

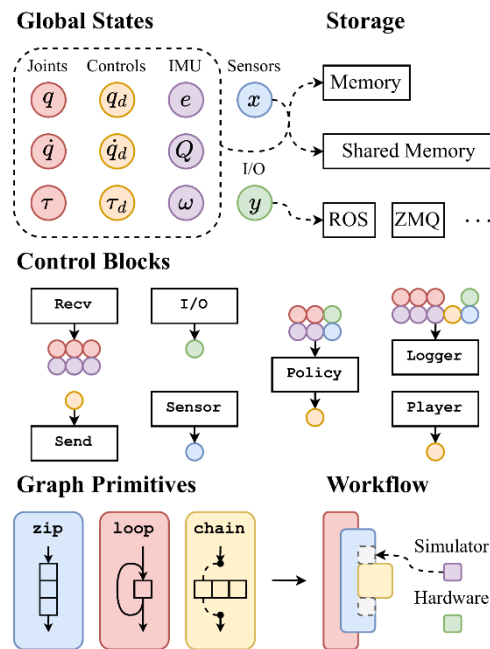
UniCon: A Unified System for Efficient Robot Learning Transfers

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Problems & Ideas

- Problems of current robot sim-to-real deployment:
 - Inconsistency in hardware and interfaces force re-implementation
 - Traditional middleware (ROS) introduces latency and overhead
- Ideas: A unified, modular and vectorized view on robot system states and control flow



Architecture of UniCon: (a) global system states with switchable storage backends; (b) modular control blocks covering platform and inference; (c) control flow graph primitives for workflow composition; and (d) unified integration with simulators and hardware.

Main Contributions

- Contributions:
 - A Lightweight framework for robot learning deployments;
 - Vectorized global states and modular control blocks enable efficient data flow;
 - 90% reduction in development effort for cross-platform deployment;
 - Enables seamless sim-to-sim, sim-to-real, and real-to-sim transfers.

Table 2 Comparison of transfer effort across workflows (code changes, in SLOC).

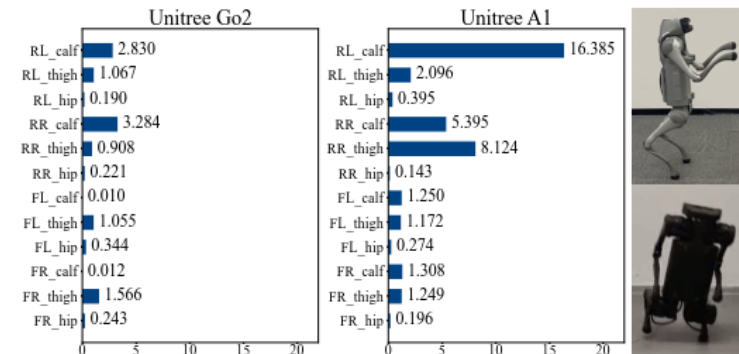
Framework	Components					Inference workflows			
	H1	Sim	G1	Adam	NN	H1	Sim	G1	Adam
Ad-hoc	852 (original code base for H1)					0	507	627	770
UniCon (ours)	393	382	35	394	350	0	0	0	0

Table 3 Comparison of framework efficiency on H1 (operation latency, in μs).

Operation	Frameworks			
	SDK (Sync)	SDK (Async)	ROS 2	UniCon (ours)
Recv	1261 $\pm$ 150	-	50 $\pm$ 88	63 $\pm$ 15
Send	1011 $\pm$ 72	1001 $\pm$ 65	587 $\pm$ 179	190 $\pm$ 45
End-to-end ¹	1805 $\pm$ 1559	1447 $\pm$ 936	1658 $\pm$ 882	732 $\pm$ 749

¹ Time between send and state timestamp, applying an inferred offset due to relative system clocks.

Compared to Ad-hoc implementation, UniCon requires no extra effort when switching deployment targets. UniCon also outperforms native Python SDK and ROS in terms of efficiency.



Using the UniCon's built-in analyzer, discrepancies can be measured to identify sources of the reality gap.