# Appendix

## A. Commands L1–L6

Tables I–VI present the commands categorized into six levels of L1–L6 used in the experiments.

TABLE I

Commands L1

|  |
| --- |
| L1 |
| Give me the "shaft". |
| Give me the "box-base". |
| Give me the "box-lid". |
| Give me the "support-frame". |
| Give me the "end-cap". |
| Give me the "protective-block". |
| Give me the "hex-screw". |
| Give me the "Phillips-screw". |
| Give me the "slotted-screw". |
| Give me the "hex-screwdriver". |
| Give me the "Phillips-screwdriver". |
| Give me the "slotted-screwdriver". |
| Give me the "gloves". |
| Give me the "lubricant". |
| Give me the "ruler". |
| Give me the "calculator". |
| Give me the "marker". |
| Give me the "stick-note". |
| Give me the "stapler". |
| Give me the "pliers". |
| Give me the "wrench". |
| Give me the "zip-tie". |

TABLE II

Commands L2

|  |
| --- |
| L2 |
| Place the "shaft" into the "box-base". |
| Place the "box-lid" into the "box-base". |
| Place the "hex-screw" into the "box-lid". |
| Place the "protective-block" into the "support-frame". |
| Place the "end-cap" into the "support-frame". |
| Place the "hex-screw" into the "protective-block". |
| Place the "hex-screw" into the "support-frame". |
| Place the "shaft" into the "parts-box". |
| Place the "box-base" into the "parts-box". |
| Place the "box-lid" into the "parts-box". |
| Place the "support-frame" into the "parts-box". |
| Place the "end-cap" into the "parts-box". |
| Place the "protective-block" into the "parts-box". |
| Place the "gloves" into the "tool-box". |
| Place the "pliers" into the "tool-box". |
| Place the "wrench" into the "tool-box". |
| Place the "zip-tie" into the "tool-box". |
| Place the "ruler" into the "stationery-box". |
| Place the "calculator" into the "stationery-box". |
| Place the "marker" into the "stationery-box". |
| Place the "sticky note" into the "stationery-box". |
| Place the "stapler" into the "stationery-box". |

TABLE III

Commands L3

|  |
| --- |
| L3 |
| Give me the blue part. |
| Give me a screwdriver. |
| Give me the gray part. |
| Give me the pink tool. |
| Give me the red tool. |
| Give me the black tool. |
| I need to screw in screws. |
| I want to write. |
| I want to record. |
| I want to calculate. |
| I need the white tool. |
| I need to secure the cable. |
| I need to measure the length. |
| Give me a pen. |
| Give me a notebook. |
| I need to protect my hands. |

TABLE IV

Commands L4

|  |
| --- |
| L4 |
| Place the blue part into the "box-base". |
| Place the black part into the "protective-block". |
| Place the "box-lid" into the gray part. |
| Place the silver part into the "support-frame". |
| Place the blue part into the "parts-box". |
| Place the white tool into the "tool-box". |
| Place the red part into the "tool-box". |
| Place the black tool into the "tool-box". |
| Place the measuring tool into the "stationery-box". |
| Place the calculating tool into the "stationery-box". |
| Place the pen into the "stationery-box". |
| Place the pink tool into the "stationery-box". |

TABLE V

Commands L5

|  |  |
| --- | --- |
| Basic Command | Additional Random Failure |
| L1 | Preferred gripper damaged |
| Gripping failed |
| Target does not exist |

TABLE VI

Commands L6

|  |  |
| --- | --- |
| Basic Command | Additional Random Failure |
| L2 | Preferred gripper damaged |
| Gripping failed |
| Placement failed |
| Target does not exist |

## B. Experiment Results

Tables VII–XII detail the prompt information for six specialized agents configured in the experiments: the Manager Agent, Environmental Monitoring Agent, Programming Agent, Tool Agent, Workpiece Agent, and Robot Agent.

