
ManiTaskGen: A Comprehensive Task Generator for Benchmarking and Improving Vision-Language Agents on Embodied Decision-Making

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Abstract

Building embodied agents capable of accomplishing arbitrary tasks is a core objective towards achieving embodied artificial general intelligence (E-AGI). While recent work has advanced such general robot policies, their training and evaluation are often limited to tasks within specific scenes, involving restricted instructions and scenarios. Existing benchmarks also typically rely on manual annotation of limited tasks in a few scenes. We argue that exploring the full spectrum of feasible tasks within any given scene is crucial, as they provide both extensive benchmarks for evaluation and valuable resources for agent improvement. Towards this end, we introduce ManiTaskGen, a novel system that automatically generates comprehensive, diverse, feasible mobile manipulation tasks for any given scene. The generated tasks encompass both process-based, specific instructions (e.g., "move object from X to Y") and outcome-based, abstract instructions (e.g., "clear the table"). We apply ManiTaskGen to both simulated and real-world scenes, demonstrating the validity and diversity of the generated tasks. We then leverage these tasks to automatically construct benchmarks, thoroughly evaluating the embodied decision-making capabilities of agents built upon existing vision-language models (VLMs). Furthermore, we propose a simple yet effective method that utilizes ManiTaskGen tasks to enhance embodied decision-making. Overall, this work presents a universal task generation framework for arbitrary scenes, facilitating both benchmarking and improvement of embodied decision-making agents.

1 Introduction

Consider an embodied agent endowed with robust primitive skills for mobile manipulation: the ability to navigate to any accessible location, grasp any movable object, and place it wherever it fits. A fundamental question then arises: *what is the full extent of the task space this agent can successfully address in a given environment?* This space appears infinite. Despite this immense potential task space, recent efforts have focused on developing general-purpose embodied agents [1–7] capable of completing any feasible task within it. A promising direction leverages VLMs [8–10] for high-level decision-making, followed by either the explicit composition of skill primitives [11–13] or the implicit integration with underlying action modules to predict joint-level actions—the latter thread is commonly referred to as Vision-Language-Action (VLA) models [14, 15, 5]. To evaluate such agents, numerous benchmarks [16–20] have also been proposed to assess their decision-making capabilities.

Despite these efforts, existing work often faces significant limitations regarding the tasks used in both policy training and benchmark design. Common practice [21, 13, 22, 20] involves manually selecting a few scenes and authoring a limited number of scene-specific tasks related to objects within those

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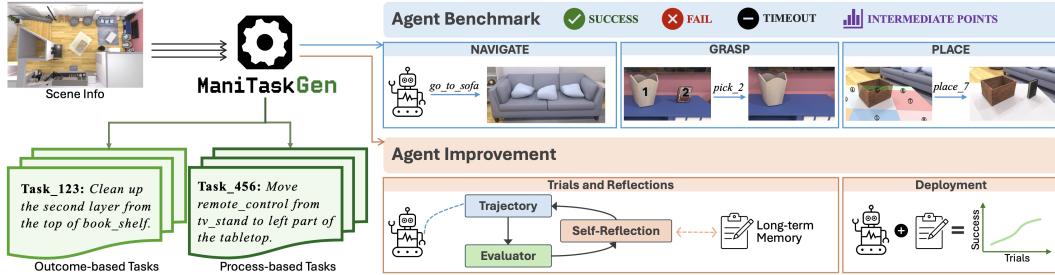


Figure 1: **Framework Overview.** ManiTaskGen is a universal system that generates a comprehensive set of feasible mobile manipulation tasks given arbitrary scene. These tasks facilitate automatic benchmarking and the improvement of embodied decision-making agents.

scenes, which serve as training or testing objectives for embodied agents. Such manual approaches are labor-intensive and require considerable human effort to design suitable tasks, resulting in prohibitively high scaling costs and making it nearly impossible to generalize task creation to the diverse range of scenes encountered in both simulated and real-world environments. This fundamental limitation creates a substantial gap between current agents and the ultimate goal of E-AGI: while the aim is an agent capable of universal generalization across diverse scenes and tasks, existing works are confined to training and evaluating the agents within limited scenarios and task variations.

To address these limitations, we present ManiTaskGen, a universal mobile manipulation task generator for arbitrary scenes. Given scene information (e.g., object poses, object bounding boxes, object mesh models, etc.), it automatically generates a comprehensive and diverse collection of feasible mobile manipulation tasks that are logically near-exhaustive for that specific scene. We ensure logical comprehensiveness by grounding task generation in a systematic analysis of the fundamental agent-environment interaction cycle, as conceptually illustrated in Fig. 2.

This cycle, where executing atomic actions (e.g., single object relocation) updates the scene state and determines subsequent available actions, inherently defines the space of all possible tasks. Based on this inherent structure, we rigorously categorize all possible tasks into two principal types: **process-based tasks**, capturing action sequences or trajectories (e.g., "move object A from X to Y"), and **outcome-based tasks**, representing reachable target states (e.g., "make the table clean"). ManiTaskGen employs distinct strategies for generating each type. Process-based tasks are generated by explicitly sampling and composing atomic action sequences, which are derived from a novel Receptacle-Aware 3D Scene Graph encoding all objects and fine-grained potential placements within the scene. Outcome-based tasks are generated using a hybrid template-based approach combined with VLM voting mechanism to produce diverse descriptions of plausible target states.

We assess the validity and diversity of the generated tasks by applying ManiTaskGen to both simulated environments (e.g., ReplicaCAD [23], AI2THOR [24]) and real-world scenes (e.g., SUN-RGBD [25]). Furthermore, we propose a framework for automatically constructing benchmarks in simulators using the generated tasks to assess embodied agent decision-making capabilities, and conduct extensive evaluations of existing VLMs using this benchmark. Finally, we design an improvement method based on Inference-time Reinforcement Learning [26, 27] to leverage ManiTaskGen tasks for enhancing the decision-making abilities of existing VLM agents.

In summary, this work makes the following contributions: (1) We propose ManiTaskGen, a universal system for generating comprehensive and diverse mobile manipulation tasks for arbitrary scenes. (2) Leveraging the automatically constructed benchmarks based on the generated tasks, we conduct an extensive evaluation of the embodied decision-making capabilities of current VLMs. (3) We demonstrate the utility of the ManiTaskGen tasks for enhancing embodied decision-making in current VLMs through a proposed inference-time RL method.

2 Related Work

Task Generation for Embodied Agents. Recent efforts have explored task generation for digital agents [28–31] and augmenting RL objectives [32, 33]. Among these, ALFRED [34] is the most relevant to our work. It combines a procedural task planner with human-annotated task directives. However, ALFRED focuses on expanding task trajectories rather than task definitions and lacks a comprehensive coverage of both process- and outcome-based mobile manipulation tasks. Moreover, it is limited to specific scenes. In contrast, ManiTaskGen aims to generate a diverse and comprehensive set of tasks for arbitrary scenes, emphasizing scalability and variability in task formulation.

Datasets and Benchmarks for Embodied Agents. Numerous datasets and benchmarks have been proposed for training [35, 24, 36, 3, 37] and evaluating [21, 34, 37] embodied agents, including those tailored to LLM/VLM-based decision-making agents [17, 18, 38, 22]. A common limitation of these benchmarks is their reliance on manually annotated tasks confined to a finite set of predefined scenes. In contrast, ManiTaskGen introduces a general and automated framework for generating rich, diverse tasks across arbitrary scenes. Beyond serving as a static dataset, it also provides dynamic evaluation and optimization platform for embodied decision-making agents, making it a more versatile resource.

3 ManiTaskGen: Comprehensive Task Generation

3.1 Premise and Formalization

We first formalize the problem space for generating comprehensive mobile manipulation tasks solvable by an agent equipped with fundamental navigate, pick, and place capabilities.

We define the scene state \mathcal{S} by the states of all objects $\mathcal{O} = \{o_1, \dots, o_N\}$ within it. The state of an object o_i is $s_i = (p_i, c_i)$, including its pose p_i and its containment state c_i . The containment state specifies the surface it is currently located on (e.g., "on surface A", "on internal surface B of a multi-layer object") or if it is held by the agent's gripper ('held'). The scene state is $\mathcal{S} = \{s_1, \dots, s_N\}$.

The set of atomic actions available to the agent is $\mathcal{A} = \{a_0, a_1, a_2, \dots\}$. Based on the agent's core capabilities, we define an atomic action $a \in \mathcal{A}$ as a parameterized object relocation operation. This conceptually represents a single, high-level step in the interaction, such as moving object o from its current location p to a new valid placement position p' . Formally, executing a feasible action a in state \mathcal{S} transitions the scene to a new state $\mathcal{S}' = a(\mathcal{S})$. These actions primarily modify the position and containment state of the manipulated object, and update the gripper's state.

The fundamental agent-environment interaction (as conceptually illustrated in Fig. 2) follows a discrete-time cycle $\mathcal{S}_t \xrightarrow{a_t} \mathcal{S}_{t+1}$, where at each step t , the agent selects an action a_t from the set of atomic actions feasible in state \mathcal{S}_t . The feasibility of actions depends on the current state (e.g., an object must be movable; a target location must be a valid surface that can accommodate the object).

Based on this formal framework, we categorize all possible mobile manipulation tasks by their objective relative to the interaction cycle. **Process-based tasks** explicitly specify a desired sequence of atomic actions $\langle a_1, \dots, a_n \rangle$ that constitute a feasible trajectory through the state space. For example, the instruction "Move the book from the shelf to the left part of the tabletop" corresponds to a sequence of parameterized object relocation actions. **Outcome-based tasks** specify a desired target scene state \mathcal{S}_{target} without dictating the intermediate actions required to reach it. For example, the instruction "Clear the table" corresponds to a target state where the containment states of relevant objects satisfy specific criteria relative to the table (e.g., no objects are on the table's surface).

This formalization provides a rigorous basis for systematically defining and generating task instances. Sec. 3.2 will detail how to utilize the given scene information to construct a Receptacle-Aware 3D Scene Graph which enables comprehensive retrieval of all objects and receptacles. In Sec. 3.3, we illustrate how to further generate both process-based and outcome-based tasks.

3.2 Receptacle-Aware 3D Scene Graph Construction

We construct a scene graph \mathbb{S} which serves as a structured representation of the scene, encoding both objects and available receptacles. The input scene information includes: object poses, object bounding boxes, and object mesh models (optional for extracting interior receptacles within objects).

The construction process involves two main steps. First, we initialize the scene graph as a structural object spatial relationship tree. This tree is based on spatial containment on surfaces: the root node represents the ground, while all other nodes correspond to scene objects. Parent-child relationships are determined by spatial containment—an object is assigned as a child of another if it rests on its surface. In addition, we will extract the interior surfaces (if any) of an object if its mesh model is available, and provide a more precise record of multi-level object placement during tree initialization. We also compute and record relative positions and distances between objects on the same surface.

After that, we identify the available receptacles within the scene. Building upon the established object relationship tree, we characterize receptacles by segmenting the free space of surfaces. Specifically, we treat each object as an anchor, and segment the free space around it into eight directional receptacle regions, with boundaries extending until they encounter another object or the edge of the supporting surface. For unoccupied surfaces, we employ a 3×3 grid segmentation by default. Visualization of our receptacle segmentation is provided in Fig. 3. Receptacle properties such as location, size, and direction relative to its anchor object or the surface are recorded. We also capture complex cases, such as a single receptacle indexed by multiple objects or the potential for merging adjacent receptacles into larger ones. Finally, all these information are stored as attributes of each node of the scene graph. This representation enables efficient retrieval of any receptacle by querying objects or surfaces. We include more details on the scene graph construction process in Appendix B.

The resulting 3D Scene Graph \mathbb{S} integrates object nodes (encoding properties like pose, bounding box, and relationships) and receptacle information (encoding properties like location, size, and relationships to objects/surfaces). This unified representation of the scene is crucial for deriving the set of feasible atomic object relocation actions, as detailed in the following section.

3.3 Generating Tasks

Building upon the Receptacle-Aware 3D Scene Graph \mathbb{S} introduced in Sec. 3.2, this subsection details our methodologies for generating comprehensive sets of process- and outcome-based tasks.

Atomic Action Derivation. We first derive the complete set of feasible atomic actions (\mathcal{A}) based on \mathbb{S} , which explicitly encodes the properties of every object (location, size, relationships) as well as all available receptacles. As formalized in Sec. 3.1, an atomic action corresponds to a parameterized object relocation operation, such as moving object o from its current location P to a new valid placement position P' . Accordingly, by identifying every object-receptacle pair where the object can be feasibly placed on the receptacle's surface, we enumerate the full set of possible target locations P' for each object. The set of atomic actions \mathcal{A} is thus defined by all currently feasible object-to-receptacle relocation operations within the scene.

Process-based Tasks. As formalized in Sec. 3.1, process-based tasks explicitly specify a desired sequence of atomic actions $\langle a_1, \dots, a_n \rangle$. Leveraging the agent-environment interaction cycle (Fig. 2) and the derived atomic action set \mathcal{A} , we generate diverse process-based tasks by systematically sampling and composing feasible action sequences. Single-step tasks are simply individual actions sampled from \mathcal{A} . Multi-step tasks are formed by chaining sequences of actions. The interaction cycle enables this chaining: after executing an action a_t in state \mathcal{S}_t , it transitions to \mathcal{S}_{t+1} , then we can sample a subsequent action a_{t+1} that is feasible in the new state \mathcal{S}_{t+1} .

We compose these sequential actions using logical connectors to form complex process-based task instructions. The most common one for defining a task sequence is THEN (e.g., "Execute a_t THEN execute a_{t+1} "). Other connectors like AND or OR can also be used to generate more diverse task structures, reflecting different types of process specifications. By iteratively sampling and chaining such feasible actions across multiple steps, we construct process-based tasks of varying lengths and complexity.

To further enhance linguistic and spatial diversity, we define and describe the target location for each object relocation action within a sampled sequence using distinct spatial strategies derived from the

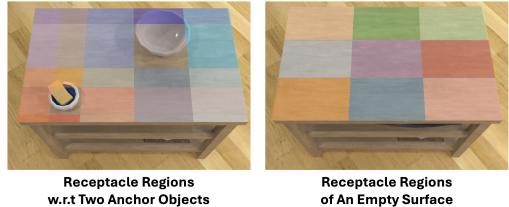


Figure 3: **Visualization of Segmented Receptacle Regions on a Surface.**

Receptacle Regions
w.r.t Two Anchor Objects

Receptacle Regions
of An Empty Surface



Figure 4: **The "lightmap's Which Show the Diversity of Generated Tasks.** Each time an object or location is mentioned in a task, we add a highlight at the corresponding position. The brightness intensity and distribution reveal that our method generates tasks covering more objects and locations.

scene graph. These strategies include: *move to a named surface*, *move to a location around a specific object*, *move to a location with specific direction relative to a specific object*, or *move to a location between two objects*. Furthermore, LLMs can be optionally used to rephrase the entire generated task instruction, increasing linguistic variation while preserving semantics.

Outcome-based Tasks. Generating outcome-based tasks, which define desired target scene states, is more challenging as it requires abstract state descriptions. A naive approach of using VLMs or LLMs directly on the scene information often yields impractical tasks and limited diversity due to model limitations in understanding complex 3D scenes (further discussed in Sec. 4).

To address this, we employ a hybrid approach combining template-based generation and VLM-based filtering. We introduce MANITASKOT-200, a manually curated outcome-based task template dataset acquired from human-written instructions on diverse scenes, comprising 200 structured templates (details in Appendix C.1). Examples of these templates include:

"Create a tidy arrangement on [PLATFORM0]." "Disorganize [PLATFORM0] to make it messy." "Sort all [SUB-OBJECTS00] on [PLATFORM0] by material."

Given a scene, we generate outcome-based tasks by instantiating MANITASKOT-200 templates with scene-specific objects. To ensure task feasibility, we then employ an ensemble of VLMs to vote on the executability of each generated instruction, filtering out impractical tasks and refining the final set. We provide more details on this process in Appendix C.2.

4 Evaluation of ManiTaskGen Tasks

To evaluate the effectiveness of ManiTaskGen in generating comprehensive and diverse tasks for varying scenes, we apply it to both simulated environments (ReplicaCAD [23], AI2THOR [24]) and real-world scene datasets (SUN-RGBD [25]).

These datasets provide scene information including object poses and bounding boxes, with ReplicaCAD and AI2THOR covering additional object mesh models which enable generating tasks w.r.t object interior surfaces. For this evaluation, we selected one representative scene from each dataset and used ManiTaskGen to generate a dataset of tasks, named as ManiTaskGen-RAS. Note that ManiTaskGen's generative process supports arbitrarily complex and length of process-based tasks by sampling from multiple interaction cycles, and instantiating outcome-based task templates with diverse objects also generates a vast number of tasks. Thus, the potential size of the task space is theoretically infinite. Yet, for the purpose of statistical analysis, we curate a finite subset of these tasks, named as ManiTaskGen-RAS-40K, com-

Datasets	Num. of Scenes	Num. of Tasks
GenSim [33]	-	100
λ [39]	20	521
M3Bench [16]	119	31,050
ALFRED [34]	120	25,743
Language Rearrangement [7]	1	1,000
Embodied Agent Interface [17]	2	438
EmbodiedBench [38]	4	1,128
ManiTaskGen-RAS-40K (Ours)	3	39,871
ManiTaskGen-RAS (Ours)	3	$+\infty$

Table 1: **Comparison between ManiTaskGen-RAS and Other Existing Datasets.**

prising a total of 39,871 tasks. Specifically, for the process-based tasks, we include 39,221 instances comprising single-step pick-and-place tasks (sampled from a single interaction cycle) and two-step tasks (sampled from two consecutive cycles and connected with the logical connector THEN). For the outcome-based tasks, we generated them by instantiating templates part from MANITASKOT-200 and employed an ensemble of VLMs (GPT-4o [40], Gemini-2.5-pro [41], Claude-3.7-sonnet [42]) to vote on their feasibility. This filtering process resulted in a final set of 650 outcome-based task instructions. More details of ManiTaskGen-RAS-40K are provided in Appendix D.1.

We compare our generated datasets with existing embodied decision-making datasets in Tab. 1. Notably, despite using only 3 scenes, ManiTaskGen-RAS-40K contains significantly more tasks than other datasets. Furthermore, our method is scene-agnostic, meaning it can be applied to any given scene, allowing for the incorporation of additional scene data sources to further expand the task set.

Next, we present further results of evaluating the quality of generated tasks from two key aspects : **Validity** and **Diversity**. For a fair comparison, we implement a GPT-based task generation approach as a baseline, referred to as GPTTaskGen. Specifically, we feed each scene's object information along with their images to GPT-4o [40], instructing it to generate the tasks. We apply this baseline method to the same 3 scenes as in ManiTaskGen-RAS-40K to generate 10,000 process-based tasks and 1,000 outcome-based tasks, referred to as GPTTaskGen-RAS. This task set serves as a direct comparison to evaluate the validity and diversity of the tasks produced by our method.

Validity Assessment. We first evaluate the validity of the generated tasks by conducting human verification on ManiTaskGen-RAS-40K and GPTTaskGen-RAS, with the results reported in Tab. 2. For process-based tasks, although our generation algorithm ensures the target location has sufficient space to accommodate the moved object, some tasks may still be infeasible due to occlusions or obstacles, making the target position difficult to reach or observe. Nevertheless, our results show that most tasks are valid, with significantly higher validity rates compared to the baseline method. For outcome-based tasks, the validity rate is expectedly lower compared to process-based tasks, as it relies on a VLM-based filtering mechanism. Yet our method produces mostly valid tasks.

