Motphys

Simulation Infrastructure for Embodied AI

Research grounds and Motphys work on simulation, training and real robot deployment

Motphys Tech Beijing Co., Ltd.

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Industry commitment to simulation

"We are using simulation heavily in our approach to build robotics."

Jim Fan, NVIDIA GEAR Sequoia Training Data interview, 2024

18 MAR 2025

NVIDIA + Google DeepMind + Disney Research

Newton physics-engine collaboration

21 JUL 2026

World Labs acquires SceniX

Real-to-sim-to-real training and evaluation

Sources: Sequoia Training Data; NVIDIA, 18 Mar 2025; World Labs, 21 Jul 2026.

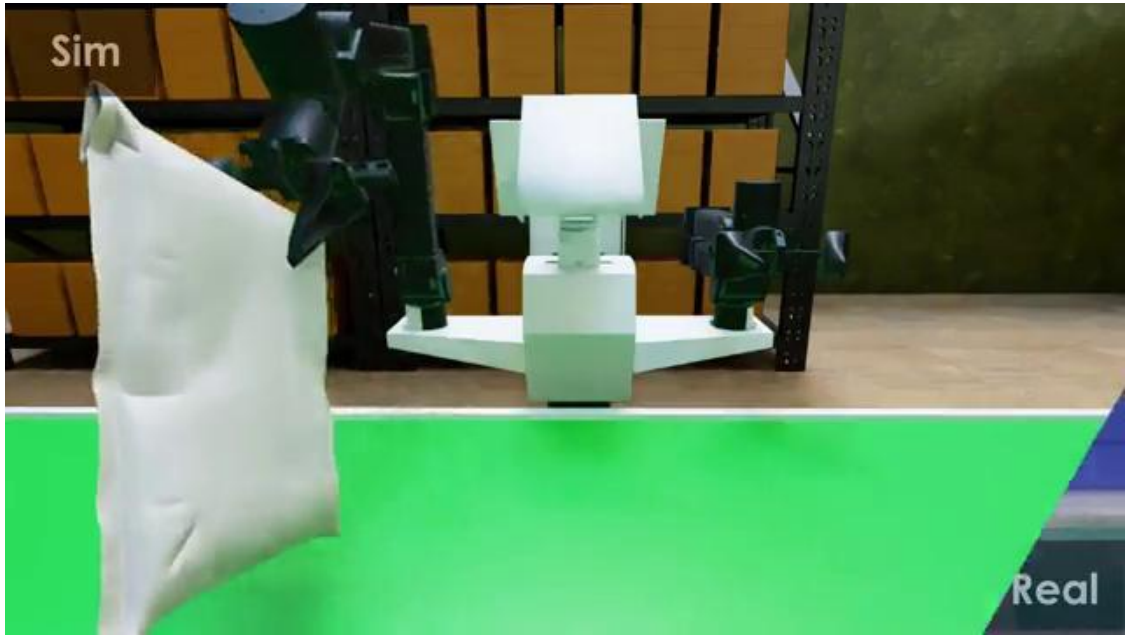
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InternData-A1: synthetic robot training data

100% **synthetic robot training data**

630k episodes 70 tasks 4 embodiments

AUTHORS' SIM / REAL ROBOT EXAMPLE 1



AUTHORS' SIM / REAL ROBOT EXAMPLE 2

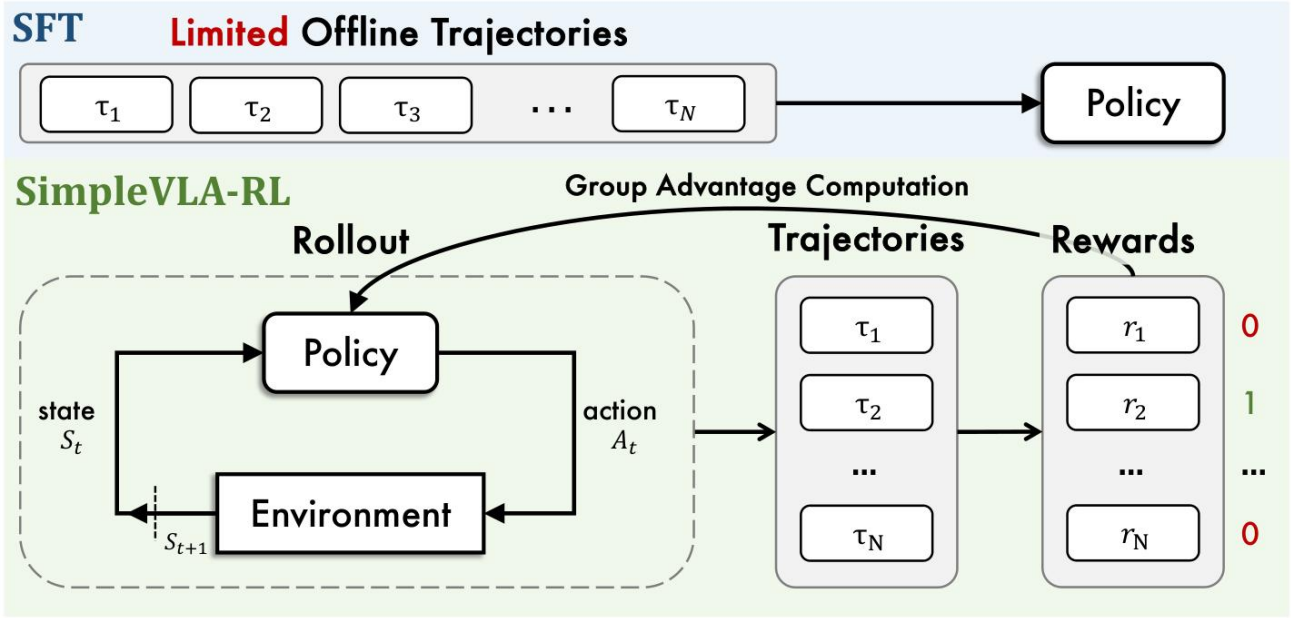


Reported sim-to-real feasibility with no real robot training data

InternData-A1 authors' project page. Synthetic-only claim covers the reported robot training data.

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SimpleVLA-RL: interactive policy improvement



REAL ROBOT SUCCESS

17.5% to 38.5%

SFT SFT + RL

+21 percentage points

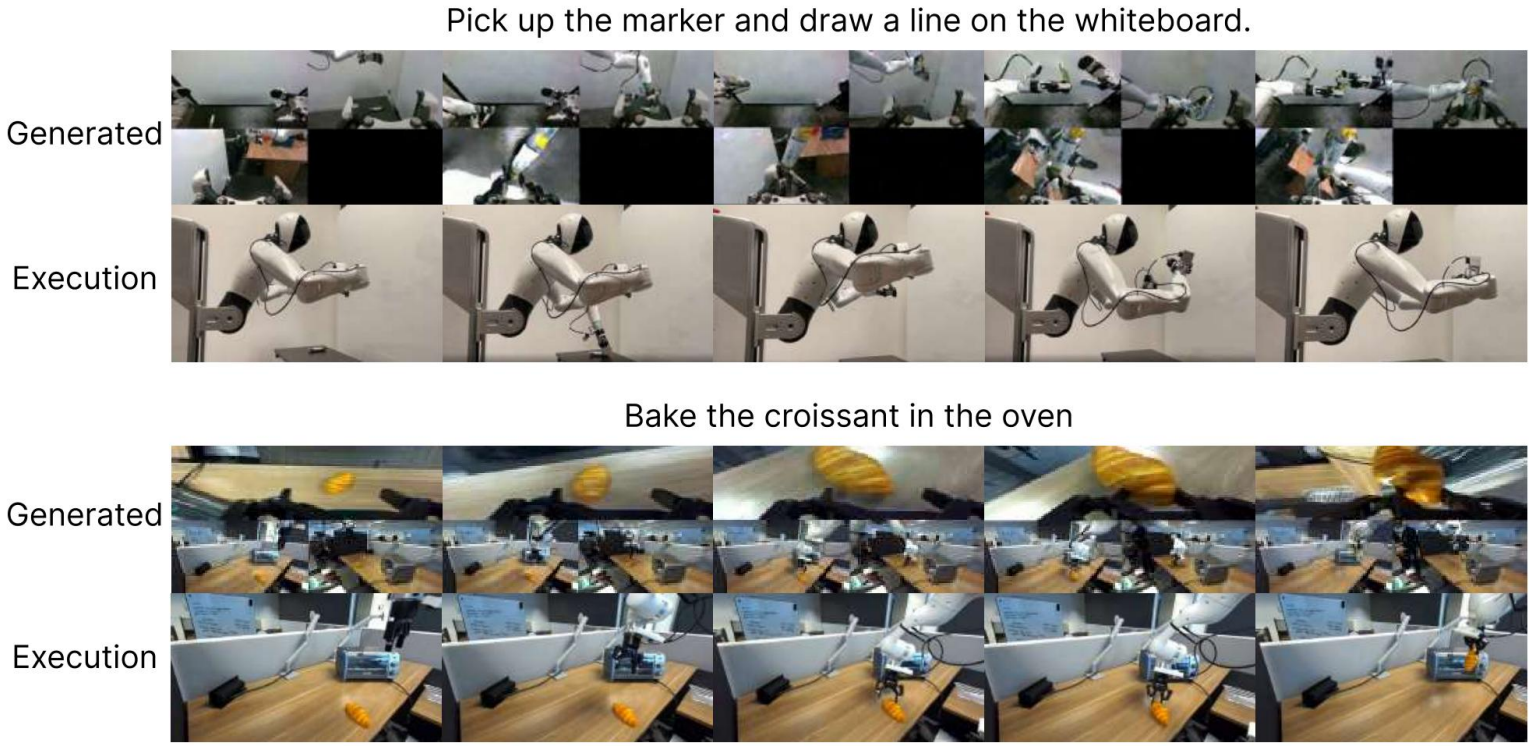
4 real robot tasks
50 trials per task
Task SFT + RL use simulated data

