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CVPR
VANCOUVER, CANADA

PartManip

Learning Cross-Category Generalizable Part Manipulation Policy from Point Cloud Observations

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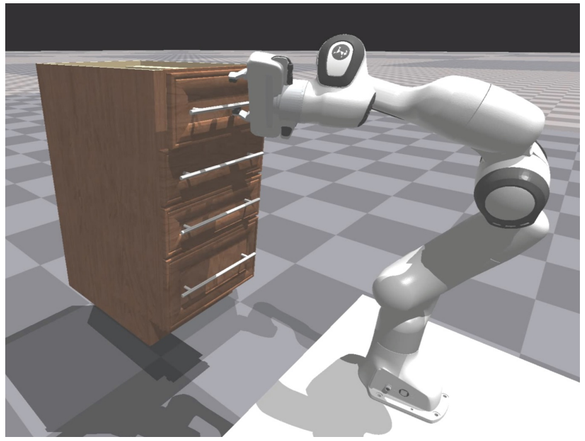
We humans can successfully manipulate certain types of parts across different objects in a similar way.

Pressing Buttons on Microwave

Opening Drawer on Table

In this work, we tackles generalizable part-based manipulation policy learning.



open drawer in simulator

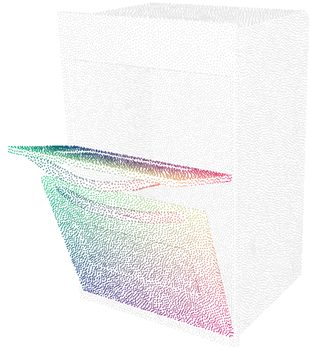
open drawer in real world

Problem Setting

1. Realistic robotic setting

2. Cross-category generalization

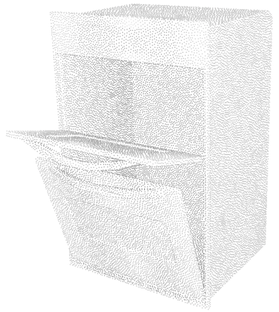
Previous works



Take inputs oracle object states
e.g. part mask, handle mask

Objects from single category

Ours



Realistic inputs,
Depth Point cloud + Robot proprioception

Objects from multi-categories and generalizes to unseen categories

Our Benchmark

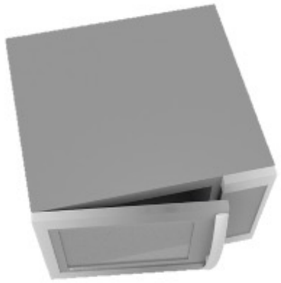
494 objects borrowed from GAPartNet[1]
11 object categories

Table

Remote

Oven

Dishwasher



Microwave

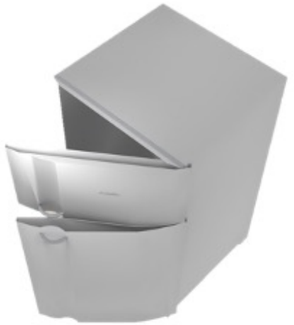
TrashCan

storage furniture

Washing machine

Safe

Phone



Refrigerator

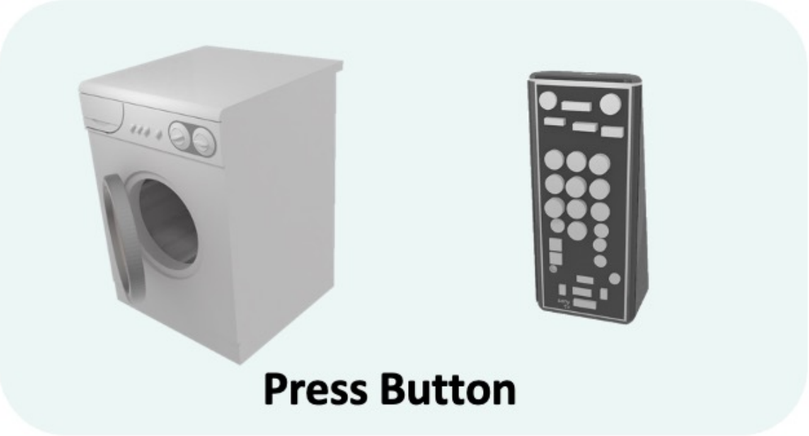
1: GAPartNet: Cross-Category Domain-Generalizable Object Perception and Manipulation via Generalizable and Actionable Parts. *Geng, et. al.*

