NEURAL INFORMATION PROCESSING SYSTEMS

北京大學 PEKING UNIVERSITY

BAAI 智源研究院

Learning Score-based Grasping Primitive for Human-assisting Dexterous Grasping

Tianhao Wu*, Mingdong Wu*, Jiyao Zhang, Yunchong Gan, Hao Dong

{thwu}@stu.pku.edu.cn,{wmingd,hao.dong}@pku.edu.cn

* Equal Contribution

hyperplane lab

Motivation

- Human hand plays a fundamental role in our daily lives, enabling us to interact with and manipulate objects in a versatile and precise manner.

- Hand loss limiting the capability of performing working, social, and daily living activities[1].

[1] Cordella F, Ciancio A L, Sacchetti R, et al. Literature review on needs of upper limb prosthesis users[J]. Frontiers in neuroscience, 2016, 10: 209.

Motivation

- The current prosthetic hand usually controls the fingers by mapping EMG or EEG signals, which can be affected by electrode shifting, muscle fatigue, etc[1].
- Some methods predict the grasp type according to image contains the object, which is not closed-loop and only has limited grasp type[2].

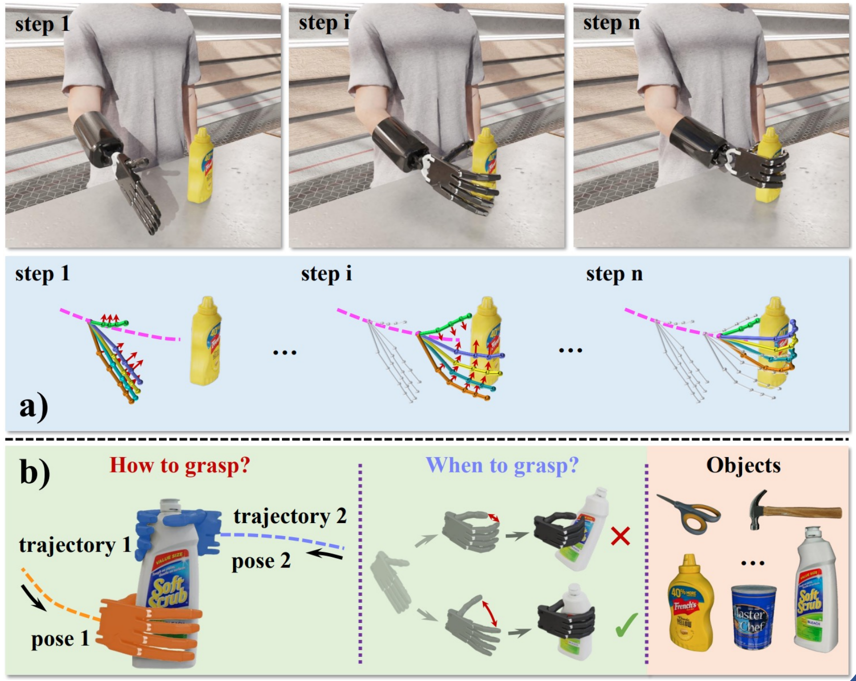
- **Human-assisting Dexterous Grasping**: train a policy to control the robotic hand's finger **autonomously in a closed-loop manner**, to assist human in grasping **diverse objects** with **diverse grasp poses** under **diverse human movement trajectories**.

[1] Zandigohar, Mehrshad, et al. "Multimodal fusion of emg and vision for human grasp intent inference in prosthetic hand control." *arXiv preprint arXiv:2104.03893* (2021).

[2] Ghazaei, Ghazal, et al. "Deep learning-based artificial vision for grasp classification in myoelectric hands." *Journal of neural engineering* 14.3 (2017): 036025.

