Current as Touch:

Proprioceptive Contact Feedback for Compliant Dexterous Manipulation

CoRL 2026 Submission

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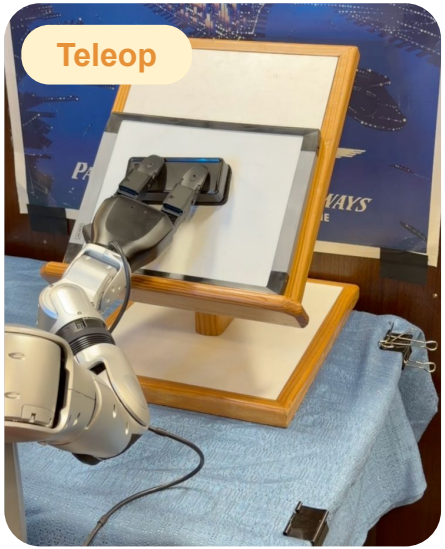
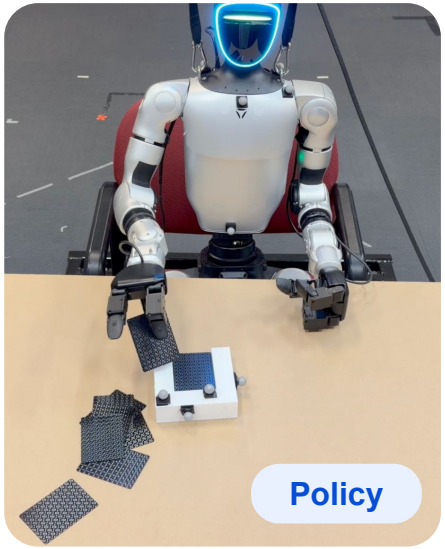
Proprioceptive Contact Feedback for Compliant Dexterous Manipulation

