Hochschule
Bonn-Rhein-Sieg
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D2: Revised Requirements, Problem Breakdown & Task Allocation

Topic: Feedback Pouring with Kinova Arm

Software Development Project

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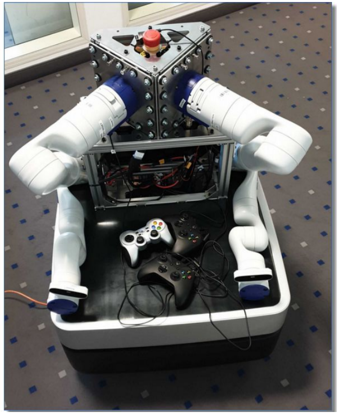
Problem Description

The task of pouring liquid or cereal is a common one in RoboCup competitions, implementing this task in Kinnova Arm (Freddy) with some feedback to ensure accuracy and consistency instead of previous timer based approach. [1]



[1] Feedback for Pouring behaviour (Toyota HSR) (HBRS-SDP/ss22-pour-feedback (github.com))

Problem Goals

- Compare HSR behaviour with Kinova Arms/ Freddy
- Explore feedback methods using available sensors **on the robot**(end-effector force estimation, RGB/-D camera(s))
- Perceive the source and target container and estimate the orientation and distance between them
- Feedback must be fast enough for controlling the pouring motion(minimum ~20Hz)

Title: US 1	Priority: Medium	Estimate:

User Story:

As a user
I want to visualise the Forces while the arm is holding, pouring and emptying the container
So that I can estimate the amount of object it is holding

Acceptance Criteria:

Scenario 1.1

Visualisation of forces for different scenarios of pouring.

Requirement Specifications

<table>
<tr><th>Title:
US 2</th><th>Priority:
Medium</th><th>Estimate:</th></tr>
<tr><td colspan="3">User Story:

As a user,
I want the robot to identify the object inside the container and measure the level
So that it can accurately pour the specified quantity of liquid.</td></tr>
<tr><td colspan="3">Acceptance Criteria:

Scenario 2.1
The robot must be able to identify the type of object inside the container.

Scenario 2.2
The robot must be able to measure the current liquid/cereal level in the container.</td></tr>
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Title: US 3	Priority: High	Estimate:

User Story:

As a user,
I want the robot to estimate the weight of the object,
So that it can safely pour the liquid without spilling.

Acceptance Criteria:

Scenario 3.1

The robot must be able to estimate the weight of the object with a reasonable margin of error.

Title: US 4	Priority: High	Estimate:

User Story:

As a user
I want to fix the position of targeted container with respect to arm base and give to the Robot
So that it can accurately align the end effector for pouring.

Acceptance Criteria:

Scenario 4.1
The robot must be able to identify the targeted container.

Scenario 4.2
The robot must be able to estimate the dimensions and position of the targeted container with respect to the arm base with a reasonable margin of error.

Scenario 4.3
The robot should continuously adjust the yaw/roll to move the end effector towards the targeted container with a reasonable margin of error.

Title: US 5	Priority: Medium	Estimate:

User Story:

As a user
I want want the robot to pour the predefined amount of liquid/cereal
So that it can accurately dispense the specified amount of liquid/cereal.

Acceptance Criteria:

Scenario 5.1

The robot must be able to accurately dispense the specified amount of liquid into the target container.

Collaboration Plans

Framework and tools

ROS 1 / ROS 2

C++/ Python

Kinematics and Dynamics Library(yet to be explored)

Team Collaboration

Slack

GitHub

Visual Studio Code

Resources

- Weight estimation example using wrist force sensor(special permission required)[1]
- Previous SDP project [2]
- More advanced liquid level estimation methods [3][4]

