Embodied Tool-Use Agent

Task Instruction ℓ

Set the dining table for me.

Skill Library $\mathcal{S}$

Agent Harness

Task Planning

Subgoal 1 ✓

…

Subgoal n ✓

Recover/ Replan

Tool Composition

State Assessment

Stop

Continue

Traces ρ

Images

Videos

Stdout

Call a_t

Feedback f_t

Toolbox $\mathcal{T}$

Observation

RGB-D

Robot State

RGB

Depth

Perception

SAM3

YOLO-World

Mask

Bounding box

Planning

GRASPNET

PyRoki

cuRobo

SciPy

Grasps

Trajectory

Control

ROS

Joint/Impedance controller

Gripper control

Motion

Policy

VLA/WAM

Tether

Action chunk

Privileged

Ground truth state

Task predicates

$\mathcal{T}_{\text{priv}}$

Simulation only

Action

Evo

State

Simulation

Straw insertion *Pan-to-plate* *Bowl grasping*

Skill-level $\mathcal{S}$

Sim2Real

Real World

Explorer — Experience Gathering

$\mathcal{E}$

$\mathcal{S}_r$ + $\mathcal{T}$ + $\mathcal{X}_{\text{dev}}$ → Execute Tasks → ρ

$\mathcal{S}_{r+1}$

ρ

Diagnoser — Diagnosis and Skill Revision

$\mathcal{D}$

$\mathcal{S}_r$ + $\mathcal{T}$ ($+\mathcal{T}_{\text{priv}}$) + ρ → Diagnose & Retry → $\mathcal{S}'$

$\mathcal{S}'$

Validator — Candidate Validation

$\mathcal{V}$

$\mathcal{S}_r$ vs $\mathcal{S}'$ + $\mathcal{T}$ + $\mathcal{X}_{\text{val}}$ → Compare SR

Reject ($\leq R$)

Accept

if SR($\mathcal{S}'$) > SR($\mathcal{S}_r$)

$\mathcal{S}_{r+1}$

Skill Library $\mathcal{S}$

- Tool Workflow — *tool-call rules & order*
- Failure Recovery — *postchecks & recovery*
- Python Scripts — *compute tool parameters*
- Success Experience — *reusable tool combos*

Experience-Driven Skill Evolution

$r = 0$ $\mathcal{S}_0$ $\mathcal{S}_1$ $\mathcal{S}_r$ $\mathcal{S}_*$ $r \to \infty$