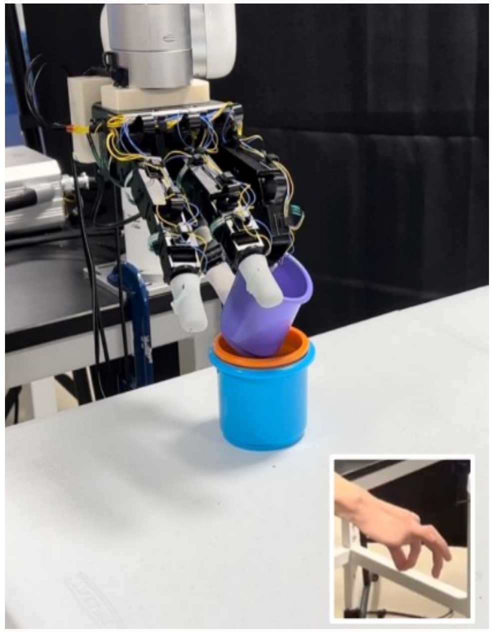
Motivation

Human-assisting Dexterous Grasping
Agent Centric



Conventional Dexterous Grasping
Object Centric

Teleoperation[1]



Robot hand finger

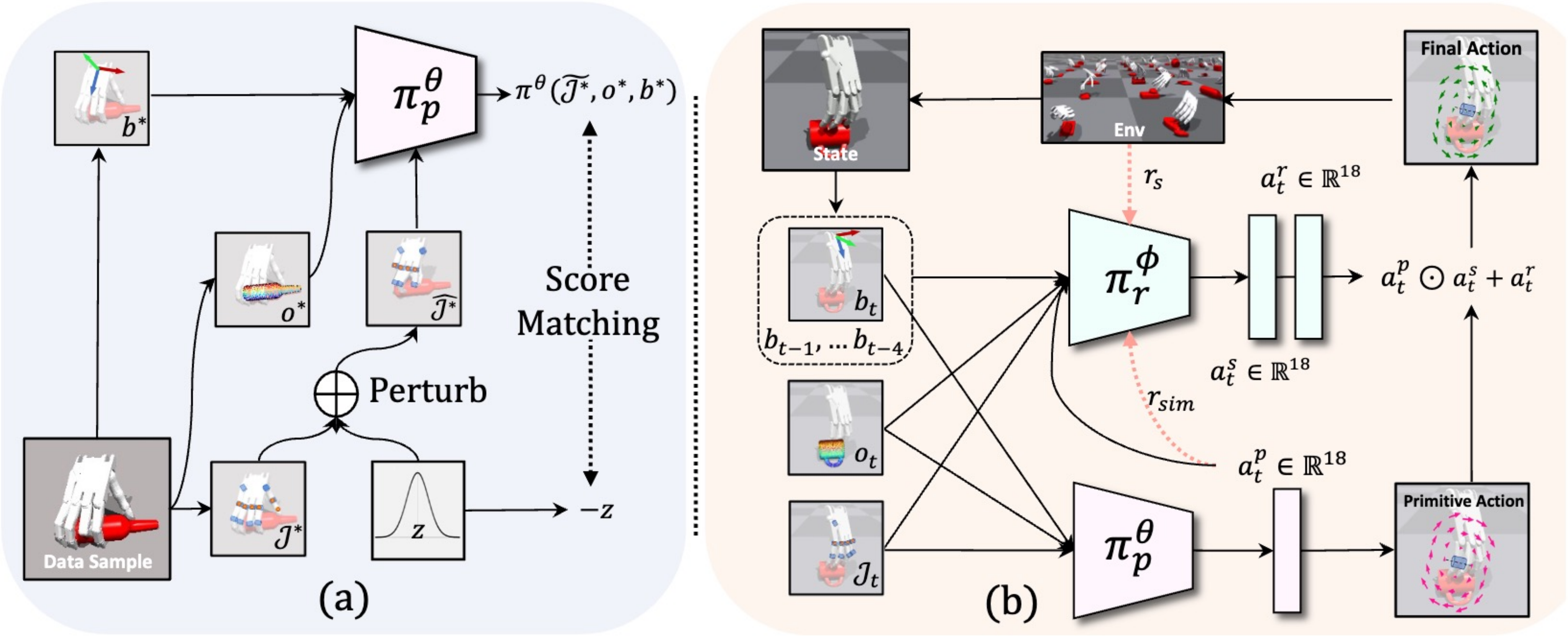
Robot wrist

Human hand finger

Human wrist

[1] Qin, Yuzhe, et al. "Anyteleop: A general vision-based dexterous robot arm-hand teleoperation system." *arXiv preprint arXiv:2307.04577* (2023).