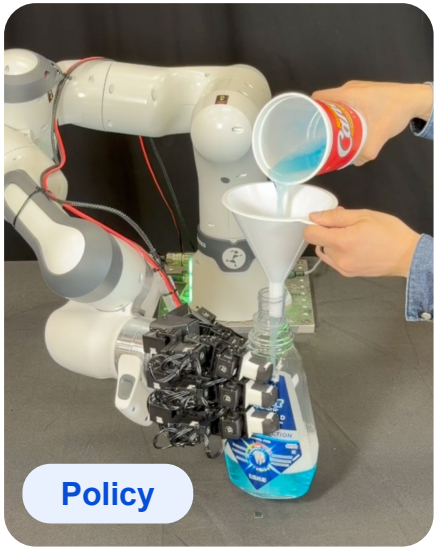
Tighten your hand
Model handles for you



Push and wipe
Easy and quick



Draw one card
No tactile sensor



Feel the weight
No tactile sensor

Dexterous manipulation needs contact feedback

Dexterous manipulation needs contact feedback

Too much force → deformation

Dexterous manipulation needs contact feedback

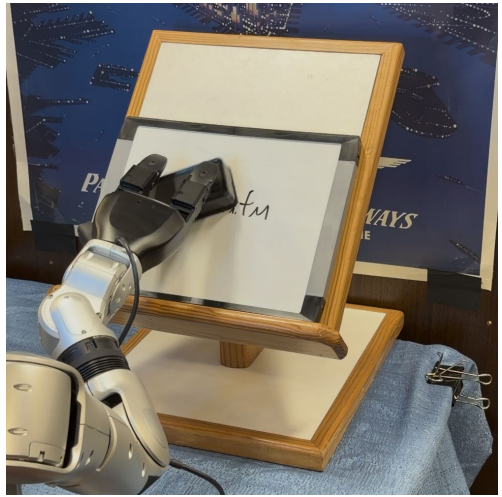
Too much force → deformation

Too little force → slip

Dexterous manipulation needs contact feedback

Too much force → deformation

Too little force → slip

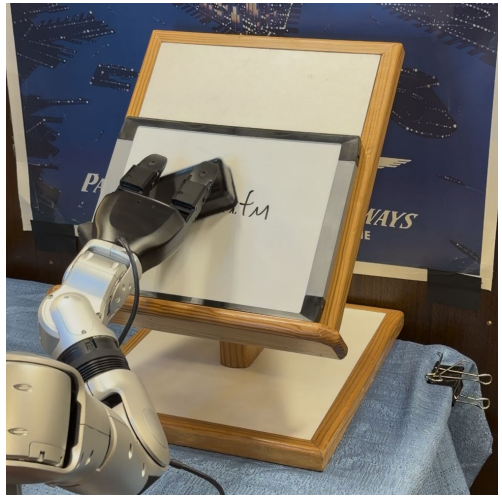


Sustained force → contact-rich tasks

Dexterous manipulation needs contact feedback

Too much force → deformation

Too little force → slip



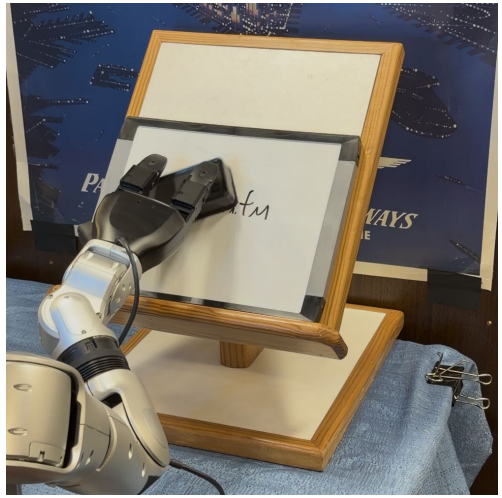
Sustained force → contact-rich tasks

Most low-cost hands: joint-position control only

Dexterous manipulation needs contact feedback

Too much force → deformation

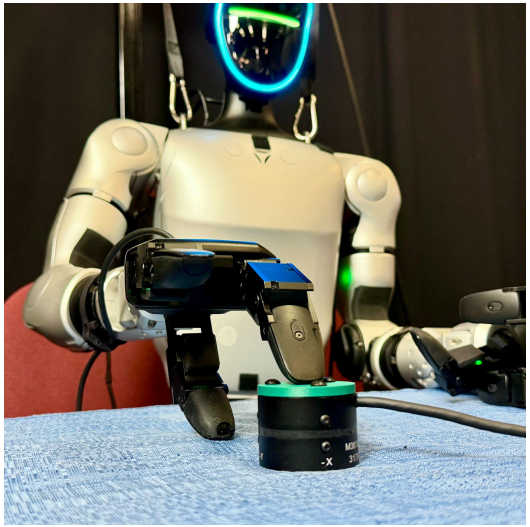
Too little force → slip



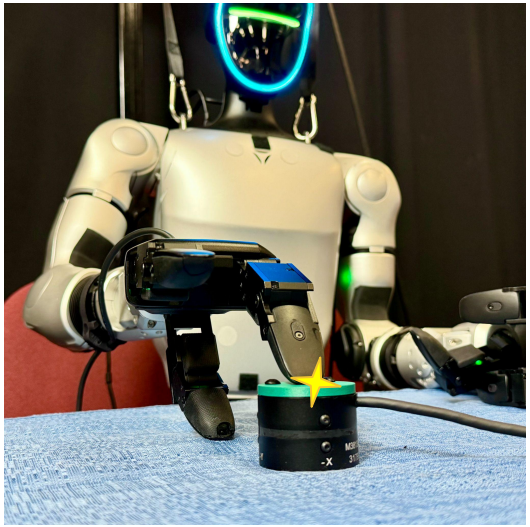
Sustained force → contact-rich tasks

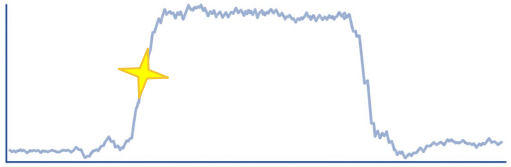
Can we get touch-like feedback from the hand itself?

Motor current is built-in touch-like feedback

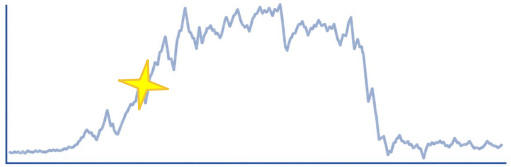


Motor current is built-in touch-like feedback



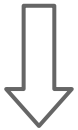


joint position



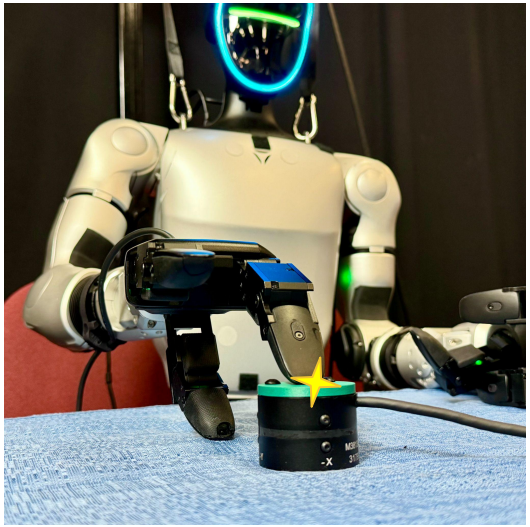
motor current

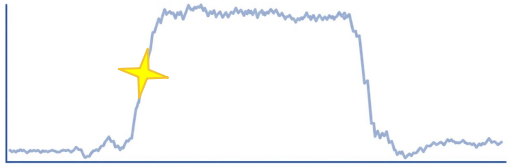
Current + Joint State



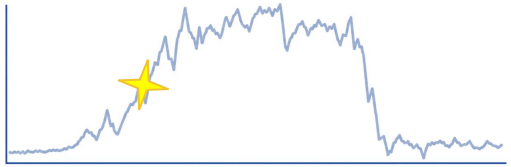
Contact Force / Object Stiffness

Motor current is built-in touch-like feedback





joint position



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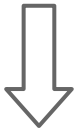
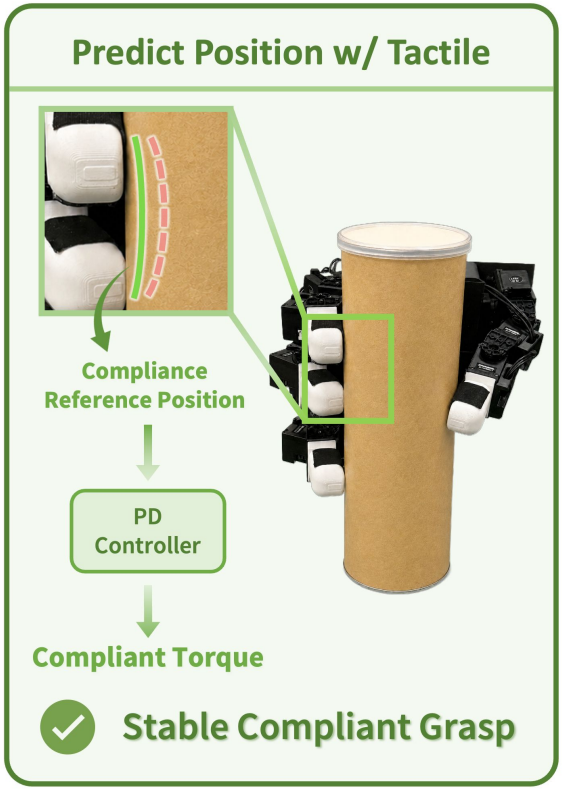