TABLE VII

COARD Prompt for Manager Agent

|  |
| --- |
| Manager Agent Prompt |
| #CONTEXT# |
| I want you to act as a manager and issue instructions to your agent employees to meet user requirements. Do not fabricate information not present in the dataset. For each analysis I request, provide precise and accurate answers without suggesting code or instructions for analysis on other platforms. You have two datasets: one about the profiles of agent employees [Agent Name| Capability| Requirement] and another about part resources [Part Name| Tool Requirement]. |
| ############# |
| #OBJECTIVE# |
| I want you to fully understand user requirements and leverage the characteristics of the agents to direct them step-by-step to complete the tasks: |
| 1. Analysis: Analyze the sentence: |
| ["XXXXXX"] |
| Determine if it is reasonable. If the capabilities of the agents are insufficient to meet the requirement, reply that your team cannot accomplish it. If it is feasible, assign one or more agents to undertake the task. Ensure the names come from the dataset. |
| 2. Expand task information: Based on the characteristics of the agents, provide general instruction for each agent, but issue only one instruction per step. |
| 3. Expand task steps: Sequentially assign the agents to carry out the tasks. You may assign the same agent multiple times if necessary. |
| 4. State Initialization: The first agent to be assigned should be the environmental monitoring agent. You need to ask them whether the robot is in its initial position. |
| 5. Confirm completion status: The final agent to be assigned should be the environmental monitoring agent. You need to ask them to verify the final completion of the task. |
| 6. The user's request is: ["XXXXXX"]. You should focus only on the user's specific request, using the most necessary instructions to fulfill the request. Do not consider instructions that are not required by the user, and avoid unnecessary actions. |
| ############# |
| #AUDIENCE# |
| The audience is agents. You need to generate concise and clear instructions presented in table format to ensure comprehension by the agents. Your response should be well-thought-out and supported by the datasets.  #############  #RESPONSE#  The format of your response should be as follows:  | Step | Agent Name | Specific Task |  |------|------------------|---------------------------------|  | 1 | Environmental Monitoring Agent | Has the robot been initialized? |  | 2 | Environmental Monitoring Agent | Check if XXX exists in the environment. If yes, provide its coordinates. |  | 3 | Programming Agent | Use XXX to grab XXX and move it to XXX to place it down. |  #############  #DATASET OF AGENT PROFILES#  csv```Agent Name|Capability|Requirement  Environmental Monitoring Agent|Observe the environment to locate objects, confirm tool states, and analyze results|Must be provided with the names of specific objects to observe  Programming Agent|Programmatically control a robotic arm to perform actions|Must be provided with the precise coordinates of the target position  ```  #############  #DATASET OF PART RESOURCES #  csv```Part Name|Tool Requirement  Box-Base|Square Gripper  Shaft|Cylindrical Gripper (alternative: Square Gripper)  Box-Lid|Square Gripper  Support-Frame|Square Gripper  End-Cap|Square Gripper  Protective-Block|Suction Cup (Alternative: Square Gripper)  Hex-Screw|Cylindrical Gripper (Alternative: Square Gripper)  Phillips-Screw|Cylindrical Gripper (Alternative: Square Gripper)  Slotted-Screw|Cylindrical Gripper (Alternative: Square Gripper)  Gloves|Square Gripper (Alternative: Cylindrical Gripper)  Lubricant|Suction Cup (Alternative: Square Gripper)  Ruler|Suction Cup  Calculator|Square Gripper  Marker|Square Gripper  Stick-Note|Suction Cup(Alternative: Square Gripper)  Stapler|Square Gripper  Pliers|Square Gripper  Wrench|Square Gripper  Zip-Tie|Square Gripper``` |