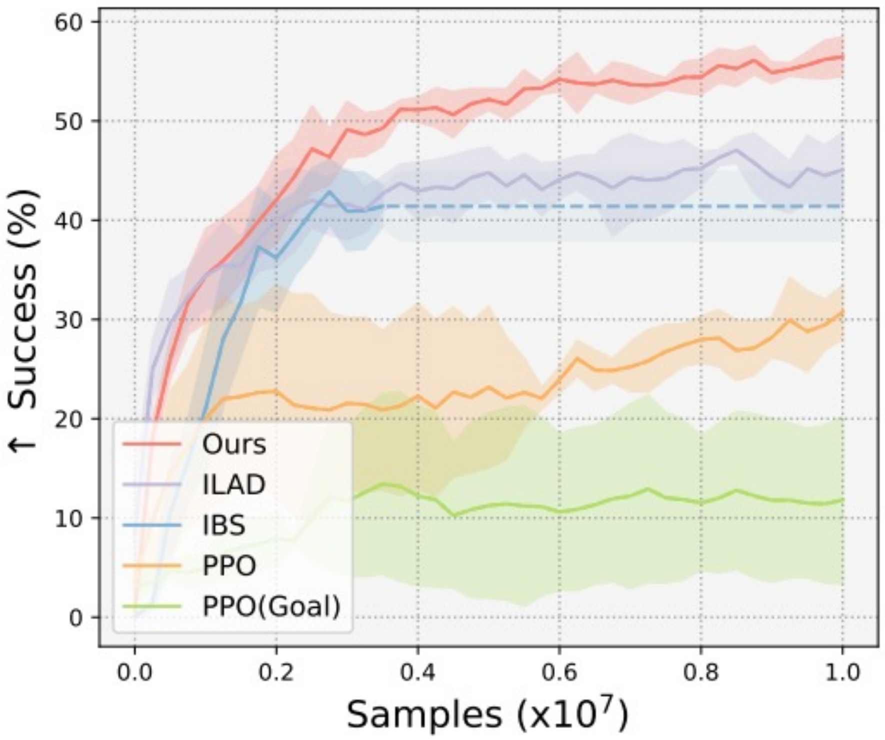
Method

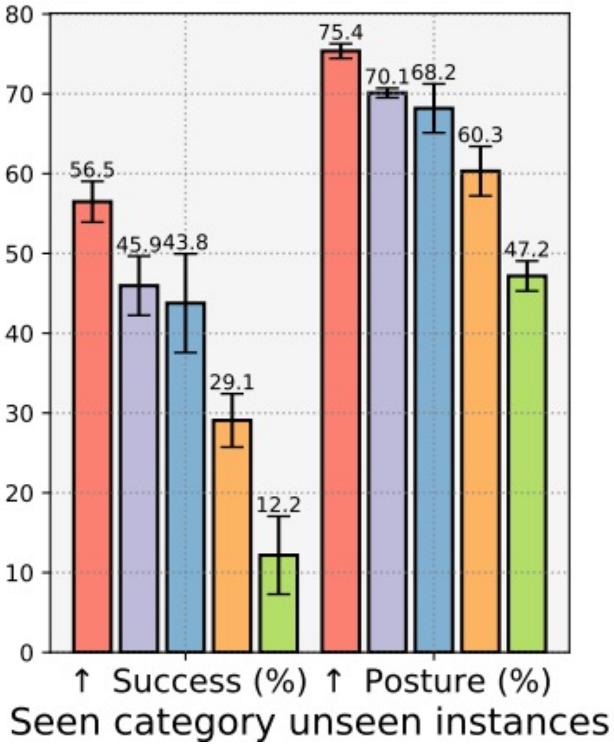


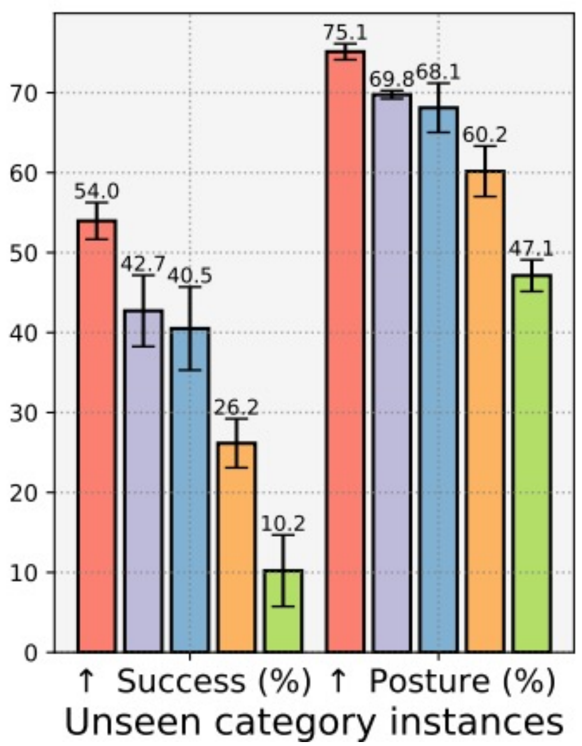
How to grasp: Primitive Policy

When to grasp: Residual Policy

Comparative Results



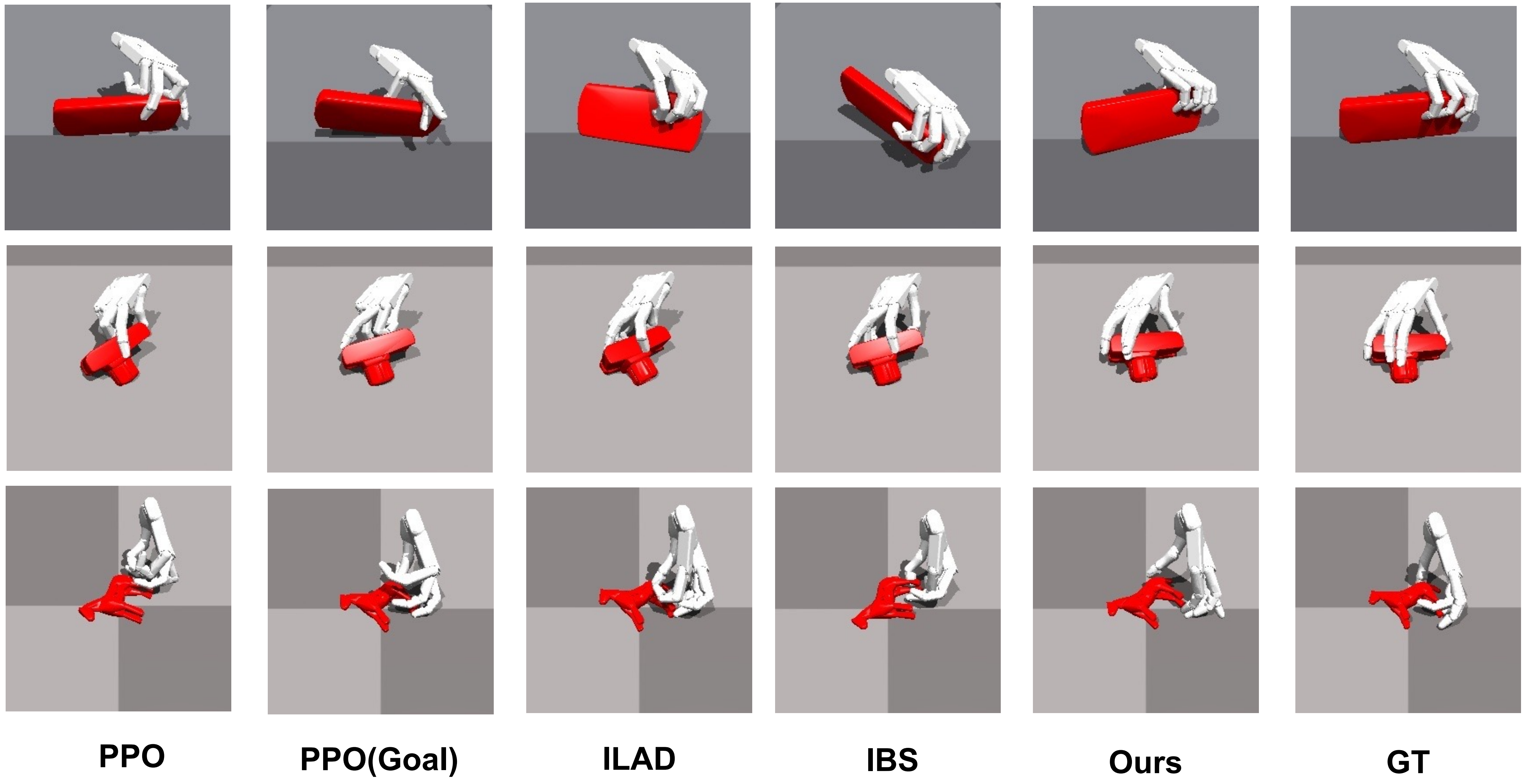