Simulation supplies exploration and feedback beyond a fixed dataset

SimpleVLA-RL, arXiv:2509.09674v1, Sec. 5.3 / Table 6. Authors' four-task sim-to-real experiment.

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DreamZero: prediction and task evaluation



LEARNED PREDICTION

Future video + actions

Task evaluation on simulation benchmarks

MOTPHYS EVALUATION DIRECTION

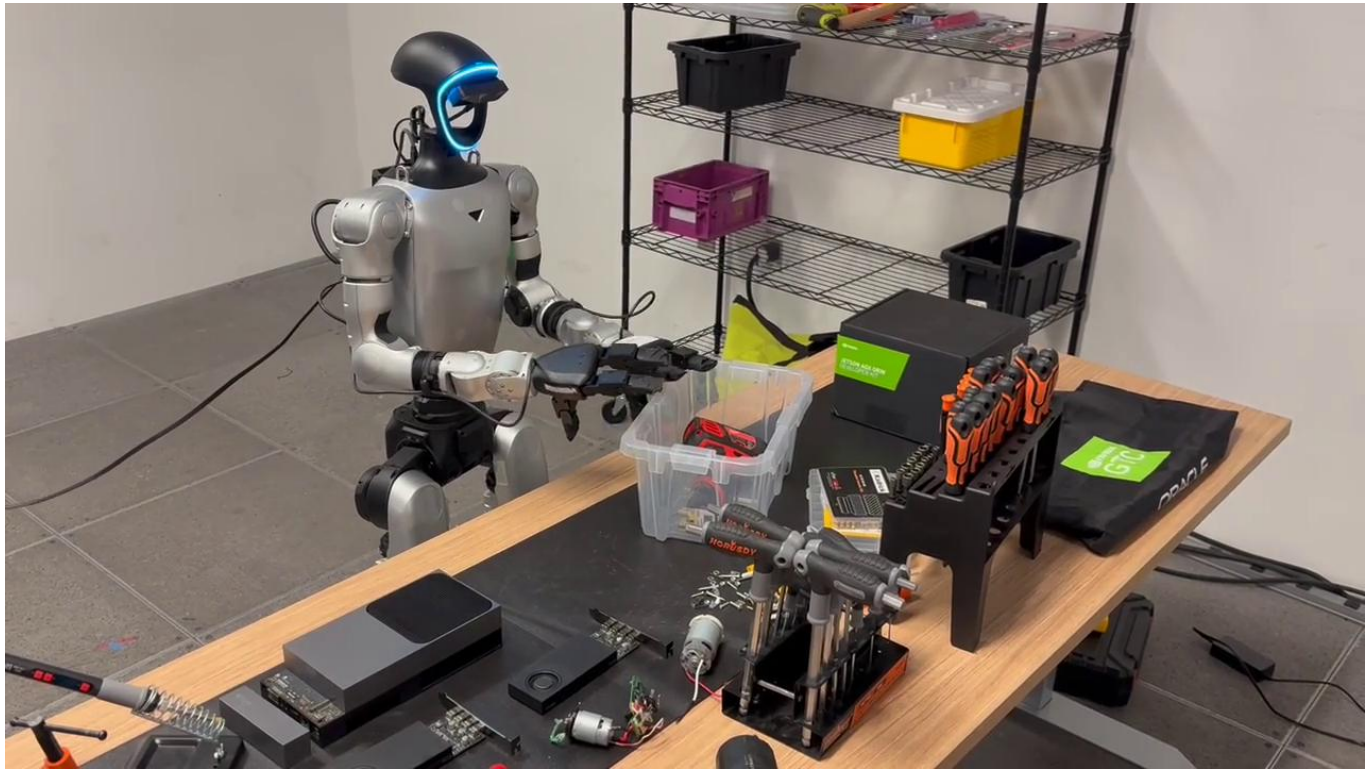
Calibrated geometry, contacts and control constraints

Failed visual predictions can become failed physical actions

DreamZero, arXiv:2602.15922v1, Fig. 16. Physical checking below is the proposed Motphys direction.

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SONIC: a generalist whole-body controller



SIMULATION-TRAINED WBC

PPO in Isaac Lab

100M+ motion frames
42M-parameter control model
128 GPUs / 21k GPU hours

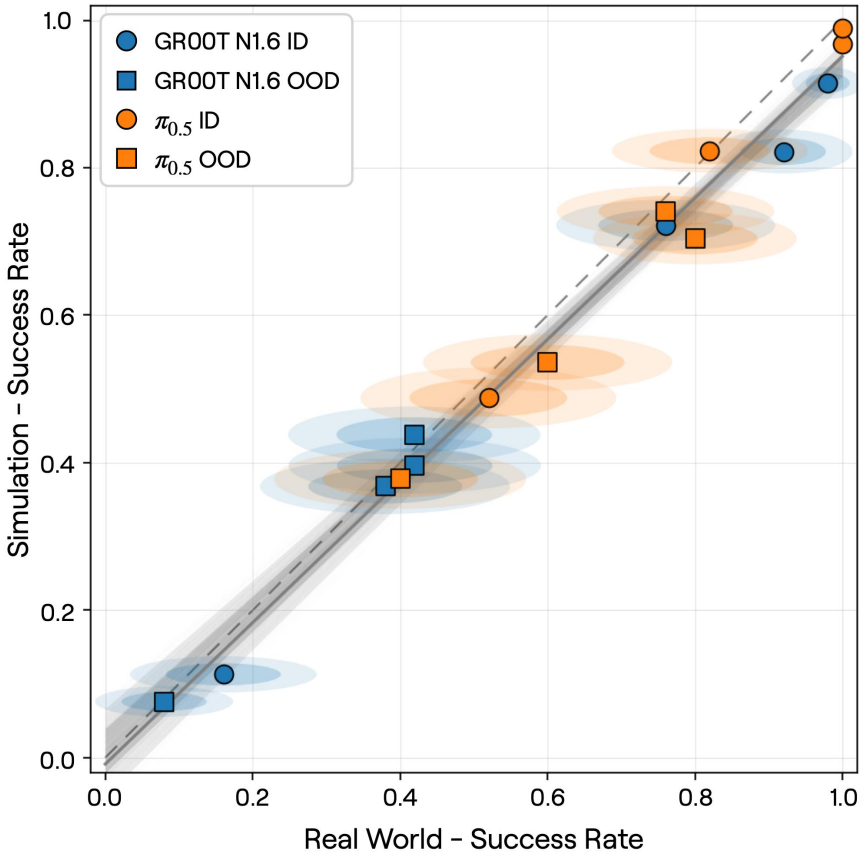
One shared policy
VLA / VR / motion commands

Scalable physics training builds a reusable whole-body control layer

SONIC authors' work, arXiv:2511.07820v4. Motion priors from human capture; control trained with PPO in Isaac Lab.

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Simulation benchmarks and real robot performance



PAIRED TASK EVALUATION

2,000 sim trials

100 real robot trials

per policy checkpoint

Ranking consistency
Progress across checkpoints
Success and failure regions

World Labs, 28 Jul 2026. Vendor-reported ALOHA cube-handover study; ID and OOD task distributions.