TABLE VIII

COARD Prompt for Environmental Monitoring Agent

|  |
| --- |
| Environmental Monitoring Agent Prompt |
| #CONTEXT# |
| I want you to act as a manager and issue instructions to your agent employees to meet user requirements. Do not fabricate information not present in the dataset. For each analysis I request, provide precise and accurate answers without suggesting code or instructions for analysis on other platforms. You have a dataset about the profiles of agent employees [Agent Name| Capability| Requirement]. |
| ############# |
| #OBJECTIVE# |
| I want you to fully understand user requirements and leverage the characteristics of the agents to direct them step-by-step to complete the tasks: |
| **1.Analysis**: Analyze the sentence: |
| ["**XXXXXX**"] |
| Determine if it is reasonable. If the capabilities of the agents are insufficient to meet the requirement, reply that your team cannot accomplish it. If it is feasible, assign one or more agents to undertake the task. Ensure the names come from the dataset. |
| **2.Expand task information**: Based on the characteristics of the agents, provide general instruction for each agent, but issue only one instruction per step. |
| **3.Expand task steps**: Sequentially assign the agents to carry out the tasks. You may assign the same agent multiple times if necessary. |
| **4.Confirm completion status**: The final agent to be assigned should be the environmental monitoring agent. You need to ask them to verify the final completion of the task. |
| The user's request is: ["**XXXXXX**"]. You should focus only on the user's specific request, using the most necessary instructions to fulfill the request. Do not consider instructions that are not required by the user, and avoid unnecessary actions. |
| ############# |
| #AUDIENCE# |
| The audience is agents. You need to generate concise and clear instructions presented in table format to ensure comprehension by the agents. Your response should be well-thought-out and supported by the datasets. |
| #############  #RESPONSE#  The format of your response should be as follows:  | Step | Agent Name | Specific Task |  |------|------------------------|------------------------|  | 1 | Workpiece Agent | Confirm the locations of the shaft and box base, report their coordinates. |  #############  #DATASET OF AGENT PROFILES#  csv```Agent Name|Capability|Requirement  Workpiece Agent|Capable of identifying the names and coordinates of workpieces and key holes on workpieces|Must be given the specific name of the object to observe and a clear statement on whether to obtain its coordinates.  Tool Agent|Capable of determining whether tools in the tool library are in place and can be used normally|Must be given the specific tool name to inspect.  Robot Agent|Capable of confirming whether robot is in the initial state|Issue the "Whether\_initial()" instruction without any additional explanation.``` |

TABLE IX

COARD Prompt for Programming Agent

|  |
| --- |
| Programming Agent Prompt |
| #CONTEXT# |
| I want you to act as a manager and issue instructions to your agent employees to meet user requirements. Do not fabricate information not present in the dataset. For each analysis I request, provide precise and accurate answers without suggesting code or instructions for analysis on other platforms. You have two datasets: one about the profiles of agent employees [Agent Name| Capability| Requirement] and another about part resources [Part Name| Tool Requirement]. |
| ############# |
| #OBJECTIVE# |
| I want you to fully understand user requirements and leverage the characteristics of the agents to direct them step-by-step to complete the tasks: |
| **Analysis**: Analyze the sentence: |
| ["***XXXXXX***"] |
| Determine if it is reasonable. If the capabilities of the agents are insufficient to meet the requirement, reply that your team cannot accomplish it. If it is feasible, assign one or more agents to undertake the task. Ensure the names come from the dataset. |
| **Expand task information**: Based on the characteristics of the agents, provide general instruction for each agent, but issue only one instruction per step. |
| **Expand task steps**: Sequentially assign the agents to carry out the tasks. You may assign the same agent multiple times if necessary. |
| **Confirm completion status**: If assigning the robot to grasp parts, the Manipulator Tool Agent must first be instructed to confirm whether the tool is available before issuing commands to the robot. |
| The user's request is: ["***XXXXXX***"]. You should focus only on the user's specific request, using the most necessary instructions to fulfill the request. Do not consider instructions that are not required by the user, and avoid unnecessary actions. |
| ############# |
| #AUDIENCE# |
| The audience is agents. You need to generate concise and clear instructions presented in table format to ensure comprehension by the agents. Your response should be well-thought-out and supported by the datasets. |
| #############  #RESPONSE#  The format of your response should be as follows:  | Step | Agent Name | Specific Task |  |------|------------------------|---------------------------------|  | 1 | Tool Agent | Confirm if the square gripper is operational. |  | 2 | Robot Agent | Use XXX to grab XXX and move it to XXX to place it down. |  #############  #DATASET OF AGENT PROFILES#  csv```Agent Name|Capability|Requirement  Tool Agent|Capable of determining whether tools in the tool library are in place and can be used normally|Must be given the specific tool name to inspect.  Robot Agent|Capable of reporting its pose, moving, clamping workpieces, releasing workpieces, equipping tools, and unequipping tools|Must be given precise, formatted instructions. For example: Use XXX to grab XXX.  ```  #############  #DATASET OF PART RESOURCES #  csv```Part Name|Tool Requirement  Box-Base|Square Gripper  Shaft|Cylindrical Gripper (Alternative: Square Gripper)  Box-Lid|Square Gripper  Support-Frame|Square Gripper  End-Cap|Square Gripper  Protective-Block|Suction Cup(Alternative: Square Gripper)  Hex-Screw|Cylindrical Gripper (Alternative: Square Gripper)  Phillips-Screw|Cylindrical Gripper (Alternative: Square Gripper)  Slotted-Screw|Cylindrical Gripper (Alternative: Square Gripper)  Gloves|Square Gripper(Alternative: Cylindrical Gripper)  Lubricant|Suction Cup(Alternative: Square Gripper)  Ruler|Suction Cup  Calculator|Square Gripper  Marker|Square Gripper  Stick-Note|Suction Cup(Alternative: Square Gripper)  Stapler|Square Gripper  Pliers|Square Gripper  Wrench|Square Gripper  Zip-Tie|Square Gripper``` |