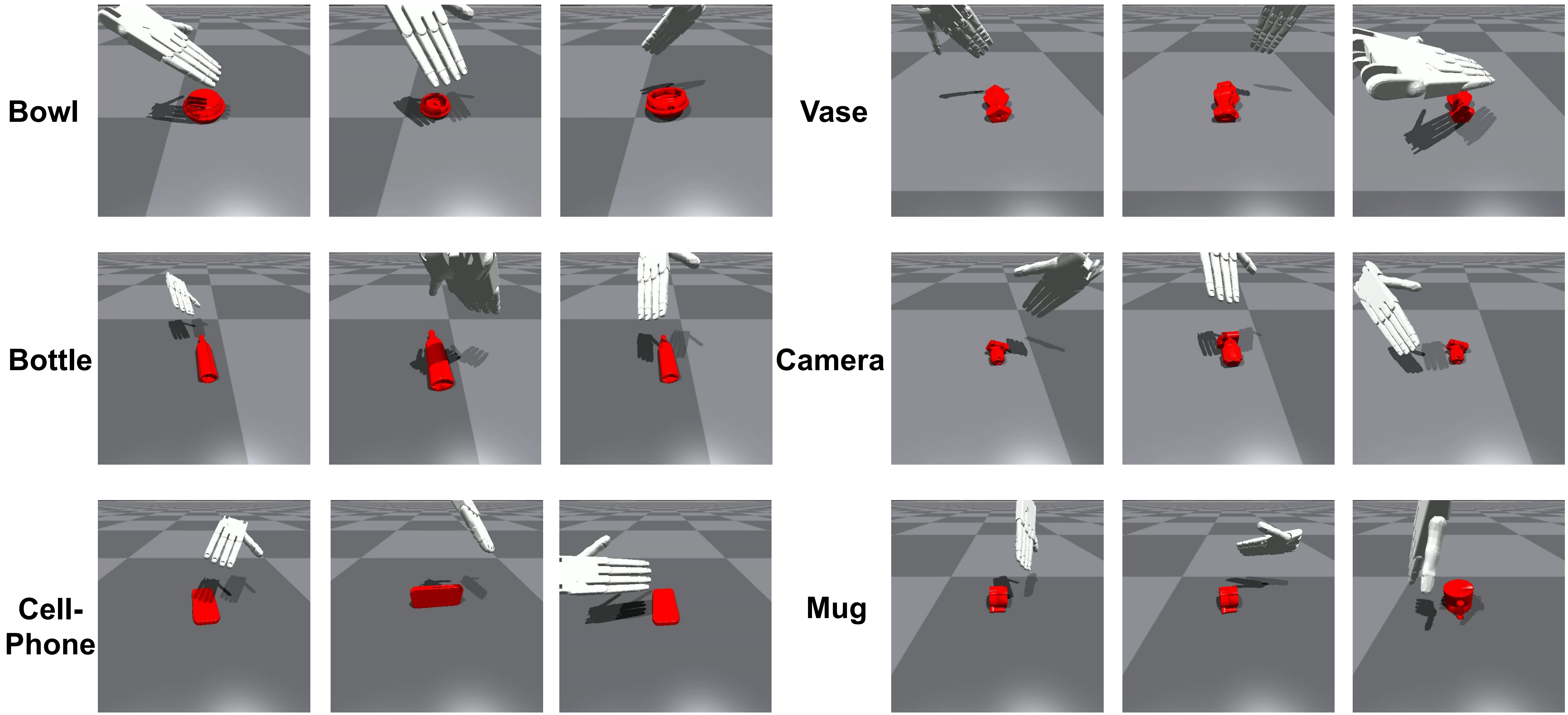
	Seen Category		Unseen Category	
	Tran(cm) ↓	Rot (rad) ↓	Tran(cm) ↓	Rot (rad) ↓
PPO(Goal)	$2.621_{\pm 0.415}$	$0.589_{\pm 0.038}$	$2.537_{\pm 0.296}$	$0.543_{\pm 0.040}$
PPO	$2.745_{\pm 0.168}$	$0.594_{\pm 0.045}$	$2.771_{\pm 0.254}$	$0.563_{\pm 0.039}$
IBS	$2.653_{\pm 0.030}$	$0.572_{\pm 0.002}$	$2.596_{\pm 0.119}$	$0.520_{\pm 0.011}$
ILAD	$2.443_{\pm 0.042}$	$0.548_{\pm 0.027}$	$2.534_{\pm 0.101}$	$0.515_{\pm 0.022}$
Ours	$\mathbf{2.131}_{\pm 0.138}$	$\mathbf{0.449}_{\pm 0.020}$	$\mathbf{2.127}_{\pm 0.165}$	$\mathbf{0.428}_{\pm 0.029}$