Contact Force / Object Stiffness

Verified on Unitree Dex 3 and LEAP Hand

Predict a position target that induces compliant force



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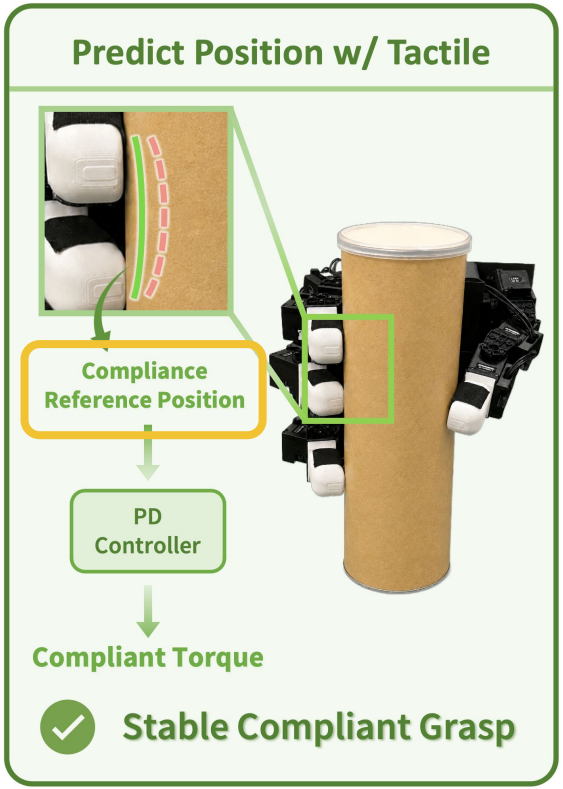

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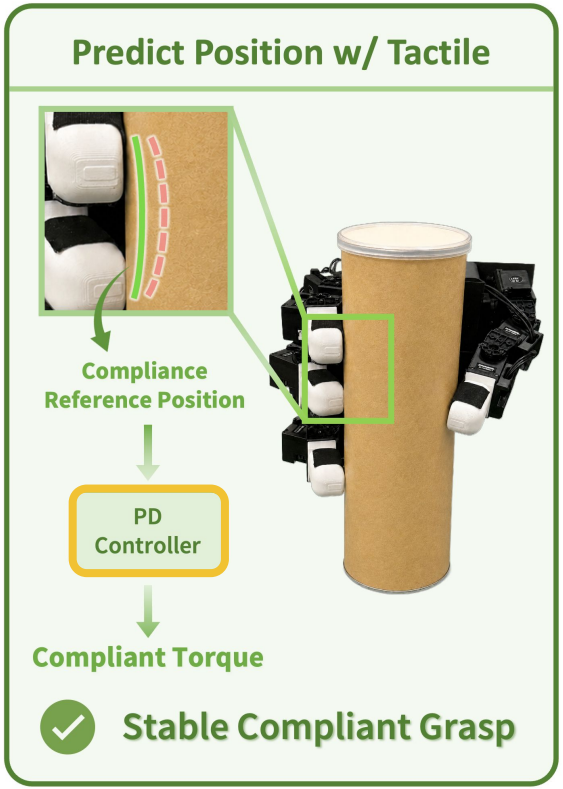

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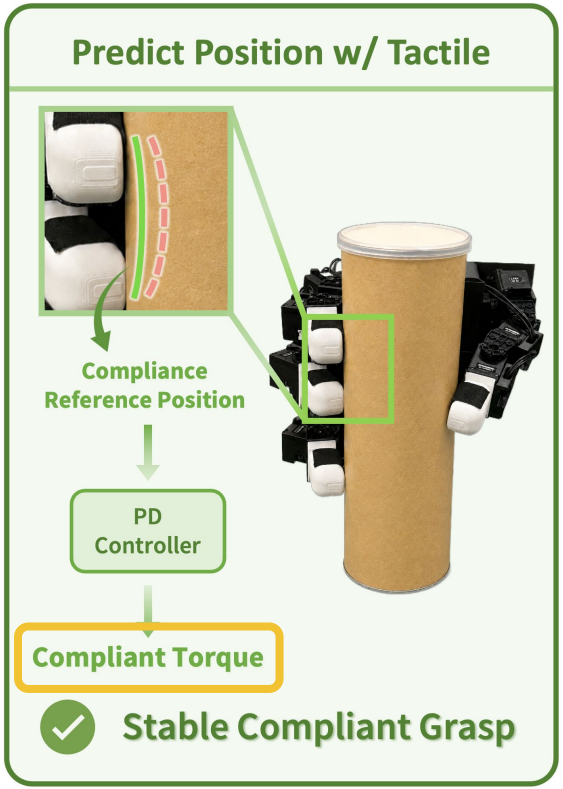

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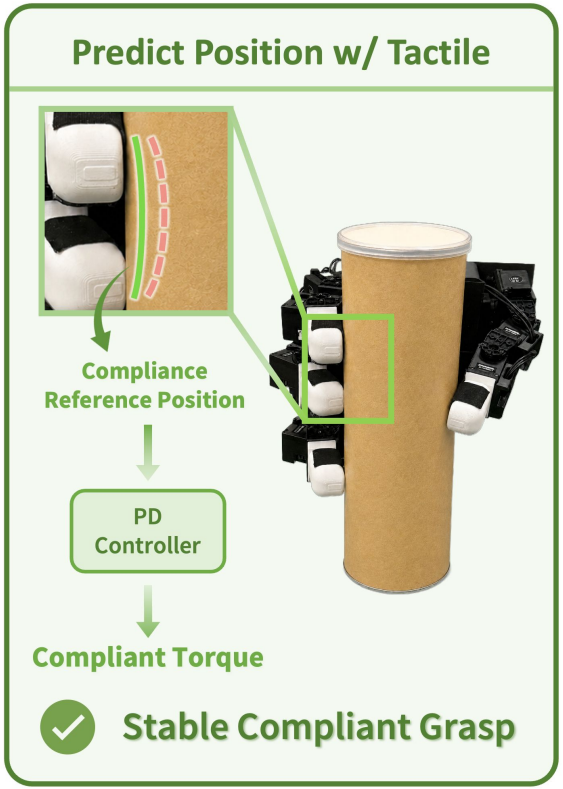