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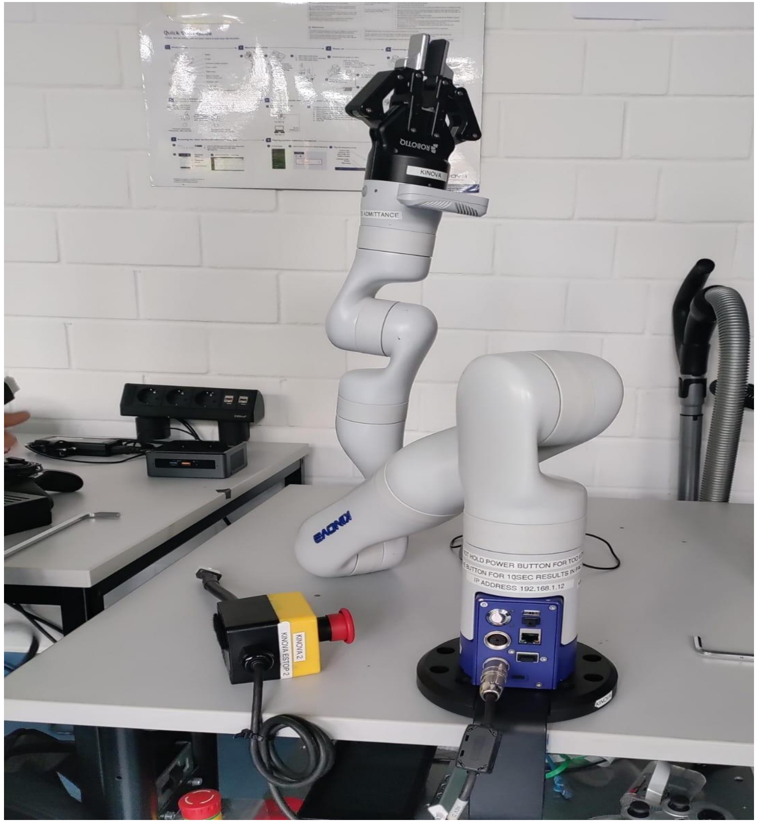
[1] Kortex API documentation, specifically on end effector wrench (named tool_external_wrench_force_*).
[2] GitHub and video
[3] Do et al. - 2016 & extension paper
[4] Narasimhan et al. – 