Stability on **seen category unseen instances** and **unseen category instances**

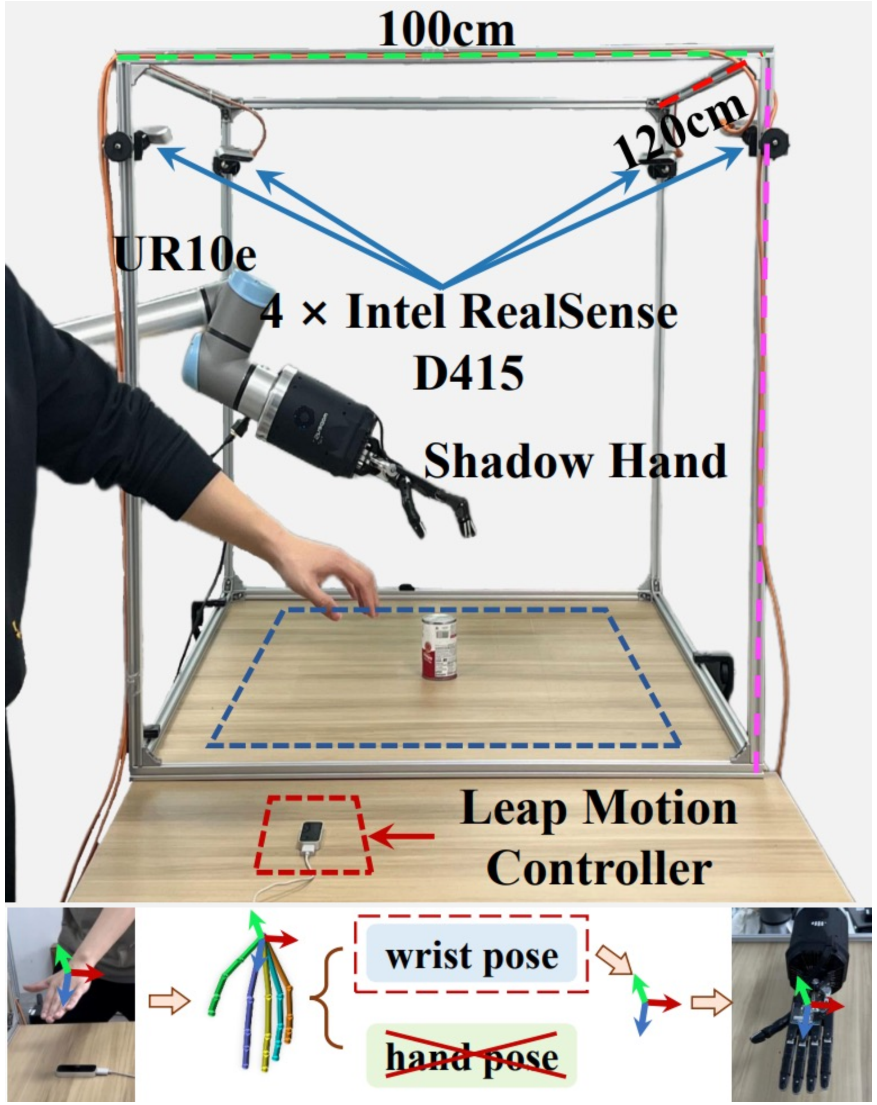
Qualitative Results – Comparison with Baselines