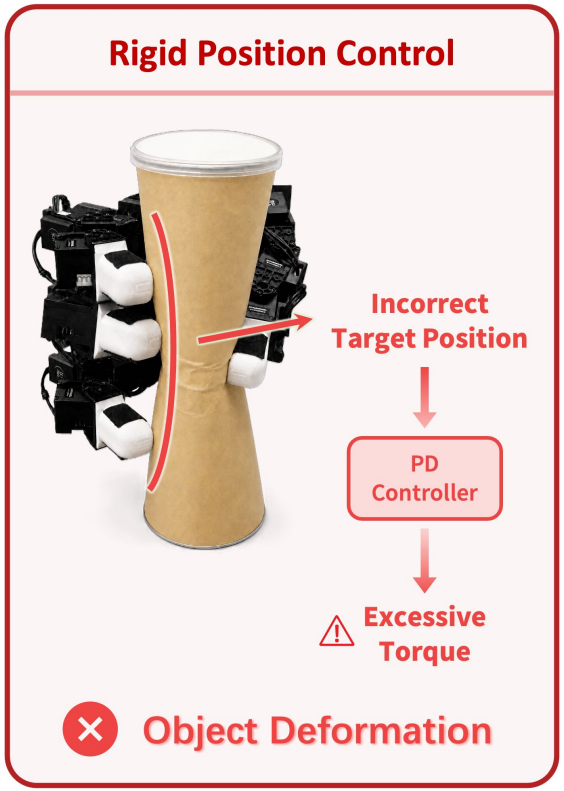

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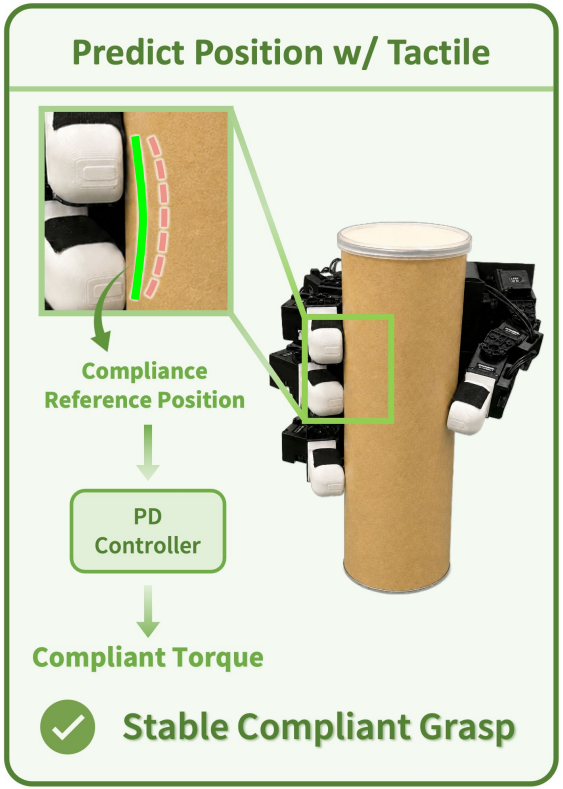
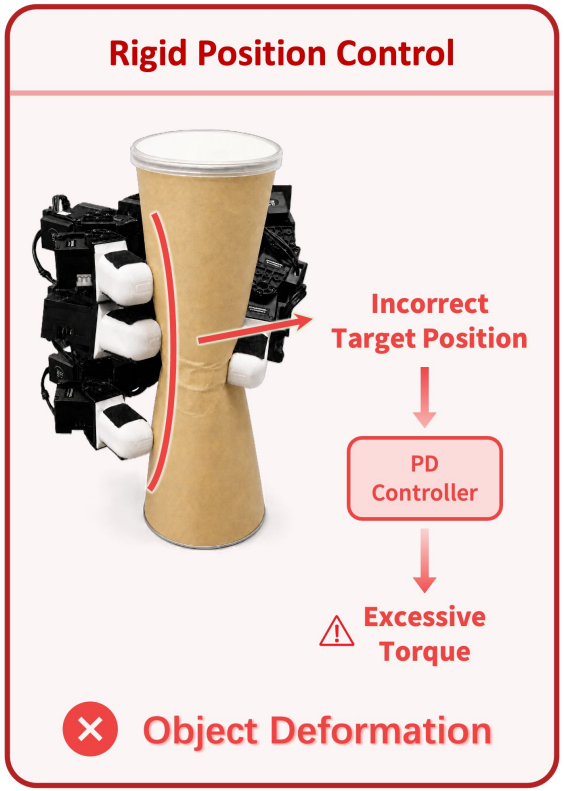
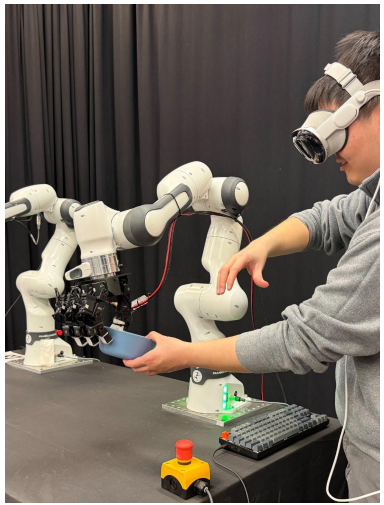




Teleoperation provides CRP labels and contact stiffness



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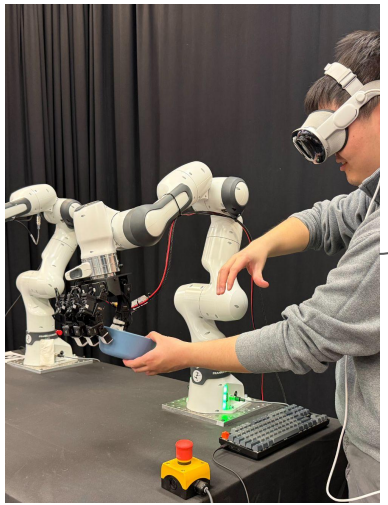