Motphys

Simulation across learning and control

Route	Role of simulation	Evidence
VLA	Synthetic robot training data	InternData-A1 Synthetic-only robot data
VLA + RL	Interactive learning and feedback	SimpleVLA-RL Real robot improvement
WAM	Task evaluation on simulation benchmarks	DreamZero Benchmark and failure cases
Whole-body control	Physics-based RL training	SONIC Reusable control policy

Calibrated simulation environments support learning and task evaluation

Sources: InternData-A1, SimpleVLA-RL, DreamZero and SONIC. Details in notes.

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Motphys: thinking, prediction and reaction

Layer	Responsibility	Simulation contribution
THINKING	Task reasoning and planning	Synthetic task experience
PREDICTION	Learned action-outcome prediction	Task evaluation with calibrated physics
REACTION	Fast skills and feedback control	Contact-rich training and recovery

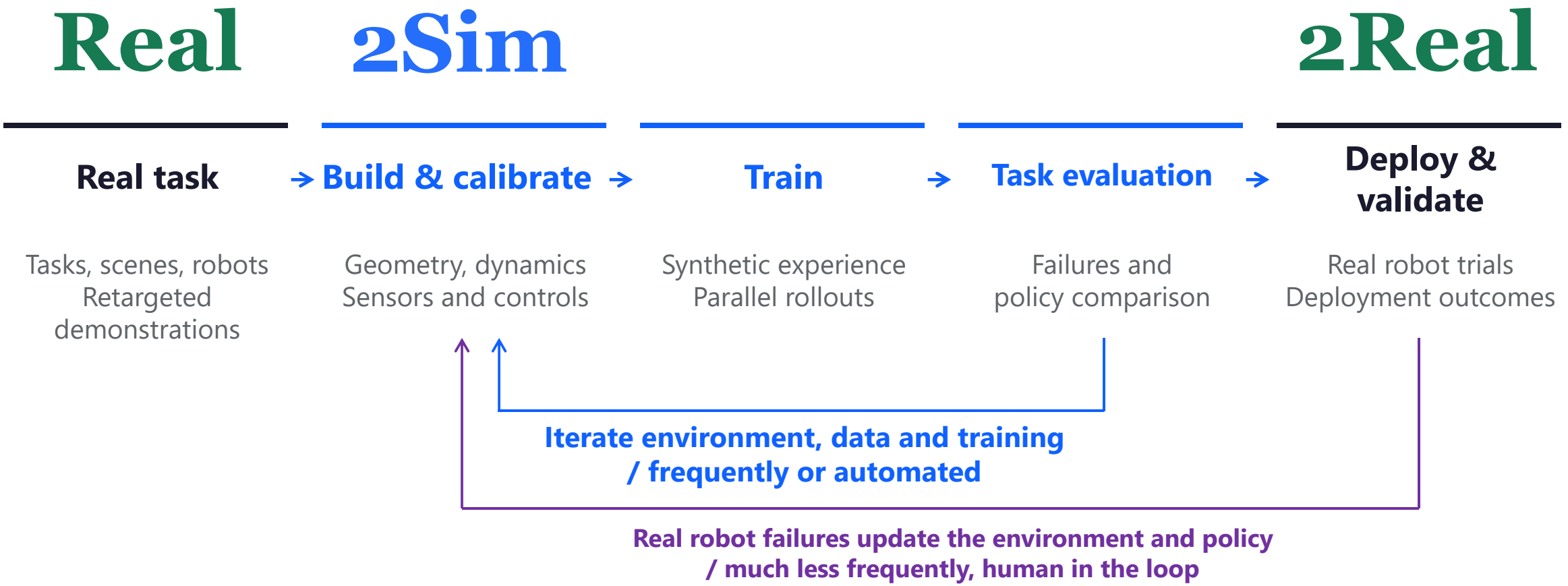
Synthetic data, training and distillation connect the layers

Real measurements calibrate the environment and validate deployment

Motphys earlier work. Prediction and physical checks describe our technical direction.

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Real2Sim2Real: calibrated development



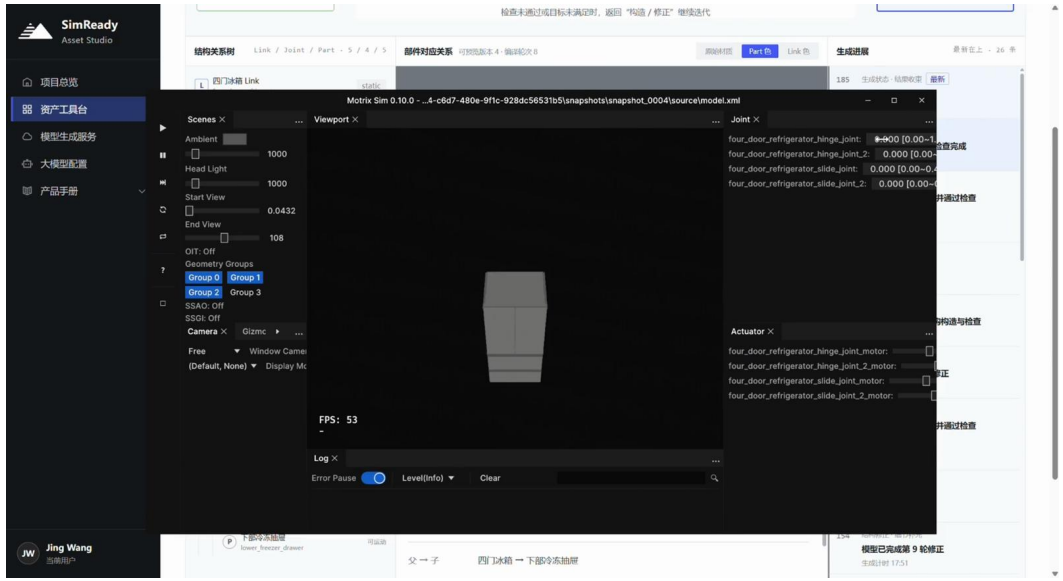
Real measurements keep the development loop useful

Motphys earlier work: calibrated development loop. Real measurements close the gap.

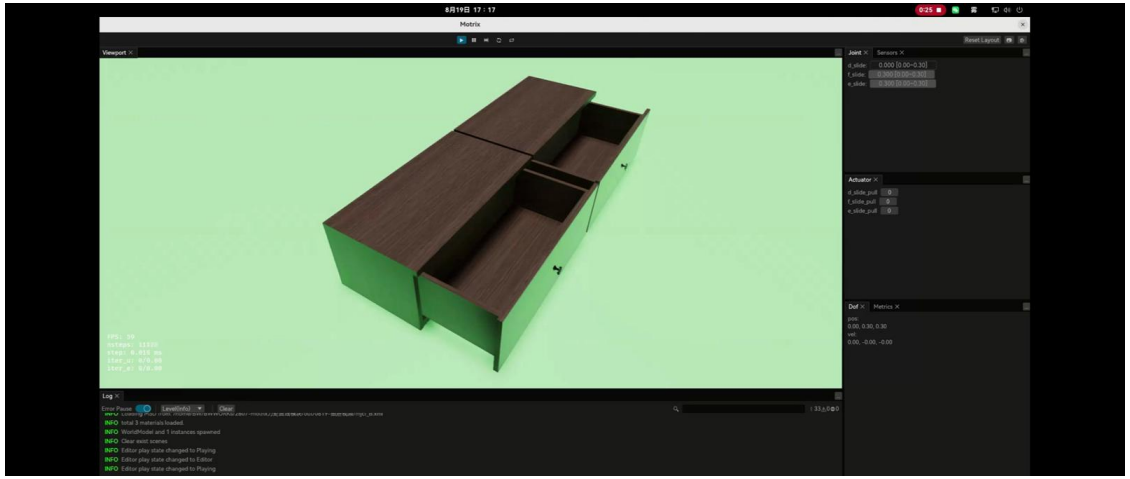
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Real2Sim: simulation environment construction

ASSET CONSTRUCTION



JOINTS AND PHYSICAL PARAMETERS



Environment component	Effect on training and task evaluation
Geometry	Perception, collision and reachability
Dynamics	Control response and timing
Contacts	Slip, forces and sensor response

Motphys earlier work. Physical calibration requires real reference measurements.