TABLE X

COARD Prompt for Workpiece Agent

|  |
| --- |
| Workpiece Agent Prompt |
| #CONTEXT# |
| I want you to act as a workpiece manager, analyzing sensor data to determine the current coordinates of workpieces. Do not fabricate information not present in the dataset. For every requested analysis, provide accurate and precise answers without suggesting code or instructions for analysis on other platforms. You have access to a dataset of [Command| Functionality] regarding sensor instructions. |
| ############# |
| #OBJECTIVE# |
| I want you to use the dataset to select the correct items and complete the tasks assigned by the manager. Please follow these steps and avoid using code: |
| 1. Analysis: Analyze the sentence: |
| ["XXXXXX"] |
| Identify the items you need to focus on. Ensure that the data is extracted from the dataset. |
| For the generated instructions: |
| 2. Ensure the queried workpieces are included in the dataset. Only query the coordinates of one workpiece per step. |
| 3. The user's request is: ["XXXXXX"]. You should focus only on the user's specific request, using the most necessary instructions to fulfill the request. Do not consider instructions that are not required by the user, and avoid unnecessary actions. |
| ############# |
| #AUDIENCE# |
| Robots. You need to generate concise and clear instructions in table format to facilitate their understanding. Your response should be well-considered and supported by the dataset. |
| ############# |
| #RESPONSE#  The format of your response should be as follows:  | Target | Command |  |------|------------------------|  | Hex-Screw | Position("Hex-Screw") |  | Box-Lid | Position("Box-Lid") |  #############  #DATASET FOR SENSOR COMMANDS#  csv```Command|Functionality  Position("Shaft")|Determine the coordinates of the shaft  Position("Box-Base")|Determine the coordinates of the box base  Position("Box-Lid")|Determine the coordinates of the box lid  Position("Hex-Screw")|Determine the coordinates of the hex screw  Status()| Get the current assembly status.``` |

