Testbed

Testbed Workflows

Dose, Shake, and Heat using One Robot

We use the ViperX robot arm to move the vial between different locations according to the following steps.

1. *set_door(val = "open"):* Open the door of the dosing device.
2. *move_object_viperx(grid location, dosing device location): Move* the vial from the grid to the dosing device.
3. *set_door(val = "close"):* Close the door of the dosing device.
4. *run_action:* Place an amount of substance in the vial using the dosing device.
5. *stop_action:* Stop the dosing device from adding substance to the vial.
6. *set_door(val = "open"):* Open the door of the dosing device.
7. *move_object-viperx(dosing device location,thermoshaker location):* Move the vial from the dosing device to the thermoshaker.
8. *start_shaking:* Shake the substance in the vial.
9. *stop_shaking:* Stop shaking the substance in the vial.
10. *move_object_viperx(thermoshaker location, grid location):* Move the vial from the thermoshaker to the grid.

Dose, Shake, and Heat using Two Robots Sequentially

This workflow repeats the steps mentioned in the "Dose, Shake, and Heat using One Robot" workflow and executes further steps using the Ned2 robot arm. The additional steps using Ned2 are:

11. *move_object_ned2(grid location, hot plate location):* Move the vial from the grid to the hotplate.
12. *start_stirring:* Start stirring the substance in the vial.
13. *stop_stirring:* Stop stirring the substance in the vial.

14. *move_object_ned2(hot plate location, grid location):* Move the vial from the hotplate to the grid.

Dose, Shake, and Heat using Two Simultaneously Moving Robots

In this workflow, we use both the ViperX and Ned2 robot arms simultaneously, but each works in its own workspace.

Workflow for ViperX Robot Arm:

1. *move_object_viperx(grid location,thermoshaker location):* Move the vial from the grid to the thermoshaker using ViperX.
2. *start_shaking:* Shake the substance in the vial.
3. *stop_shaking:* Stop shaking the substance in the vial.
4. *move_object_viperx(thermoshaker location, grid location):* Move the vial from the thermoshaker to the grid using ViperX.
5. Repeat steps 1-3 two more times.

Workflow for Ned2 Robot Arm:

1. *set door(val = "open"):* Open the door of the dosing device.
2. *move_object_ned2(grid location, dosing device location):* Move the vial from the grid to the dosing device.
3. *set_door(val = "close"):* Close the door of the dosing device.
4. *run_action*: Place an amount of substance in the vial using the dosing device.
5. *stop_action:* Stop the dosing device from adding substance to the vial.
6. *move_object_ned2(dosing device location, hot plate location):* Move the vial from the dosing device to the hotplate.
7. *start stirring:* Start stirring the substance in the vial.
8. stop stirring: Stop stirring the substance in the vial.
9. *move_object_ned2(hot plate location, grid location):* Move the vial from the hotplate to the grid.
10. Repeat steps 1-7 one more time.

Testbed Device Commands

We present the commands along with their descriptions for the robot arms on the testbed: ViperX (Table 1) and Ned2 (Table 2). For each of the robot arms, we develop a high level method for moving a vial from location a to location b. We call this method *'move object viperx'* for ViperX robot arm and *'move object ned2'* for Ned2 robot arm. These methods take the two locations as part of its arguments. We outline the steps below.

1. Open the robot arm gripper.
2. Move the robot arm to location a.
3. Close the robot arm gripper.
4. Move the robot arm to location b.
5. Open the robot arm gripper.

Further, we present the commands for the Mocked-up Devices: dosing device (Table 3), Thermoshaker (Table 4), and Hotplate (Table 5).

Commands	**Description**
$robot\_write\_commands$	Moving the robot arm. **Note: The command has a set of arguments that specifies the cartesian position the robot arm should move to.**
$robot\_write\_joint\_command(joint\_name = \text{“}gripper\text{”}, command = 250.0)$	Open robot arm gripper.
$robot\_write\_joint\_command(joint\_name = \text{“}gripper\text{”}, command = -250.0)$	Close robot arm gripper.

Table 1: ViperX Robot Arm Commands

Commands	**Description**
$move\_pose$	Moving the robot arm. **Note: The command has a set of arguments that specifies the cartesian position the robot arm should move to.**
$open\_gripper$	Open robot arm gripper.
$close\_gripper$	Close robot arm gripper.

Table 2: Ned2 Robot Arm Commands

Commands	Description
$set\_door(val = \text{“}open\text{”})$	Open dosing device door.
$set\_door(val = \text{“}close\text{”})$	Close dosing device door.
run_action	Start adding substance in a vial.
$stop\_action$	Stop adding substance in a vial.

Table 3: Dosing Device Commands

Commands	Description
$start\_shaking$	Starting shaking solution in a vial.
$stop\_shaking$	Stop shaking solution in a vial.

Table 4: Thermoshaker Commands

Commands	Description
$start\_stirring$	Starting stirring solution in a vial.
$stop\_stirring$	Stop stirring solution in a vial.

Table 5: Hoplate Commands