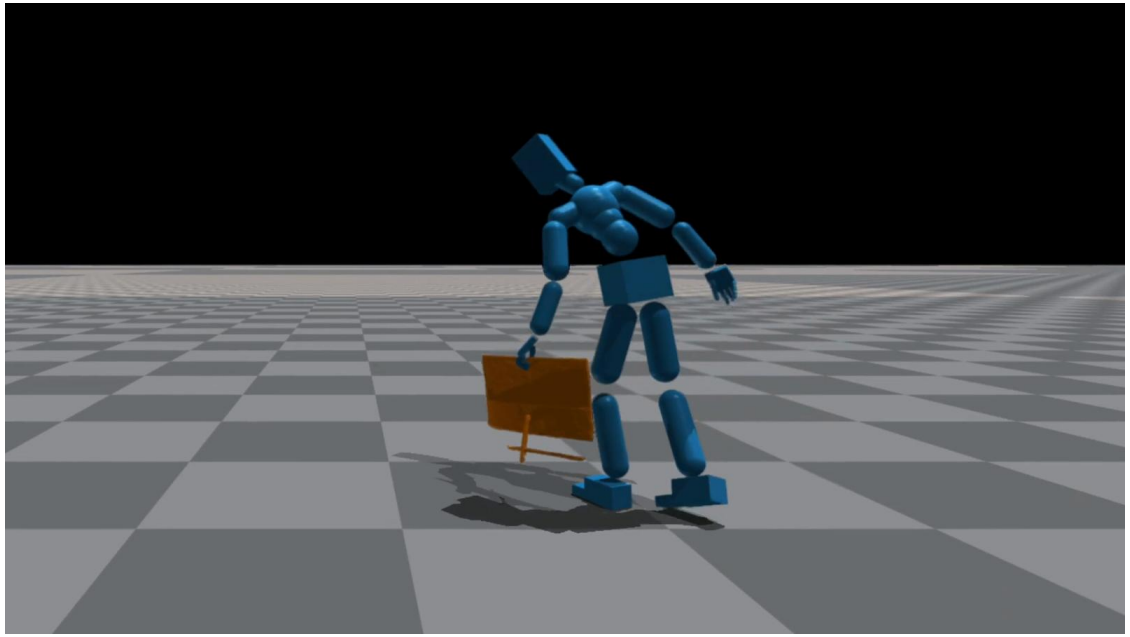
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Demonstrations and simulation data

CAPTURE AND RETARGET



SIMULATED INTERACTION

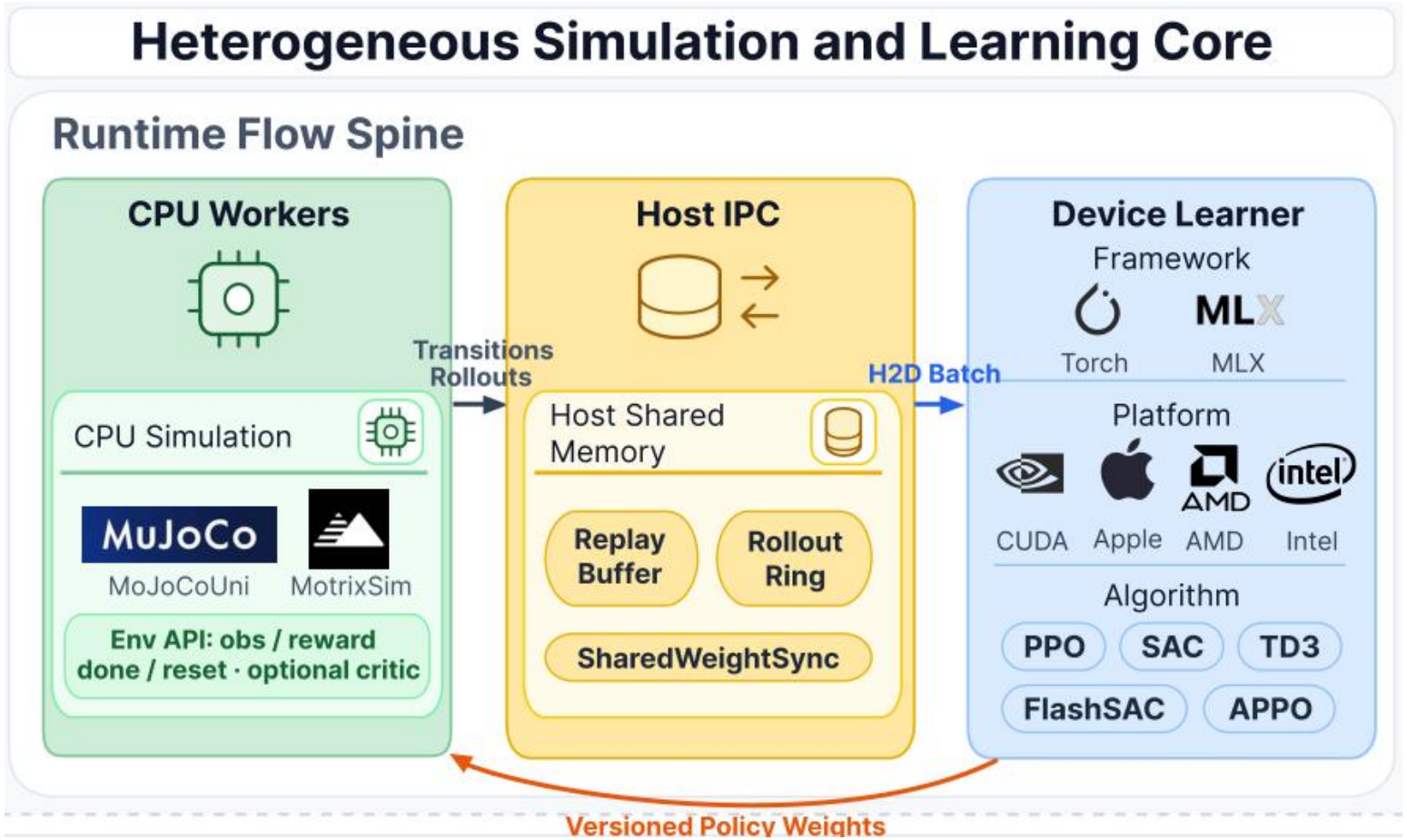


Robot mappings, task labels and provenance make data reusable

Motphys earlier work: hand-motion retargeting and simulated interaction examples.

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UniLab: CPU simulation, GPU learning



HETEROGENEOUS RUNTIME

CPU physics
GPU learning

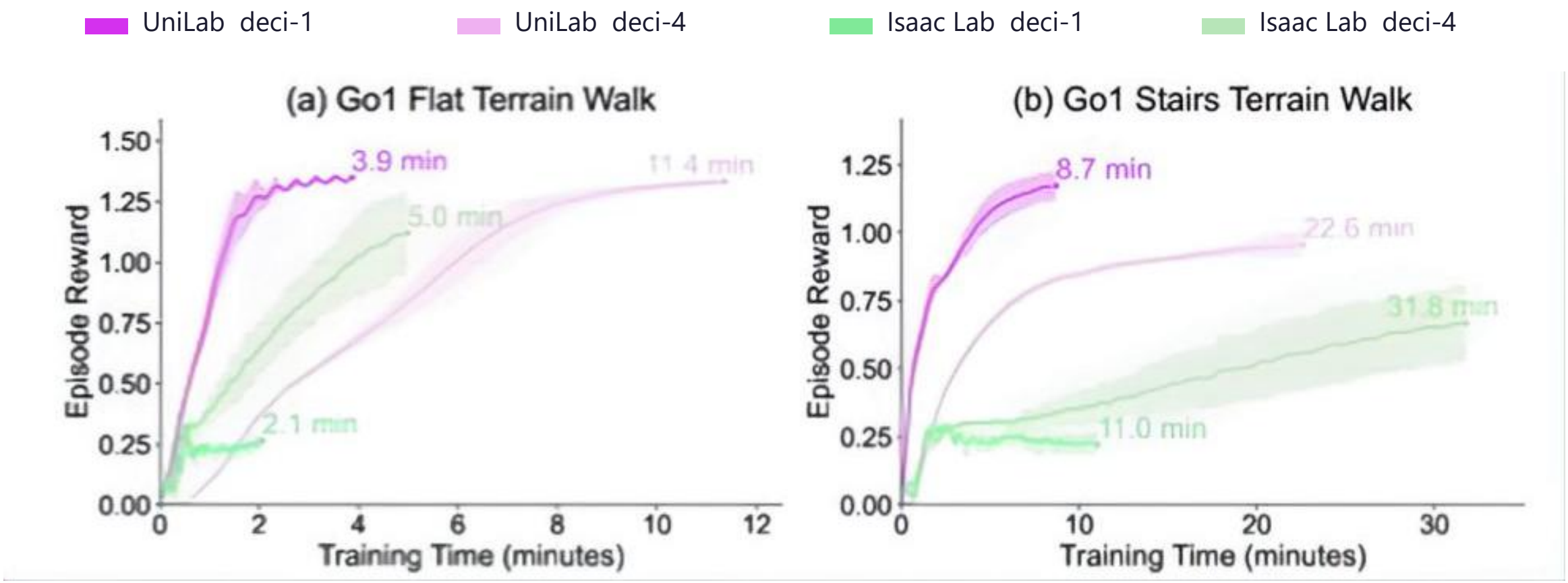
Physics backends
MotrixSim / MuJoCoUni

Decoupled runtime
Cross-platform training

UniLab, CoRL 2026. https://arxiv.org/abs/2605.30313

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UniLab vs Isaac Lab: training efficiency



Higher rewards in less time in the recorded Go1 configurations

UniLab, CoRL 2026. https://arxiv.org/abs/2605.30313 Go1 endpoints are not matched-target speedups.

