LightPlanner: Unleashing the Reasoning Capabilities of Lightweight Large Language Models in Task Planning

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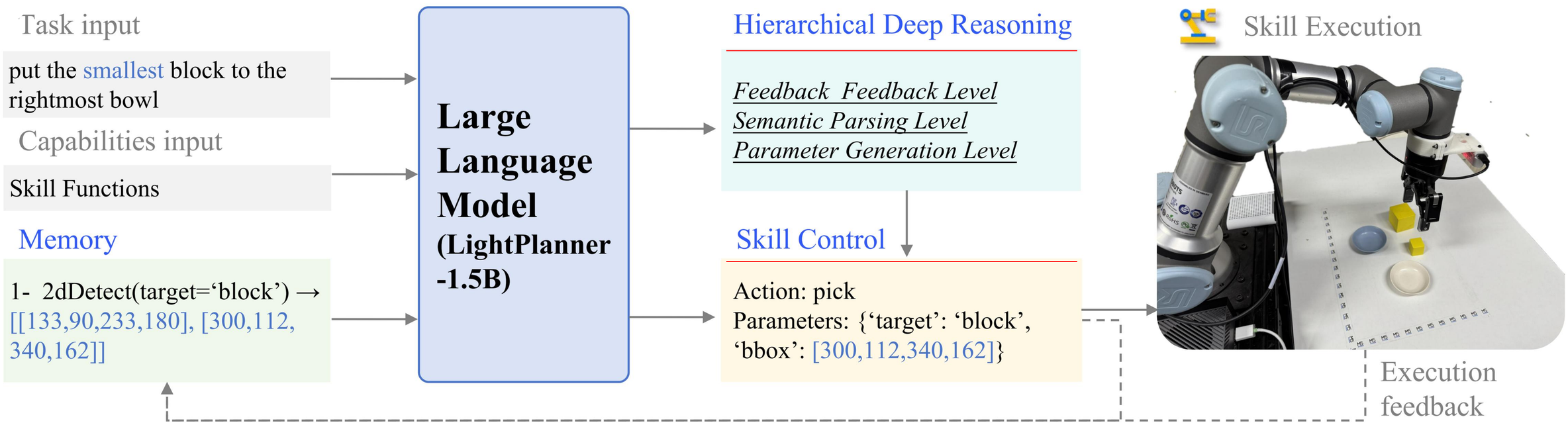
Introduction & Motivation

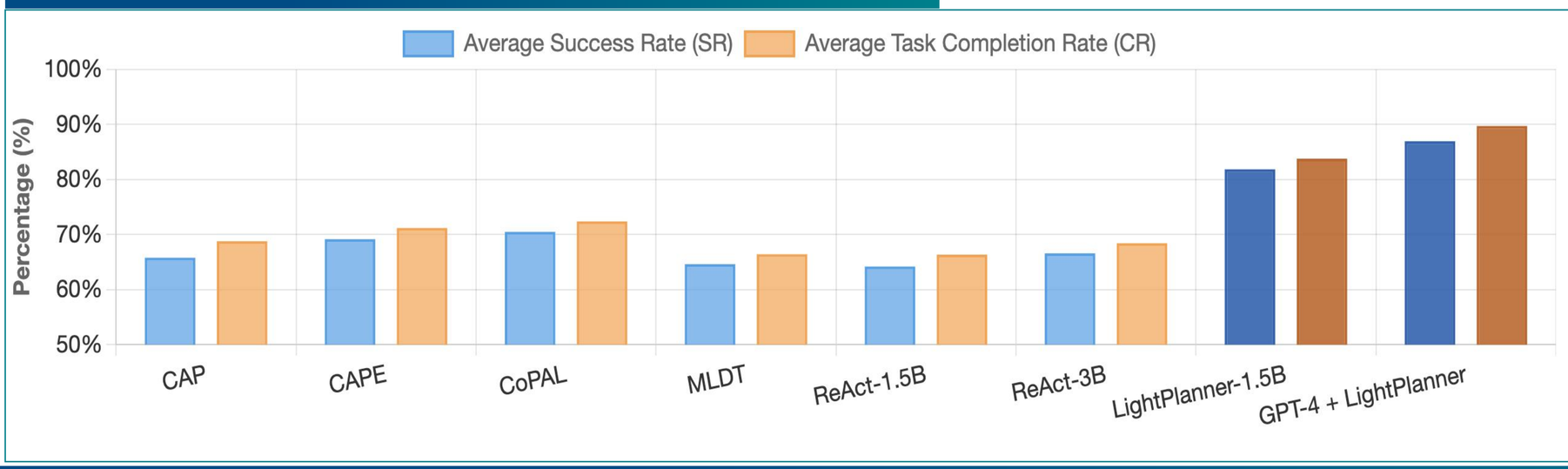
- **Goal:** Enable lightweight Large Language Models (LLMs) to perform complex robotic task planning on edge devices.
- **Challenge:** Standard lightweight LLMs (<3B parameters) excel at efficiency but fail in tasks requiring multi-step, dynamic logical reasoning (e.g., "pick the largest block").
- **Problem:** Existing methods rely on high-performance LLMs (like GPT-4) or use fixed skill templates that lack flexibility for dynamic commands.
- **Our Solution:** LightPlanner, a novel planner that enhances the reasoning of small LLMs to achieve high success rates in complex tasks