Diversity Assessment. We proceed to assess the diversity of the generated task set, which reflects how well the tasks cover various scenarios. To compare task diversity, we randomly sample 100 tasks for the same apartment scene of ReplicaCAD from ManiTaskGen-RAS-40K and GPTTaskGen-RAS, and count their object and location coverings. Fig. 4 presents two "lightmap"s that visualize the distribution of involved objects and locations. Specifically, we light up the centroid of an object or location whenever it appears in a task. The figure clearly demonstrates that our method generates a wider range of tasks, covering more diverse objects and locations compared to the baseline.

5 Benchmarking and Improving Embodied Decision-Making

In this section, we showcase two important applications of ManiTaskGen: benchmarking and improving embodied decision-making agents. In Sec. 5.1, we design an automatic framework for constructing benchmarks using tasks generated by ManiTaskGen, evaluate the decision-making capabilities of existing VLM agents. In Sec. 5.2, we further propose an inference-time improvement method that utilizes ManiTaskGen tasks and validate its effectiveness through experimental results.

5.1 Benchmarking VLM Agents

To facilitate necessary agent-environment interaction, the benchmark is constructed within an simulator [43]. After loading the given interactive scene and generating the tasks, at each timestep of an episode, the VLM-based agent receives observations from the environment and selects an abstracted action (Sec. 5.1.1) to execute. The environment will be automatically updated and conduct the result judgment (Sec. 5.1.2) if a completion signal is given. Sec. 5.1.3 presents our benchmark results.

5.1.1 Action Space and Test Flow

Action Space. We define a discrete, abstracted action space that the VLM-based agent selects from at each timestep. The scene graph \mathbb{S} introduced in Sec. 3.2 is used to calculate feasible walkable areas

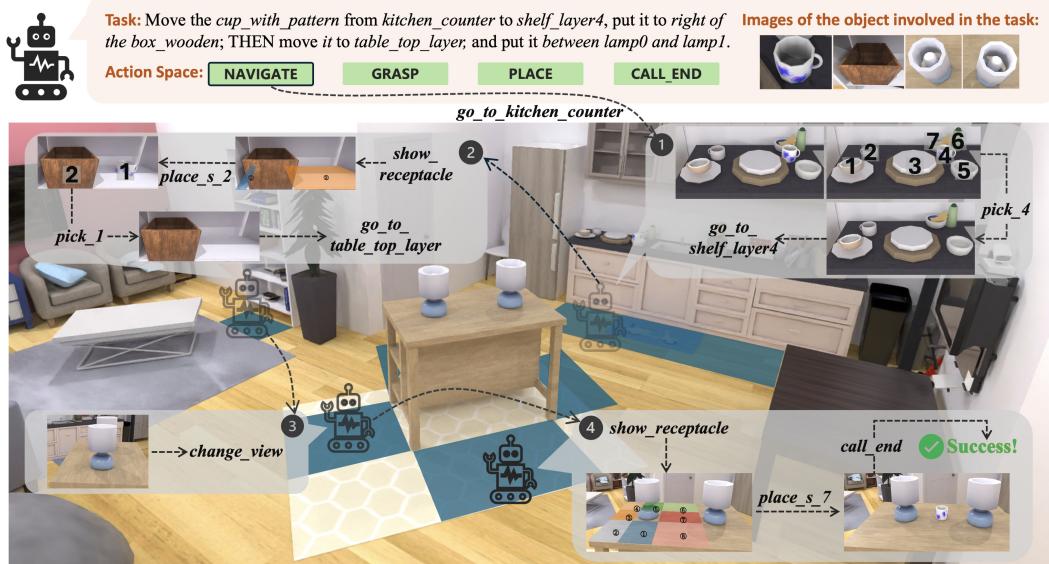


Figure 5: **Visualization of An Example Testing Episode.** The agent is equipped with abstracted navigation (`go_to`, `change_view`), grasping (`pick`) and placing (`show_receptacle`, `place`) skills. Blue marks indicate the walkable locations around ground objects involved in this episode.

around each ground object, which define possible navigation targets, and also to identify platforms within objects and segment them into receptacle regions. The detailed action space includes:

- `go_to(platform_id)`: Navigate to a walkable area around a specific platform of an object.
- `change_view`: Re-navigate to a different walkable area (if any) of the current platform.
- `pick(object_id)`: Grasp the object with the specified ID. The `object_ids` are associated with the tags provided as the visual observation when the agent is located near a platform.
- `show_receptacle(object_id)`: Visualize feasible receptacle regions (tagged by `receptacle_IDs`) associated with an specified object on the current platform.
- `place`: Place the held object at a specified location. We offer two placement modes:
 - `place_r`: Place the object at a random feasible receptacle on the current platform.
 - `place_s([object_id:receptacle_id])`: Place the object within the space defined by the list of receptacle regions associated with specified objects on current platform. If multiple receptacles are provided, the system merges them into a larger placement region if they are connected or overlapped.
- `call_end`: Signals the agent’s intention to complete the task and terminates the episode.

Test Flow. An example episode of the benchmark test flow is visualized in Fig. 5. At each timestep, the agent receives multimodal observations from the system, including rendered images (with tags for objects or, after `show_receptacle`, for receptacles), and text information. The system executes the given actions, updates the environment, and provides the next observation. An episode terminates when the agent executes `call_end` or a preset timestep limit is reached. After termination, the benchmark automatically evaluates the episode, following the criteria illustrated in the next section.

5.1.2 Task Difficulty and Evaluation Criteria

Task Difficulty Levels. We classify ManiTaskGen tasks into four difficulty levels. Levels 1 to 3 are process-based tasks, with increasing structural and perceptual complexity. Level 1 comprises single-step pick-and-place tasks involving unique target objects. Level 2 introduces perceptual ambiguity with non-unique target objects requiring disambiguation and additional description, such as moving a red cup when multiple cups are present on the same platform. Level 3 consists of two sub-tasks formed by chaining atomic actions (two one-step pick-and-place tasks from Level 1 or 2) using the logical connector `THEN`. Level 4 includes all outcome-based tasks.

	Level 1		Level 2		Level 3		Average	
	IP	SR (%)						
Human	96.0	82.5	95.0	80.5	95.0	80.0	95.3	81.0
Random	0.7	0.0	0.7	0.0	0.7	0.0	0.7	0.0
GPT-4o[40]	71.6	40.1	42.9	16.3	57.0	8.2	57.2	21.5
GPT-4.1[40]	67.5	36.4	46.4	20.4	54.4	4.2	56.1	20.3
GPT-4.1-mini [40]	67.0	34.0	45.9	22.4	45.3	0.0	52.7	18.8
Gemini-2.5-flash[41]	75.0	40.3	40.8	14.3	56.0	4.1	57.3	19.6
Gemini-2.5-pro [41]	82.3	51.5	54.1	22.4	68.9	13.3	68.4	29.1
Claude-3.7-sonnet [42]	73.9	45.7	55.6	28.6	54.7	8.9	61.4	27.7
Claude-3.5-haiku [42]	60.0	31.5	40.3	12.2	37.8	2.2	46.0	15.3
Qwen-2.5-VL-72B-Ins [44]	55.1	28.2	37.2	8.2	43.5	4.4	45.3	13.6
Llama-3.3-70B-Vision-Ins [8]	66.1	37.6	42.9	12.2	51.4	0.0	53.5	16.6

Table 3: **Evaluation Results on Existing VLMs.** We cover both proprietary (upper part) and open-source models (lower part). Here, IP refers to Intermediate Points, and SR refers to Success Rate.

Evaluation Criteria. For process-based tasks (Levels 1 to 3), the expected final scene state is precisely defined, enabling automatic success verification by comparing the initial and final scene graphs. For each testing episode, we conclude following evaluation metrics: (1) **Success Rate (SR)**; (2) **Intermediate Points (IP)**. For Level 1 & 2 tasks, a successful episode should include the following four sub-steps, each contributing 25 points of IP: Navigate to the correct starting location; Grasp the correct object; Navigate to the correct destination with the right object; Place the right object in the correct place. IP for Level 3 tasks is computed by averaging points from the two sequential sub-tasks. Regarding Level 4 tasks, which involve abstract descriptions of scene state changes (e.g., "make the desk cleaner"), defining an unbiased and precise success-state scene graph is challenging. Possible evaluation methods include human verification or leveraging VLMs to assess whether the final scene state satisfies the requirements. We leave benchmarking Level 4 tasks in future work.

5.1.3 Benchmarking Results on VLM Agents

We evaluate existing VLM-based embodied agents in the simulated scenes [23, 24] from ManiTaskGen-RAS-40K. Specifically, we randomly sample 1000 tasks for each level of the tasks. A timestep limit of 20 is set for Level 1 & 2 tasks, and 40 for Level 3 tasks. Results are shown in Tab. 3. We observe that all models achieve a low average SR (under 30%), significantly below human-level performance. Performance generally decreases with increasing task difficulty. Longer tasks (Level 3) lead to significantly lower performance compared to single-step tasks, highlighting the substantial challenge posed by the generated tasks. To further analyze failure cases, in Fig. 6, we visualize the sub-step mistake distribution from Gemini-2.5-pro [41] for Level 3 tasks. We observe that wrong placement accounts for the largest proportion of mistakes, suggesting that VLMs' spatial understanding capabilities may serve as a primary bottleneck for mobile manipulation tasks. Furthermore, analysis of execution traces reveals that while the agent performs well in navigation in early stages of the episode (e.g., navigating to the first target object), it makes more navigation mistakes in later steps, indicating that longer-horizon tasks pose a greater challenge to the VLM agent's decision-making capabilities.

5.2 Improving VLM Agents

ManiTaskGen tasks can not only be used for benchmarking VLMs, but also for optimizing VLM-based agents. There are two prominent directions for improvement: one leverages precisely labeled task trajectories for supervised fine-tuning (SFT) [45, 46], and the other is reinforcement fine-tuning (RFT) [26, 47], utilizing feedback of task execution process for unsupervised optimization. Given that ManiTaskGen enables automated evaluation of the final results as well as intermediate

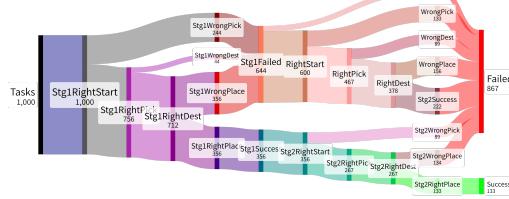


Figure 6: **Success and Failure Modes** from Gemini-2.5-pro in each stage of Level 3 tasks.

the substantial challenge posed by the generated tasks. To further analyze failure cases, in Fig. 6, we visualize the sub-step mistake distribution from Gemini-2.5-pro [41] for Level 3 tasks. We observe that wrong placement accounts for the largest proportion of mistakes, suggesting that VLMs' spatial understanding capabilities may serve as a primary bottleneck for mobile manipulation tasks. Furthermore, analysis of execution traces reveals that while the agent performs well in navigation in early stages of the episode (e.g., navigating to the first target object), it makes more navigation mistakes in later steps, indicating that longer-horizon tasks pose a greater challenge to the VLM agent's decision-making capabilities.

Model Name	IP (Before)	IP (After)	SR (Before)	SR (After)
GPT-4.1[40]	75.5	79.4	38%	49%
Gemini-2.5-flash[41]	79.4	81.7	36%	58%
Claude-3.5-haiku [42]	68.9	79.4	36%	51%

Table 4: **Improvement of Agent Performance.**

steps (Sec. 5.1), we adopt an inference-time RFT policy to enhance agent capabilities inspired by Reflexion [26] and ReAct [27]. Specifically, we design a self-reflection model that processes the evaluation results of each episode to generate a verbal summary. This summary is then stored in a long-term memory and used as part of the input for the agent when attempting the task in future episodes. We present details of our optimization process in Sec. 5.2.1, and experimental results in Sec. 5.2.2.

5.2.1 Optimization based on Self-Reflection

Given a trial episode and its evaluation results (including final success judgment and intermediate step evaluations), a rule-based self-reflection model automatically generates the following summary:

- The task goal, the history of the trial episode, and whether the task was ultimately successful.
- If the task was not successful, a summary indicating which intermediate step goals were achieved and the point in the action history up to which they were successfully completed. As described in Sec. 5.1.2, these correct intermediate steps include: navigate to the starting location, grasp the object, navigate to the destination location, and place the object .
- For the intermediate goals underachieved, what are the next suggested actions.
- Corresponding observation images in each part of the summary.

We maintain a long-term memory to store these verbal summaries from multiple trial episodes. The optimization process is iterative. After each trial, the corresponding self-reflection updates the long-term memory, which is used as part of the input for the agent when attempting subsequent trials.

5.2.2 Improvement Results

To ensure no data leakage between optimization and deployment, we select tasks from the ReplicaCAD [23] scene of ManiTaskGen-RAS as source trial episodes, and subsequently tested in the AI2THOR [24] scene. Tab. 4 summarizes the performance improvements of agents after optimization. We used 10 trial episodes for optimization, then conducted evaluation on 100 randomly sampled test tasks, which are all Level 1 tasks. As shown in the table, our optimization significantly improved both the task execution success rate and the Intermediate Points score. We further investigated the impact of the number of trial episodes on final agent performance. Results are presented in Fig. 7. Preliminary results show that agent performance continuously improves with an increasing number of self-reflection trial episodes. Similar findings have been observed in previous work [26]. Therefore, these findings further underscore the significance of ManiTaskGen. Because it can generate and evaluate tasks in arbitrary scenes, thus providing abundant resources for agent improvement.

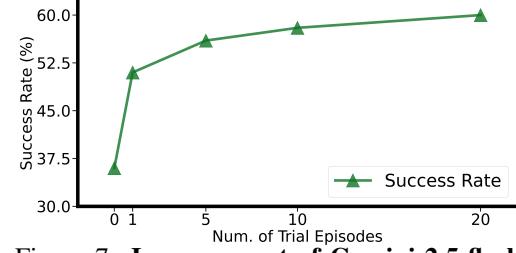


Figure 7: **Improvement of Gemini-2.5-flash Agent.** We find that more trial episodes continuously contribute to the agent performance.

6 Conclusion and Future Work

In this paper, we introduce ManiTaskGen, an automated method for task generation for any given scene. ManiTaskGen can generate a comprehensive set of long-horizon mobile manipulation tasks, covering both process-based and outcome-based tasks, thereby providing a diverse set of testing scenarios and improving resources for embodied decision-making agents. Our experiments demonstrate the validity and diversity of the generated tasks, while also showcasing their practical usability by benchmarking and improving the decision-making capabilities of existing VLM-based agents.

Limitations and future work. Currently, ManiTaskGen has focused on embodied decision-making agents with navigate, grasp, and place capabilities. Future work will extend to a broader skill set, including fine-grained object manipulation and tasks involving non-pose state changes. Additionally, due to the inherent subjectivity and randomness often associated with outcome-based task judgment, this work did not demonstrate existing VLM agent performance and improvement specifically on these tasks. Future work will consider introducing human judgment or RLHF-based improvement.

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Appendix

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A Extended Related Work

Improvement of VLM-based Agents. Numerous research has explored various strategies to improve LLM/VLM-based digital agents [48, 47, 49, 27, 50] and embodied agents [51, 52, 15, 7, 53]. One important line of work employs collected demonstrations for supervised fine-tuning (SFT) [15, 48, 54, 55]. Given sufficient data, SFT ensures the resulting model achieves comparable performance with the source demonstrations. However, demonstration collection is labor-intensive and expensive, making it challenging to scale across diverse tasks and scenarios. Another prominent thread of methods leverages Reinforcement Learning (RL) [47, 56, 26, 57] to tune agent policies, through learning from reward models based on human feedbacks [58, 56], task-specific handcrafted reward functions [59, 47], or reward generators [51, 26]. To demonstrate the application of ManiTaskGen tasks for agent improvement, we designed and implemented a simple inference-time RL method inspired by Reflexion [26] and ReAct [27]. The method leverages the generated tasks and evaluations for self-reflection, and experimental results demonstrate its effectiveness. Future work involves extending ManiTaskGen’s compatibility with more advanced RL-based improvement methods [51, 52]. Overall, ManiTaskGen produces abundant resources for agent improvement, including task instructions as well as final and sub-step evaluations, thereby empowering various approaches to tune VLM-based agents.

B Constructing Receptacle-Aware 3D Scene Graph

As described in Sec. 3.2, the process of constructing the 3D scene graph mainly consists of 2 stages: (1) Initializing the scene graph based on mutual spatial relationships between objects; (2) Calculating receptacle regions anchored by objects. We provide further details on each part below.

B.1 Scene Graph Initialization

First, based on each object’s pose and the size of its bounding box, we infer the spatial relationships between objects along the vertical axis. These spatial relationships are used to initialize the scene graph. In the scene graph, each node represents an object, and a child node indicates that the corresponding object is placed on the upper surface of its parent. For scenes that provide object mesh models (e.g., ReplicaCAD and AI2THOR), we additionally extract internal surfaces suitable for object placement and record them in nodes’ attributes. Consequently, the scene graph is extended such that a child node can be placed on either an internal or external surface of its parent node. To facilitate subsequent identification and indexing of receptacles within the scene, we also define the following attributes for each node (i.e., each object) during the scene graph initialization stage.

Ground Objects and Surface Objects. We divide all objects in a scene into ground objects and surface objects, where ground objects are those resting directly on the ground, while surface objects are those supported by other objects. We assume the robot can only manipulate surface objects.

Walkable Spaces. For each ground object, we define the space unobstructed in the vertical direction of its bounding box as its walkable space. These walkable spaces serve as navigation targets for the robot when traversing the scene. For surface objects placed on ground objects, the corresponding ground object’s walkable space is also used as the robot’s navigation target when approaching those surface objects. In our implementation, we adopt a threshold of 50 cm to determine whether the unobstructed space in a given direction is sufficient to be considered walkable. A single ground object may have multiple walkable spaces, corresponding to different edges of its bounding box.

Headings of Objects. To support the generation of direction-related tasks (e.g., placing object A to the left of object B), we also define the heading of each object. For ground objects, we assume that their heading is determined by the robot’s standing orientation when navigating to the area around the object (decided by the walkable spaces)—specifically, the direction the robot is facing is taken as the *front* (heading) of the ground object, as shown in Fig.8 (a). If a ground object has multiple walkable spaces, its heading is not fixed and depends on the robot’s actual standing orientation. For surface objects, we assume their heading always aligns with that of the supporting ground object. Therefore, for surface objects whose bounding boxes are not parallel to those of their supporting ground objects, we still use the ground object’s heading as the sole reference when reasoning about their directional relationships.