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GS-Playground: visual training at scale

PHYSICS + BATCH 3DGS

~10,000 FPS

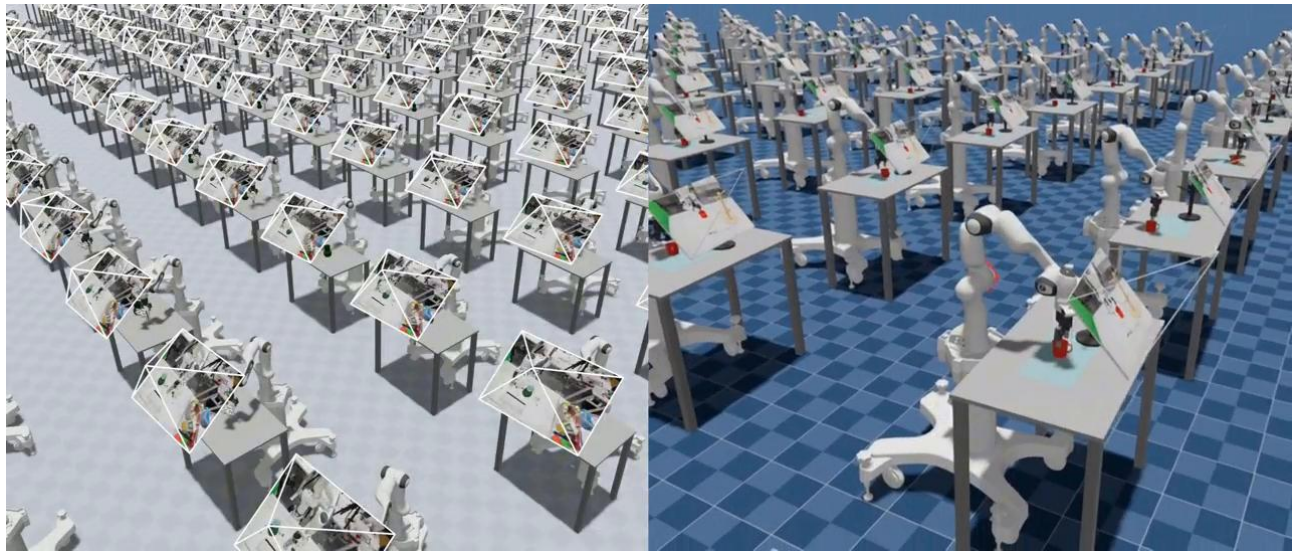
640 × 480 aggregate render throughput

Physics and images stay aligned

Parallel training with realistic vision

Automated Real2Sim

SimReady assets for robot-policy learning



Up to 2,048 parallel environments
RTX 4090 + i9-14900K

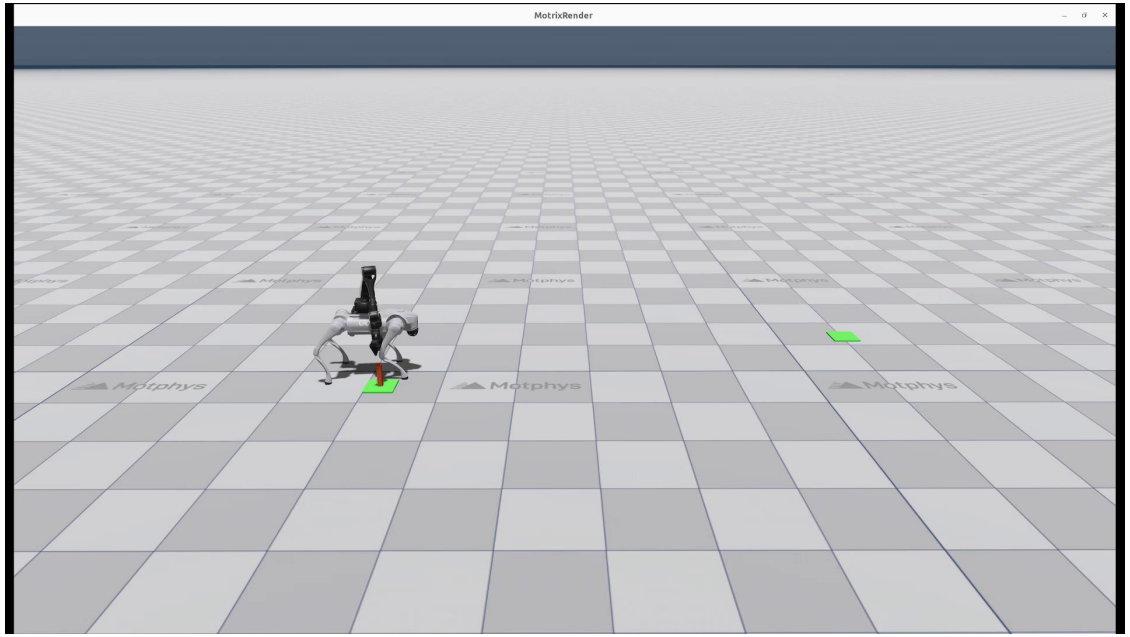
Parallel physics and photorealistic rendering for robot training

GS-Playground, RSS 2026. https://arxiv.org/abs/2604.25459

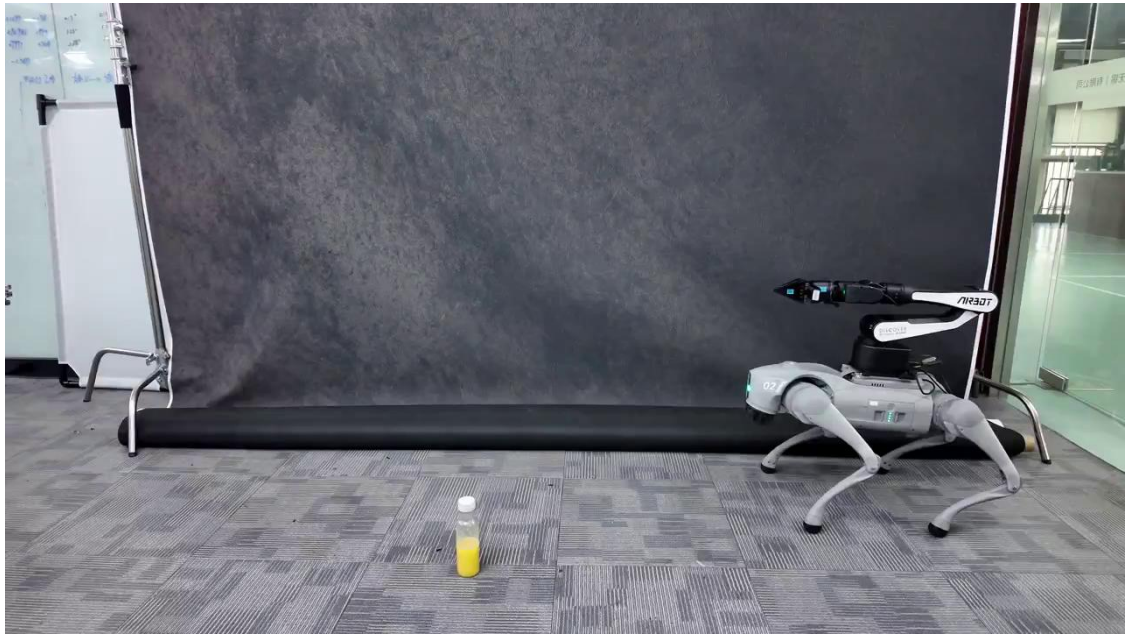
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Quadruped control: sim-to-real deployment