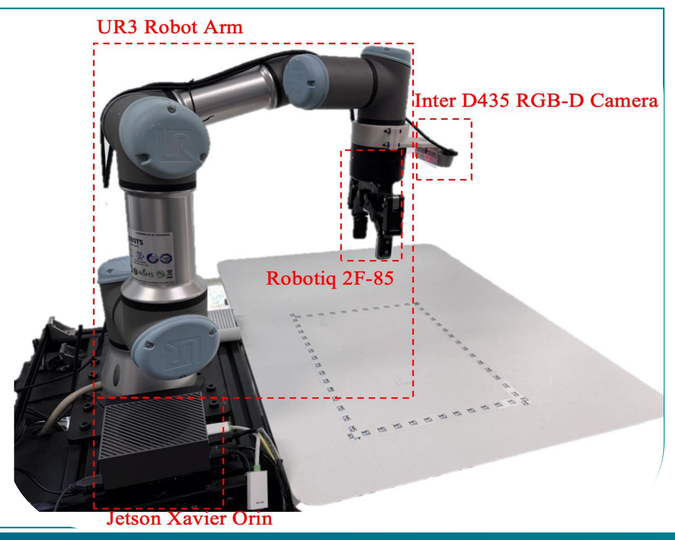
The LightPlanner Framework



Execution Feedback Level: Okay, I've located two blocks. One has a bounding box of [130, 90, 230, 180] and the other is [300, 110, 340, 160].
Semantic Parsing Level: Alright, my mission is to grab the smallest block and place it in the rightmost bowl. I've identified two blocks and now I'm going for the smaller one. This is exactly what I should be doing according to my task goal.
Parameter Generation Level: Okay, I need to pick the smallest block. I've already detected two blocks with bounding boxes [130, 90, 230, 180] and [300, 110, 340, 160]. To determine the smallest, I need to calculate the area of each bounding box.
The area of the first block is (233 - 133) * (180 - 90) = 100 * 90 = 9000.
The area of the second block is (340 - 300) * (162 - 112) = 40 * 50 = 2000.
Since 2000 is smaller than 9000, the second block with the bounding box [300, 112, 340, 162] is the smallest. Now I can proceed with the 'pick' action, using the bounding box of the smallest block.

Key Results





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My research bridges Embodied AI and MLLMs to build intelligent agents that perceive, reason, and act in the physical world.
First-author publications at IROS'25, CVPR'25, & NIPS'25.
Contributed to the TAIROS platform at Tencent Robotics X Lab, earning the Outstanding Intern Award (1 of 5 recipients).
Seeking collaborations in Embodied Cognition and Decision-making.