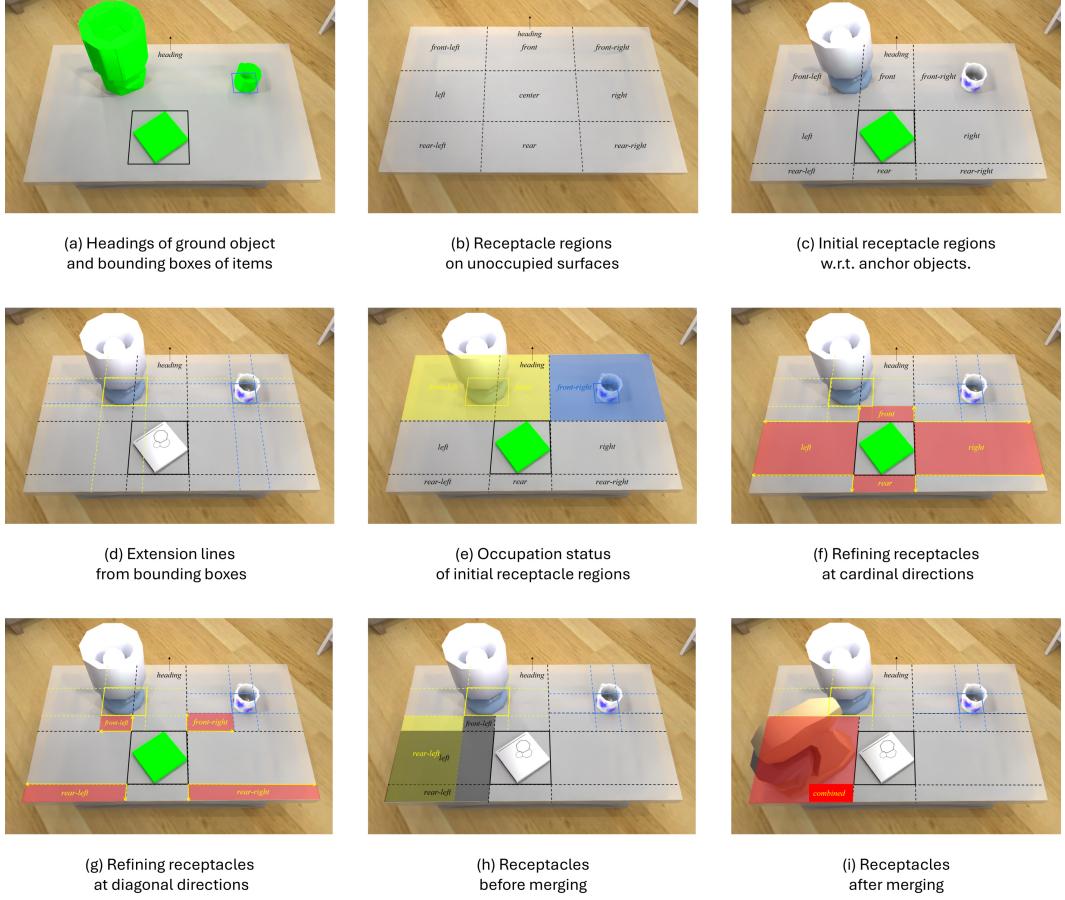


Figure 8: **Visualization of Rules Involved in Scene Graph Construction.**

B.2 Calculating Receptacle Regions

We construct accurate receptacle region retrieval information in three steps. First, we compute an initial set of rough receptacles based on empty surfaces or the spatial relationships between existing objects and the supporting surfaces (Sec. B.2.1). Next, we refine these receptacles by considering the relative positions of objects on the same surface (Sec. B.2.2). Finally, we introduce rules for merging adjacent or overlapping receptacles (Sec. B.2.3).

B.2.1 Initial Receptacles

Initial receptacles is computed mainly to better determine the relative positioning of objects.

For unoccupied surfaces, we divide the area into a 3×3 grid consisting of nine identical rectangular regions, as visualized in Fig. 8 (b). The interior rectangle is defined as the "center" region. For the surrounding eight regions, we designate their directions based on the surface's heading: the direction aligned with the heading is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." These receptacle regions are directly indexed by surfaces in the scene graph. For occupied surfaces, we use a different approach while maintaining the same directional terminology, as shown in Fig. 8 (c) and (d). We treat each surface object as an anchor object to index the receptacle regions around it. Specifically, we extend the vertices and edges of each object's bounding box outward until they reach the platform's boundaries. The regions swept by the extended edges define the object's initial receptacles in four cardinal directions (front, rear, left, right), while the paths traced by the extended vertices determine the initial receptacles in the four diagonal directions (front-left, front-right, rear-left, rear-right).

With these initial receptacles for each anchor object, we then determine the relative positioning of other objects on the same surface by identifying which of our calculated initial receptacles they overlap with. Fig. 8 (e) illustrates this process. The relative positioning and occupation information will also be recorded in the scene graph.

B.2.2 Refined Receptacles

We proceed to refine the initial receptacles based on accurate object positions and bounding boxes, and record their properties into the scene graph.

For cardinal directions, we project the edge of an object’s bounding box along its perpendicular direction until it intersects another object’s bounding box or the platform boundary. The region swept during this projection forms the refined receptacle in this cardinal direction, as shown in Fig. 8 (f).

For diagonal directions, we project the vertices of the object’s bounding box along two corresponding cardinal directions until they encounter the extension line of another object’s bounding box or the platform boundary. The rectangle formed by these two projection paths represents the refined receptacle in this diagonal direction, as illustrated in Fig. 8 (g).

Thus, these refined receptacles are treated as final ones indexed by anchor objects. Together with the receptacle regions indexed directly by empty surfaces, they establish a systematic representation for efficient and retrieval of the free spaces on surfaces.

B.2.3 Merging Receptacles

Merging receptacles is applied in task generation and during interaction for object placement, to support retrieving multiple refined receptacles.

When generating process-based tasks, for any surface object in the scene, we traverse all receptacle regions in the scene to determine whether there is sufficient space to place the object. If not, for multiple receptacle regions belonging to the same surface, we attempt to merge up to four adjacent or overlapping receptacle regions. If the merged receptacle region provides enough space to accommodate the object, we then generate the corresponding task. Fig. 8 (h) shows an example of merging four receptacles when generating the task of placing a large kitchen utensil in the scene.

During interaction between the agent and the environment, the agent may select any number of receptacles on a surface, regardless of whether they are indexed by the same anchor object. The system will then attempt to merge them into a larger receptacle region if they are connected or overlapped, and to assess if the resulted one has enough space to fit the object, as shown in Fig. 8 (i).

C Generating Outcome-based Tasks

C.1 Details of MANITASKOT-200 Dataset

C.1.1 Dataset Collection Process

The MANITASKOT-200 dataset contains 200 templates for outcome-based tasks, processed based on the human instructions collected from Amazon Mechanical Turk (AMT) [60]. We first rendered scene images from real-world and simulated datasets, including Habitat [23], ScanNet [61], and SUN-RGBD [25]. Next, we launched an instruction collection job in AMT [60] to gather natural language instructions from human annotators specific for the provided images. The detailed job description is shown below:

General Description: Imagine a powerful mobile robot that can move any object except immovable ground furniture. Describe in natural language the tasks it can perform, especially high-level complex tasks.

Detailed Instruction: Imagine we have a powerful mobile robot that can move and place any non-ground object in a room. Your task is to describe high-level, complex tasks the robot can perform in this room using natural language. Pictures of the room and its layout are provided here ([link](#)). First, please review layout.png, [0][ROOM].png, and then all the other images to understand the room layout and

object reference information. Make sure your tasks are reasonable and closely follow the provided images.

Key Points: (1) For immovable ground objects in the room, when referring to these objects, strictly use the numbered labels listed below: [1][DESK], [2][SHELVING], etc. (2) When referring to other small objects, you can describe them freely, but make sure to enclose the object names in square brackets, like this: [book], [plastic bottle], [small robotic arm]. (3) Please use your imagination as much as possible and give complex, high-level, and imaginative instructions.

Examples of tasks we want:

- (1) Help me clear the top of [1][DESK].
- (2) Organize all [soda cans] on the top layer of [2][SHELVING] to line them up in a row.
- (3) Tidy up the [2][SHELVING] to make it aesthetically pleasing.
- (4) The [7][DESK] is too messy. Organize the objects on top of it to make it neat.
- (5) Take out the [cans] from under the [paper box] on the left side of [3][DESK] and arrange them into an equilateral triangle.

We view these examples as positive ones because they contain complex, high-level instructions.

Examples of tasks we do NOT want:

- (1) Move the [paperbox] under [1][DESK] to [8][DESK]
 - (2) Pick up the [tiny robotic arm] from [3][DESK] and place it on the [5][CHAIR].
- We view these examples as negative ones because these tasks are too simple or the instructions are too detailed.

Based on the collected human instructions, we manually filtered out low-quality and repeated ones and removed specific object names in each instruction to create the final templates. In the end, we organized a set of 200 task templates, named as MANITASKOT-200.

C.1.2 More Examples of MANITASKOT-200

We provide more templates from MANITASKOT-200 as follows:

- "Align all [SUB-PLATFORM-OBJECTS00] on [PLATFORM0] symmetrically."
- "Create a "staircase" on [PLATFORM0] by arranging the objects to resemble steps."
- "Create a pattern with the [SUB-PLATFORM-OBJECTS00] on [PLATFORM0] by placing them in a spiral, starting from the center of the [PLATFORM0] and expanding outward."
- "Arrange [SUB-PLATFORM-CATEGORY-OBJECTS00] on [PLATFORM0] by height and type."
- "Design a thematic organization system on [PLATFORM0] for all [SUB-PLATFORM-OBJECTS00], separating items by color and function."
- "Organize the entire contents of [PLATFORM0] by categorizing items into labeled sections, with frequently used items at a central location for easy access."
- "Declutter the right side of [PLATFORM0] by moving all loose objects to the left side and aligning them by size."
- "Design a "mirrored room" on top of [PLATFORM0] by arranging the objects to create a sense of symmetry and reflection."
- "Create an artistic arrangement on [PLATFORM0]."
- "Carefully arrange all the [SUB-PLATFORM-CATEGORY-OBJECTS00] on [PLATFORM0] in ascending order of size, leaving a clear space in the center for the [SUB-PLATFORM-OBJECTS00] from [PLATFORM0] to be placed as a decorative piece."

The full dataset will be released soon.



Figure 9: Visualization of the 3 Scenes Used to Generate ManiTaskGen-RAS-40K.

C.2 VLM-based Voting Mechanism

As described in Sec. 3.3, the process of generating outcome-based tasks involves 2 steps. Firstly, we fill the templates from MANITASKOT-200 with valid combinations of platforms and objects, and then we employ a VLM-based voting mechanism to roll out reasonable tasks.

In our implementation, we use an ensemble of 3 VLMs (GPT-4o [40], Gemini-2.5-pro [41], Claude-3.7-sonnet [42]) to assess a given task. For each VLM, we introduce the task goals and the capabilities of the agent (navigate, pick, place), along with pictures of all platforms involved in the task. Each VLM is required to output 1 of 3 assessment levels: feasible, partially feasible or not feasible. A task will be included in the final dataset only if at least 2 out of the 3 VLMs vote for it as a feasible one. The detailed prompt we use for this process is shown below:

Prompts for Outcome-based Task Assessment
<p>Task: [TASK_DESCRIPTION, IMAGES_OF_INVOLVED_OBJECTS_AND_PLATFORMS]</p> <p>Evaluate if the given task is feasible for such a robot whose abilities involve: navigate, pick up any movable object and place objects anywhere they fit on a given platform.</p> <p>Assessment criteria:</p> <ol style="list-style-type: none"> 1. Are all required objects present in the scene? 2. Is there sufficient free space on the target platform given the required object placement? 3. Are the required state achievable given the robot's capabilities and the objects we have in the involved platforms? 4. Would completing the task create any unstable or physically impossible object arrangements? <p>Only output a single line: "Feasible", "Partially feasible", or "Not feasible". Do not output anything else.</p>

D Experiment Details

D.1 Details of ManiTaskGen-RAS-40K

To build ManiTaskGen-RAS-40K, we choose 1 scene from ReplicaCAD, AI2THOR and SUN-RGBD respectively. For ReplicaCAD, we select the scene *apt_0*; For AI2THOR, we select the scene *floorplan_train2_1 of RoboTHOR*; For SUN-RGBD, we choose the scene *0000885-000176498993 of hotel_uc*. Fig. 9 shows the visualization of these scenes.

Next, we demonstrate the detail of generating tasks using the selected scenes. In Sec. D.1.1, we illustrate the data preprocessing pipeline; In Sec. D.1.2, we describe how we use the processed data to generate ManiTaskGen-RAS-40K of controlled task complexity and length.

D.1.1 Scene Data Preprocessing

For each given scene, our preprocessing pipeline consists of two parts: **Item Renaming** and **Removal of Overlapping Objects**.



Figure 10: **Ambiguous Item Naming in ReplicaCAD.**

Item Renaming. We observe that the original object naming in certain input scenes (e.g., ReplicaCAD and AI2THOR) is somewhat casual. As shown in Fig. 10, many books and kitchen utensils share identical base names and are only distinguished by numerical suffixes. This naming convention makes it difficult for the generated process-based tasks to differentiate between Level-1 and Level-2 tasks (as defined in Sec. 5.1.2). To address this, we employ a VLM to rename objects in the given scene. The new naming scheme follows the format "`{category_name}_{specific_name}`". When a process-based task involves an object that shares the same `{category_name}` with other objects on the same surface, the task is classified as Level-2; otherwise, it is treated as Level-1. The prompt we provide to the VLM is detailed below. The renaming results for ReplicaCAD are presented in Tab. 5,

Prompts for Item Renaming

You are a professional item classification and naming assistant. You need to provide a unique and meaningful name for each item based on indoor object images.

I need your help to classify and rename a series of indoor object images. Each image contains an item, probably on a supporting platform, to be named. Please follow these requirements:

1. Naming Rules:

- Each item name must be unique
- Names should reflect the item's category and characteristics
- Use English naming format '`{category_name}_{specific_name}`', no non-alphabetic characters allowed

2. Naming Examples:

- A red mug -> `kitchenware_red_mug`
- A textbook -> `book_textbook`
- A desk lamp -> `electronics_desk_lamp`

Please review the images and provide standardized names according to the above rules. The following images are the items to be classified, one item per image.

[Item Image]

The provided image contains an item to be renamed, probably being placed on some platform. Your response should be a single line of the new name, with '`_`' connecting different words, e.g. '`utensil_white_soap_dispenser`' (without quotes). Don't include redundant characters, don't include characters other than alphabets and underscores, don't coincide with any previous name you've given in the [ITEM NAME LIST].

Name (before)	Name (after)
frl_apartment_kitchen_utensil_01	kitchenware_ceramic_lidded_container
frl_apartment_kitchen_utensil_02	bathroom_light_green_pump_bottle
frl_apartment_kitchen_utensil_03	kitchenware_spice_container
frl_apartment_kitchen_utensil_04	kitchenware_white_paper_towel_holder
frl_apartment_kitchen_utensil_05	kitchenware_navy_blue_lidded_dish
frl_apartment_kitchen_utensil_06	kitchenware_short_glass
frl_apartment_kitchen_utensil_08	kitchenware_grey_mug
frl_apartment_kitchen_utensil_09	bathroom_dark_blue_bottle
frl_apartment_knifeblock	kitchenware_wooden_knife_block
frl_apartment_lamp_01	lighting_modern_table_lamp
frl_apartment_lamp_02	lighting_blue_base_table_lamp
frl_apartment_pan_01	kitchenware_dark_blue_saucepan
frl_apartment_picture_02	decor_autumn_tree_canvas
frl_apartment_picture_03	decor_silver_photo_frame
frl_apartment_picture_04	decor_abstract_framed_print
frl_apartment_plate_01	kitchenware_white_octagonal_plate
frl_apartment_plate_02	kitchenware_wooden_cake_stand
frl_apartment_remote-control_01	electronics_black_remote_control
frl_apartment_shoebox_01	storage_dark_grey_round_box
frl_apartment_shoe_01	shoes_black_oxford_shoes
frl_apartment_shoe_02	shoes_brown_leather_oxford
frl_apartment_shoe_03	shoes_red_slingback_sandal
frl_apartment_shoe_04	shoes_blue_sneaker
frl_apartment_small_appliance_01	kitchenware_beige_coffee_grinder
frl_apartment_small_appliance_02	bathroom_grey_soap_dispenser
frl_apartment_sponge_dish	kitchenware_small_white_bowl_with_butter
frl_apartment_basket	kitchenware_beige_utensil_holder
frl_apartment_book_01	books_dark_red_hardcover
frl_apartment_book_02	books_navy_blue_hardcover
frl_apartment_book_03	books_brown_hardcover_journal
frl_apartment_book_04	books_black_hardcover
frl_apartment_book_05	electronics_white_router_box
frl_apartment_book_06	electronics_navy_blue_printer
frl_apartment_bowl_06	kitchenware_small_white_bowl
frl_apartment_bowl_07	kitchenware_white_porcelain_bowl
frl_apartment_box	storage_brown_wooden_box
frl_apartment_camera_02	electronics_white_security_camera
frl_apartment_choppingboard_02	decor_wooden_cube
frl_apartment_clock	decor_mantel_clock
frl_apartment_cup_01	kitchenware_small_white_mug
frl_apartment_cup_02	kitchenware_blue_floral_mug
frl_apartment_cup_03	kitchenware_beige_tea_cup
frl_apartment_cushion_03	furniture_light_blue_throw_pillows

Table 5: Renaming Results of ReplicaCAD.

Removal of Overlapped Objects. We further observe that in certain scenes (e.g., SUN-RGBD), objects located on the same surface exhibit significant bounding box overlap. During preprocessing, we remove such objects to ensure data cleanliness.

D.1.2 Generating Tasks of Controlled Complexity and Length

After preprocessing the input scene data, we build the scene graph and use it to generate the tasks, as described in Sec. 3.3. We first generate atomic actions using the patterns provided in Tab. 6. After that, we generate all possible single-step pick-and-place tasks (i.e., Level 1 and Level 2 tasks). For more complex, longer-horizon multi-step pick-and-place tasks, we limited them to two-step sequences and sampled 5,000 instances for ReplicaCAD and AI2THOR, while only sampling SUN-RGBD to 500 instances (due to fewer objects and platforms in the scene of SUN-RGBD). Similarly, for

outcome-based tasks, we generated constrained quantities for different scenes, with specific numbers detailed in Tab.7.

Atomic Action Pattern	Generation Logic
Move to a named surface	If the object can fit on the surface.
Move to a location around a specific object	If there exists a place to fit this object, which only involves receptacle regions of one specific object.
Move to a location with specific direction relative to a specific object	If there exists a place to fit this object, which only involves receptacle regions of specific direction relative to the specific object.
Move to a location between two objects	If there exists a place to fit this object, and the covered receptacle regions correspond to complementary directional pairs from two different objects (e.g., left side of object A and right side of object B; front-left of object A and back-right of object B).

Table 6: **Patterns and Logics for Generating Atomic Actions.**

Note that, for AI2THOR scenes, no Level-2 tasks were generated since there were no instances of multiple objects belonging to the same category existing on the same surface after the renaming process. Tab. 7 shows the exact numbers of tasks we generate for each scene.

Dataset	Level 1	Level 2	Level 3	Level 4	Total
ReplicaCAD	2195	24153	5000	500	31848
AI2THOR	2218	0	5000	100	7318
SUN-RGBD	35	120	500	50	705
Total	4448	24273	10500	650	39871

Table 7: **Number of Tasks at Each Level across Datasets.**

D.2 Examples of Complete Benchmark Episodes

Below we display two full episode histories of benchmarking experiments elaborated in Sec. 5.1.3. In Sec. D.2.1, we present a successful episode performed by Claude-3.7-sonnet in the ReplicaCAD scene. In Sec. D.2.2, we show a failed episode performed by Gemini-2.5-pro in the AI2THOR scene.

D.2.1 Successful Episode

The following episode shows how claude-3.7-sonnet performed a task successfully in ReplicaCAD. When encountered perceptual ambiguity, it repeatedly picking up the possible objects, and immediately use *place_r* to place it down when recognized. Eventually it picks up the correct item at the fourth attempt. Then it went to the destination, asked for the receptacle pictures and placed it down successfully.



Figure 11: Images Given at the Step 0 of the Successful Episode.