SIMULATION



REAL ROBOT



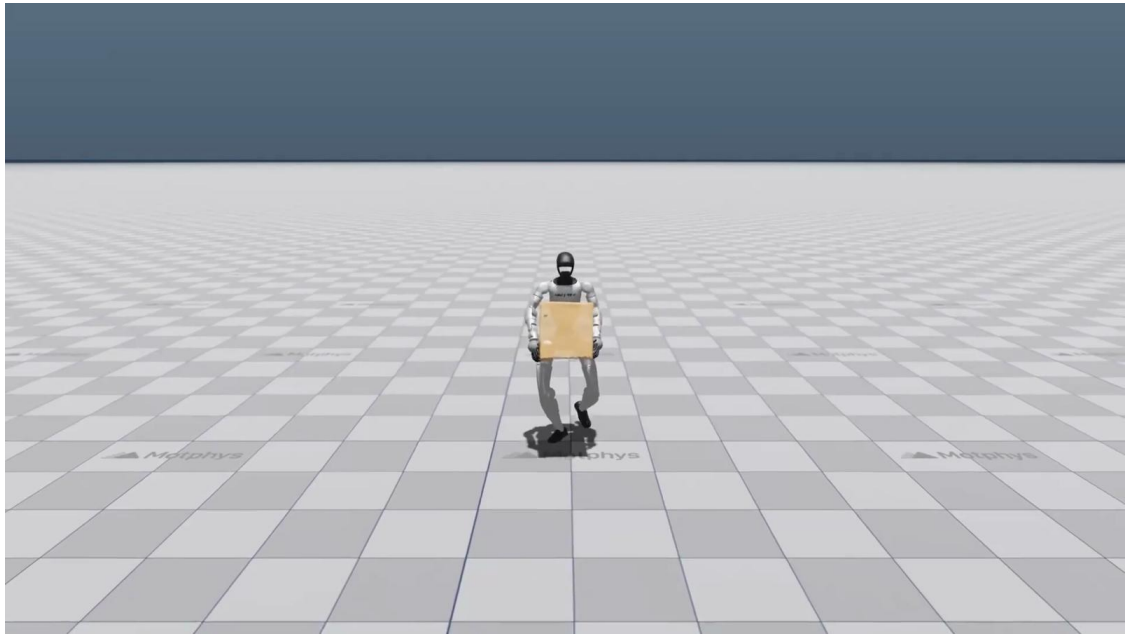
Calibrated simulation enables successful real robot deployment

Motphys earlier work: quadruped simulation and hardware. Demonstrated-task scope.

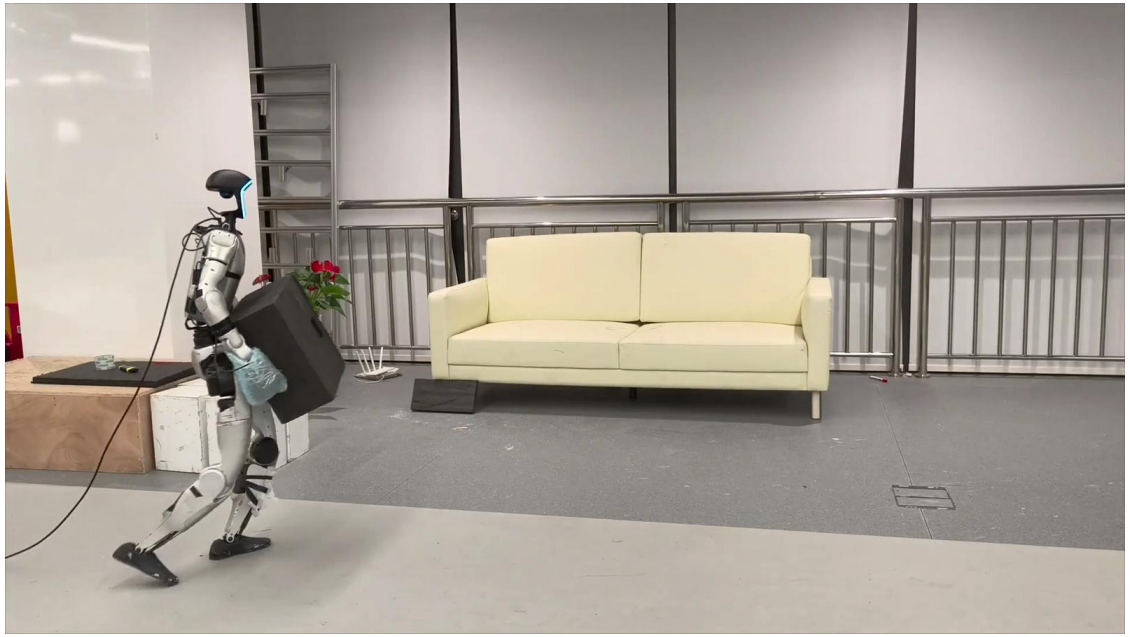
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Whole-body control: real robot deployment

SIMULATION



REAL ROBOT



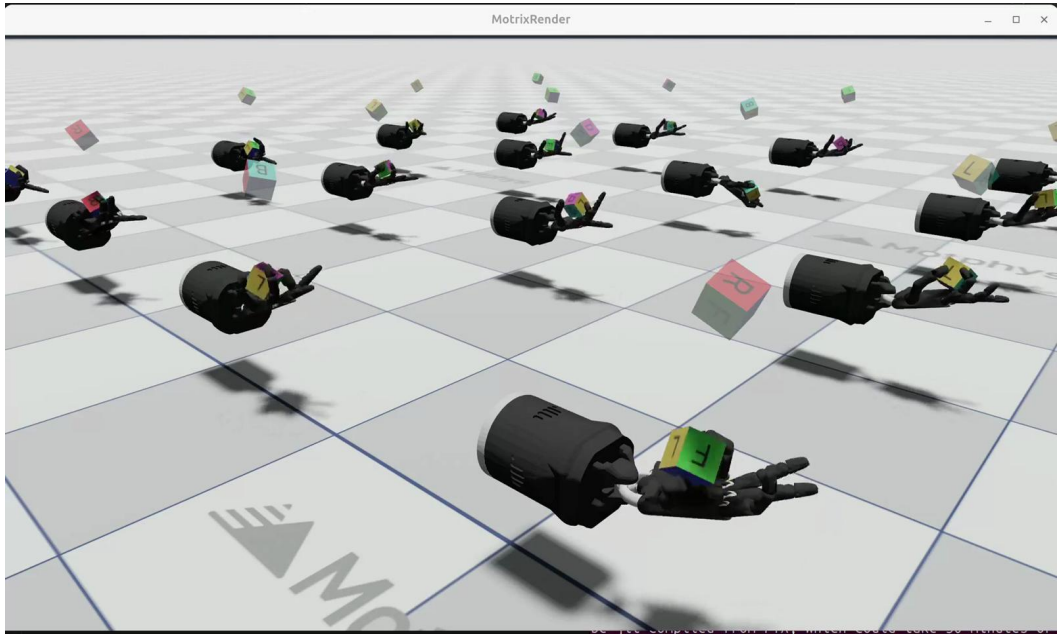
Simulation-trained whole-body control deploys on a real robot

Motphys earlier work: whole-body control. Qualitative deployment evidence, not a numerical success-rate study.

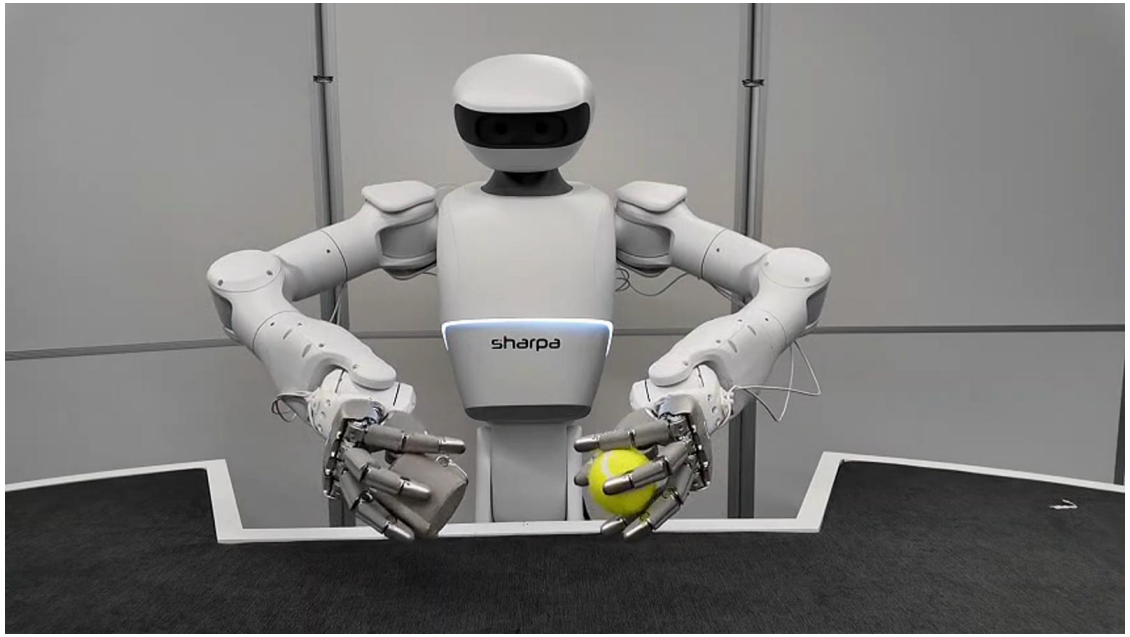
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Dexterous manipulation: sim-to-real deployment

SIMULATION



REAL ROBOT



Calibrated contacts support successful real robot manipulation

Motphys earlier work: dexterous simulation and hardware. Demonstrated-task scope.

