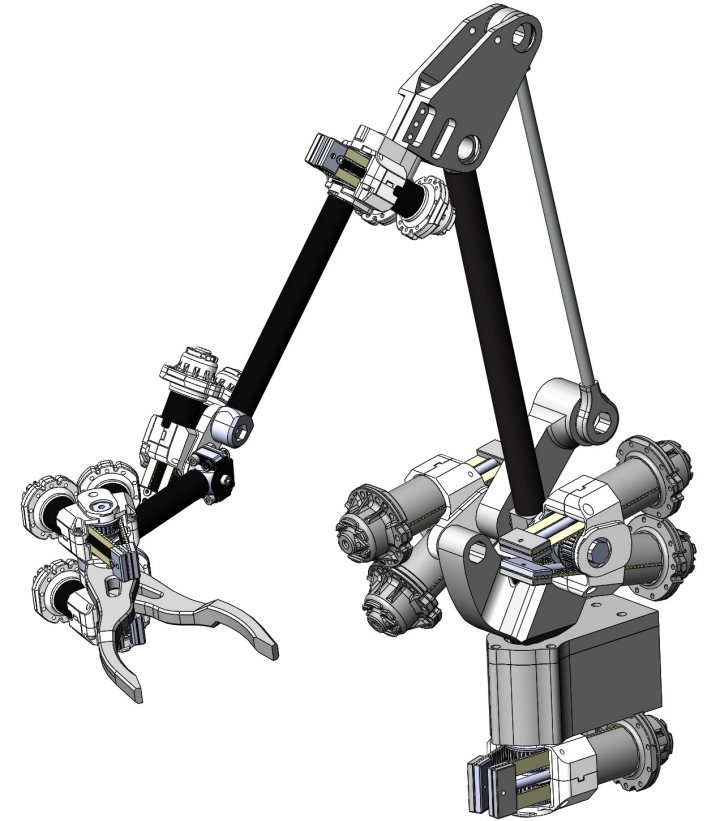


TopPlate (BGN)



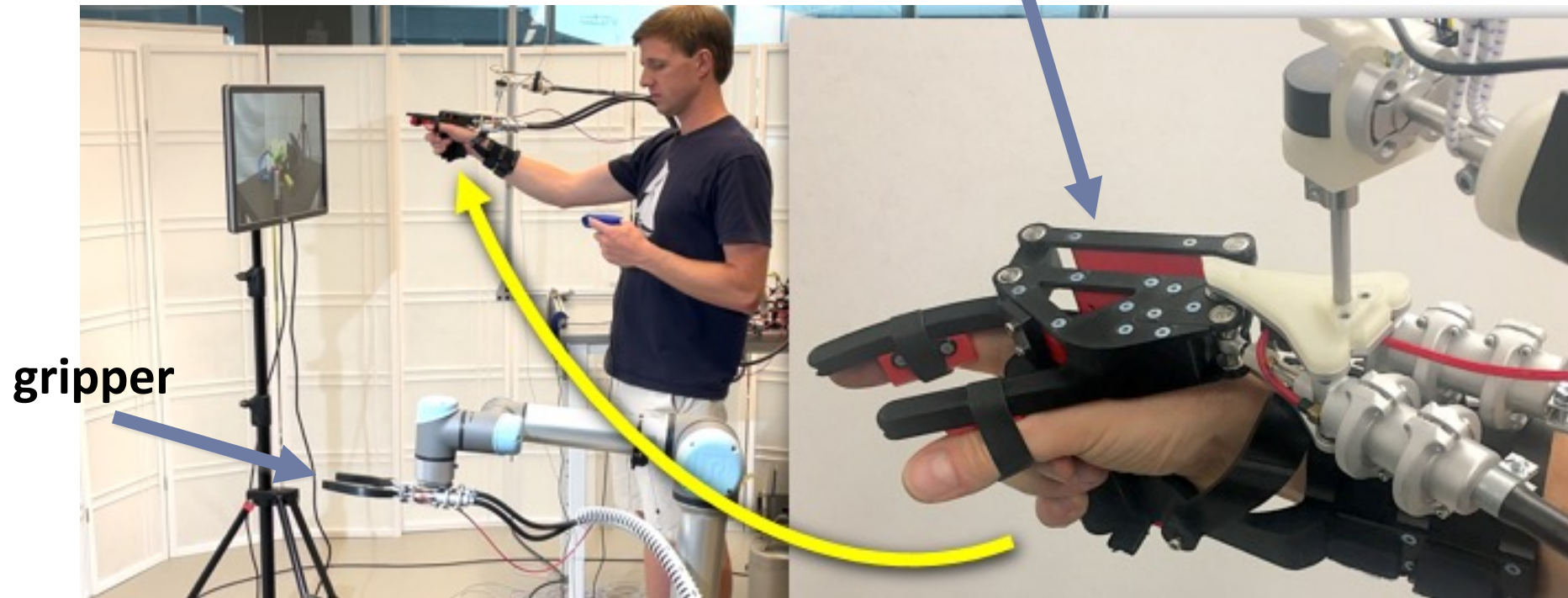
Ongoing Work

- **Robot platform**
 - Transitioning to 6-DOF arm with fully remote-direct-drive (RDD) actuation and force sensing.
- **Learning**
 - New work in learning from demonstration to be combined with using TCN's for tactile timeseries data -> teleop. demonstrations
 - $O(2)$ Equivariant SAC



Ongoing Work

Teleop. setup with haptic glove



gripper

