Legs as Manipulator: Pushing Quadrupedal Agility Beyond Locomotion

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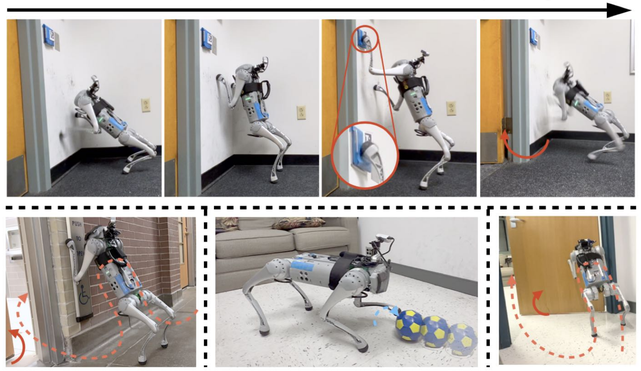
ICRA LONDON · 2023

robo-skills.github.io

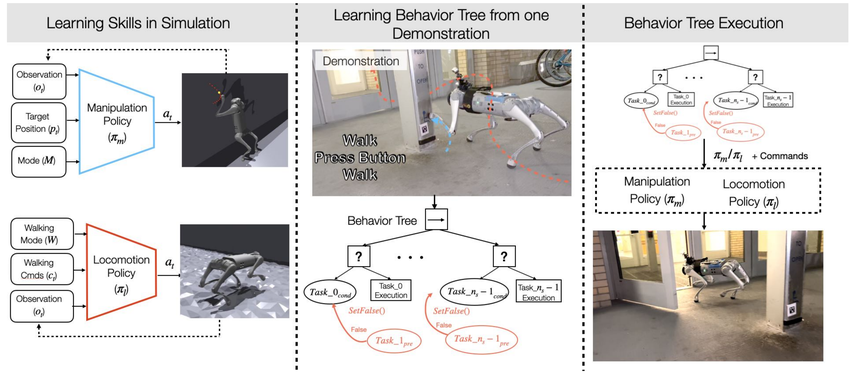
Both long horizon and short horizon tasks involving walking, climbing, de-climbing and simple manipulation skills like pushing a button.



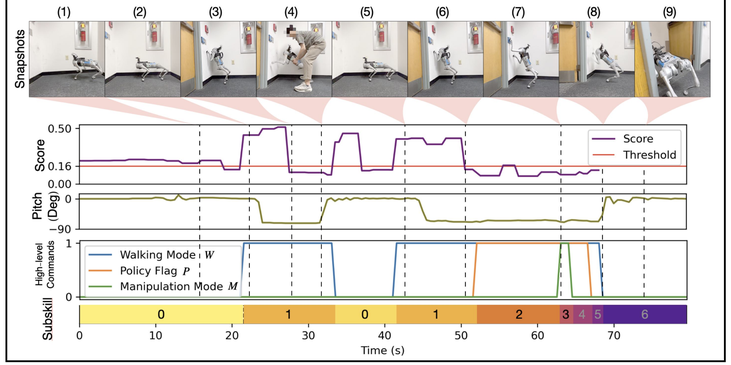
Long horizon task.

Short horizon tasks.

We first learn skills in simulation and then learn a high-level task abstraction in the real world. Then we execute the learned behavior tree together with the skills learned in simulation.

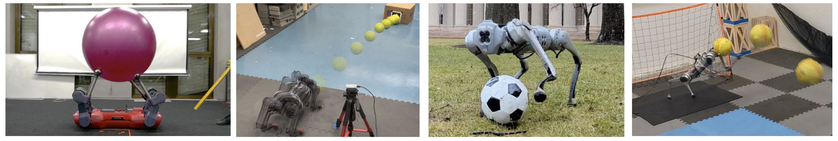


Demonstration of a long horizon door-opening task with learned behavior tree from expert demonstration.



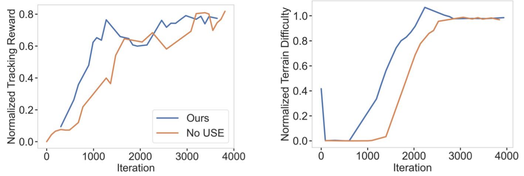
Quadrupedal robots can walk across challenging scenarios

However quadrupedal animals not only use their legs to walk but also to open a door, dig a hole, pull an object, etc.
Existing work usually studies this problem in a decoupled manner or does not fully utilize the agility of the legs.



In this work, we study this **joint problem** of learning **locomotion** as well as **manipulation** skill.

We use Regularized Online Adaptation (**ROA**) and Unified State Estimator (**USE**) to sim-to-real.



(a) Tracking performance

(b) Terrain difficulty

USE helps the locomotion policy to achieve better performance and also boosts the training speed.

	Vel Error↓	Traj Error↓	Latent Loss Loco↓	Latent Loss Manip↓
Ours	29±11	3.1±3.0	8.6±6.3	6.5±6.0
RMA	39±30	4.7±6.1	92±33	53±27

ROA, while still showing a significant improvement in the student policy (about 30%) compared to RMA, achieving an order of magnitude improvement in regressing to environment latent.

Our method outperforms baselines in real world experiments in long/short horizon tasks' success rates/

Ours	3/3	5/5
w/o RB	1.2/3	2.6/5
Replay	1/3	2.6/5
	Subskills Completed	

Ours	6.2/7	5/5
w/o RB	2.6/7	2.6/5
Replay	1.8/7	2/5
	Subskills Completed	