Motphys

A unified training framework needs shared standards

Motphys alone is not enough. The framework must combine contributors' strengths.

Layer	MotrixSim	Isaac Sim	MuJoCo	SAPIEN	Genesis	Habitat
Asset routes	URDF / MJCF / USD*	USD + URDF / MJCF	MJCF / URDF	URDF + scene assets	URDF / MJCF / USD	URDF + scene datasets
Execution	Motrix interfaces*	Sim / Lab interfaces	mj_* / MJX	Scene step	Scene step	Sim / Lab interfaces
What to align	Time, controls	Drives, materials	Actuators, contacts	Drives, contacts	Frames, parameters	Sensors, scene state

* Motphys-reported routes; specific extension coverage needs per-version verification.

Shared standards Assets and formats Controls and timing Task definitions

A shared framework combines contributors' strengths. Formats are one starting point for interoperability.

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Shared infrastructure: ITU collaboration

Reusable simulation environments
Portable interfaces and comparable benchmarks
Contribute real robot measurements and tasks

Enkai Zhou enkai.zhou@motphys.com
Yuan Gao yuan.gao@motphys.com

Motphys welcomes collaboration across models, simulation platforms and robot facilities.

Motphys

Simulation platforms and integration

Platform / stack	Physics foundation	Common use	Integration context
MotrixSim / UniLab / MotrixLab	MotrixSim	Contact-rich control, training and data	Physics layer + peer RL frameworks
Isaac Sim / Lab	PhysX / simulation backends	Robotics, sensors, policy training	USD-centered ecosystem
MuJoCo / MJX	MuJoCo	Dynamics and robot learning	MJCF models; training integrations
SAPIEN / ManiSkill	PhysX	Manipulation and embodied tasks	Task/asset ecosystem
Genesis	Genesis solvers	Parallel simulation and robot learning	Multi-format import
Habitat Sim / Lab	Bullet integration	Navigation and embodied environments	Scene datasets; robot/task integrations

List to be expanded

Physics engines, simulation platforms and training frameworks have different roles

Official docs; UniLab paper and first-party Motphys description. Frameworks and physics backends are distinct.

Motphys

Motphys work and shared value

Motphys work	Reusable evidence and artifacts	Shared value
Environment construction	Assets, parameters and calibration records	Reusable assets
Data pipelines	Mappings, trajectories and provenance	Reusable data
Efficient training	Runtimes and reproducible comparisons	Broader access
Real robot deployment	Task trials and failure records	Comparable evidence

Motphys engineering areas and their relevance to shared infrastructure.

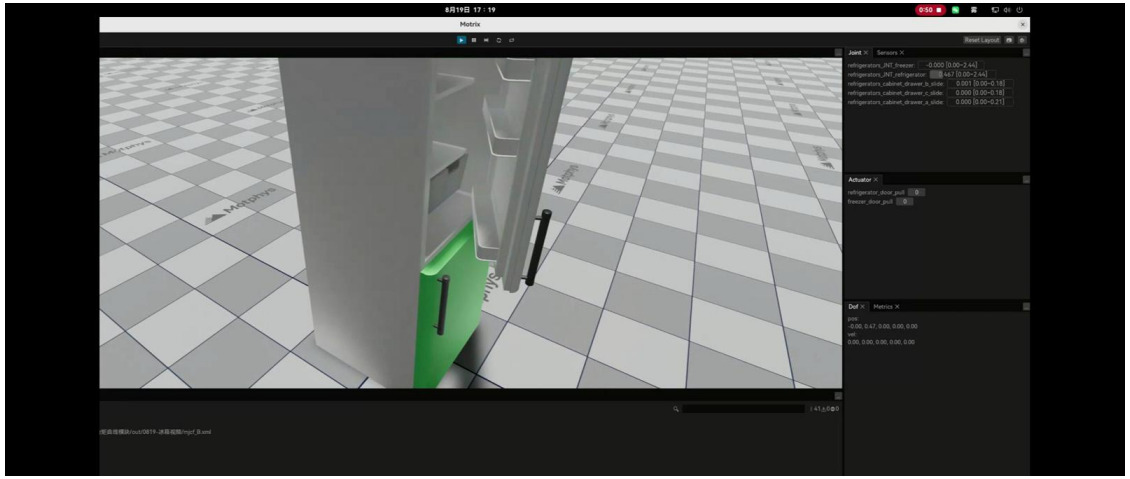
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SimReady: generation and joint validation

3D ASSET GENERATION



JOINT INTERACTION AND VALIDATION

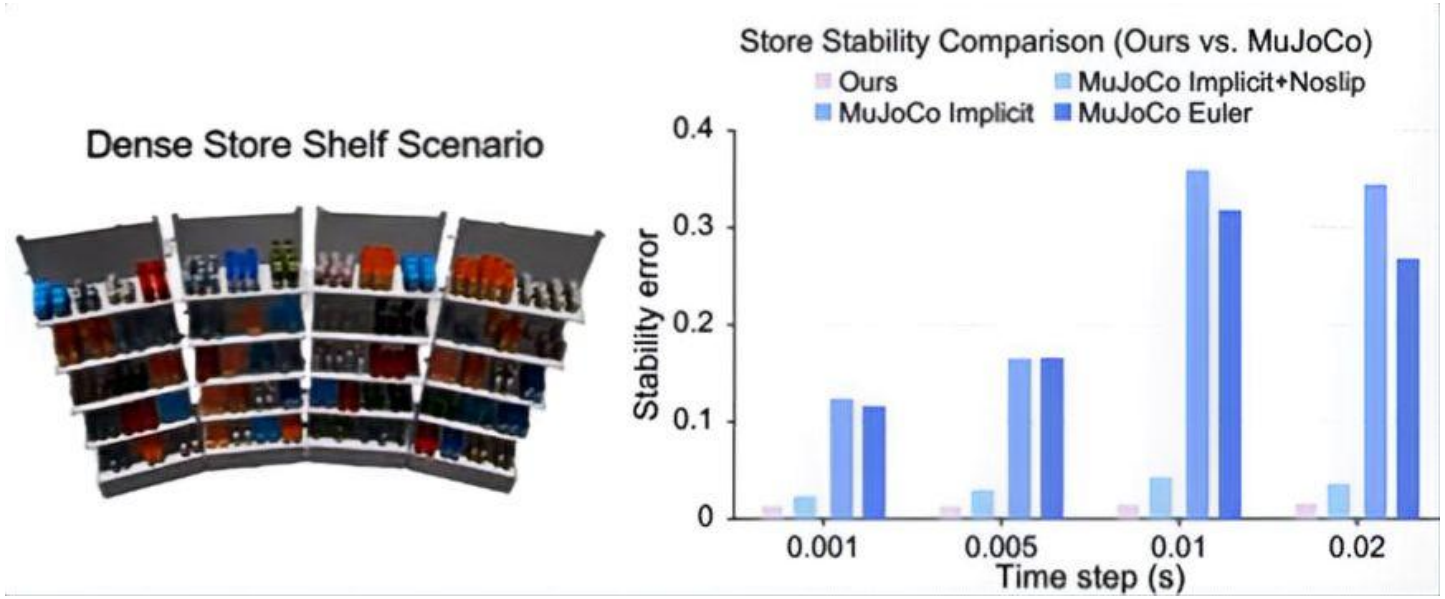


Reusable SimReady assets carry geometry, constraints and validation evidence

Motphys earlier work: 3D asset generation and joint interaction.