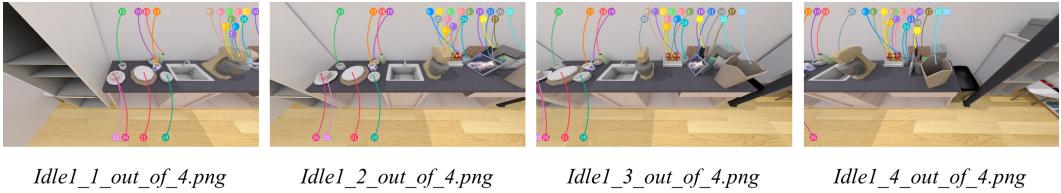


Figure 12: Images Given after Step 1 of the Successful Episode.

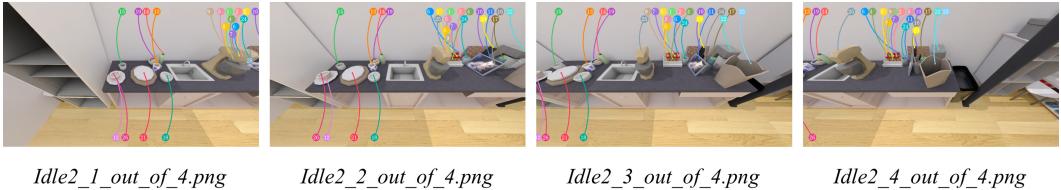


Figure 13: Images Given after Step 2 of the Successful Episode.

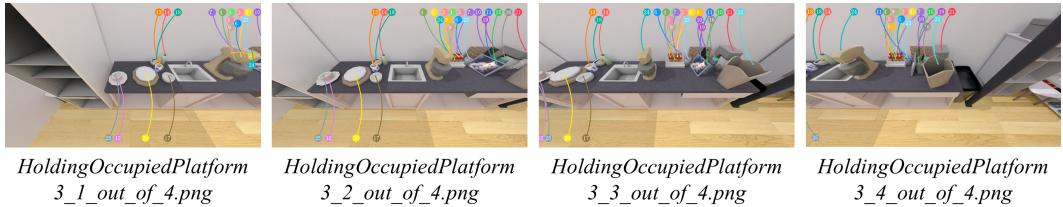


Figure 14: Images Given after Step 3 of the Successful Episode.

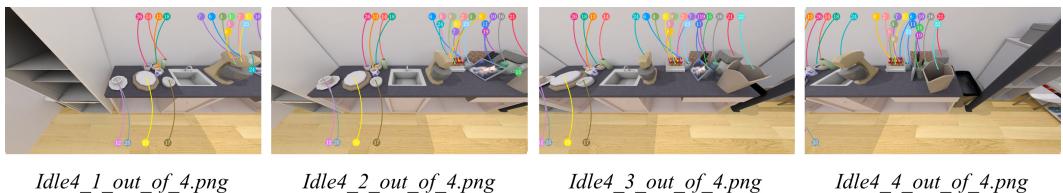


Figure 15: Images Given after Step 4 of the Successful Episode.

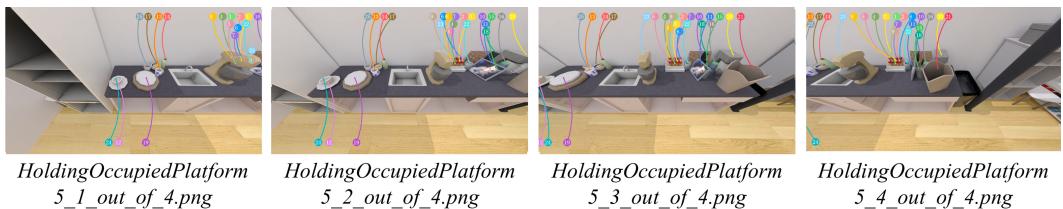


Figure 16: Images Given after Step 5 of the Successful Episode.

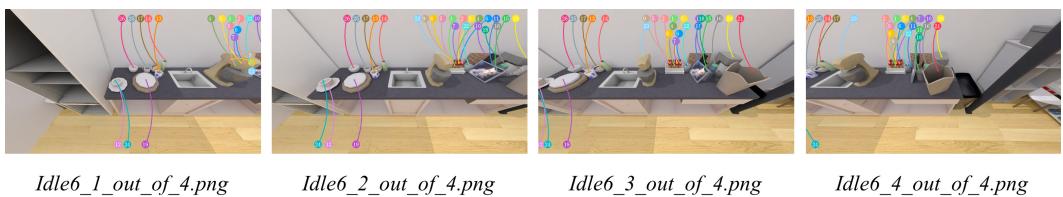


Figure 17: Images Given after Step 6 of the Successful Episode.

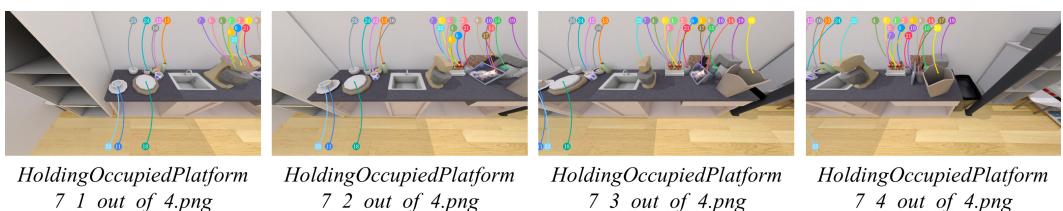


Figure 18: Images Given after Step 7 of the Successful Episode.

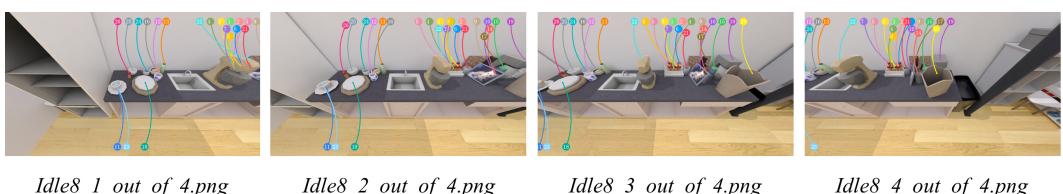


Figure 19: Images Given after Step 8 of the Successful Episode.

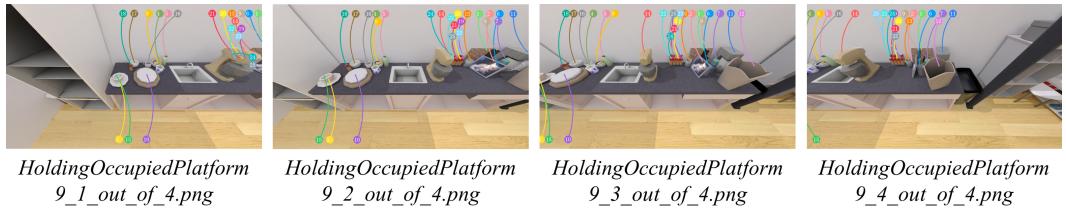


Figure 20: Images Given after Step 9 of the Successful Episode.

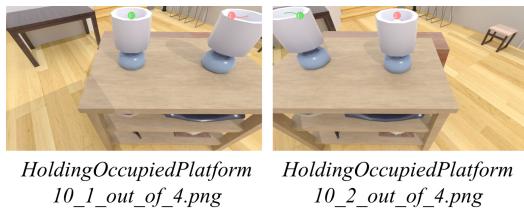


Figure 21: Images Given after Step 10 of the Successful Episode.



Figure 22: Images Given after Step 11 of the Successful Episode.



Figure 23: Images Given after Step 12 of the Successful Episode.



Figure 24: Images Given after Step 13 of the Successful Episode.

Success Episode by Claude-3.7-sonnet

System Message: You are a household assistant robot equipped with a vision system and manipulation capabilities. You need to complete a task in a 3D environment, mainly involving moving, picking up, and placing objects. Your goal is to move an object from one place to another correctly according to instructions. Please strictly follow the given Action Space for operations.

At the beginning of each task, you will be informed of a specific task to complete.

Throughout the task execution, you will transition between multiple states and have access to a set of possible actions (action space).

You may receive one of the following task types involving one object and another object or a platform. (an object/another object/a platform are the name of objects or platforms, dir is one of the 8 directions):

- move an object to a platform.
- move an object to the dir of a platform.
- move an object around another object.
- move an object to the dir of another object.
- move an object between another object and yet another object.

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions:

[front-left, front, front-right],

[left, center, right],

[rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Task success criteria:

- move an object to a platform: The task is considered successful only when an object is placed anywhere on the specified platform.
- move an object to the dir of a platform: The task is considered successful only when an object is placed on the platform and the geometric center of the placement is in the dir direction relative to the platform.
- move an object around another object: The task is considered successful only when an object is placed in any of the receptacles surrounding another object.
- move an object to the dir of another object: The task is considered successful only when an object is placed in the receptacles surrounding another object and overlaps with the dir direction.
- move an object between another object and yet another object: The task is considered successful only when an object is placed such that it intersects with receptacles in a pair of opposite directions between another object and yet another object.

Your action space, includes walking to platforms, picking up items, putting items down, rotating direction, getting information about directions around an object; CALL-END, placing an item in a specific direction on a platform, in a direction relative to another object, or placing it anywhere. Whenever you're about to choose an action, I will provide your current action space. If you choose an action that cannot be performed, such as trying to pick up an object repeatedly or attempting to place an object in a space that's too small, you'll receive a notification.

Picking up an item: Corresponds to the command "pick_object_{object number}_of_current_platform".

Walking to a platform: Corresponds to the command "go_to_platform_name".

Rotating direction: Corresponds to the command "change_view".

Getting an image of an object: Corresponds to the command
"show_receptacle_of_object_{object_number}_of_current_platform".

Putting down your holding item on empty platform: Corresponds to the command "place_s_[(region_idx1,region_idx2)...]" where dir_idx1, dir_idx2 are NUMBERS, indicating the index of the receptacles; Putting down your item on an occupied platform: Corresponds to the command "place_s_[(object_idx1,dir_idx1)...]",where object_idx1, dir_idx1 are NUMBERS, indicating the object and its corresponding receptacles. For example, "place_s_[(1,2), (2,5)]" means putting down your item at the union of object 1's 2nd receptacles and object 2's 5th receptacles. Note that for placement action, the system will attempt to find a valid placement area that intersects with all the regions you selected. If it fails, it will place the object anywhere within your chosen space and you'll receive a notification.

You may be shown various types of images:

0) At the beginning of a task, if the task involves objects on a platform that contains other objects of the same type (e.g., the object is a book on a bookshelf with many books), you will receive a notification and images of these objects to help you distinguish them.

1) Whenever you move to a platform, you will see an image of the platform from your current perspective (or multiple images for longer platforms, indicating you can move horizontally to better observe the platform). If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects. If there are objects on the platform, guiding lines will indicate the object numbers.

2) If there are objects on a platform, you can use

"show_receptacle_of_object_x_of_current_platform" to get a focused image of that object with numbered receptacles around it. This allows you to see the available receptacles around the object.

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.

2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first (although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.

3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.

4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

[*See Fig. 11]

The task involves identical objects. To help you distinguish them, we have provided images of the relevant objects.

Here are 1 images, named [AmbiguousObject.png'] respectively. Their description is as follows: This image, AmbiguousObject.png, is an image of the object you are going to move, with its adjacent objects transparentized. The object is kitchenware_white_paper_towel_holder. The object is located on object_kitchen_counter_1_body_platform_1.

Here are 1 images, named [AmbiguousDestinationObjectA.png'] respectively. Their description is as follows: This image, AmbiguousDestinationObjectA.png, is an image of the object you are going to place an object nearby, with its adjacent objects transparentized. The object is lighting_blue_base_table_lamp. The object is located on object_table_02_40_platform_2.

Here are 1 images, named [AmbiguousDestinationObjectB.png'] respectively. Their description is as follows: This image, AmbiguousDestinationObjectB.png, is an image of the object you are going to place an object nearby, with its adjacent objects transparentized. The object is lighting_blue_base_table_lamp. The object is located on object_table_02_40_platform_2.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Initially, kitchenware_white_paper_towel_holder is on

object_kitchen_counter_1_body_platform_1, and lighting_blue_base_table_lamp is on

object_table_02_40_platform_2, together with lighting_blue_base_table_lamp.

Steps used: 0/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

Your available action space:

- 'CALL_END': Call end (terminate the task). - ['go_to_object_sofa_10_platform_0',
'go_to_object_sofa_10_platform_1', 'go_to_object_sofa_10_platform_2',
'go_to_object_table_04_13_platform_0', 'go_to_object_chair_04_46_platform_0',
'go_to_object_chair_04_47_platform_0', 'go_to_object_chair_05_7_platform_0',
'go_to_object_chair_05_8_platform_0', 'go_to_object_stool_02_18_platform_0',
'go_to_object_stool_02_6_platform_0', 'go_to_object_rack_01_75_platform_0',
'go_to_object_rack_01_75_platform_1', 'go_to_object_rack_01_75_platform_2',
'go_to_object_kitchen_counter_1_body_platform_0',
'go_to_object_kitchen_counter_1_body_platform_1',
'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
'go_to_object_wall_cabinet_01_4_platform_1',
'go_to_object_wall_cabinet_01_4_platform_2',
'go_to_object_wall_cabinet_01_4_platform_3',
'go_to_object_wall_cabinet_01_4_platform_4',
'go_to_object_wall_cabinet_01_4_platform_5',
'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
'go_to_object_wall_cabinet_02_21_platform_1',
'go_to_object_wall_cabinet_02_21_platform_2',
'go_to_object_wall_cabinet_02_21_platform_3',
'go_to_object_wall_cabinet_02_21_platform_4',
'go_to_object_wall_cabinet_02_21_platform_5',
'go_to_object_wall_cabinet_02_21_platform_6',
'go_to_object_chestOfDrawers_01_2_body_platform_0',
'go_to_object_chestOfDrawers_01_2_body_platform_1',
'go_to_object_chestOfDrawers_01_2_body_platform_2',
'go_to_object_chestOfDrawers_01_2_body_platform_3',
'go_to_object_chestOfDrawers_01_2_body_platform_4',
'go_to_object_chestOfDrawers_01_2_body_platform_5',
'go_to_object_chestOfDrawers_01_2_body_platform_6',
'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'].

Please choose one of the available actions.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

VLM Response: go_to_object_kitchen_counter_1_body_platform_1

User Message:

You are currently at object_kitchen_counter_1_body_platform_1.

And you are holding nothing.

Your available action space:

- ['go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1',
'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0',
'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0',

```

'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0',
'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0',
'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1',
'go_to_object_rack_01_75_platform_2',
'go_to_object_kitchen_counter_1_body_platform_0',
'go_to_object_kitchen_counter_1_body_platform_1',
'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
'go_to_object_wall_cabinet_01_4_platform_1',
'go_to_object_wall_cabinet_01_4_platform_2',
'go_to_object_wall_cabinet_01_4_platform_3',
'go_to_object_wall_cabinet_01_4_platform_4',
'go_to_object_wall_cabinet_01_4_platform_5',
'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
'go_to_object_wall_cabinet_02_21_platform_1',
'go_to_object_wall_cabinet_02_21_platform_2',
'go_to_object_wall_cabinet_02_21_platform_3',
'go_to_object_wall_cabinet_02_21_platform_4',
'go_to_object_wall_cabinet_02_21_platform_5',
'go_to_object_wall_cabinet_02_21_platform_6',
'go_to_object_chestOfDrawers_01_2_body_platform_0',
'go_to_object_chestOfDrawers_01_2_body_platform_1',
'go_to_object_chestOfDrawers_01_2_body_platform_2',
'go_to_object_chestOfDrawers_01_2_body_platform_3',
'go_to_object_chestOfDrawers_01_2_body_platform_4',
'go_to_object_chestOfDrawers_01_2_body_platform_5',
'go_to_object_chestOfDrawers_01_2_body_platform_6',
'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
['pick_object_1_of_current_platform', 'pick_object_2_of_current_platform',
'pick_object_3_of_current_platform', 'pick_object_4_of_current_platform',
'pick_object_5_of_current_platform', 'pick_object_6_of_current_platform',
'pick_object_7_of_current_platform', 'pick_object_8_of_current_platform',
'pick_object_9_of_current_platform', 'pick_object_10_of_current_platform',
'pick_object_11_of_current_platform', 'pick_object_12_of_current_platform',
'pick_object_13_of_current_platform', 'pick_object_14_of_current_platform',
'pick_object_15_of_current_platform', 'pick_object_16_of_current_platform',
'pick_object_17_of_current_platform', 'pick_object_18_of_current_platform',
'pick_object_19_of_current_platform', 'pick_object_20_of_current_platform',
'pick_object_21_of_current_platform', 'pick_object_22_of_current_platform',
'pick_object_23_of_current_platform', 'pick_object_24_of_current_platform',
'pick_object_25_of_current_platform', 'pick_object_26_of_current_platform'] -
['show_receptacle_of_object_1_of_current_platform',
'show_receptacle_of_object_2_of_current_platform',
'show_receptacle_of_object_3_of_current_platform',
'show_receptacle_of_object_4_of_current_platform',
'show_receptacle_of_object_5_of_current_platform',
'show_receptacle_of_object_6_of_current_platform',
'show_receptacle_of_object_7_of_current_platform',
'show_receptacle_of_object_8_of_current_platform',
'show_receptacle_of_object_9_of_current_platform',
'show_receptacle_of_object_10_of_current_platform',
'show_receptacle_of_object_11_of_current_platform',

```

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'show_receptacle_of_object_12_of_current_platform',
'show_receptacle_of_object_13_of_current_platform',
'show_receptacle_of_object_14_of_current_platform',
'show_receptacle_of_object_15_of_current_platform',
'show_receptacle_of_object_16_of_current_platform',
'show_receptacle_of_object_17_of_current_platform',
'show_receptacle_of_object_18_of_current_platform',
'show_receptacle_of_object_19_of_current_platform',
'show_receptacle_of_object_20_of_current_platform',
'show_receptacle_of_object_21_of_current_platform',
'show_receptacle_of_object_22_of_current_platform',
'show_receptacle_of_object_23_of_current_platform',
'show_receptacle_of_object_24_of_current_platform',
'show_receptacle_of_object_25_of_current_platform',
'show_receptacle_of_object_26_of_current_platform'] - 'CALL_END': Call end (terminate the task). - 'change_view': Change the viewing angle to observe the scene from another perspective.
```

Choose one of the available actions.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 1/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 12]

Here are 4 images, named ['Idle_1_1_out_of_4.png', 'Idle_1_2_out_of_4.png', 'Idle_1_3_out_of_4.png', 'Idle_1_4_out_of_4.png'] respectively. Their description is as follows: These images show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_kitchen_counter_1_body_platform_1. If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: change_view

User Message:

Unable to rotate to another view. The platform you at only have 1 walkable place for you.

You are currently at object_kitchen_counter_1_body_platform_1.

And you are holding nothing.

Your available action space:

```
- ['go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1',
 'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0',
 'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0',
 'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0',
 'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0',
 'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1',
 'go_to_object_rack_01_75_platform_2',
 'go_to_object_kitchen_counter_1_body_platform_0',
 'go_to_object_kitchen_counter_1_body_platform_1',
 'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
 'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
 'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
 'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
 'go_to_object_wall_cabinet_01_4_platform_1',
 'go_to_object_wall_cabinet_01_4_platform_2',
 'go_to_object_wall_cabinet_01_4_platform_3',
 'go_to_object_wall_cabinet_01_4_platform_4',
 'go_to_object_wall_cabinet_01_4_platform_5',
 'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
 'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
 'go_to_object_wall_cabinet_02_21_platform_1',
 'go_to_object_wall_cabinet_02_21_platform_2',
 'go_to_object_wall_cabinet_02_21_platform_3',
 'go_to_object_wall_cabinet_02_21_platform_4',
 'go_to_object_wall_cabinet_02_21_platform_5',
 'go_to_object_wall_cabinet_02_21_platform_6',
 'go_to_object_chestOfDrawers_01_2_body_platform_0',
 'go_to_object_chestOfDrawers_01_2_body_platform_1',
 'go_to_object_chestOfDrawers_01_2_body_platform_2',
 'go_to_object_chestOfDrawers_01_2_body_platform_3',
 'go_to_object_chestOfDrawers_01_2_body_platform_4',
 'go_to_object_chestOfDrawers_01_2_body_platform_5',
 'go_to_object_chestOfDrawers_01_2_body_platform_6',
 'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
 'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
 'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
 ['pick_object_1_of_current_platform', 'pick_object_2_of_current_platform',
 'pick_object_3_of_current_platform', 'pick_object_4_of_current_platform',
 'pick_object_5_of_current_platform', 'pick_object_6_of_current_platform',
 'pick_object_7_of_current_platform', 'pick_object_8_of_current_platform',
 'pick_object_9_of_current_platform', 'pick_object_10_of_current_platform',
 'pick_object_11_of_current_platform', 'pick_object_12_of_current_platform',
 'pick_object_13_of_current_platform', 'pick_object_14_of_current_platform',
 'pick_object_15_of_current_platform', 'pick_object_16_of_current_platform',
 'pick_object_17_of_current_platform', 'pick_object_18_of_current_platform',
 'pick_object_19_of_current_platform', 'pick_object_20_of_current_platform',
 'pick_object_21_of_current_platform', 'pick_object_22_of_current_platform',
 'pick_object_23_of_current_platform', 'pick_object_24_of_current_platform',
 'pick_object_25_of_current_platform', 'pick_object_26_of_current_platform'] -
 ['show_receptacle_of_object_1_of_current_platform',
 'show_receptacle_of_object_2_of_current_platform',
 'show_receptacle_of_object_3_of_current_platform',
 'show_receptacle_of_object_4_of_current_platform',
 'show_receptacle_of_object_5_of_current_platform']
```

```

'show_receptacle_of_object_6_of_current_platform',
'show_receptacle_of_object_7_of_current_platform',
'show_receptacle_of_object_8_of_current_platform',
'show_receptacle_of_object_9_of_current_platform',
'show_receptacle_of_object_10_of_current_platform',
'show_receptacle_of_object_11_of_current_platform',
'show_receptacle_of_object_12_of_current_platform',
'show_receptacle_of_object_13_of_current_platform',
'show_receptacle_of_object_14_of_current_platform',
'show_receptacle_of_object_15_of_current_platform',
'show_receptacle_of_object_16_of_current_platform',
'show_receptacle_of_object_17_of_current_platform',
'show_receptacle_of_object_18_of_current_platform',
'show_receptacle_of_object_19_of_current_platform',
'show_receptacle_of_object_20_of_current_platform',
'show_receptacle_of_object_21_of_current_platform',
'show_receptacle_of_object_22_of_current_platform',
'show_receptacle_of_object_23_of_current_platform',
'show_receptacle_of_object_24_of_current_platform',
'show_receptacle_of_object_25_of_current_platform',
'show_receptacle_of_object_26_of_current_platform'] - 'CALL_END': Call end (terminate
the task). - 'change_view': Change the viewing angle to observe the scene from another
perspective.

```

Choose one of the available actions.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 2/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 13]

Here are 4 images, named ['Idle_2_1_out_of_4.png', 'Idle_2_2_out_of_4.png', 'Idle_2_3_out_of_4.png', 'Idle_2_4_out_of_4.png'] respectively.

Their description is as follows: These images show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_kitchen_counter_1_body_platform_1.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you

think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM_response: pick_15_of_current_platform

User Message:

You are currently at object_kitchen_counter_1_body_platform_1.

And you are holding kitchenware_small_white_mug.

Your available action space:

```
[ 'go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1',
  'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0',
  'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0',
  'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0',
  'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0',
  'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1',
  'go_to_object_rack_01_75_platform_2',
  'go_to_object_kitchen_counter_1_body_platform_0',
  'go_to_object_kitchen_counter_1_body_platform_1',
  'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
  'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
  'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
  'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
  'go_to_object_wall_cabinet_01_4_platform_1',
  'go_to_object_wall_cabinet_01_4_platform_2',
  'go_to_object_wall_cabinet_01_4_platform_3',
  'go_to_object_wall_cabinet_01_4_platform_4',
  'go_to_object_wall_cabinet_01_4_platform_5',
  'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
  'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
  'go_to_object_wall_cabinet_02_21_platform_1',
  'go_to_object_wall_cabinet_02_21_platform_2',
  'go_to_object_wall_cabinet_02_21_platform_3',
  'go_to_object_wall_cabinet_02_21_platform_4',
  'go_to_object_wall_cabinet_02_21_platform_5',
  'go_to_object_wall_cabinet_02_21_platform_6',
  'go_to_object_chestOfDrawers_01_2_body_platform_0',
  'go_to_object_chestOfDrawers_01_2_body_platform_1',
  'go_to_object_chestOfDrawers_01_2_body_platform_2',
  'go_to_object_chestOfDrawers_01_2_body_platform_3',
  'go_to_object_chestOfDrawers_01_2_body_platform_4',
  'go_to_object_chestOfDrawers_01_2_body_platform_5',
  'go_to_object_chestOfDrawers_01_2_body_platform_6',
  'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
  'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
  'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
[ 'show_receptacle_of_object_1_of_current_platform',
  'show_receptacle_of_object_2_of_current_platform',
  'show_receptacle_of_object_3_of_current_platform',
  'show_receptacle_of_object_4_of_current_platform',
  'show_receptacle_of_object_5_of_current_platform',
  'show_receptacle_of_object_6_of_current_platform',
  'show_receptacle_of_object_7_of_current_platform',
  'show_receptacle_of_object_8_of_current_platform',
  'show_receptacle_of_object_9_of_current_platform',
  'show_receptacle_of_object_10_of_current_platform',
  'show_receptacle_of_object_11_of_current_platform',
  'show_receptacle_of_object_12_of_current_platform',
```

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'show_receptacle_of_object_13_of_current_platform',
'show_receptacle_of_object_14_of_current_platform',
'show_receptacle_of_object_15_of_current_platform',
'show_receptacle_of_object_16_of_current_platform',
'show_receptacle_of_object_17_of_current_platform',
'show_receptacle_of_object_18_of_current_platform',
'show_receptacle_of_object_19_of_current_platform',
'show_receptacle_of_object_20_of_current_platform',
'show_receptacle_of_object_21_of_current_platform',
'show_receptacle_of_object_22_of_current_platform',
'show_receptacle_of_object_23_of_current_platform',
'show_receptacle_of_object_24_of_current_platform',
'show_receptacle_of_object_25_of_current_platform'] - 'CALL_END': Call end (terminate
the task). - 'change_view': Change the viewing angle to observe the scene from another
perspective. - 'place_r': Place the object in an arbitrary place on the platform. -
'place_s_[object_idx1,dir_idx1...]': Place the object in the union area of regions with
indices (object_idx1,region_idx1)(object_idx1's region_idx1 space) etc. All available pairs
are in [(1, 1), (1, 2), (1, 3), (1, 4), (2, 1), (5, 1), (6, 1), (8, 1), (10, 1), (11, 1), (11, 2), (11, 3),
(12, 1), (12, 2), (12, 3), (12, 4), (12, 5), (12, 6), (12, 7), (12, 8), (13, 1), (14, 1), (14, 2), (14, 3),
(14, 4), (14, 5), (16, 1), (16, 2), (16, 3), (17, 1), (17, 2), (17, 3), (17, 4), (17, 5), (17, 6), (18, 1),
(19, 1), (20, 1), (20, 2), (20, 3), (20, 4), (20, 5), (21, 1), (21, 2), (21, 3), (21, 4), (21, 5), (22, 1),
(22, 2), (22, 3), (23, 1), (24, 1), (24, 2), (24, 3), (24, 4), (24, 5), (24, 6), (24, 7), (24, 8), (25, 1),
(25, 2)], and a valid choice should be a subset of it.

```

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions: [front-left, front, front-right], [left, center, right], [rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 3/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 14]

Here are 4 images, named [‘HoldingOccupiedPlatform3_1_out_of_4.png’, ‘HoldingOccupiedPlatform3_2_out_of_4.png’, ‘HoldingOccupiedPlatform3_3_out_of_4.png’, ‘HoldingOccupiedPlatform3_4_out_of_4.png’] respectively.

Their description is as follows: These image show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_kitchen_counter_1_body_platform_1.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it’s guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can’t determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: place_r

User Message:

The object has been placed successfully. You can now call end if you think you've finished the task correctly, or can also pick up the object again if you think the placement is not correct.

You are currently at object_kitchen_counter_1_body_platform_1.

And you are holding nothing.

Your available action space:

- ['go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1',
 'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0',
 'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0',
 'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0',
 'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0',
 'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1',
 'go_to_object_rack_01_75_platform_2',
 'go_to_object_kitchen_counter_1_body_platform_0',
 'go_to_object_kitchen_counter_1_body_platform_1',
 'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
 'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
 'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
 'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
 'go_to_object_wall_cabinet_01_4_platform_1',
 'go_to_object_wall_cabinet_01_4_platform_2',
 'go_to_object_wall_cabinet_01_4_platform_3',
 'go_to_object_wall_cabinet_01_4_platform_4',
 'go_to_object_wall_cabinet_01_4_platform_5',
 'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
 'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
 'go_to_object_wall_cabinet_02_21_platform_1',
 'go_to_object_wall_cabinet_02_21_platform_2',
 'go_to_object_wall_cabinet_02_21_platform_3',
 'go_to_object_wall_cabinet_02_21_platform_4',
 'go_to_object_wall_cabinet_02_21_platform_5',
 'go_to_object_wall_cabinet_02_21_platform_6',
 'go_to_object_chestOfDrawers_01_2_body_platform_0',
 'go_to_object_chestOfDrawers_01_2_body_platform_1',
 'go_to_object_chestOfDrawers_01_2_body_platform_2',
 'go_to_object_chestOfDrawers_01_2_body_platform_3',
 'go_to_object_chestOfDrawers_01_2_body_platform_4',
 'go_to_object_chestOfDrawers_01_2_body_platform_5',

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'go_to_object_chestOfDrawers_01_2_body_platform_6',
'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
['pick_object_1_of_current_platform', 'pick_object_2_of_current_platform',
'pick_object_3_of_current_platform', 'pick_object_4_of_current_platform',
'pick_object_5_of_current_platform', 'pick_object_6_of_current_platform',
'pick_object_7_of_current_platform', 'pick_object_8_of_current_platform',
'pick_object_9_of_current_platform', 'pick_object_10_of_current_platform',
'pick_object_11_of_current_platform', 'pick_object_12_of_current_platform',
'pick_object_13_of_current_platform', 'pick_object_14_of_current_platform',
'pick_object_15_of_current_platform', 'pick_object_16_of_current_platform',
'pick_object_17_of_current_platform', 'pick_object_18_of_current_platform',
'pick_object_19_of_current_platform', 'pick_object_20_of_current_platform',
'pick_object_21_of_current_platform', 'pick_object_22_of_current_platform',
'pick_object_23_of_current_platform', 'pick_object_24_of_current_platform',
'pick_object_25_of_current_platform', 'pick_object_26_of_current_platform'] -
['show_receptacle_of_object_1_of_current_platform',
'show_receptacle_of_object_2_of_current_platform',
'show_receptacle_of_object_3_of_current_platform',
'show_receptacle_of_object_4_of_current_platform',
'show_receptacle_of_object_5_of_current_platform',
'show_receptacle_of_object_6_of_current_platform',
'show_receptacle_of_object_7_of_current_platform',
'show_receptacle_of_object_8_of_current_platform',
'show_receptacle_of_object_9_of_current_platform',
'show_receptacle_of_object_10_of_current_platform',
'show_receptacle_of_object_11_of_current_platform',
'show_receptacle_of_object_12_of_current_platform',
'show_receptacle_of_object_13_of_current_platform',
'show_receptacle_of_object_14_of_current_platform',
'show_receptacle_of_object_15_of_current_platform',
'show_receptacle_of_object_16_of_current_platform',
'show_receptacle_of_object_17_of_current_platform',
'show_receptacle_of_object_18_of_current_platform',
'show_receptacle_of_object_19_of_current_platform',
'show_receptacle_of_object_20_of_current_platform',
'show_receptacle_of_object_21_of_current_platform',
'show_receptacle_of_object_22_of_current_platform',
'show_receptacle_of_object_23_of_current_platform',
'show_receptacle_of_object_24_of_current_platform',
'show_receptacle_of_object_25_of_current_platform',
'show_receptacle_of_object_26_of_current_platform'] - 'CALL_END': Call end (terminate
the task). - 'change_view': Change the viewing angle to observe the scene from another
perspective.

```

Choose one of the available actions.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.

3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.

4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 4/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 15]

Here are 4 images, named ['Idle_4_1_out_of_4.png', 'Idle_4_2_out_of_4.png', 'Idle_4_3_out_of_4.png', 'Idle_4_4_out_of_4.png'] respectively.

Their description is as follows: These images show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_kitchen_counter_1_body_platform_1.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM_response: pick_object_17_of_current_platform

User Message:

You are currently at object_kitchen_counter_1_body_platform_1.

And you are holding kitchenware_small_white_bowl.

Your available action space: -['go_to_object_sofa_10_platform_0',
'go_to_object_sofa_10_platform_1', 'go_to_object_sofa_10_platform_2',
'go_to_object_table_04_13_platform_0', 'go_to_object_chair_04_46_platform_0',
'go_to_object_chair_04_47_platform_0', 'go_to_object_chair_05_7_platform_0',
'go_to_object_chair_05_8_platform_0', 'go_to_object_stool_02_18_platform_0',
'go_to_object_stool_02_6_platform_0', 'go_to_object_rack_01_75_platform_0',
'go_to_object_rack_01_75_platform_1', 'go_to_object_rack_01_75_platform_2',
'go_to_object_kitchen_counter_1_body_platform_0',
'go_to_object_kitchen_counter_1_body_platform_1',
'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
'go_to_object_wall_cabinet_01_4_platform_1',
'go_to_object_wall_cabinet_01_4_platform_2',
'go_to_object_wall_cabinet_01_4_platform_3',
'go_to_object_wall_cabinet_01_4_platform_4',
'go_to_object_wall_cabinet_01_4_platform_5',
'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
'go_to_object_wall_cabinet_02_21_platform_1',
'go_to_object_wall_cabinet_02_21_platform_2',
'go_to_object_wall_cabinet_02_21_platform_3',
'go_to_object_wall_cabinet_02_21_platform_4',
'go_to_object_wall_cabinet_02_21_platform_5',
'go_to_object_wall_cabinet_02_21_platform_6',
'go_to_object_chestOfDrawers_01_2_body_platform_0',

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'go_to_object_chestOfDrawers_01_2_body_platform_1',
'go_to_object_chestOfDrawers_01_2_body_platform_2',
'go_to_object_chestOfDrawers_01_2_body_platform_3',
'go_to_object_chestOfDrawers_01_2_body_platform_4',
'go_to_object_chestOfDrawers_01_2_body_platform_5',
'go_to_object_chestOfDrawers_01_2_body_platform_6',
'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
[show_receptacle_of_object_1_of_current_platform',
'show_receptacle_of_object_2_of_current_platform',
'show_receptacle_of_object_3_of_current_platform',
'show_receptacle_of_object_4_of_current_platform',
'show_receptacle_of_object_5_of_current_platform',
'show_receptacle_of_object_6_of_current_platform',
'show_receptacle_of_object_7_of_current_platform',
'show_receptacle_of_object_8_of_current_platform',
'show_receptacle_of_object_9_of_current_platform',
'show_receptacle_of_object_10_of_current_platform',
'show_receptacle_of_object_11_of_current_platform',
'show_receptacle_of_object_12_of_current_platform',
'show_receptacle_of_object_13_of_current_platform',
'show_receptacle_of_object_14_of_current_platform',
'show_receptacle_of_object_15_of_current_platform',
'show_receptacle_of_object_16_of_current_platform',
'show_receptacle_of_object_17_of_current_platform',
'show_receptacle_of_object_18_of_current_platform',
'show_receptacle_of_object_19_of_current_platform',
'show_receptacle_of_object_20_of_current_platform',
'show_receptacle_of_object_21_of_current_platform',
'show_receptacle_of_object_22_of_current_platform',
'show_receptacle_of_object_23_of_current_platform',
'show_receptacle_of_object_24_of_current_platform',
'show_receptacle_of_object_25_of_current_platform'] - 'CALL_END': Call end (terminate
the task). - 'change_view': Change the viewing angle to observe the scene from another
perspective. - 'place_r': Place the object in an arbitrary place on the platform. -

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'place_s_[object_idx1,dir_idx1...]': Place the object in the union area of regions with indices (object_idx1,region_idx1)(object_idx1's region_idx1 space) etc. All available pairs are in [(1, 1), (1, 2), (1, 3), (1, 4), (2, 1), (5, 1), (6, 1), (8, 1), (10, 1), (11, 1), (11, 2), (11, 3), (12, 1), (12, 2), (12, 3), (12, 4), (12, 5), (12, 6), (12, 7), (12, 8), (13, 1), (13, 2), (14, 1), (14, 2), (14, 3), (14, 4), (14, 5), (16, 1), (16, 2), (16, 3), (17, 1), (18, 1), (19, 1), (19, 2), (19, 3), (19, 4), (19, 5), (20, 1), (20, 2), (20, 3), (20, 4), (20, 5), (21, 1), (21, 2), (21, 3), (22, 1), (23, 1), (23, 2), (23, 3), (23, 4), (23, 5), (23, 6), (23, 7), (23, 8), (24, 1), (24, 2), (25, 1), (25, 2), (25, 3)], and a valid choice should be a subset of it.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions: [front-left, front, front-right], [left, center, right], [rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 5/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 16]

Here are 4 images, named ['HoldingOccupiedPlatform5_1_out_of_4.png', 'HoldingOccupiedPlatform5_2_out_of_4.png', 'HoldingOccupiedPlatform5_3_out_of_4.png', 'HoldingOccupiedPlatform5_4_out_of_4.png'] respectively.

Their description is as follows: These image show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_kitchen_counter_1_body_platform_1.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: place_r

User Message:

The object has been placed successfully. You can now call end if you think you've finished the task correctly, or can also pick up the object again if you think the placement is not correct.

You are currently at object_kitchen_counter_1_body_platform_1.

And you are holding nothing.

Your available action space: - ['go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1', 'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0', 'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0', 'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0', 'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0', 'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1', 'go_to_object_rack_01_75_platform_2', 'go_to_object_kitchen_counter_1_body_platform_0', 'go_to_object_kitchen_counter_1_body_platform_1', 'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3', 'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',

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'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
'go_to_object_wall_cabinet_01_4_platform_1',
'go_to_object_wall_cabinet_01_4_platform_2',
'go_to_object_wall_cabinet_01_4_platform_3',
'go_to_object_wall_cabinet_01_4_platform_4',
'go_to_object_wall_cabinet_01_4_platform_5',
'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
'go_to_object_wall_cabinet_02_21_platform_1',
'go_to_object_wall_cabinet_02_21_platform_2',
'go_to_object_wall_cabinet_02_21_platform_3',
'go_to_object_wall_cabinet_02_21_platform_4',
'go_to_object_wall_cabinet_02_21_platform_5',
'go_to_object_wall_cabinet_02_21_platform_6',
'go_to_object_chestOfDrawers_01_2_body_platform_0',
'go_to_object_chestOfDrawers_01_2_body_platform_1',
'go_to_object_chestOfDrawers_01_2_body_platform_2',
'go_to_object_chestOfDrawers_01_2_body_platform_3',
'go_to_object_chestOfDrawers_01_2_body_platform_4',
'go_to_object_chestOfDrawers_01_2_body_platform_5',
'go_to_object_chestOfDrawers_01_2_body_platform_6',
'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
['pick_object_1_of_current_platform', 'pick_object_2_of_current_platform',
'pick_object_3_of_current_platform', 'pick_object_4_of_current_platform',
'pick_object_5_of_current_platform', 'pick_object_6_of_current_platform',
'pick_object_7_of_current_platform', 'pick_object_8_of_current_platform',
'pick_object_9_of_current_platform', 'pick_object_10_of_current_platform',
'pick_object_11_of_current_platform', 'pick_object_12_of_current_platform',
'pick_object_13_of_current_platform', 'pick_object_14_of_current_platform',
'pick_object_15_of_current_platform', 'pick_object_16_of_current_platform',
'pick_object_17_of_current_platform', 'pick_object_18_of_current_platform',
'pick_object_19_of_current_platform', 'pick_object_20_of_current_platform',
'pick_object_21_of_current_platform', 'pick_object_22_of_current_platform',
'pick_object_23_of_current_platform', 'pick_object_24_of_current_platform',
'pick_object_25_of_current_platform', 'pick_object_26_of_current_platform'] -
['show_receptacle_of_object_1_of_current_platform',
'show_receptacle_of_object_2_of_current_platform',
'show_receptacle_of_object_3_of_current_platform',
'show_receptacle_of_object_4_of_current_platform',
'show_receptacle_of_object_5_of_current_platform',
'show_receptacle_of_object_6_of_current_platform',
'show_receptacle_of_object_7_of_current_platform',
'show_receptacle_of_object_8_of_current_platform',
'show_receptacle_of_object_9_of_current_platform',
'show_receptacle_of_object_10_of_current_platform',
'show_receptacle_of_object_11_of_current_platform',
'show_receptacle_of_object_12_of_current_platform',
'show_receptacle_of_object_13_of_current_platform',
'show_receptacle_of_object_14_of_current_platform',
'show_receptacle_of_object_15_of_current_platform',
'show_receptacle_of_object_16_of_current_platform',
'show_receptacle_of_object_17_of_current_platform',
'show_receptacle_of_object_18_of_current_platform',
'show_receptacle_of_object_19_of_current_platform',

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'show_receptacle_of_object_20_of_current_platform',
'show_receptacle_of_object_21_of_current_platform',
'show_receptacle_of_object_22_of_current_platform',
'show_receptacle_of_object_23_of_current_platform',
'show_receptacle_of_object_24_of_current_platform',
'show_receptacle_of_object_25_of_current_platform',
'show_receptacle_of_object_26_of_current_platform'] - 'CALL_END': Call end (terminate the task). - 'change_view': Change the viewing angle to observe the scene from another perspective.
```