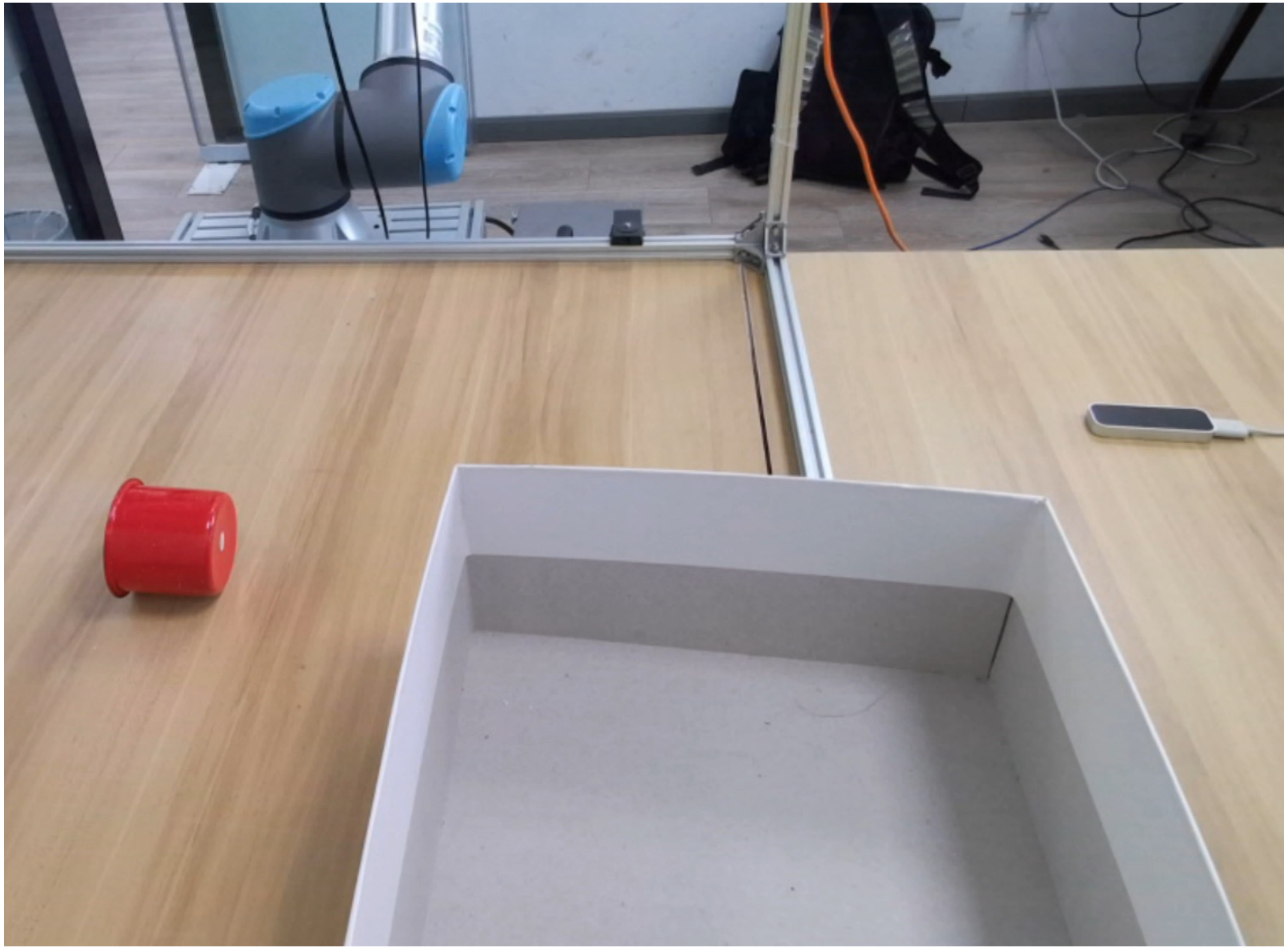
Qualitative Results – User-Awareness of Our Method