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Benchmark interpretation



COMPARISON RECORD

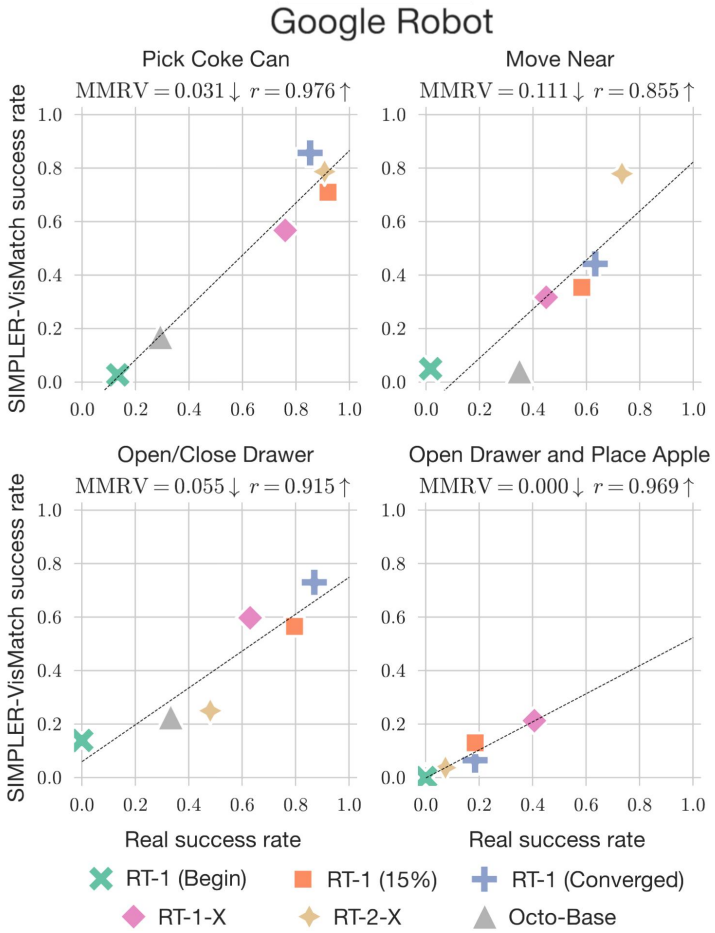
Task and target metric
Hardware and versions
Physics / control timing
Algorithm and seeds
Matched budget or threshold
Reference measurements

Numerical stability and physical accuracy need different reference tests

Original Motphys dense-shelf numerical-stability figure; not a calibrated physical-fidelity test.

Motphys

SIMPLER: paired evaluation



SIMPLER research project, 2024. Original Google Robot result figure; correlations are task-specific.

WHAT TO MEASURE

Performance correlation

Pearson r assesses linear association; small differences can be noise-sensitive.

Ranking consistency

MMRV measures rank violations. Lower values indicate better consistency.

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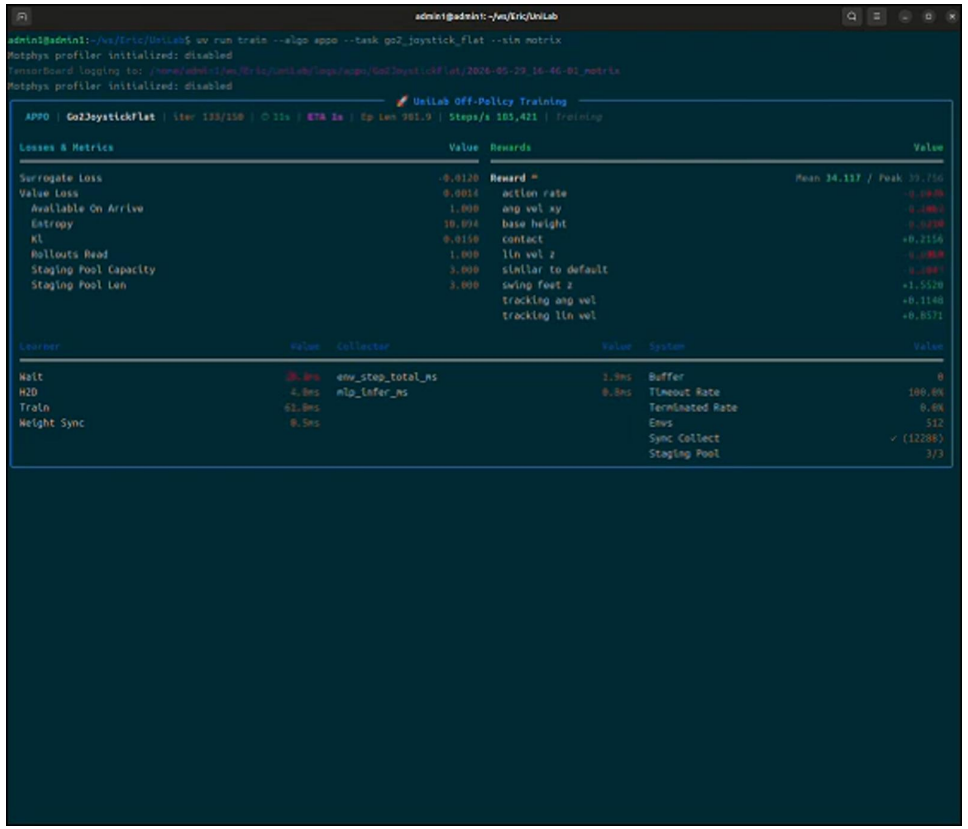
Selected research sources

Motphys research	UniLab: arXiv:2605.30313, CoRL 2026 GS-Playground: arXiv:2604.25459, RSS 2026 Motphys earlier engineering work
Training and evaluation cases	InternData-A1 and SimpleVLA-RL SONIC and DreamZero World Labs and SIMPLER
Platform and API evidence	Official platform and API documentation UniLab and GS-Playground author pages Full paper links in relevant notes

Full source URLs and local reference paths are recorded in the notes of each relevant slide.

Motphys

Training execution and replay



BENCHMARK SCOPE

Motphys earlier work training demo

Reported 12-second locomotion example
Specific setup, not a general training time

UniLab vs Isaac Lab

Go1 curves in the main talk
Paper efficiency range uses broader baselines

Keep task, metric and baseline attached to each result

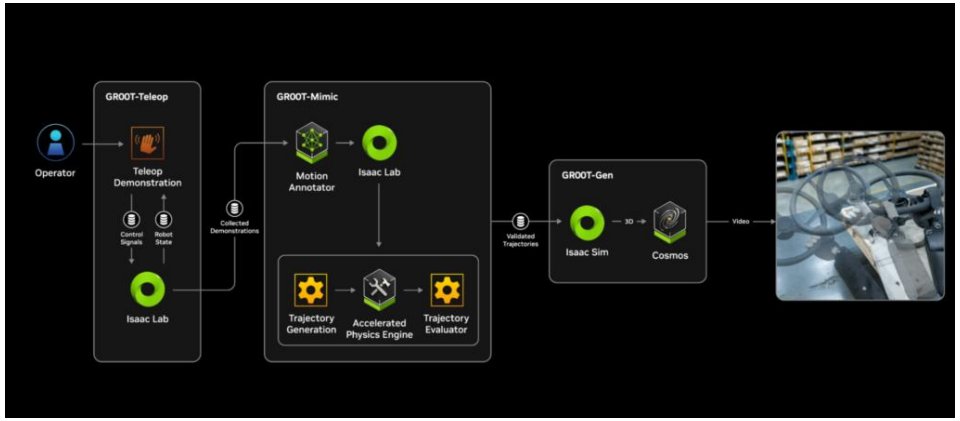
Motphys earlier work: training execution and replay. Separate from the Go1 comparison.

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Synthetic experience at scale

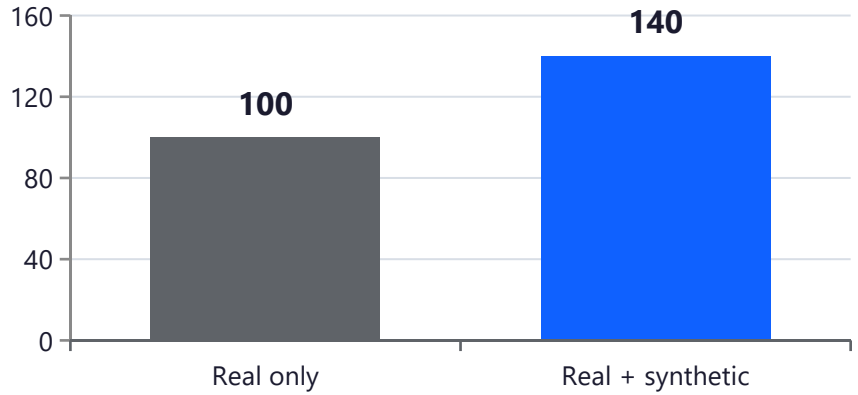
780,000

synthetic trajectories in 11 hours



+40%

reported performance
vs. real data alone



NVIDIA-reported GR00T synthetic-motion blueprint result. Index: real-only = 100; not a success-rate percentage.