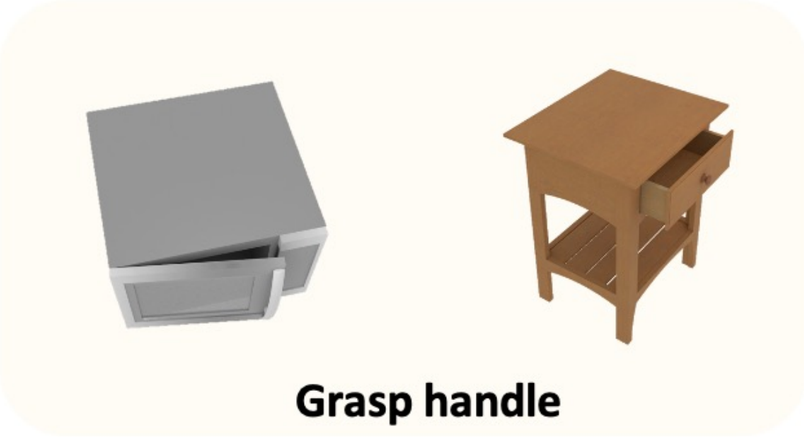
Our Benchmark

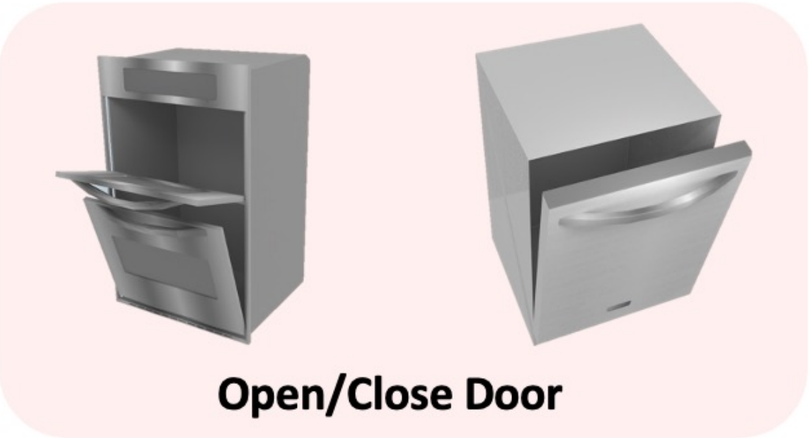
494 objects
11 object categories

Six tasks

1432 different parts

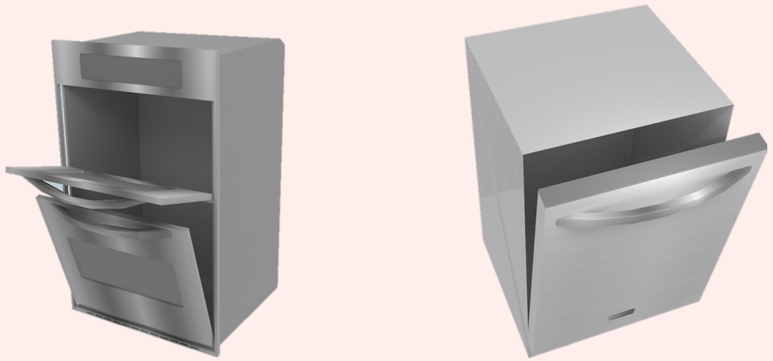




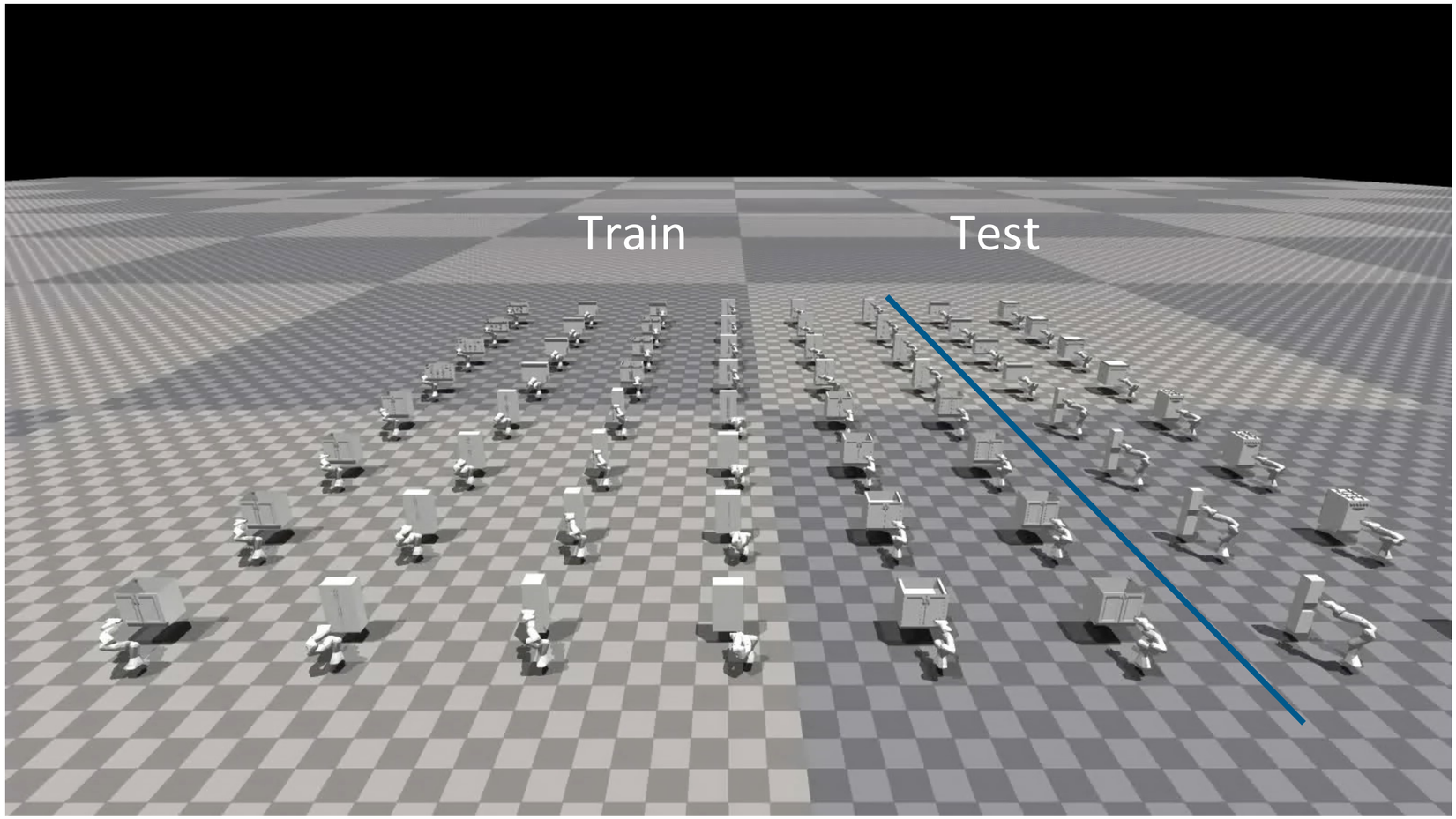


Task Example: Opening Doors

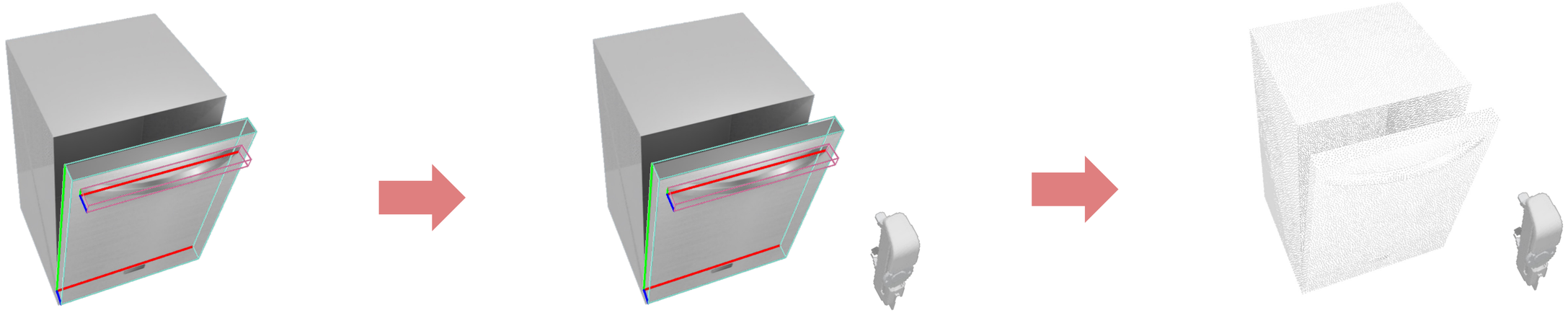
363 Training Doors
63 unseen doors in seen categories
77 unseen doors in unseen categories