Choose one of the available actions.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 6/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 17]

Here are 4 images, named ['Idle_6_1_out_of_4.png', 'Idle_6_2_out_of_4.png', 'Idle_6_3_out_of_4.png', 'Idle_6_4_out_of_4.png'] respectively.

Their description is as follows: These images show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_kitchen_counter_1_body_platform_1.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM_response: pick_object_7_of_current_platform

User Message:

You are currently at object_kitchen_counter_1_body_platform_1.

And you are holding kitchenware_spice_container.

Your available action space: -['go_to_object_sofa_10_platform_0',
'go_to_object_sofa_10_platform_1', 'go_to_object_sofa_10_platform_2',
'go_to_object_table_04_13_platform_0', 'go_to_object_chair_04_46_platform_0',
'go_to_object_chair_04_47_platform_0', 'go_to_object_chair_05_7_platform_0',
'go_to_object_chair_05_8_platform_0', 'go_to_object_stool_02_18_platform_0',
'go_to_object_stool_02_6_platform_0', 'go_to_object_rack_01_75_platform_0',
'go_to_object_rack_01_75_platform_1', 'go_to_object_rack_01_75_platform_2',

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'go_to_object_kitchen_counter_1_body_platform_0',
'go_to_object_kitchen_counter_1_body_platform_1',
'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
'go_to_object_wall_cabinet_01_4_platform_1',
'go_to_object_wall_cabinet_01_4_platform_2',
'go_to_object_wall_cabinet_01_4_platform_3',
'go_to_object_wall_cabinet_01_4_platform_4',
'go_to_object_wall_cabinet_01_4_platform_5',
'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
'go_to_object_wall_cabinet_02_21_platform_1',
'go_to_object_wall_cabinet_02_21_platform_2',
'go_to_object_wall_cabinet_02_21_platform_3',
'go_to_object_wall_cabinet_02_21_platform_4',
'go_to_object_wall_cabinet_02_21_platform_5',
'go_to_object_wall_cabinet_02_21_platform_6',
'go_to_object_chestOfDrawers_01_2_body_platform_0',
'go_to_object_chestOfDrawers_01_2_body_platform_1',
'go_to_object_chestOfDrawers_01_2_body_platform_2',
'go_to_object_chestOfDrawers_01_2_body_platform_3',
'go_to_object_chestOfDrawers_01_2_body_platform_4',
'go_to_object_chestOfDrawers_01_2_body_platform_5',
'go_to_object_chestOfDrawers_01_2_body_platform_6',
'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
['show_receptacle_of_object_1_of_current_platform',
'show_receptacle_of_object_2_of_current_platform',
'show_receptacle_of_object_3_of_current_platform',
'show_receptacle_of_object_4_of_current_platform',
'show_receptacle_of_object_5_of_current_platform',
'show_receptacle_of_object_6_of_current_platform',
'show_receptacle_of_object_7_of_current_platform',
'show_receptacle_of_object_8_of_current_platform',
'show_receptacle_of_object_9_of_current_platform',
'show_receptacle_of_object_10_of_current_platform',
'show_receptacle_of_object_11_of_current_platform',
'show_receptacle_of_object_12_of_current_platform',
'show_receptacle_of_object_13_of_current_platform',
'show_receptacle_of_object_14_of_current_platform',
'show_receptacle_of_object_15_of_current_platform',
'show_receptacle_of_object_16_of_current_platform',
'show_receptacle_of_object_17_of_current_platform',
'show_receptacle_of_object_18_of_current_platform',
'show_receptacle_of_object_19_of_current_platform',
'show_receptacle_of_object_20_of_current_platform',
'show_receptacle_of_object_21_of_current_platform',
'show_receptacle_of_object_22_of_current_platform',
'show_receptacle_of_object_23_of_current_platform',
'show_receptacle_of_object_24_of_current_platform',
'show_receptacle_of_object_25_of_current_platform'] - 'CALL_END': Call end (terminate
the task). - 'change_view': Change the viewing angle to observe the scene from another
perspective. - 'place_r': Place the object in an arbitrary place on the platform. -
'place_s([(object_idx1, dir_idx1)...])': Place the object in the union area of regions with

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indices (object_idx1,region_idx1)(object_idx1's region_idx1 space) etc. All available pairs are in [(1, 1), (1, 2), (1, 3), (1, 4), (2, 1), (5, 1), (6, 1), (6, 2), (7, 1), (8, 1), (9, 1), (10, 1), (10, 2), (10, 3), (11, 1), (11, 2), (11, 3), (11, 4), (11, 5), (11, 6), (11, 7), (12, 1), (12, 2), (13, 1), (13, 2), (13, 3), (13, 4), (13, 5), (15, 1), (15, 2), (15, 3), (16, 1), (17, 1), (18, 1), (18, 2), (18, 3), (18, 4), (19, 1), (19, 2), (19, 3), (19, 4), (19, 5), (20, 1), (20, 2), (20, 3), (21, 1), (22, 1), (22, 2), (22, 3), (22, 4), (22, 5), (22, 6), (22, 7), (22, 8), (23, 1), (23, 2), (24, 1), (24, 2), (24, 3), (25, 1), (25, 2), (25, 3), (25, 4), (25, 5)], and a valid choice should be a subset of it.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions: [front-left, front, front-right], [left, center, right], [rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 7/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 18]

Here are 4 images, named ['HoldingOccupiedPlatform7_1_out_of_4.png', 'HoldingOccupiedPlatform7_2_out_of_4.png', 'HoldingOccupiedPlatform7_3_out_of_4.png', 'HoldingOccupiedPlatform7_4_out_of_4.png'] respectively.

Their description is as follows: These image show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_kitchen_counter_1_body_platform_1.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: place_r

User Message:

The object has been placed successfully. You can now call end if you think you've finished the task correctly, or can also pick up the object again if you think the placement is not correct.

You are currently at object_kitchen_counter_1_body_platform_1.

And you are holding nothing.

Your available action space:

```
- ['go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1',
 'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0',
 'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0',
 'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0',
 'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0',
 'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1',
 'go_to_object_rack_01_75_platform_2',
 'go_to_object_kitchen_counter_1_body_platform_0',
 'go_to_object_kitchen_counter_1_body_platform_1',
 'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
 'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
 'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
 'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
 'go_to_object_wall_cabinet_01_4_platform_1',
 'go_to_object_wall_cabinet_01_4_platform_2',
 'go_to_object_wall_cabinet_01_4_platform_3',
 'go_to_object_wall_cabinet_01_4_platform_4',
 'go_to_object_wall_cabinet_01_4_platform_5',
 'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
 'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
 'go_to_object_wall_cabinet_02_21_platform_1',
 'go_to_object_wall_cabinet_02_21_platform_2',
 'go_to_object_wall_cabinet_02_21_platform_3',
 'go_to_object_wall_cabinet_02_21_platform_4',
 'go_to_object_wall_cabinet_02_21_platform_5',
 'go_to_object_wall_cabinet_02_21_platform_6',
 'go_to_object_chestOfDrawers_01_2_body_platform_0',
 'go_to_object_chestOfDrawers_01_2_body_platform_1',
 'go_to_object_chestOfDrawers_01_2_body_platform_2',
 'go_to_object_chestOfDrawers_01_2_body_platform_3',
 'go_to_object_chestOfDrawers_01_2_body_platform_4',
 'go_to_object_chestOfDrawers_01_2_body_platform_5',
 'go_to_object_chestOfDrawers_01_2_body_platform_6',
 'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
 'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
 'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -  
['pick_object_1_of_current_platform', 'pick_object_2_of_current_platform',
 'pick_object_3_of_current_platform', 'pick_object_4_of_current_platform',
 'pick_object_5_of_current_platform', 'pick_object_6_of_current_platform',
 'pick_object_7_of_current_platform', 'pick_object_8_of_current_platform',
 'pick_object_9_of_current_platform', 'pick_object_10_of_current_platform',
 'pick_object_11_of_current_platform', 'pick_object_12_of_current_platform',
 'pick_object_13_of_current_platform', 'pick_object_14_of_current_platform',
 'pick_object_15_of_current_platform', 'pick_object_16_of_current_platform',
 'pick_object_17_of_current_platform', 'pick_object_18_of_current_platform',
 'pick_object_19_of_current_platform', 'pick_object_20_of_current_platform',
 'pick_object_21_of_current_platform', 'pick_object_22_of_current_platform',
 'pick_object_23_of_current_platform', 'pick_object_24_of_current_platform',
```

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'pick_object_25_of_current_platform', 'pick_object_26_of_current_platform'] -  

['show_receptacle_of_object_1_of_current_platform',  

 'show_receptacle_of_object_2_of_current_platform',  

 'show_receptacle_of_object_3_of_current_platform',  

 'show_receptacle_of_object_4_of_current_platform',  

 'show_receptacle_of_object_5_of_current_platform',  

 'show_receptacle_of_object_6_of_current_platform',  

 'show_receptacle_of_object_7_of_current_platform',  

 'show_receptacle_of_object_8_of_current_platform',  

 'show_receptacle_of_object_9_of_current_platform',  

 'show_receptacle_of_object_10_of_current_platform',  

 'show_receptacle_of_object_11_of_current_platform',  

 'show_receptacle_of_object_12_of_current_platform',  

 'show_receptacle_of_object_13_of_current_platform',  

 'show_receptacle_of_object_14_of_current_platform',  

 'show_receptacle_of_object_15_of_current_platform',  

 'show_receptacle_of_object_16_of_current_platform',  

 'show_receptacle_of_object_17_of_current_platform',  

 'show_receptacle_of_object_18_of_current_platform',  

 'show_receptacle_of_object_19_of_current_platform',  

 'show_receptacle_of_object_20_of_current_platform',  

 'show_receptacle_of_object_21_of_current_platform',  

 'show_receptacle_of_object_22_of_current_platform',  

 'show_receptacle_of_object_23_of_current_platform',  

 'show_receptacle_of_object_24_of_current_platform',  

 'show_receptacle_of_object_25_of_current_platform',  

 'show_receptacle_of_object_26_of_current_platform'] - 'CALL_END': Call end (terminate  

the task). - 'change_view': Change the viewing angle to observe the scene from another  

perspective.

```

Choose one of the available actions.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 8/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 19]

Here are 4 images, named ['Idle_8_1_out_of_4.png', 'Idle_8_2_out_of_4.png', 'Idle_8_3_out_of_4.png', 'Idle_8_4_out_of_4.png'] respectively.

Their description is as follows: These images show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_kitchen_counter_1_body_platform_1.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM_response: pick_object_1_of_current_platform

User Message:

You are currently at object_kitchen_counter_1_body_platform_1.
And you are holding kitchenware_white_paper_towel_holder.
Your available action space: -['go_to_object_sofa_10_platform_0',
'go_to_object_sofa_10_platform_1', 'go_to_object_sofa_10_platform_2',
'go_to_object_table_04_13_platform_0', 'go_to_object_chair_04_46_platform_0',
'go_to_object_chair_04_47_platform_0', 'go_to_object_chair_05_7_platform_0',
'go_to_object_chair_05_8_platform_0', 'go_to_object_stool_02_18_platform_0',
'go_to_object_stool_02_6_platform_0', 'go_to_object_rack_01_75_platform_0',
'go_to_object_rack_01_75_platform_1', 'go_to_object_rack_01_75_platform_2',
'go_to_object_kitchen_counter_1_body_platform_0',
'go_to_object_kitchen_counter_1_body_platform_1',
'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
'go_to_object_wall_cabinet_01_4_platform_1',
'go_to_object_wall_cabinet_01_4_platform_2',
'go_to_object_wall_cabinet_01_4_platform_3',
'go_to_object_wall_cabinet_01_4_platform_4',
'go_to_object_wall_cabinet_01_4_platform_5',
'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
'go_to_object_wall_cabinet_02_21_platform_1',
'go_to_object_wall_cabinet_02_21_platform_2',
'go_to_object_wall_cabinet_02_21_platform_3',
'go_to_object_wall_cabinet_02_21_platform_4',
'go_to_object_wall_cabinet_02_21_platform_5',
'go_to_object_wall_cabinet_02_21_platform_6',
'go_to_object_chestOfDrawers_01_2_body_platform_0',
'go_to_object_chestOfDrawers_01_2_body_platform_1',
'go_to_object_chestOfDrawers_01_2_body_platform_2',
'go_to_object_chestOfDrawers_01_2_body_platform_3',
'go_to_object_chestOfDrawers_01_2_body_platform_4',
'go_to_object_chestOfDrawers_01_2_body_platform_5',
'go_to_object_chestOfDrawers_01_2_body_platform_6',
'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
['show_receptacle_of_object_1_of_current_platform',
'show_receptacle_of_object_2_of_current_platform',
'show_receptacle_of_object_3_of_current_platform',
'show_receptacle_of_object_4_of_current_platform',
'show_receptacle_of_object_5_of_current_platform',
'show_receptacle_of_object_6_of_current_platform',
'show_receptacle_of_object_7_of_current_platform',
'show_receptacle_of_object_8_of_current_platform',

'show_receptacle_of_object_9_of_current_platform',
 'show_receptacle_of_object_10_of_current_platform',
 'show_receptacle_of_object_11_of_current_platform',
 'show_receptacle_of_object_12_of_current_platform',
 'show_receptacle_of_object_13_of_current_platform',
 'show_receptacle_of_object_14_of_current_platform',
 'show_receptacle_of_object_15_of_current_platform',
 'show_receptacle_of_object_16_of_current_platform',
 'show_receptacle_of_object_17_of_current_platform',
 'show_receptacle_of_object_18_of_current_platform',
 'show_receptacle_of_object_19_of_current_platform',
 'show_receptacle_of_object_20_of_current_platform',
 'show_receptacle_of_object_21_of_current_platform',
 'show_receptacle_of_object_22_of_current_platform',
 'show_receptacle_of_object_23_of_current_platform',
 'show_receptacle_of_object_24_of_current_platform',
 'show_receptacle_of_object_25_of_current_platform'] - 'CALL_END': Call end (terminate the task). - 'change_view': Change the viewing angle to observe the scene from another perspective. - 'place_r': Place the object in an arbitrary place on the platform. - 'place_s([(object_idx1, dir_idx1)...])': Place the object in the union area of regions with indices (object_idx1, region_idx1)(object_idx1's region_idx1 space) etc. All available pairs are in [(1, 1), (2, 1), (2, 2), (2, 3), (3, 1), (3, 2), (3, 3), (3, 4), (3, 5), (3, 6), (3, 7), (4, 1), (4, 2), (5, 1), (5, 2), (5, 3), (5, 4), (5, 5), (7, 1), (7, 2), (7, 3), (8, 1), (9, 1), (10, 1), (10, 2), (10, 3), (11, 1), (11, 2), (11, 3), (11, 4), (11, 5), (12, 1), (12, 2), (12, 3), (13, 1), (13, 2), (13, 3), (13, 4), (14, 1), (14, 2), (14, 3), (14, 4), (14, 5), (14, 6), (14, 7), (14, 8), (15, 1), (15, 2), (16, 1), (16, 2), (16, 3), (17, 1), (17, 2), (17, 3), (17, 4), (17, 5), (18, 1), (18, 2), (18, 3), (18, 4), (19, 1), (19, 2), (19, 3), (19, 4), (19, 5), (19, 6), (20, 1), (20, 2), (20, 3), (20, 4), (21, 1), (21, 2), (21, 3), (21, 4), (22, 1), (22, 2), (22, 3), (22, 4), (23, 1), (23, 2), (23, 3), (24, 1), (24, 2), (25, 1)], and a valid choice should be a subset of it.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions: [front-left, front, front-right], [left, center, right], [rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.

4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 9/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 20]

Here are 4 images, named ['HoldingOccupiedPlatform9_1_out_of_4.png', 'HoldingOccupiedPlatform9_2_out_of_4.png', 'HoldingOccupiedPlatform9_3_out_of_4.png', 'HoldingOccupiedPlatform9_4_out_of_4.png'] respectively.

Their description is as follows: These image show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_kitchen_counter_1_body_platform_1.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: [go_to_object_table_02_40_platform_2](#)

User Message:

You are currently at object_table_02_40_platform_2.

And you are holding kitchenware_white_paper_towel_holder.

Your available action space:

```
-['go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1',
 'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0',
 'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0',
 'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0',
 'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0',
 'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1',
 'go_to_object_rack_01_75_platform_2',
 'go_to_object_kitchen_counter_1_body_platform_0',
 'go_to_object_kitchen_counter_1_body_platform_1',
 'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
 'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
 'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
 'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
 'go_to_object_wall_cabinet_01_4_platform_1',
 'go_to_object_wall_cabinet_01_4_platform_2',
 'go_to_object_wall_cabinet_01_4_platform_3',
 'go_to_object_wall_cabinet_01_4_platform_4',
 'go_to_object_wall_cabinet_01_4_platform_5',
 'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
 'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
 'go_to_object_wall_cabinet_02_21_platform_1',
 'go_to_object_wall_cabinet_02_21_platform_2',
 'go_to_object_wall_cabinet_02_21_platform_3',
 'go_to_object_wall_cabinet_02_21_platform_4',
 'go_to_object_wall_cabinet_02_21_platform_5',
 'go_to_object_wall_cabinet_02_21_platform_6',
 'go_to_object_chestOfDrawers_01_2_body_platform_0',
```

```

'go_to_object_chestOfDrawers_01_2_body_platform_1',
'go_to_object_chestOfDrawers_01_2_body_platform_2',
'go_to_object_chestOfDrawers_01_2_body_platform_3',
'go_to_object_chestOfDrawers_01_2_body_platform_4',
'go_to_object_chestOfDrawers_01_2_body_platform_5',
'go_to_object_chestOfDrawers_01_2_body_platform_6',
'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -  

['show_receptacle_of_object_1_of_current_platform',
'show_receptacle_of_object_2_of_current_platform'] - 'CALL_END': Call end (terminate  

the task). - 'change_view': Change the viewing angle to observe the scene from another  

perspective. - 'place_r': Place the object in an arbitrary place on the platform. -  

'place_s_[object_idx1, dir_idx1]...]': Place the object in the union area of regions with  

indices (object_idx1, region_idx1)(object_idx1's region_idx1 space) etc. All available pairs  

are in [(1, 1), (1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (1, 7), (1, 8), (2, 1), (2, 2), (2, 3), (2, 4), (2, 5),  

(2, 6), (2, 7), (2, 8)], and a valid choice should be a subset of it.

```

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions:
[front-left, front, front-right],
[left, center, right],
[rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 10/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 21]

Here are 2 images, named ['HoldingOccupiedPlatform10_1_out_of_2.png',
'HoldingOccupiedPlatform10_2_out_of_2.png'] respectively.

Their description are as follows: These image show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_table_02_40_platform_2.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: show_receptacle_of_object_1_of_current_platform

User Message:

[*See Fig. 22 ShowReceptacle_11.png]

Here are 1 images, named ['ShowReceptacle_11.png'] respectively.

Their description is as follows: This image shows the available receptacles around object 1 on the platform, you see this because you've taken "show_receptacle" action previously. The numbers from 1 to 8 indicate the available receptacles. Not all numbers from 1 to 8 may be present, as some receptacles might be too small or blocked. To use the numbers shown in the image to specify where you want to place the object you are holding, you can include (1, receptacles_idx (receptacles_idx in [1, 8]) in the output action.

You are currently at object_table_02_40_platform_2.

And you are holding kitchenware_white_paper_towel_holder.

Your available action space:

```
-['go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1',
 'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0',
 'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0',
 'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0',
 'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0',
 'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1',
 'go_to_object_rack_01_75_platform_2',
 'go_to_object_kitchen_counter_1_body_platform_0',
 'go_to_object_kitchen_counter_1_body_platform_1',
 'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
 'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
 'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
 'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
 'go_to_object_wall_cabinet_01_4_platform_1',
 'go_to_object_wall_cabinet_01_4_platform_2',
 'go_to_object_wall_cabinet_01_4_platform_3',
 'go_to_object_wall_cabinet_01_4_platform_4',
 'go_to_object_wall_cabinet_01_4_platform_5',
 'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
 'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
 'go_to_object_wall_cabinet_02_21_platform_1',
 'go_to_object_wall_cabinet_02_21_platform_2',
 'go_to_object_wall_cabinet_02_21_platform_3',
 'go_to_object_wall_cabinet_02_21_platform_4',
 'go_to_object_wall_cabinet_02_21_platform_5',
 'go_to_object_wall_cabinet_02_21_platform_6',
 'go_to_object_chestOfDrawers_01_2_body_platform_0',
 'go_to_object_chestOfDrawers_01_2_body_platform_1',
 'go_to_object_chestOfDrawers_01_2_body_platform_2',
 'go_to_object_chestOfDrawers_01_2_body_platform_3',
 'go_to_object_chestOfDrawers_01_2_body_platform_4',
 'go_to_object_chestOfDrawers_01_2_body_platform_5',
```

```

'go_to_object_chestOfDrawers_01_2_body_platform_6',
'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
['show_receptacle_of_object_1_of_current_platform',
'show_receptacle_of_object_2_of_current_platform'] - 'CALL_END': Call end (terminate
the task). - 'change_view': Change the viewing angle to observe the scene from another
perspective. - 'place_r': Place the object in an arbitrary place on the platform. -
'place_s_[object_idx1,dir_idx1]...]' : Place the object in the union area of regions with
indices (object_idx1,region_idx1)(object_idx1's region_idx1 space) etc. All available pairs
are in [(1, 1), (1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (1, 7), (1, 8), (2, 1), (2, 2), (2, 3), (2, 4), (2, 5),
(2, 6), (2, 7), (2, 8)], and a valid choice should be a subset of it.
All your current available actions are listed as above (all are without quotes and square
brackets). Please don't mix up it with the action space of previous steps.
Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative
to the robot's perspective and the heading of the object or platform you are interacting with.
The heading of a ground object is not fixed and depends on where the robot is standing and
facing.
Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided
into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to
you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions
proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right,"
and "front-right." The grid is conceptually numbered as follows, based on these directions:
[front-left, front, front-right],
[left, center, right],
[rear-left, rear, rear-right]

```

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the
edges of the object's bounding box to the platform's boundaries. The resulting regions define
the object's 8 receptacles, and the direction is defined similarly. Here are some useful
suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps
within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your
standing position to find the correct orientation, try combining multiple receptacles, or
remove objects that are blocking your way first(although you generally do not need to do
this). Specifically, for the task asking you put object to empty platforms, try combining
adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused
image of the target object and examine it carefully. This is important because the receptacles
may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only
receive the same hint informing you your invalid action. If you make mistakes, just start
output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and
lighting_blue_base_table_lamp

Steps used: 11/20. You can only take at most 20 steps, so hurry if you've almost used all of
them!

[*See Fig. 22 *HoldingOccupiedPlatform11_1_out_of_2.png,HoldingOccupiedPlatform11_2_out_of_2.png*

Here are 2 images, named ['HoldingOccupiedPlatform11_1_out_of_2.png',
'HoldingOccupiedPlatform11_2_out_of_2.png'] respectively.

Their description are as follows: These images show the platform you are currently on in one
view, with regions or objects marked with numbers for you to place objects accurately. The
platform is object_table_02_40_platform_2.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place
objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform,

guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will be marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: show_receptacle_of_object_2_of_current_platform

User Message:

[*See Fig. 23 *ShowReceptacle_12.png*]

Here are 1 images, named ['ShowReceptacle_12.png'] respectively.

Their description is as follows: This image shows the available receptacles around object 1 on the platform, you see this because you've taken "show_receptacle" action previously. The numbers from 1 to 8 indicate the available receptacles. Not all numbers from 1 to 8 may be present, as some receptacles might be too small or blocked. To use the numbers shown in the image to specify where you want to place the object you are holding, you can include (1, receptacles_idx (receptacles_idx in [1, 8]) in the output action.

You are currently at object_table_02_40_platform_2.

And you are holding kitchenware_white_paper_towel_holder.

Your available action space:

```
-['go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1',
 'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0',
 'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0',
 'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0',
 'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0',
 'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1',
 'go_to_object_rack_01_75_platform_2',
 'go_to_object_kitchen_counter_1_body_platform_0',
 'go_to_object_kitchen_counter_1_body_platform_1',
 'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
 'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
 'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
 'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
 'go_to_object_wall_cabinet_01_4_platform_1',
 'go_to_object_wall_cabinet_01_4_platform_2',
 'go_to_object_wall_cabinet_01_4_platform_3',
 'go_to_object_wall_cabinet_01_4_platform_4',
 'go_to_object_wall_cabinet_01_4_platform_5',
 'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
 'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
 'go_to_object_wall_cabinet_02_21_platform_1',
 'go_to_object_wall_cabinet_02_21_platform_2',
 'go_to_object_wall_cabinet_02_21_platform_3',
 'go_to_object_wall_cabinet_02_21_platform_4',
 'go_to_object_wall_cabinet_02_21_platform_5',
 'go_to_object_wall_cabinet_02_21_platform_6',
 'go_to_object_chestOfDrawers_01_2_body_platform_0',
 'go_to_object_chestOfDrawers_01_2_body_platform_1',
 'go_to_object_chestOfDrawers_01_2_body_platform_2',
 'go_to_object_chestOfDrawers_01_2_body_platform_3',
 'go_to_object_chestOfDrawers_01_2_body_platform_4',
 'go_to_object_chestOfDrawers_01_2_body_platform_5',
 'go_to_object_chestOfDrawers_01_2_body_platform_6',
 'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
 'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
 'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
 ['show_receptacle_of_object_1_of_current_platform',
```

'show_receptacle_of_object_2_of_current_platform'] - 'CALL_END': Call end (terminate the task). - 'change_view': Change the viewing angle to observe the scene from another perspective. - 'place_r': Place the object in an arbitrary place on the platform. -

'place_s_[object_idx1,dir_idx1...]' : Place the object in the union area of regions with indices (object_idx1,region_idx1)(object_idx1's region_idx1 space) etc. All available pairs are in [(1, 1), (1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (1, 7), (1, 8), (2, 1), (2, 2), (2, 3), (2, 4), (2, 5), (2, 6), (2, 7), (2, 8)], and a valid choice should be a subset of it.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions: [front-left, front, front-right],

[left, center, right],

[rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.

2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.

3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.

4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 12/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 23 *HoldingOccupiedPlatform12_1_out_of_2.png*,

HoldingOccupiedPlatform12_2_out_of_2.png]

Here are 2 images, named [*'HoldingOccupiedPlatform12_1_out_of_2.png'*,

'HoldingOccupiedPlatform12_2_out_of_2.png'] respectively.

Their description are as follows: These images show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is *object_table_02_40_platform_2*.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: place_s_[(1,7),(1,8),(2,3),(2,4)]

User Message:

The object has been placed successfully. You can now call end if you think you've finished the task correctly, or can also pick up the object again if you think the placement is not correct.

You are currently at object_table_02_40_platform_2.

And you are holding nothing.

Your available action space:

```
- ['go_to_object_sofa_10_platform_0', 'go_to_object_sofa_10_platform_1',
 'go_to_object_sofa_10_platform_2', 'go_to_object_table_04_13_platform_0',
 'go_to_object_chair_04_46_platform_0', 'go_to_object_chair_04_47_platform_0',
 'go_to_object_chair_05_7_platform_0', 'go_to_object_chair_05_8_platform_0',
 'go_to_object_stool_02_18_platform_0', 'go_to_object_stool_02_6_platform_0',
 'go_to_object_rack_01_75_platform_0', 'go_to_object_rack_01_75_platform_1',
 'go_to_object_rack_01_75_platform_2',
 'go_to_object_kitchen_counter_1_body_platform_0',
 'go_to_object_kitchen_counter_1_body_platform_1',
 'go_to_object_fridge_0_body_platform_1', 'go_to_object_fridge_0_body_platform_3',
 'go_to_object_fridge_0_body_platform_4', 'go_to_object_fridge_0_body_platform_5',
 'go_to_object_fridge_0_body_platform_6', 'go_to_object_fridge_0_body_platform_7',
 'go_to_object_bin_03_3_platform_0', 'go_to_object_wall_cabinet_01_4_platform_0',
 'go_to_object_wall_cabinet_01_4_platform_1',
 'go_to_object_wall_cabinet_01_4_platform_2',
 'go_to_object_wall_cabinet_01_4_platform_3',
 'go_to_object_wall_cabinet_01_4_platform_4',
 'go_to_object_wall_cabinet_01_4_platform_5',
 'go_to_object_wall_cabinet_01_4_platform_6', 'go_to_object_table_03_14_platform_1',
 'go_to_object_table_01_48_platform_0', 'go_to_object_wall_cabinet_02_21_platform_0',
 'go_to_object_wall_cabinet_02_21_platform_1',
 'go_to_object_wall_cabinet_02_21_platform_2',
 'go_to_object_wall_cabinet_02_21_platform_3',
 'go_to_object_wall_cabinet_02_21_platform_4',
 'go_to_object_wall_cabinet_02_21_platform_5',
 'go_to_object_wall_cabinet_02_21_platform_6',
 'go_to_object_chestOfDrawers_01_2_body_platform_0',
 'go_to_object_chestOfDrawers_01_2_body_platform_1',
 'go_to_object_chestOfDrawers_01_2_body_platform_2',
 'go_to_object_chestOfDrawers_01_2_body_platform_3',
 'go_to_object_chestOfDrawers_01_2_body_platform_4',
 'go_to_object_chestOfDrawers_01_2_body_platform_5',
 'go_to_object_chestOfDrawers_01_2_body_platform_6',
 'go_to_object_table_02_40_platform_0', 'go_to_object_table_02_40_platform_1',
 'go_to_object_table_02_40_platform_2', 'go_to_object_tvstand_88_platform_0',
 'go_to_object_cabinet_3_body_platform_0', 'go_to_object_cabinet_3_body_platform_1'] -
 ['pick_object_1_of_current_platform', 'pick_object_2_of_current_platform',
 'pick_object_3_of_current_platform'] -
 ['show_receptacle_of_object_1_of_current_platform',
 'show_receptacle_of_object_2_of_current_platform',
 'show_receptacle_of_object_3_of_current_platform'] - 'CALL_END': Call end (terminate
 the task). - 'change_view': Change the viewing angle to observe the scene from another
 perspective.
```

Choose one of the available actions.

All your current available actions are listed as above (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 13/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 24]

Here are 2 images, named ['Idle_13_1_out_of_2.png', 'Idle_13_2_out_of_2.png'] respectively.

Their description is as follows: These image show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_table_02_40_platform_2.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: CALL_END

(call-ended)

Task_result:

Target object placed between two objects.

Task_status:

Success

D.2.2 Failed Episode

The following episode shows how Gemini-2.5-pro failed in attempting a task in AI2THOR. It picked up the object and went to the destination correctly, but it failed to recognize the correct receptacle region.

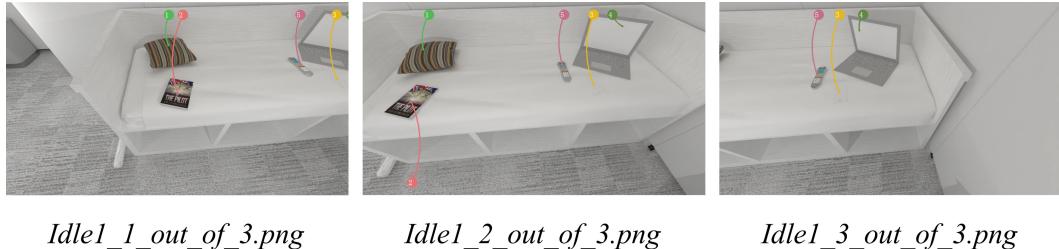


Figure 25: **Images Given after Step 1 of the Failed Episode.**

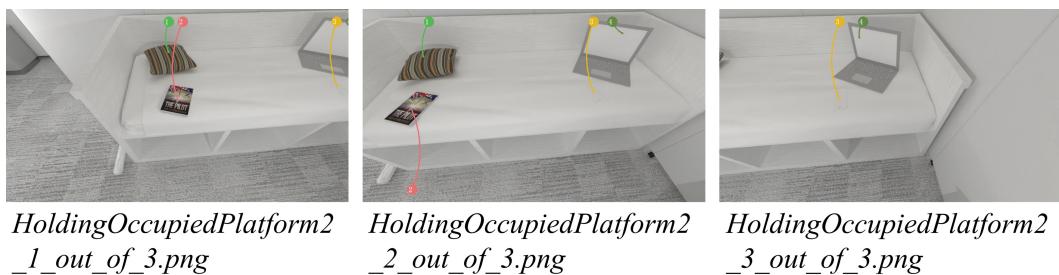


Figure 26: **Images Given after Step 2 of the Failed Episode.**



Figure 27: **Images Given after Step 3 of the Failed Episode.**

Unsuccessful Episode by Gemini-2.5-pro

System Message: You are a household assistant robot equipped with a vision system and manipulation capabilities. You need to complete a task in a 3D environment, mainly involving moving, picking up, and placing objects. Your goal is to move an object from one place to another correctly according to instructions. Please strictly follow the given Action Space for operations.

At the beginning of each task, you will be informed of a specific task to complete.

Throughout the task execution, you will transition between multiple states and have access to a set of possible actions (action space).

You may receive one of the following task types involving one object and another object or a platform. (an object/another object/a platform are the name of objects or platforms, dir is one of the 8 directions):



Figure 28: Images Given after Step 4 of the Failed Episode.

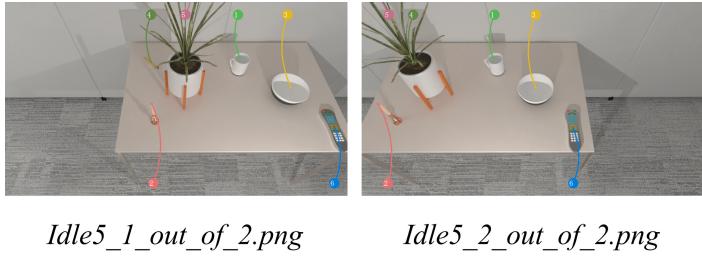


Figure 29: Images Given After Step 5 of the Failed Episode.

- move an object to a platform. - move an object to the dir of a platform. - move an object around another object. - move an object to the dir of another object. - move an object between another object and yet another object.

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions:
 [front-left, front, front-right],
 [left, center, right],
 [rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly.

Task success criteria:

- move an object to a platform: The task is considered successful only when an object is placed anywhere on the specified platform.
- move an object to the dir of a platform: The task is considered successful only when an object is placed on the platform and the geometric center of the placement is in the dir direction relative to the platform.
- move an object around another object: The task is considered successful only when an object is placed in any of the receptacles surrounding another object.
- move an object to the dir of another object: The task is considered successful only when an object is placed in the receptacles surrounding another object and overlaps with the dir direction.
- move an object between another object and yet another object: The task is considered successful only when an object is placed such that it intersects with receptacles in a pair of opposite directions between another object and yet another object.

Your action space, includes walking to platforms, picking up items, putting items down, rotating direction, getting information about directions around an object; CALL_END, placing an item in a specific direction on a platform, in a direction relative to another object, or placing it anywhere. Whenever you're about to choose an action, I will provide your current action space. If you choose an action that cannot be performed, such as trying to pick up an object repeatedly or attempting to place an object in a space that's too small, you'll receive a notification.

Picking up an item: Corresponds to the command "pick_object_object_number_of_current_platform".

Walking to a platform: Corresponds to the command "go_to_platform name".

Rotating direction: Corresponds to the command "change_view".

Getting an image of an object: Corresponds to the command "show_receptacle_of_object_object_number_of_current_platform".

Putting down your holding item on empty platform: Corresponds to the command "place_s_[region_idx1,region_idx2...]" where dir_idx1, dir_idx2 are NUMBERS, indicating the index of the receptacles; Putting down your item on an occupied platform: Corresponds to the command "place_s_[(object_idx1,dir_idx1)...]", where object_idx1, dir_idx1 are NUMBERS, indicating the object and its corresponding receptacles. For example, "place_s_[(1,2), (2,5)]" means putting down your item at the union of object 1's 2nd receptacles and object 2's 5th receptacles. Note that for placement action, the system will attempt to find a valid placement area that intersects with all the regions you selected. If it fails, it will place the object anywhere within your chosen space and you'll receive a notification.

You may be shown various types of images:

0) At the beginning of a task, if the task involves objects on a platform that contains other objects of the same type (e.g., the object is a book on a bookshelf with many books), you will receive a notification and images of these objects to help you distinguish them.

1) Whenever you move to a platform, you will see an image of the platform from your current perspective (or multiple images for longer platforms, indicating you can move horizontally to better observe the platform). If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects. If there are objects on the platform, guiding lines will indicate the object numbers.

2) If there are objects on a platform, you can use

"show_receptacle_of_object_x_of_current_platform" to get a focused image of that object with numbered receptacles around it. This allows you to see the available receptacles around the object.

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.

2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.

3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.

4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move Remote to Bowl's rear-left receptacles Initially, Remote is on object_hemnes_day_bed_platform_5, and Bowl is on object_dining_table_mella_platform_0. Steps used: 0/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

Your available action space:

- ‘CALL_END’: Call end (terminate the task). -
 [‘go_to_object_hemnes_day_bed_platform_5’, ‘go_to_object_bin_6_platform_0’,
 ‘go_to_object_Side_Table_317_1_platform_1’,
 ‘go_to_object_side_table_strind_platform_0’,
 ‘go_to_object_side_table_strind_platform_1’,
 ‘go_to_object_Side_Table_203_1_platform_0’,
 ‘go_to_object_Side_Table_203_1_platform_1’, ‘go_to_object_chair_antnas_platform_0’,
 ‘go_to_object_dresser_birkeland_platform_0’,
 ‘go_to_object_dresser_birkeland_platform_1’,
 ‘go_to_object_dresser_birkeland_platform_2’,
 ‘go_to_object_dresser_birkeland_platform_3’,
 ‘go_to_object_dresser_birkeland_platform_4’,
 ‘go_to_object_dresser_birkeland_platform_5’,
 ‘go_to_object_dresser_birkeland_platform_6’, ‘go_to_object_Basketball_1_platform_0’,
 ‘go_to_object_dining_table_mella_platform_0’,
 ‘go_to_object_Floor_Lamp_13_platform_0’,
 ‘go_to_object_armchair_emmabo_platform_0’, ‘go_to_object_BaseballBat_2_platform_0’].
 Please choose one of the available actions.

All your current available actions are listed as above (all are without quotes and square brackets). Please don’t mix up it with the action space of previous steps.

VLM Response: go_to_object_hemnes_day_bed_platform_5

User Message:

You are currently at object_hemnes_day_bed_platform_5.

And you are holding nothing.

Your available action space:

- [‘go_to_object_hemnes_day_bed_platform_5’, ‘go_to_object_bin_6_platform_0’,
 ‘go_to_object_Side_Table_317_1_platform_1’,
 ‘go_to_object_side_table_strind_platform_0’,
 ‘go_to_object_side_table_strind_platform_1’,
 ‘go_to_object_Side_Table_203_1_platform_0’,
 ‘go_to_object_Side_Table_203_1_platform_1’, ‘go_to_object_chair_antnas_platform_0’,
 ‘go_to_object_dresser_birkeland_platform_0’,
 ‘go_to_object_dresser_birkeland_platform_1’,
 ‘go_to_object_dresser_birkeland_platform_2’,
 ‘go_to_object_dresser_birkeland_platform_3’,
 ‘go_to_object_dresser_birkeland_platform_4’,
 ‘go_to_object_dresser_birkeland_platform_5’,
 ‘go_to_object_dresser_birkeland_platform_6’, ‘go_to_object_Basketball_1_platform_0’,
 ‘go_to_object_dining_table_mella_platform_0’,
 ‘go_to_object_Floor_Lamp_13_platform_0’,
 ‘go_to_object_armchair_emmabo_platform_0’, ‘go_to_object_BaseballBat_2_platform_0’] -
 [‘pick_object_1_of_current_platform’, ‘pick_object_2_of_current_platform’,
 ‘pick_object_3_of_current_platform’, ‘pick_object_4_of_current_platform’,
 ‘pick_object_5_of_current_platform’] -
 [‘show_receptacles_of_object_1_of_current_platform’,
 ‘show_receptacles_of_object_2_of_current_platform’,
 ‘show_receptacles_of_object_3_of_current_platform’,
 ‘show_receptacles_of_object_4_of_current_platform’,
 ‘show_receptacles_of_object_5_of_current_platform’] - ‘CALL_END’: Call end (terminate
 the task). - ‘rotate_observation_view_of_current_platform’: Change the viewing angle to
 observe the scene from another perspective.

Choose one of the available actions.

All your current available actions are listed as above (all are without quotes and square brackets). Please don’t mix up it with the action space of previous steps.

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the receptacles may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

Current task:

Move kitchenware_white_paper_towel_holder between lighting_blue_base_table_lamp and lighting_blue_base_table_lamp

Steps used: 1/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

[*See Fig. 25]

Here are 3 images, named ['Idle_1_1_out_of_3.png', 'Idle_1_2_out_of_3.png', 'Idle_1_3_out_of_3.png'] respectively. Their description is as follows: These images show the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_hemnes_day_bed_platform_5. If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: pick_object_5_of_current_platform

You are currently at object_hemnes_day_bed_platform_5.

And you are holding Remote.

Your available action space:

```
-['go_to_object_hemnes_day_bed_platform_5', 'go_to_object_bin_6_platform_0',
'go_to_object_Side_Table_317_1_platform_1',
'go_to_object_side_table_strind_platform_0',
'go_to_object_side_table_strind_platform_1',
'go_to_object_Side_Table_203_1_platform_0',
'go_to_object_Side_Table_203_1_platform_1', 'go_to_object_chair_antnas_platform_0',
'go_to_object_dresser_birkeland_platform_0',
'go_to_object_dresser_birkeland_platform_1',
'go_to_object_dresser_birkeland_platform_2',
'go_to_object_dresser_birkeland_platform_3',
'go_to_object_dresser_birkeland_platform_4',
'go_to_object_dresser_birkeland_platform_5',
'go_to_object_dresser_birkeland_platform_6', 'go_to_object_Basketball_1_platform_0',
'go_to_object_dining_table_mella_platform_0',
'go_to_object_Floor_Lamp_13_platform_0',
'go_to_object_armchair_emmabo_platform_0', 'go_to_object_BaseballBat_2_platform_0']
- ['show_receptacles_of_object_1_of_current_platform',
'show_receptacles_of_object_2_of_current_platform',
'show_receptacles_of_object_3_of_current_platform',
'show_receptacles_of_object_4_of_current_platform'] - 'CALL_END': Call end (terminate the task). - 'rotate_observation_view_of_current_platform': Change the viewing angle to
```

observe the scene from another perspective. - 'place_r': Place the object in an arbitrary place on the platform. - 'place_s_[object_idx1, dir_idx1]...]' : Place the object in the union area of regions with indices (object_idx1, region_idx1)(object_idx1's region_idx1 space) etc. All available pairs are in [(1, 1), (1, 2), (1, 3), (1, 4), (1, 5), (2, 1), (2, 2), (2, 3), (3, 1), (3, 2), (3, 3), (3, 4), (3, 5), (3, 6), (4, 1), (4, 2), (4, 3), (4, 4), (4, 5), (4, 6), (4, 7)], and a valid choice should be a subset of it.

All your current available actions are listed as follows (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Current task:

Move Remote to Bowl's rear-left receptacles

Steps used: 2/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions: [front-left, front, front-right], [left, center, right], [rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the regions may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

[*See Fig. 26] Here are 3 images, named

'HoldingOccupiedPlatformState_2_1_out_of_3.png',
'HoldingOccupiedPlatformState_2_2_out_of_3.png',
'HoldingOccupiedPlatformState_2_3_out_of_3.png' respectively.

Their description is as follows: This image shows the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_hemnes_day_bed_platform_5.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: go_to_object_dining_table_mella_platform_0

You are currently at object_dining_table_mella_platform_0.

And you are holding Remote.

Your available action space:

```
[ 'go_to_object_hemnes_day_bed_platform_5', 'go_to_object_bin_6_platform_0',
  'go_to_object_Side_Table_317_1_platform_1',
  'go_to_object_side_table_strind_platform_0',
  'go_to_object_side_table_strind_platform_1',
  'go_to_object_Side_Table_203_1_platform_0',
  'go_to_object_Side_Table_203_1_platform_1', 'go_to_object_chair_antnas_platform_0',
  'go_to_object_dresser_birkeland_platform_0',
  'go_to_object_dresser_birkeland_platform_1',
  'go_to_object_dresser_birkeland_platform_2',
  'go_to_object_dresser_birkeland_platform_3',
  'go_to_object_dresser_birkeland_platform_4',
  'go_to_object_dresser_birkeland_platform_5',
  'go_to_object_dresser_birkeland_platform_6', 'go_to_object_Basketball_1_platform_0',
  'go_to_object_dining_table_mella_platform_0',
  'go_to_object_Floor_Lamp_13_platform_0',
  'go_to_object_armchair_emmabo_platform_0', 'go_to_object_BaseballBat_2_platform_0']
- ['show_receptacles_of_object_1_of_current_platform',
  'show_receptacles_of_object_2_of_current_platform',
  'show_receptacles_of_object_3_of_current_platform',
  'show_receptacles_of_object_4_of_current_platform',
  'show_receptacles_of_object_5_of_current_platform'] - 'CALL_END': Call end (terminate the task).
- 'rotate_observation_view_of_current_platform': Change the viewing angle to observe the scene from another perspective.
- 'place_r': Place the object in an arbitrary place on the platform.
- 'place_s_[object_idx1,dir_idx1]...]'': Place the object in the union area of regions with indices (object_idx1,region_idx1)(object_idx1's region_idx1 space) etc. All available pairs are in [(1, 1), (1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (1, 7), (1, 8), (2, 1), (2, 2), (2, 3), (2, 4), (2, 5), (3, 1), (3, 2), (3, 3), (3, 4), (3, 5), (3, 6), (3, 7), (3, 8), (4, 1), (4, 2), (4, 3), (4, 4), (4, 5), (4, 6), (4, 7), (5, 1), (5, 2), (5, 3), (5, 4), (5, 5)], and a valid choice should be a subset of it.
```

All your current available actions are listed as follows (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Current task:

Move Remote to Bowl's rear-left receptacles

Steps used: 3/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions: [front-left, front, front-right], [left, center, right], [rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do

this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.

3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the regions may not be intuitive.

4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

[*See Fig. 27]

Here are 2 images, named ['HoldingOccupiedPlatform_3_1_out_of_2.png', 'HoldingOccupiedPlatform_3_2_out_of_2.png'] respectively.

Their description is as follows: This image shows the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_dining_table_mella_platform_0.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: show_receptacle_of_object_5_of_current_platform

[* See Fig. 28 ShowReceptacle_4.png]

Here are 1 images, named ['ShowReceptacle_4.png'] respectively.

Their description is as follows: This image shows the available receptacles around object 3 on the platform, you see this because you've taken "show_receptacles" action previously. The numbers from 1 to 8 indicate the available receptacles. Not all numbers from 1 to 8 may be present, as some receptacles might be too small or blocked. To use the numbers shown in the image to specify where you want to place the object you are holding, you can include (3, receptacles_idx (receptacles_idx in [1, 8]) in the output action.

You are currently at
object_dining_table_mella_platform_0.

And you are holding Remote.

Your available action space:

```
-['go_to_object_hemnes_day_bed_platform_5', 'go_to_object_bin_6_platform_0',
 'go_to_object_Side_Table_317_1_platform_1',
 'go_to_object_side_table_strind_platform_0',
 'go_to_object_side_table_strind_platform_1',
 'go_to_object_Side_Table_203_1_platform_0',
 'go_to_object_Side_Table_203_1_platform_1', 'go_to_object_chair_antnas_platform_0',
 'go_to_object_dresser_birkeland_platform_0',
 'go_to_object_dresser_birkeland_platform_1',
 'go_to_object_dresser_birkeland_platform_2',
 'go_to_object_dresser_birkeland_platform_3',
 'go_to_object_dresser_birkeland_platform_4',
 'go_to_object_dresser_birkeland_platform_5',
 'go_to_object_dresser_birkeland_platform_6', 'go_to_object_Basketball_1_platform_0',
 'go_to_object_dining_table_mella_platform_0',
 'go_to_object_Floor_Lamp_13_platform_0',
 'go_to_object_armchair_emmabo_platform_0', 'go_to_object_BaseballBat_2_platform_0']
 - ['show_receptacles_of_object_1_of_current_platform',
 'show_receptacles_of_object_2_of_current_platform',
 'show_receptacles_of_object_3_of_current_platform',
 'show_receptacles_of_object_4_of_current_platform',
 'show_receptacles_of_object_5_of_current_platform'] - 'CALL_END': Call end (terminate
```

the task). - 'rotate_observation_view_of_current_platform': Change the viewing angle to observe the scene from another perspective. - 'place_r': Place the object in an arbitrary place on the platform. - 'place_s_[object_idx1,dir_idx1]...]'': Place the object in the union area of regions with indices (object_idx1,region_idx1)(object_idx1's region_idx1 space) etc. All available pairs are in [(1, 1), (1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (1, 7), (1, 8), (2, 1), (2, 2), (2, 3), (2, 4), (2, 5), (3, 1), (3, 2), (3, 3), (3, 4), (3, 5), (3, 6), (3, 7), (3, 8), (4, 1), (4, 2), (4, 3), (4, 4), (4, 5), (4, 6), (4, 7), (5, 1), (5, 2), (5, 3), (5, 4), (5, 5)], and a valid choice should be a subset of it.

All your current available actions are listed as follows (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Current task:

Move Remote to Bowl's rear-left receptacles

Steps used: 4/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

Understanding directions: Directions like 'front', 'rear', 'left', and 'right' are defined relative to the robot's perspective and the heading of the object or platform you are interacting with. The heading of a ground object is not fixed and depends on where the robot is standing and facing.

Empty Surfaces (Platforms): When interacting with an empty platform, imagine it divided into a 3x3 grid. The direction aligned with the heading (also, the FARTHEST middle space to you, NOT THE NEAREST MIDDLE SPACE) is labeled "front," with the remaining regions proceeding counterclockwise as "front-left," "left," "rear-left," "rear," "rear-right," "right," and "front-right." The grid is conceptually numbered as follows, based on these directions: [front-left, front, front-right], [left, center, right], [rear-left, rear, rear-right]

Occupied Surfaces (Objects on Platforms): For objects on platforms, imagine extending the edges of the object's bounding box to the platform's boundaries. The resulting regions define the object's 8 receptacles, and the direction is defined similarly. Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the regions may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

[* See Fig. 28 *HoldingOccupiedPlatform_4_1_out_of_2.png,HoldingOccupiedPlatform_4_2_out_of_2.png*]

Here are 2 images, named ['HoldingOccupiedPlatform4_1_out_of_2.png', 'HoldingOccupiedPlatform4_2_out_of_2.png'] respectively.

Their description is as follows: This image shows the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_dining_table_mella_platform_0.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUIDELINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM_response: place_s_[(3,8)]

The object has been placed successfully. You can now call end if you think you've finished the task correctly, or can also pick up the object again if you think the placement is not correct.

You are currently at object_dining_table_mella_platform_0.

And you are holding nothing.

Your available action space:

```
- ['go_to_object_hemnes_day_bed_platform_5', 'go_to_object_bin_6_platform_0',
 'go_to_object_Side_Table_317_1_platform_1',
 'go_to_object_side_table_strind_platform_0',
 'go_to_object_side_table_strind_platform_1',
 'go_to_object_Side_Table_203_1_platform_0',
 'go_to_object_Side_Table_203_1_platform_1', 'go_to_object_chair_antnas_platform_0',
 'go_to_object_dresser_birkeland_platform_0',
 'go_to_object_dresser_birkeland_platform_1',
 'go_to_object_dresser_birkeland_platform_2',
 'go_to_object_dresser_birkeland_platform_3',
 'go_to_object_dresser_birkeland_platform_4',
 'go_to_object_dresser_birkeland_platform_5',
 'go_to_object_dresser_birkeland_platform_6', 'go_to_object_Basketball_1_platform_0',
 'go_to_object_dining_table_mella_platform_0',
 'go_to_object_Floor_Lamp_13_platform_0',
 'go_to_object_armchair_emmabo_platform_0', 'go_to_object_BaseballBat_2_platform_0'] -
 ['pick_object_1_of_current_platform', 'pick_object_2_of_current_platform',
 'pick_object_3_of_current_platform', 'pick_object_4_of_current_platform',
 'pick_object_5_of_current_platform', 'pick_object_6_of_current_platform'] -
 ['show_receptacles_of_object_1_of_current_platform',
 'show_receptacles_of_object_2_of_current_platform',
 'show_receptacles_of_object_3_of_current_platform',
 'show_receptacles_of_object_4_of_current_platform',
 'show_receptacles_of_object_5_of_current_platform',
 'show_receptacles_of_object_6_of_current_platform']
 - 'CALL_END': Call end (terminate the task). -
 'rotate_observation_view_of_current_platform': Change the viewing angle to observe the scene from another perspective.
```

Choose one of the available actions.

All your current available actions are listed as follows (all are without quotes and square brackets). Please don't mix up it with the action space of previous steps.

Current task:

Move Remote to Bowl's rear-left receptacles

Steps used: 5/20. You can only take at most 20 steps, so hurry if you've almost used all of them!

Here are some useful suggestions for you to better finish the task:

1. Your extra actions do not affect the success of the task, you only need to keep your steps within the total step limit.
2. When you want to place an object but cannot find enough space, you can try changing your standing position to find the correct orientation, try combining multiple receptacles, or remove objects that are blocking your way first(although you generally do not need to do this). Specifically, for the task asking you put object to empty platforms, try combining adjacent receptacles may be very useful.
3. For tasks that involve placing objects near other objects, please remember to get a focused image of the target object and examine it carefully. This is important because the regions may not be intuitive.
4. Important: Don't output anything other than the action you want to take. You will only receive the same hint informing you your invalid action. If you make mistakes, just start output correct actions from the next prompt without any apologize.

[* See Fig. 29]

Here are 2 images, named ['Idle_5_1_out_of_2.png', 'Idle_5_2_out_of_2.png'] respectively.

Their description is as follows: This image shows the platform you are currently on in one view, with regions or objects marked with numbers for you to place objects accurately. The platform is object_dining_table_mella_platform_0.

If the platform has no objects, a 3x3 grid will be marked on the platform to help you place objects, with each grid marked in numbers from 1 to 9. If there are objects on the platform, guiding lines will indicate the object numbers. Note that if you see multiple images, it means the platform is too long to be captured in one image, and it's guaranteed that the same object will marked in THE SAME COLOR GUILDLINES AND THE SAME NUMBER. If you think you can't determine the number of an item in one picture, you can go through other pictures and see if this item is marked more clearly.

VLM Response: CALL_END

(call-ended)

Task_result:

Target object placed in wrong direction, expected: rear-left, found: rear-right.

Task_status:

Failed