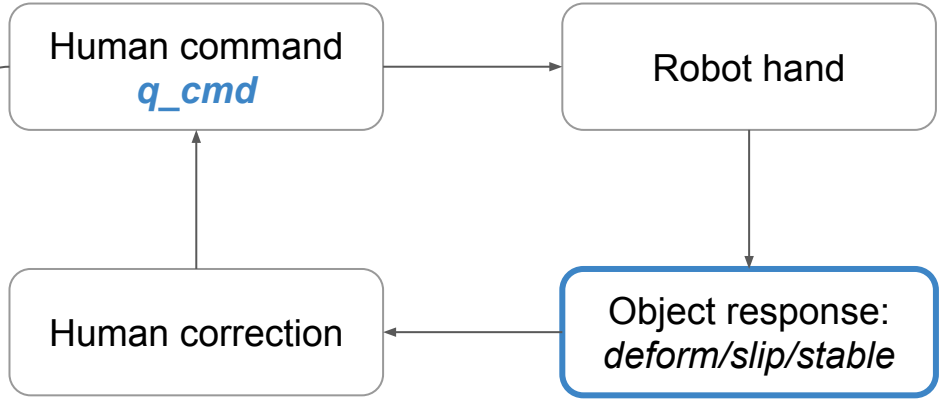

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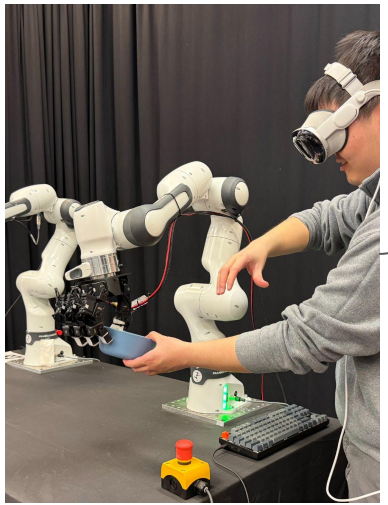
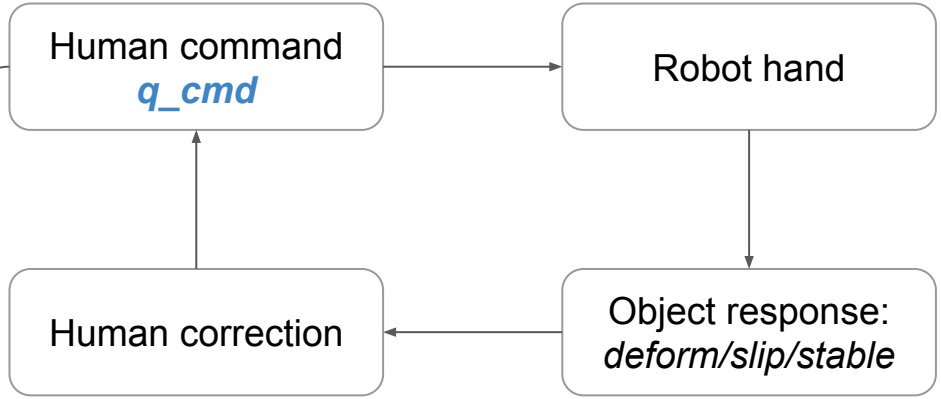