Open Door



Method Overview

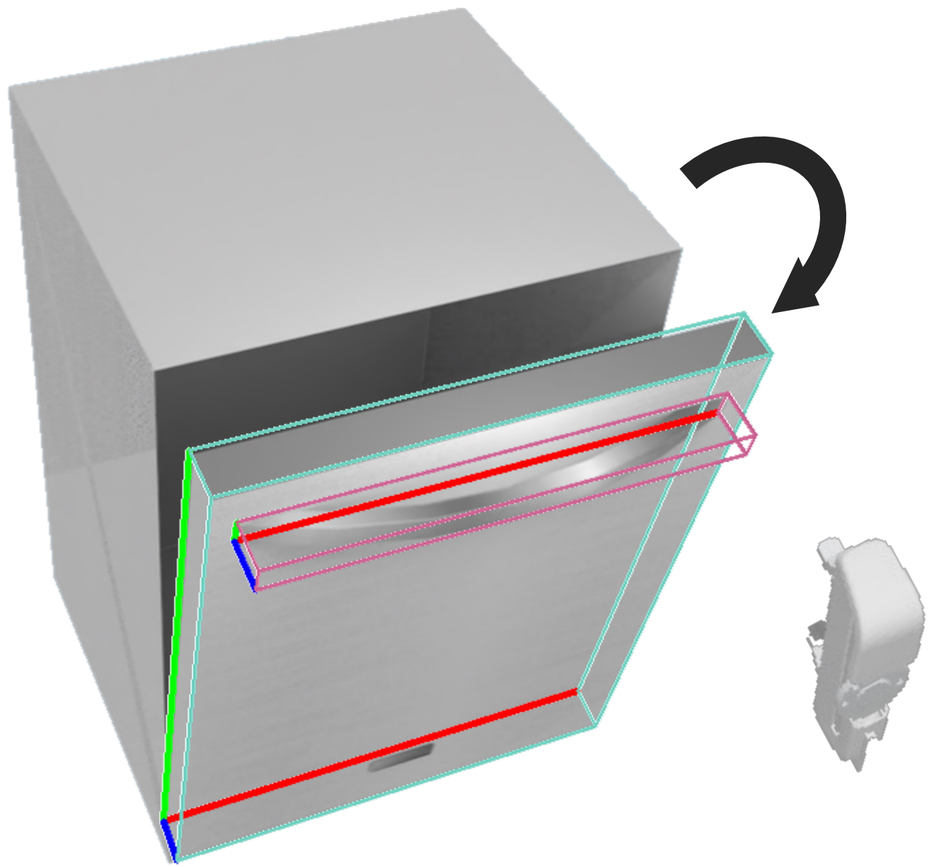


Part-Aware Reward

State-based Expert Policy

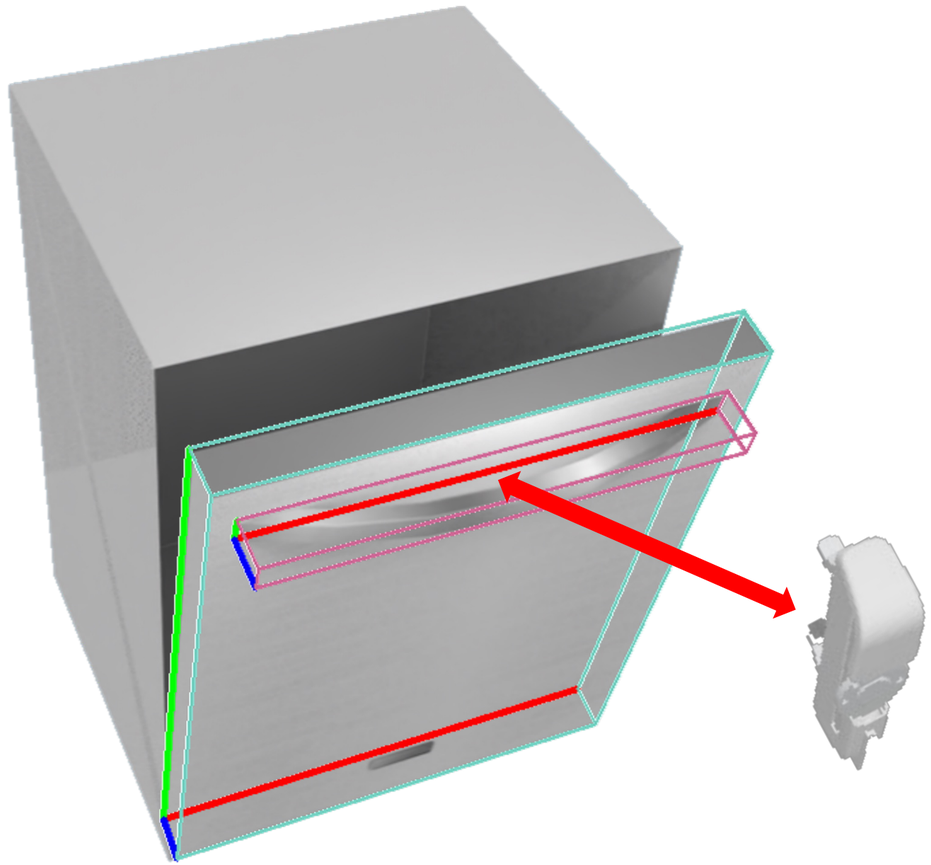
Vision-based Student Policy

Part-Aware Reward



Part Moving Reward:
Moving distance of rotations of the target part

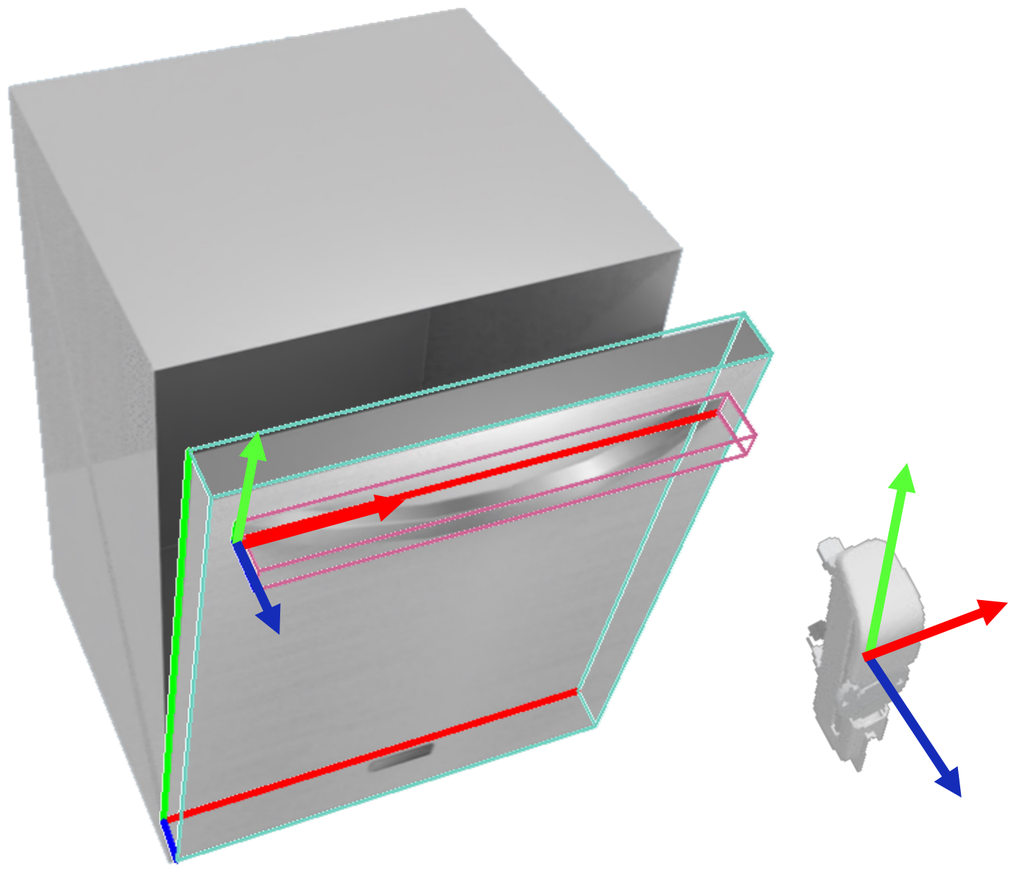
Part-Aware Reward



Part Moving Reward:
Moving distance of rotations of the target part