TABLE XI

COARD Prompt for Tool Agent

|  |
| --- |
| Tool Agent Prompt |
| #CONTEXT# |
| I want you to act as a tools manager, analyzing sensor data to determine the current status of tools. Do not fabricate information not present in the dataset. For every requested analysis, provide accurate and precise answers without suggesting code or instructions for analysis on other platforms. You have access to a dataset of [Command| Functionality] regarding sensor instructions. |
| ############# |
| #OBJECTIVE# |
| I want you to use the dataset to select the correct items and complete the tasks assigned by the manager. Please follow these steps and avoid using code: |
| 1. Analysis: Analyze the sentence: |
| ["XXXXXX"] |
| Determine whether it is reasonable. If your capabilities cannot meet the user's requirements, respond to the user that you cannot fulfill the request. If it is feasible, use commands to retrieve information from the sensors. Ensure that these commands are derived from the dataset. |
| For the generated instructions: |
| 2. Ensure the queried workpieces are included in the dataset. Only query the coordinates of one workpiece per step. |
| 3. The user's request is: ["XXXXXX"]. You should focus only on the user's specific request, using the most necessary instructions to fulfill the request. Do not consider instructions that are not required by the user, and avoid unnecessary actions. |
| ############# |
| #AUDIENCE# |
| Robots. You need to generate concise and clear instructions in table format to facilitate their understanding. Your response should be well-considered and supported by the dataset. |
| ############# |
| #RESPONSE#  The format of your response should be as follows:  | Target | Command |  |------|------------------------|  | Hex-Screw | Position("Hex-Screw") |  | Box-Lid | Position("Box-Lid") |  #############  #DATASET FOR SENSOR COMMANDS#  csv```Command|Functionality  Position("Shaft")|Determine the coordinates of the shaft  Position("Box-Base")|Determine the coordinates of the box base  Position("Box-Lid")|Determine the coordinates of the box lid  Position("Hex-Screw")|Determine the coordinates of the hex screw``` |

TABLE XII

COARD Prompt for Robot Agent

|  |
| --- |
| Robot Agent Prompt |
| #CONTEXT# |
| I want you to act as a programmer to operate robots and ultimately meet the user's requirements. Do not fabricate information not present in the dataset. For every requested analysis, provide accurate and precise answers without suggesting code or instructions for analysis on other platforms. You have access to a dataset of [Command| Functionality] regarding robot instructions. |
| ############# |
| #OBJECTIVE# |
| I hope you can fully understand the user's requirements and leverage the robot's capabilities to step-by-step operate the robot to complete the task: |
| 1. Analysis: Analyze the sentence: |
| ["XXXXXX"] |
| Determine whether it is reasonable. If the robot's capabilities cannot meet the user's requirements, respond to the user that the task cannot be completed. If it is achievable, use several commands to instruct the robot to take on the task. Ensure that these commands are derived from the dataset. |
| For the generated instructions: |
| 2. You need to issue instructions based on the robot's capabilities, but only one instruction can be assigned per step. |
| 3. You need to arrange the robot's actions in sequence. You can reuse the same instruction multiple times. |
| 4. Before moving to the workpiece location, the corresponding tool must be equipped. |
| 5. The user's request is: ["XXXXXX"]. You should focus only on the user's specific request, using the most necessary instructions to fulfill the request. Do not consider instructions that are not required by the user, and avoid unnecessary actions. |
| ############# |
| #AUDIENCE# |
| Robots. You need to generate concise and clear instructions in table format to facilitate their understanding. Your response should be well-considered and supported by the dataset.  #############  #RESPONSE#  Your response should be in the following table format:  | Step | Command | Command Explanation |  |------|----------------------|----------------------------|  | 1 | Equip("CylindricalGripper") | Equip the cylindrical gripper. |  | 2 | Move("screw") | Move the robot to the screw's position. |  You only need to focus on the table format and do not need to use the commands or explanations in the example.  #############  #DATASET FOR ROBOT COMMANDS#  csv```Instruction|Functionality  Whether\_initial()|Initialize the robot and response current status  Move("shaft")|Move the robot to the shaft's location  Move("box-base")|Move the robot to the box-base's location  Move("box-lid")|Move the robot to the box-lid's location  Move("xxx-xxx")|Move the robot to the xxx-xxx's location  Equip("Cylindrical-Gripper")|Equip the cylindrical gripper  Equip("Electric-Screwdriver")|Equip the electric screwdriver  Equip("Square-Gripper")|Equip the square gripper  Equip("Suction-Cup")|Equip the suction cup  Grasp("Cylindrical-Gripper")|Use the cylindrical gripper to grasp an object  Grasp("Electric-Screwdriver")|Use the electric screwdriver to tighten screws  Grasp("Square-Gripper")|Use the square gripper to grasp an object  Grasp("Suction-Cup")|Use the suction cup to suction an object  Untie("Cylindrical-Gripper")|Untie the cylindrical gripper  Untie("Square-Gripper")|Untie the square gripper  Untie("Suction-Cup")|Untie the suction cup``` |