***q_cmd* becomes noisy but valid CRP supervision**

Teleoperation provides CRP labels and contact stiffness

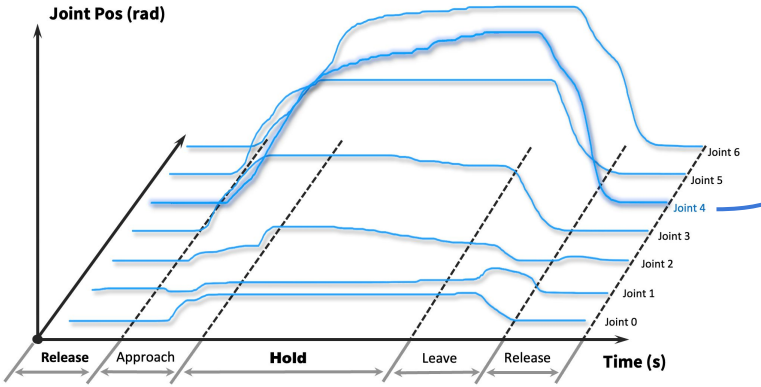
Human command
q_cmd

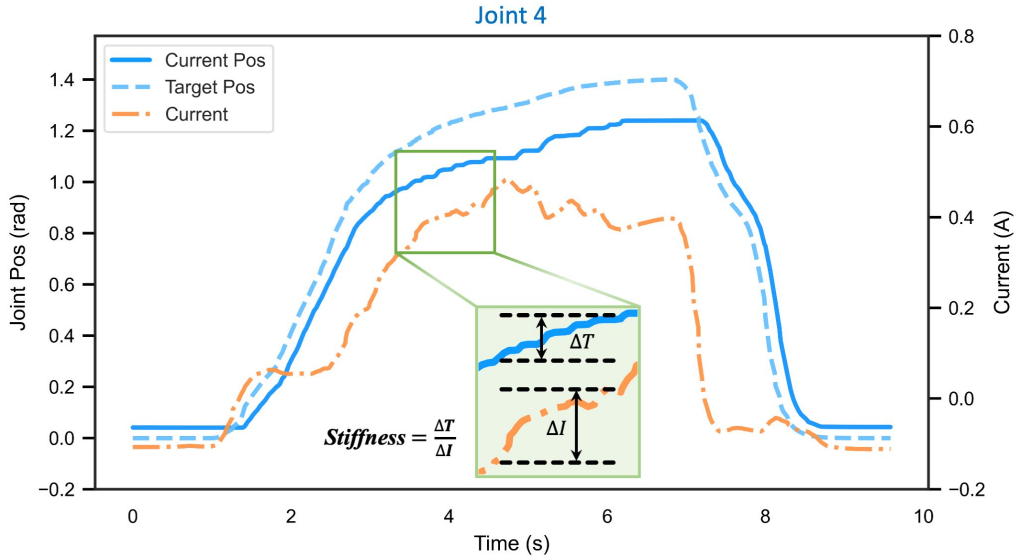
Robot hand

Human correction

Object response:
deform/slip/stable

_q_cmd_ becomes noisy but valid CRP supervision





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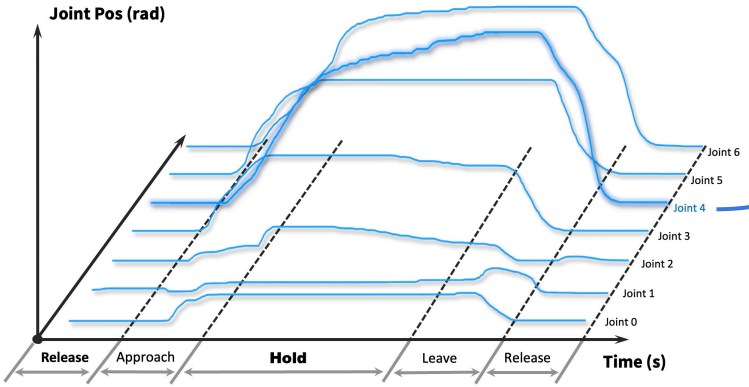

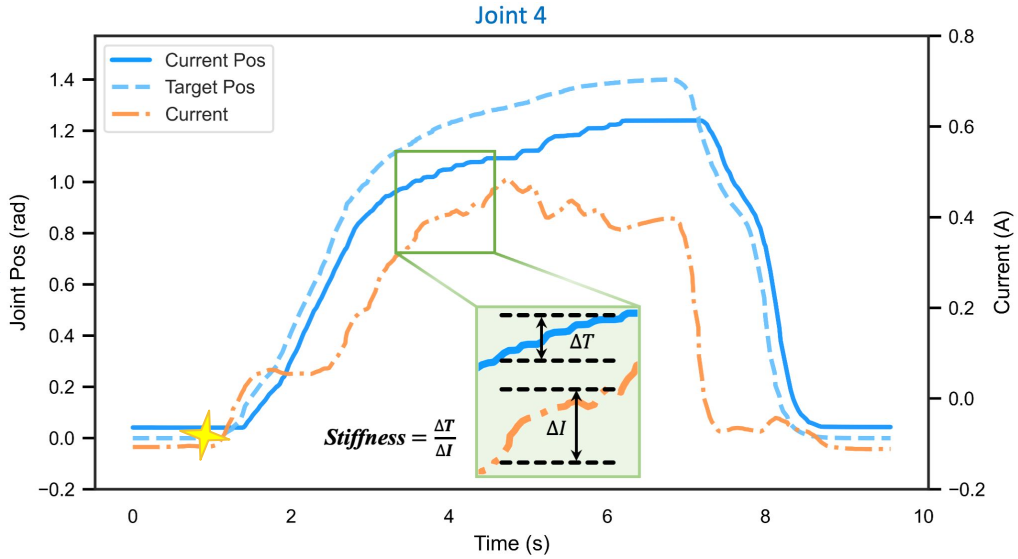

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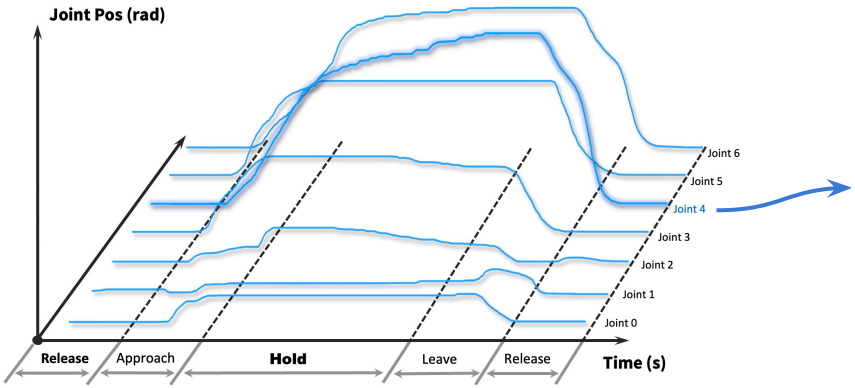