Handle Distance Reward:
the negative value of the distance from the handle center to the center of the tips.

Part-Aware Reward

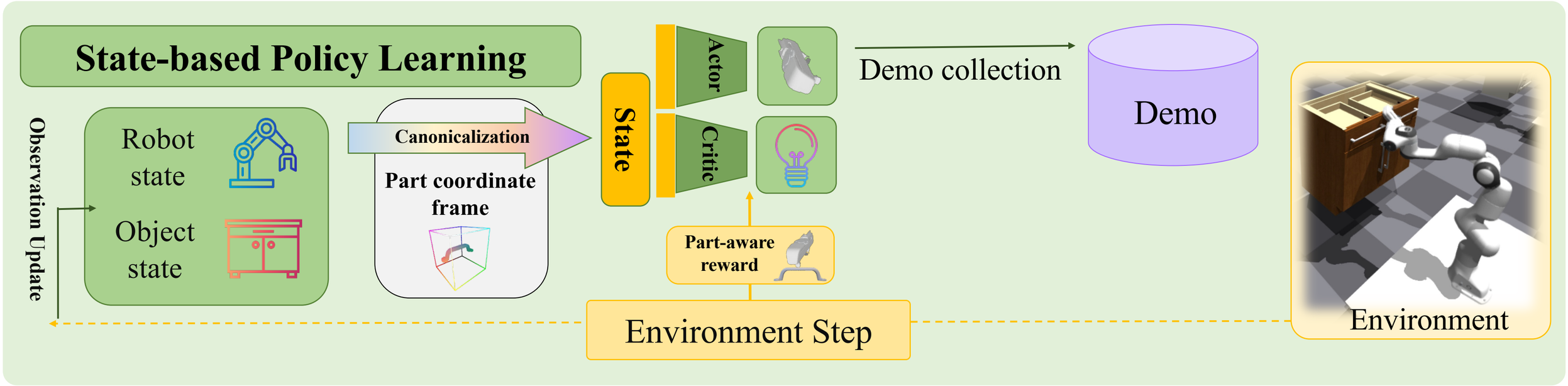


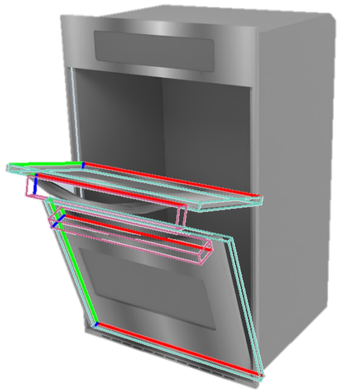
Part Moving Reward:
Moving distance of rotations of the target part

Handle Distance Reward:
the negative value of the distance from the handle center to the center of the tips.