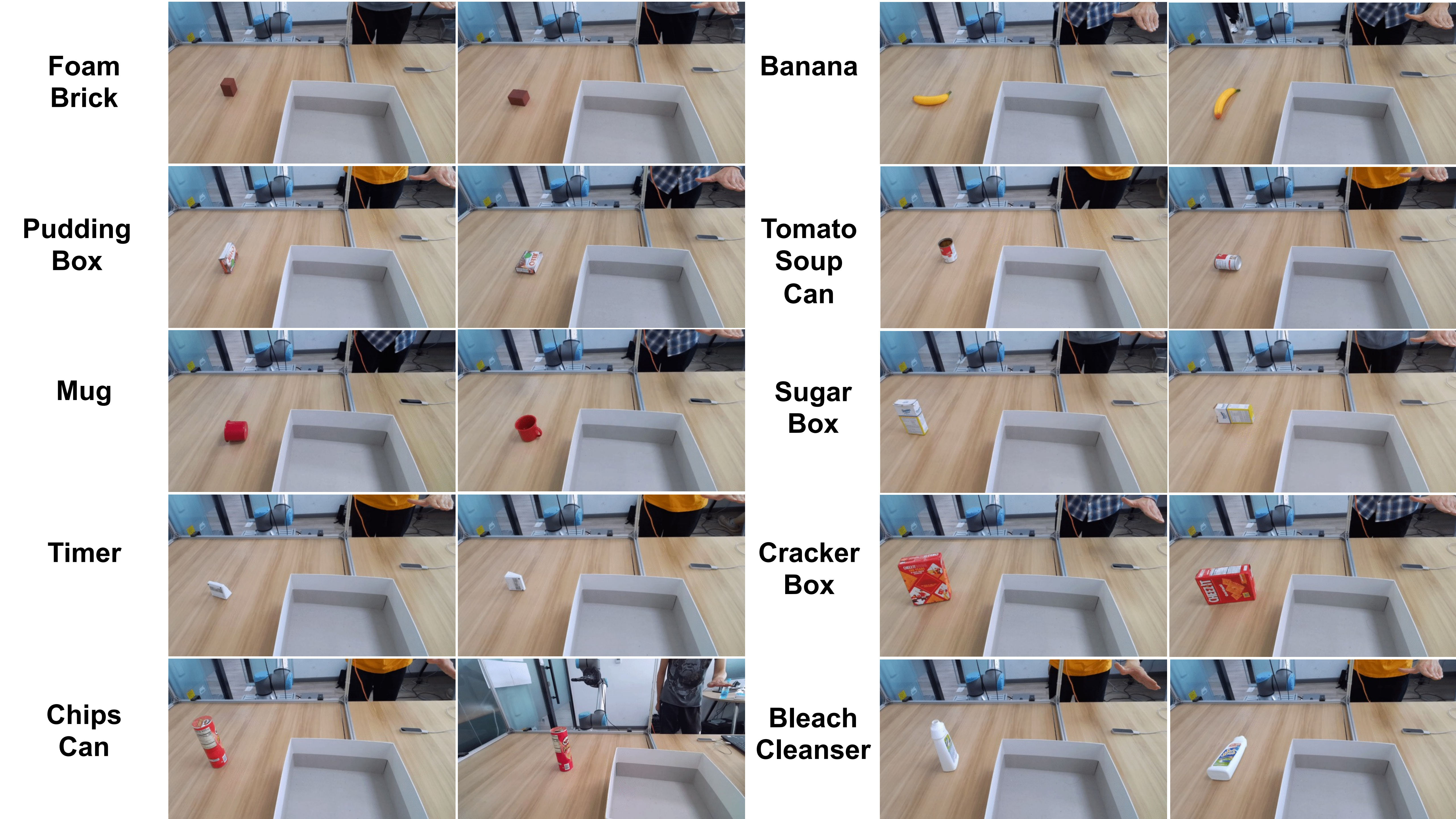
Real-World Experiment



a) real-world setup



b) real-world experiment demonstration


Foam Brick
Banana
Pudding Box
Tomato Soup Can
Mug
Sugar Box
Timer
Cracker Box
Chips Can
Bleach Cleanser

Thank for your watching!

https://sites.google.com/view/graspgf