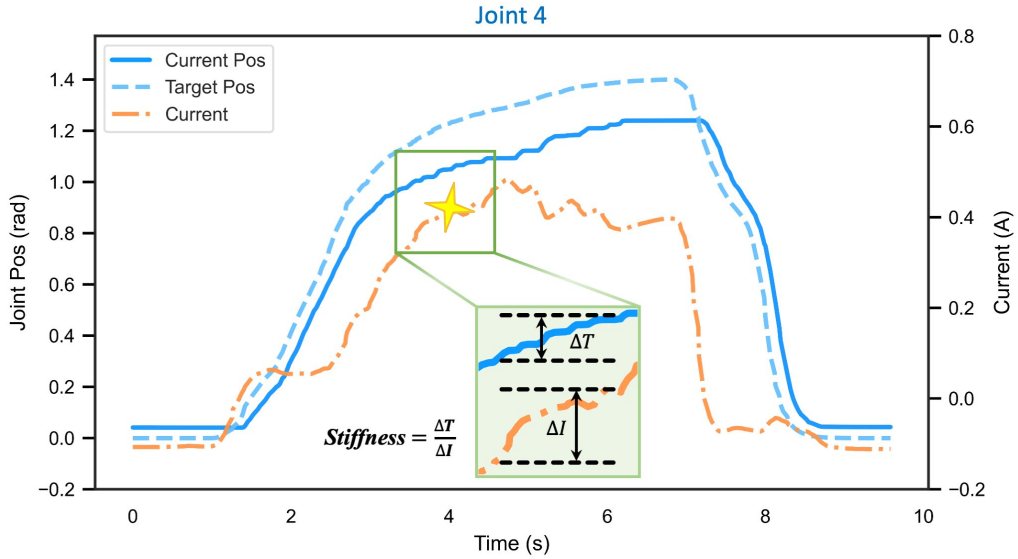

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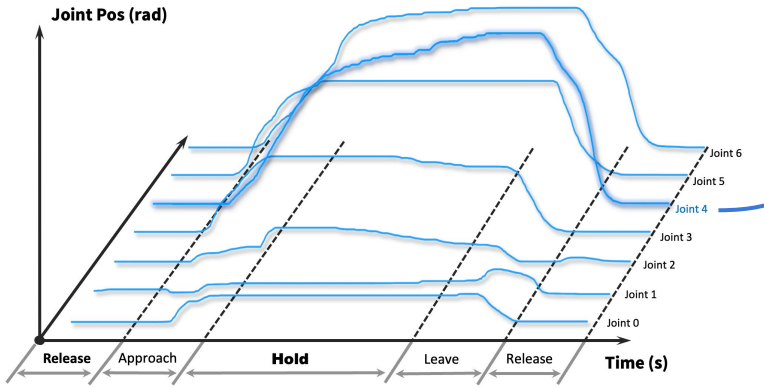
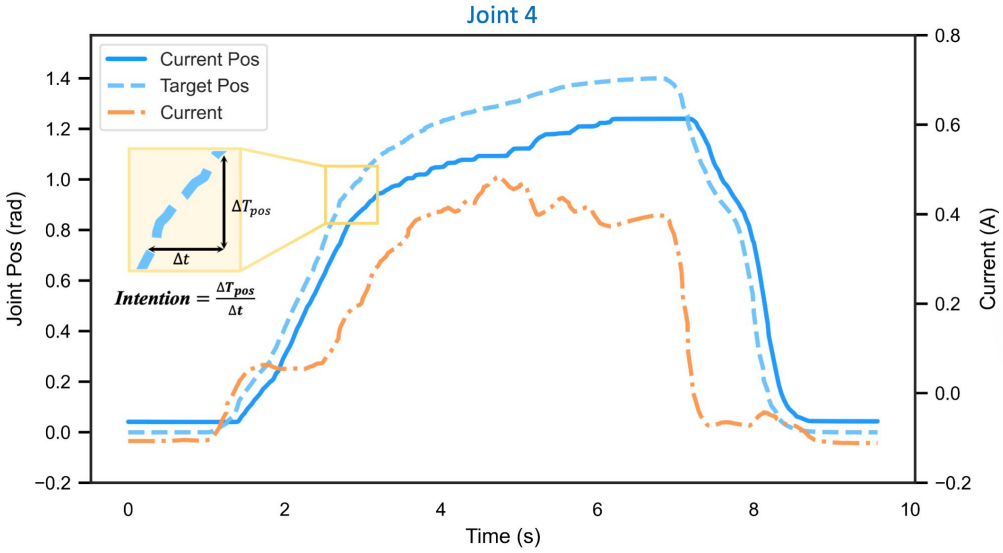
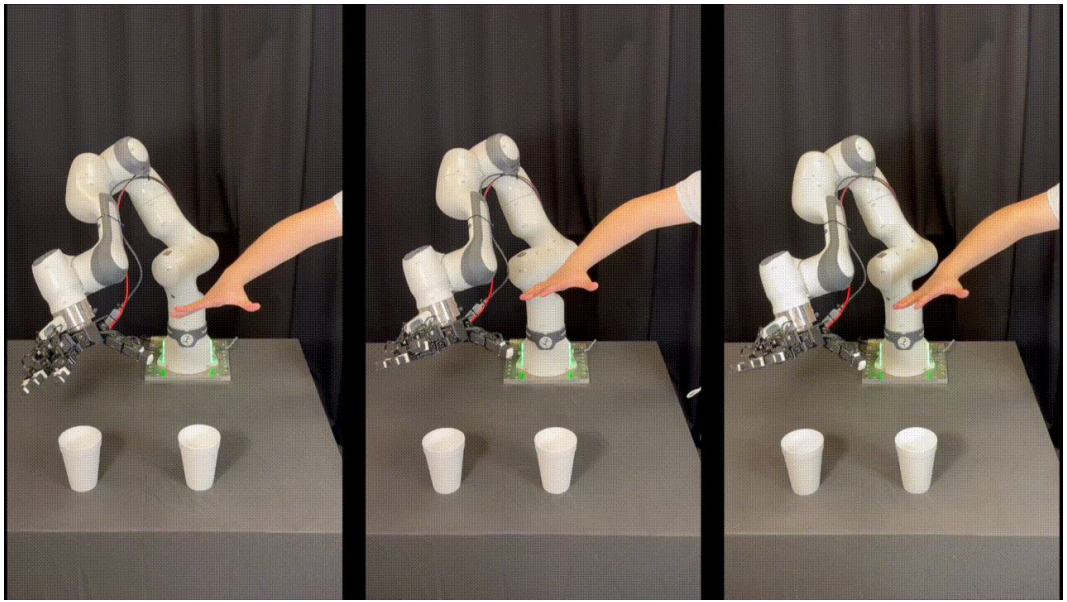