Rotation Reward:
the dot production of three axes of gripper and handle

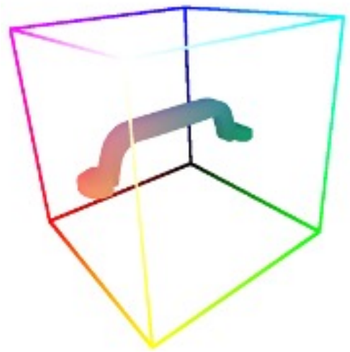
State-based Policy Training





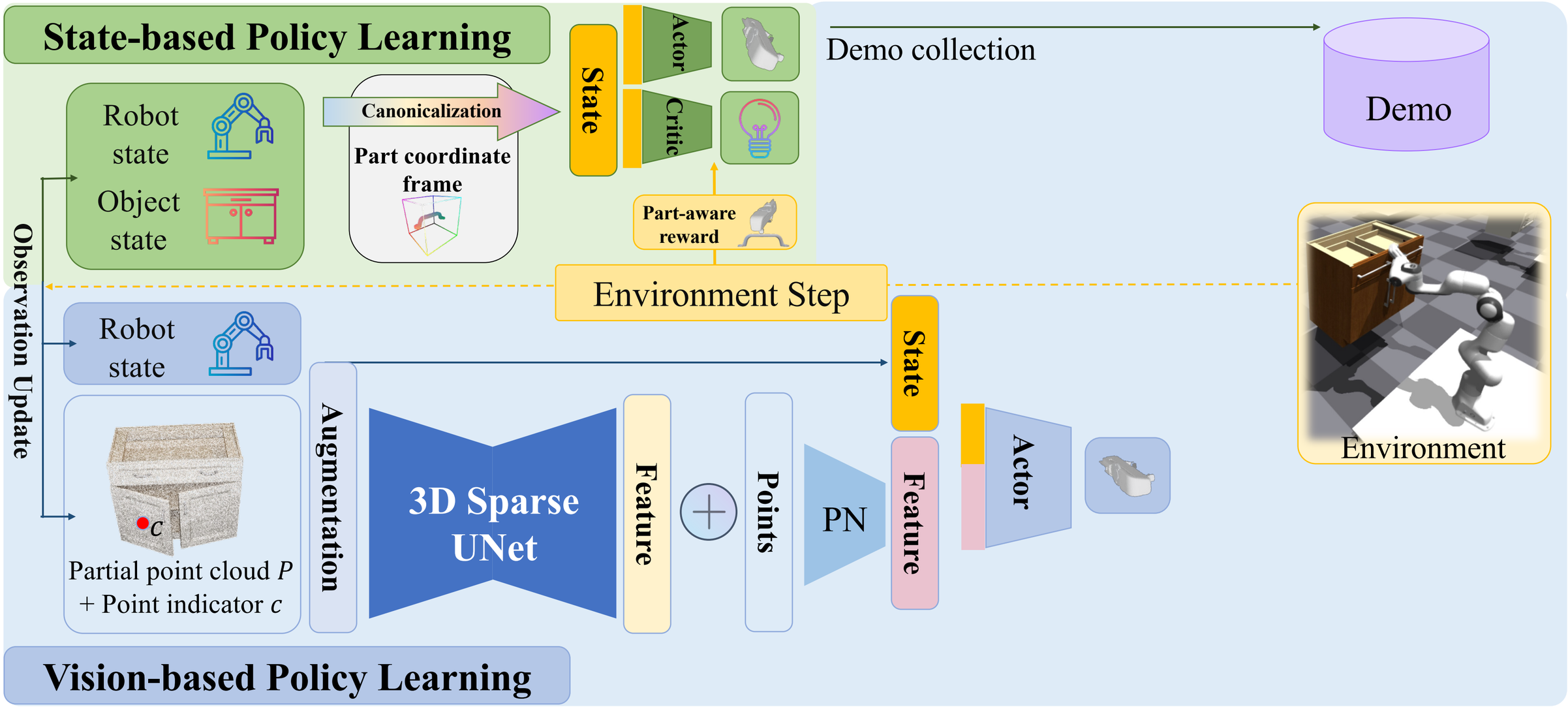
Part Bounding Box
Handle Bounding Box

Robot arm joint angle

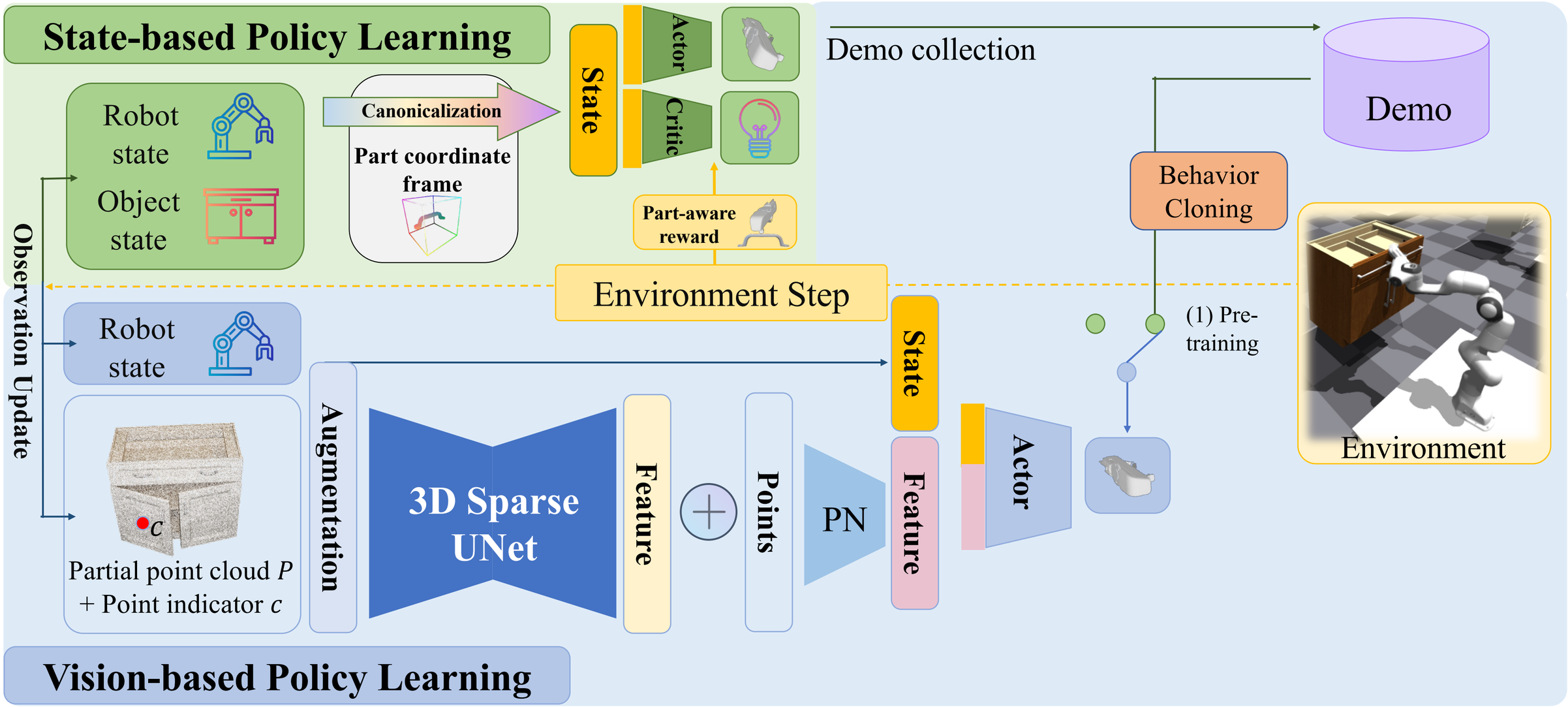