Foam cup stacking: gentle contact



Challenge

Avoid over-grasping fragile objects

Results

100% success

0% deformation

fastest completion

Increasing current → more conservative CRP

Whiteboard wiping: sustained contact

Challenge

Maintain proper pressure on the surface

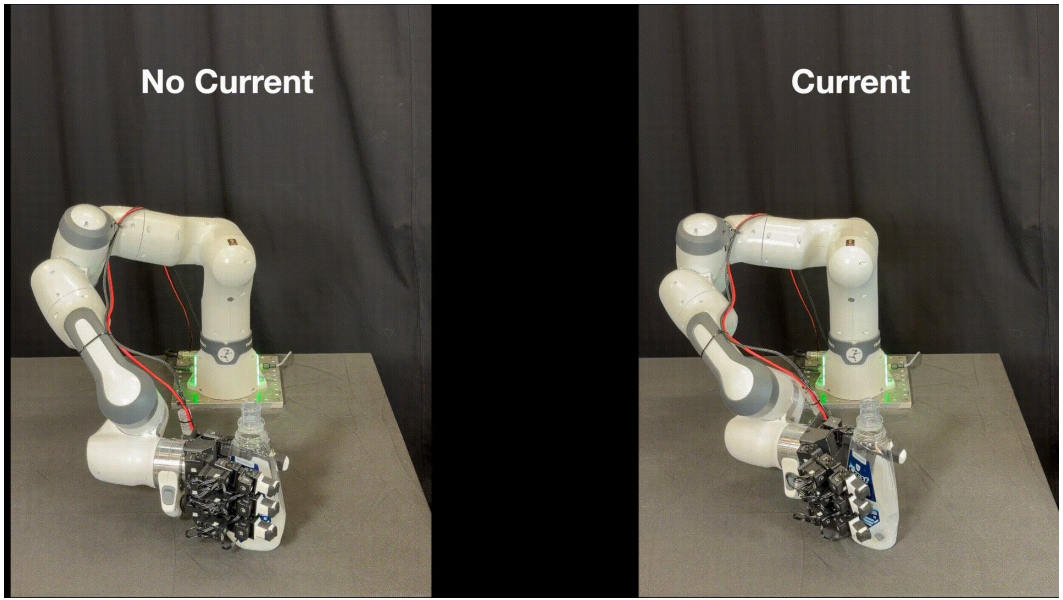
Results

100% success

fastest completion

Current indicates how hard the eraser is pressed

Bottle holding: dynamic load adaptation



Water poured in

↓

Bottle pose ≈ unchanged

↓

Load increases

↓

Finger-base side-swing current increases

↓

Implicit load signal

Results

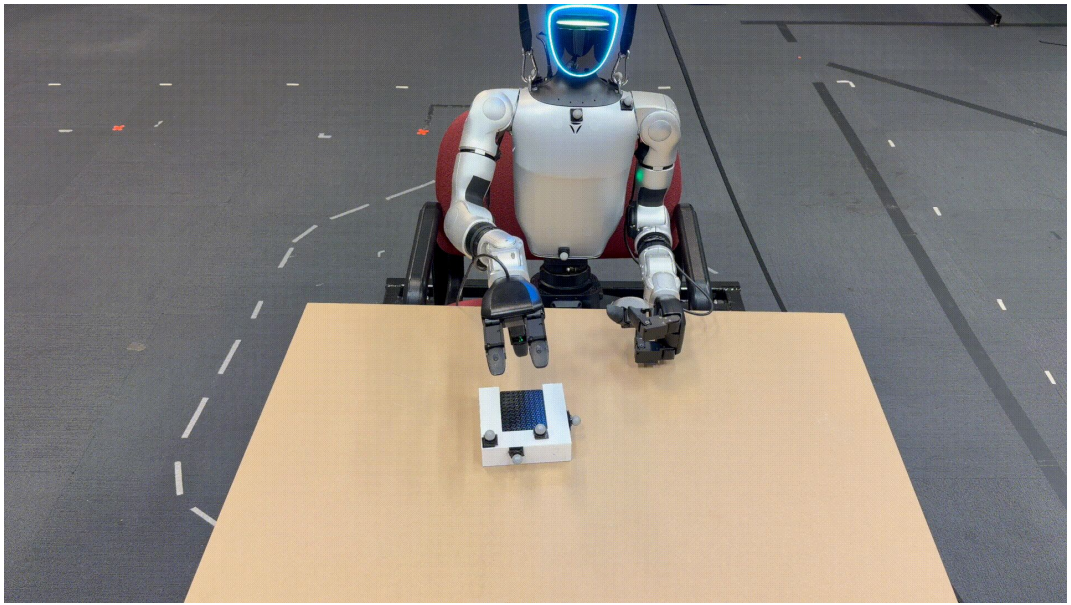
250g: 100% stable with current

350g OOD: prevents drops

force keeps tracking water volume

Side-swing motors reflect vertical force

Single-card picking: precise normal force



Challenge

Too little → missed

Too much → multiple cards

Results

Strict success: 55.8% → 76.9%

Multi-card failure: 7.7% → 0.0%

Current distinguishes contact formation vs excessive force

Caption

Slide 1

Dexterous manipulation is not just position tracking.
In contact-rich tasks, the hand must regulate whether it is pressing too hard, slipping, or maintaining contact.
But low-cost dexterous hands usually only expose joint-position control, and tactile or force sensors add cost and fragility.
So the question is: can we get touch-like feedback from the hand itself?

Slide 2

The key observation is that motor current changes when the motor pushes against an object.
Since current is related to actuator torque, it contains information about contact force and object resistance.
The paper verifies this on Dex3 and LEAP Hand, motivating the idea of using current as built-in tactile-like feedback.

Slide 3

The method does not estimate force or command torque.
It predicts a compliance reference position, or CRP, which is still a joint-position target for a standard PD controller.
A current-conditioned CRP changes the PD error, and therefore changes the contact force.
Too deep may crush the object; too conservative may slip.
The model learns the position target that induces the right compliant torque.

Slide 4

CRP supervision comes from teleoperation.
The human observes deformation, slip, or stable grasping and continuously corrects the command, so the command trajectory becomes a noisy but valid CRP label.

This data also contains stiffness.
In free space, Δq causes little current change; in contact, especially with stiff objects, small Δq can create large ΔI.
So ΔI over Δq gives the model contact stiffness, which determines whether the CRP should be conservative or deeper.

User intention is represented by command velocity instead of raw command position, telling the model whether the user wants to grasp, release, or hold.
Foam cup