Canonical space of the handle

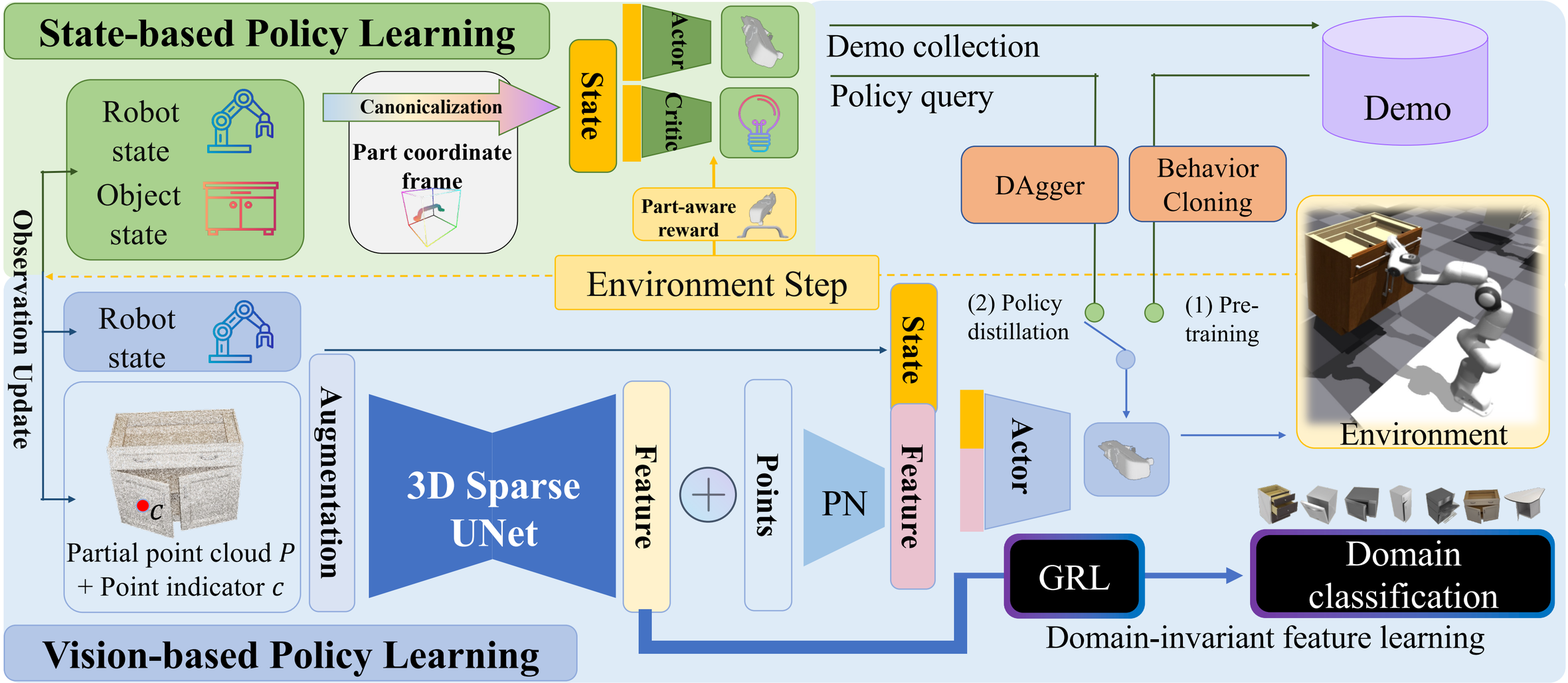
Vision-based Policy Training



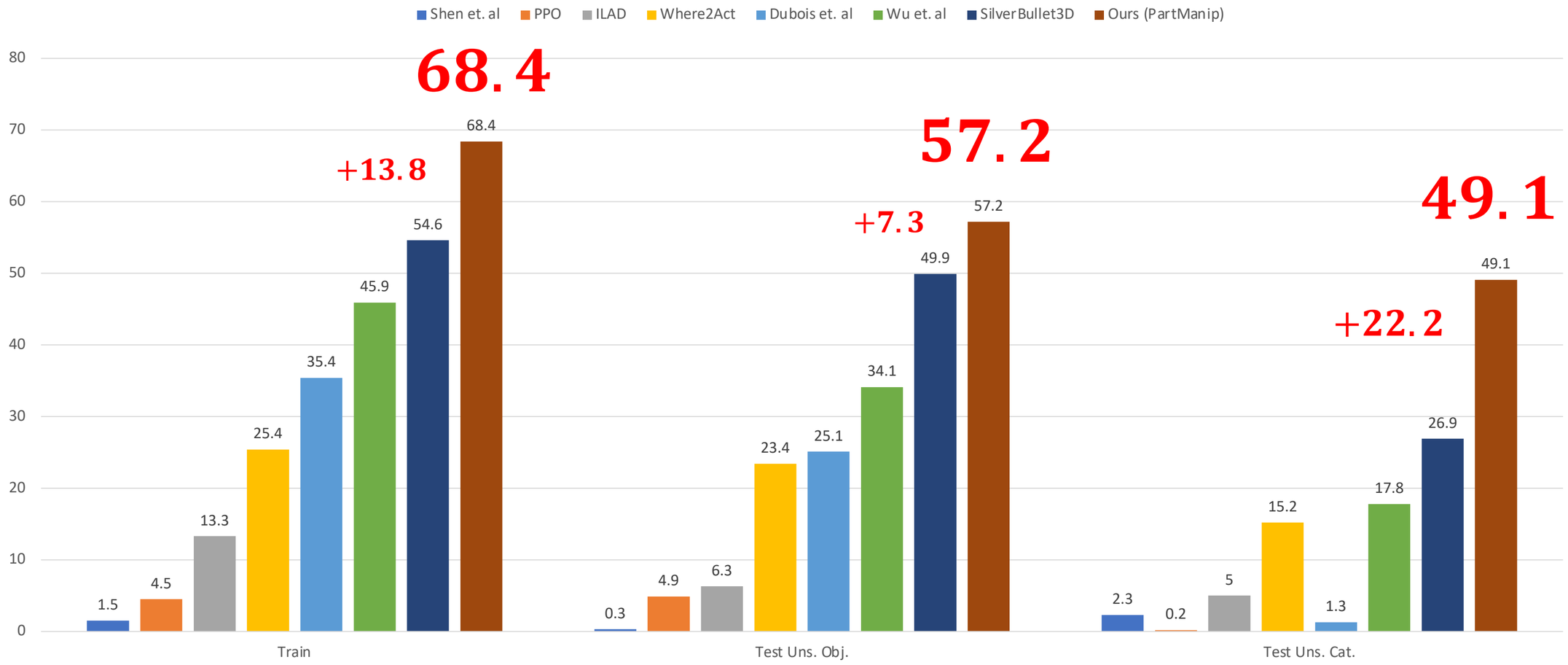
Vision-based Policy Training



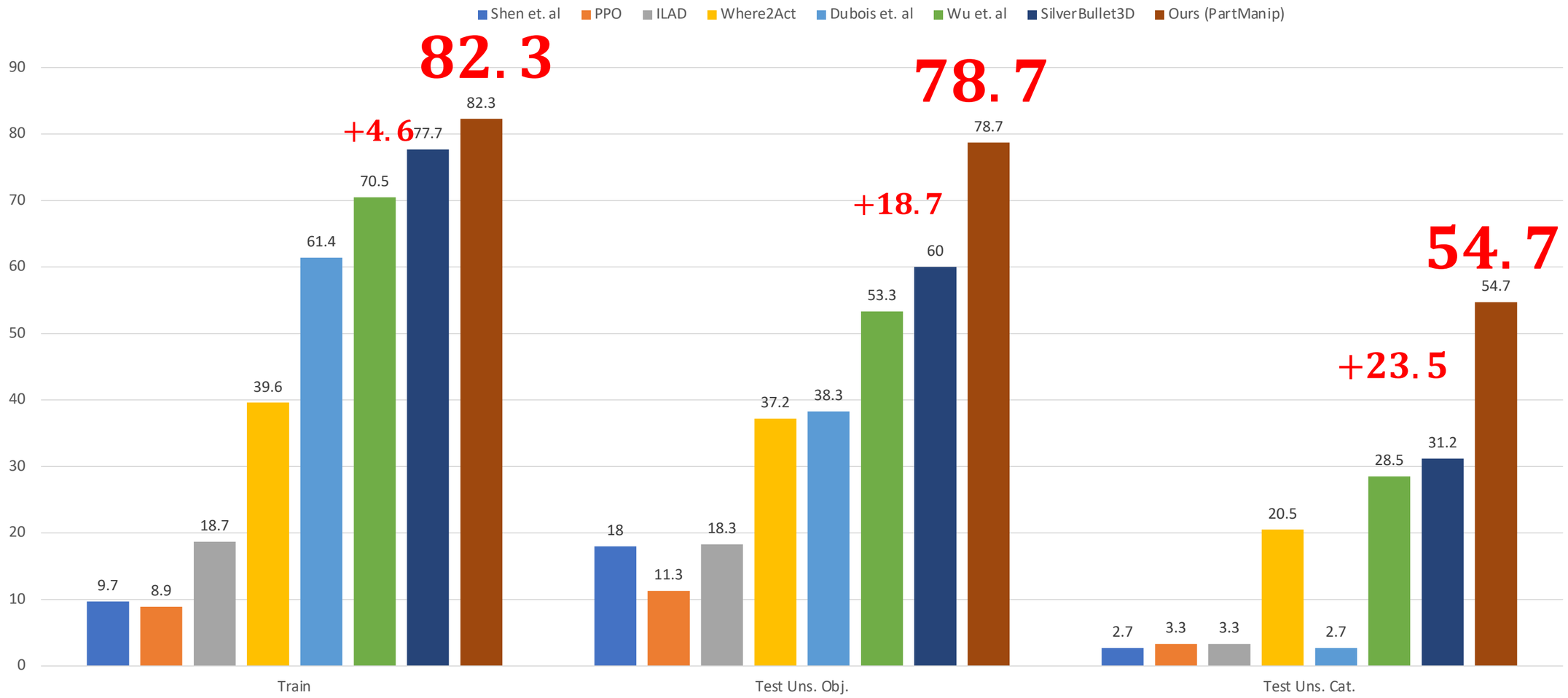
Vision-based Policy Training



Results of Opening Door



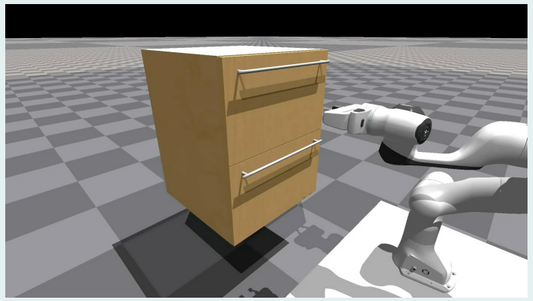
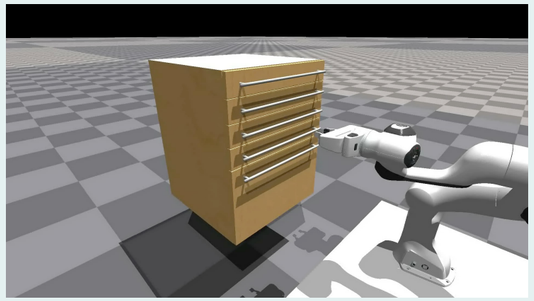
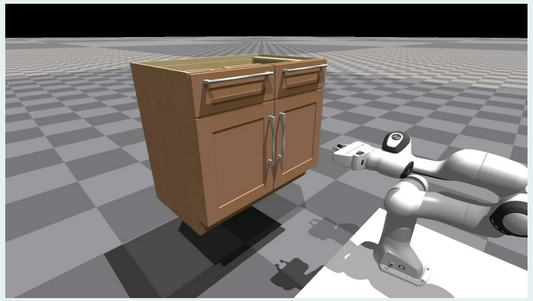
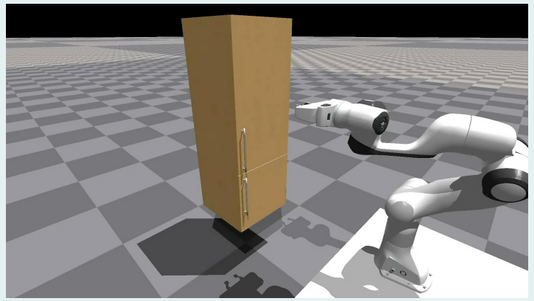
Results of Opening Drawer



Training Results

GAIL based Approach[1]

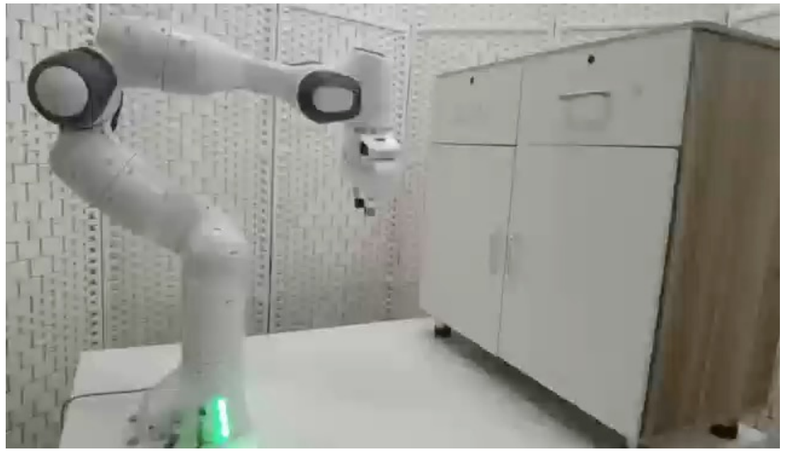
Ours

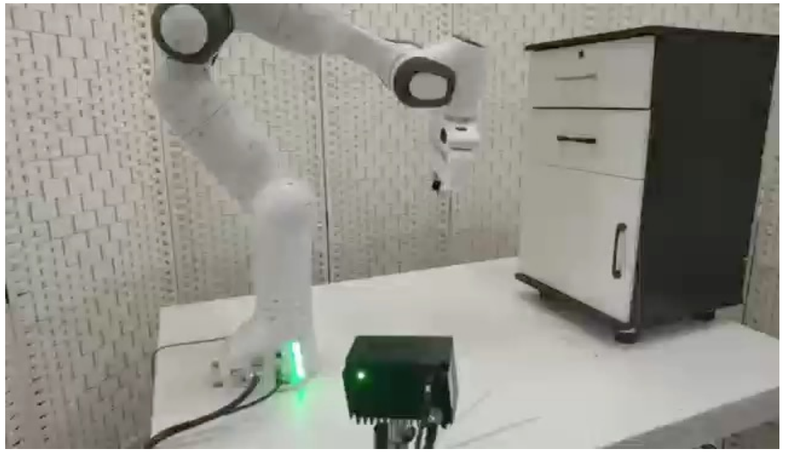





1: Learning Category-Level Generalizable Object Manipulation Policy via Generative Adversarial Self-Imitation Learning from Demonstrations, *Shen, et. al.*

Real-World Experiment

Open doors and drawers
in the real world





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Thanks for watching!

Project

Code