2022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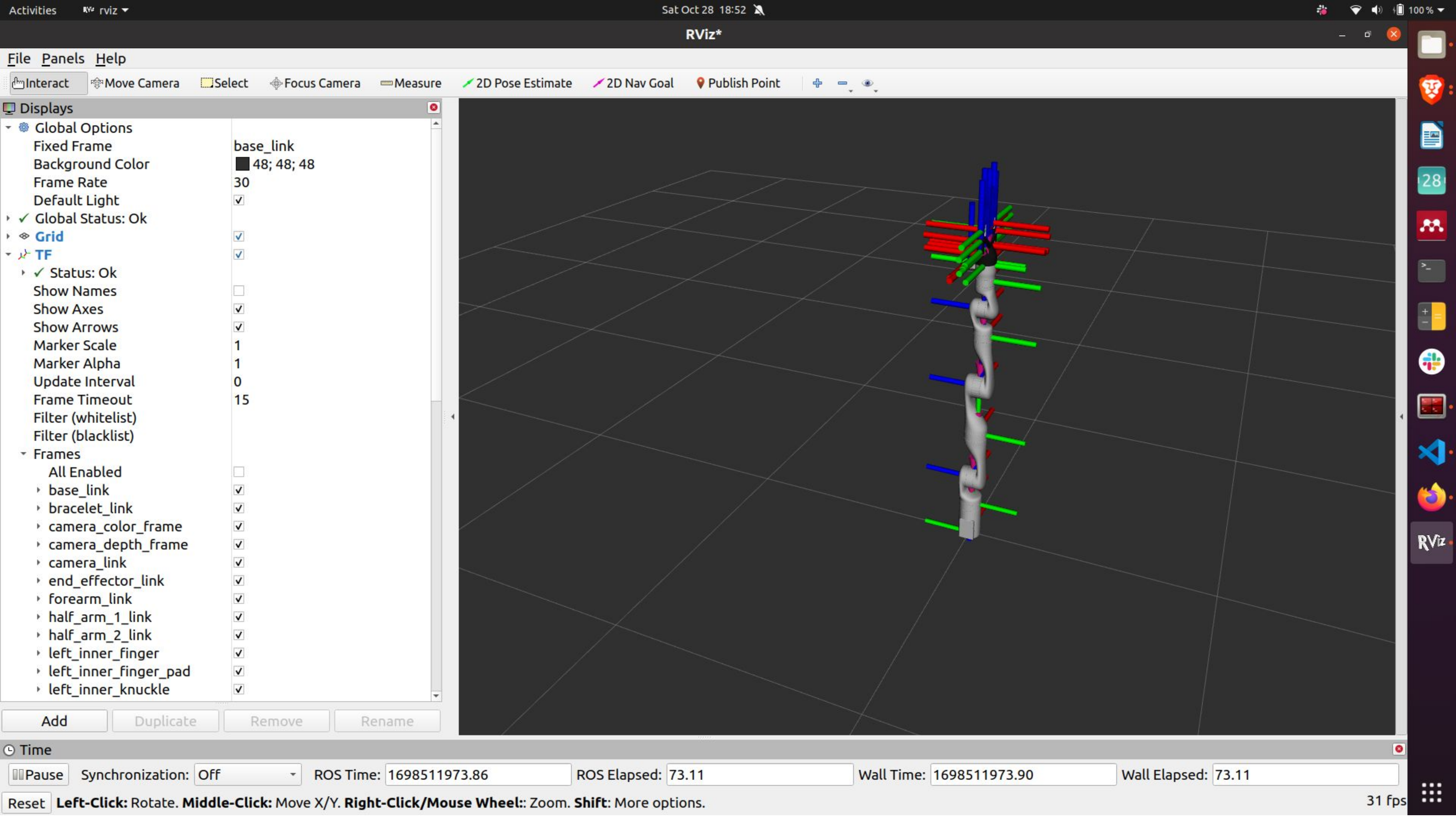
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half_arm_1_link
half_arm_2_link
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left_inner_finger_pad
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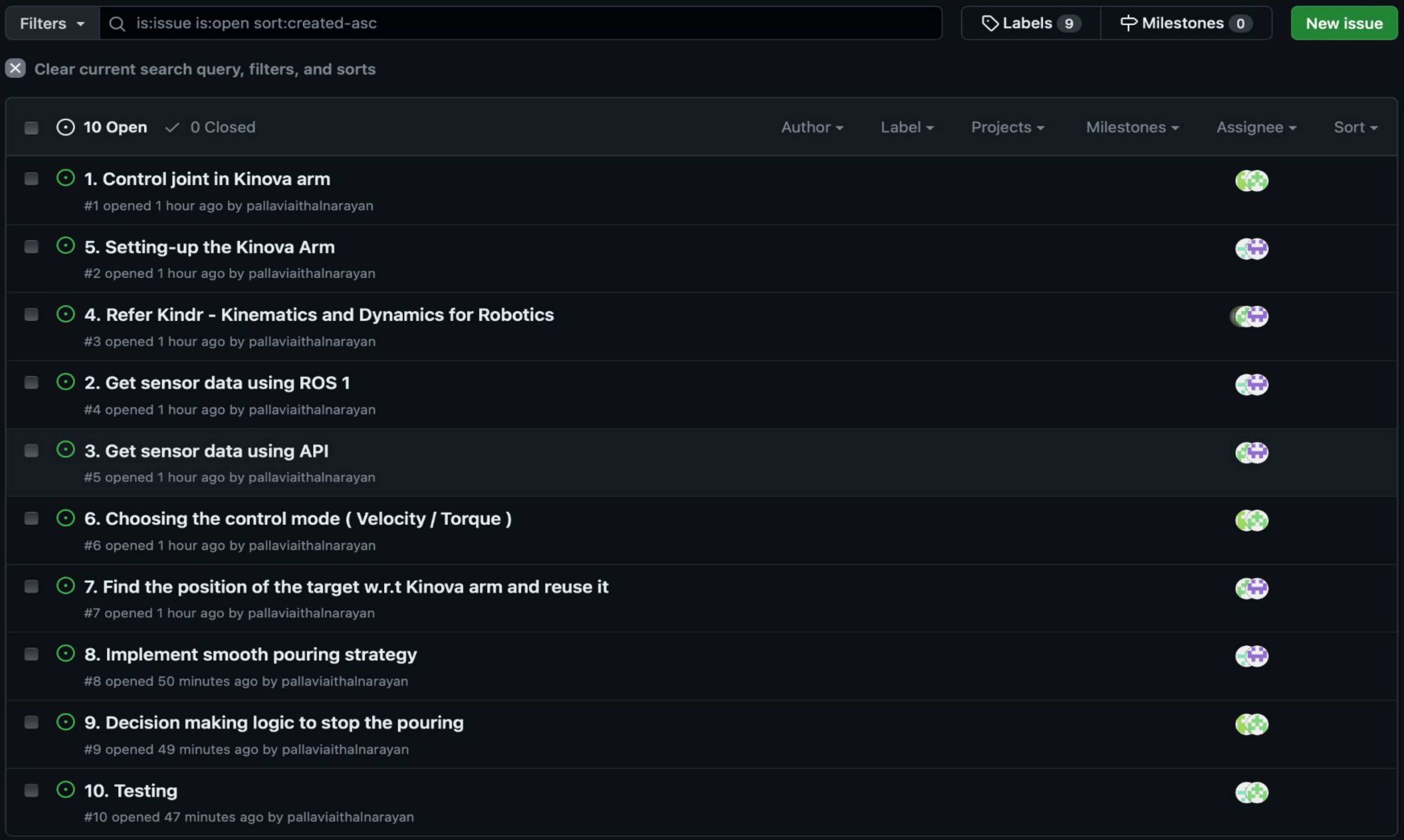
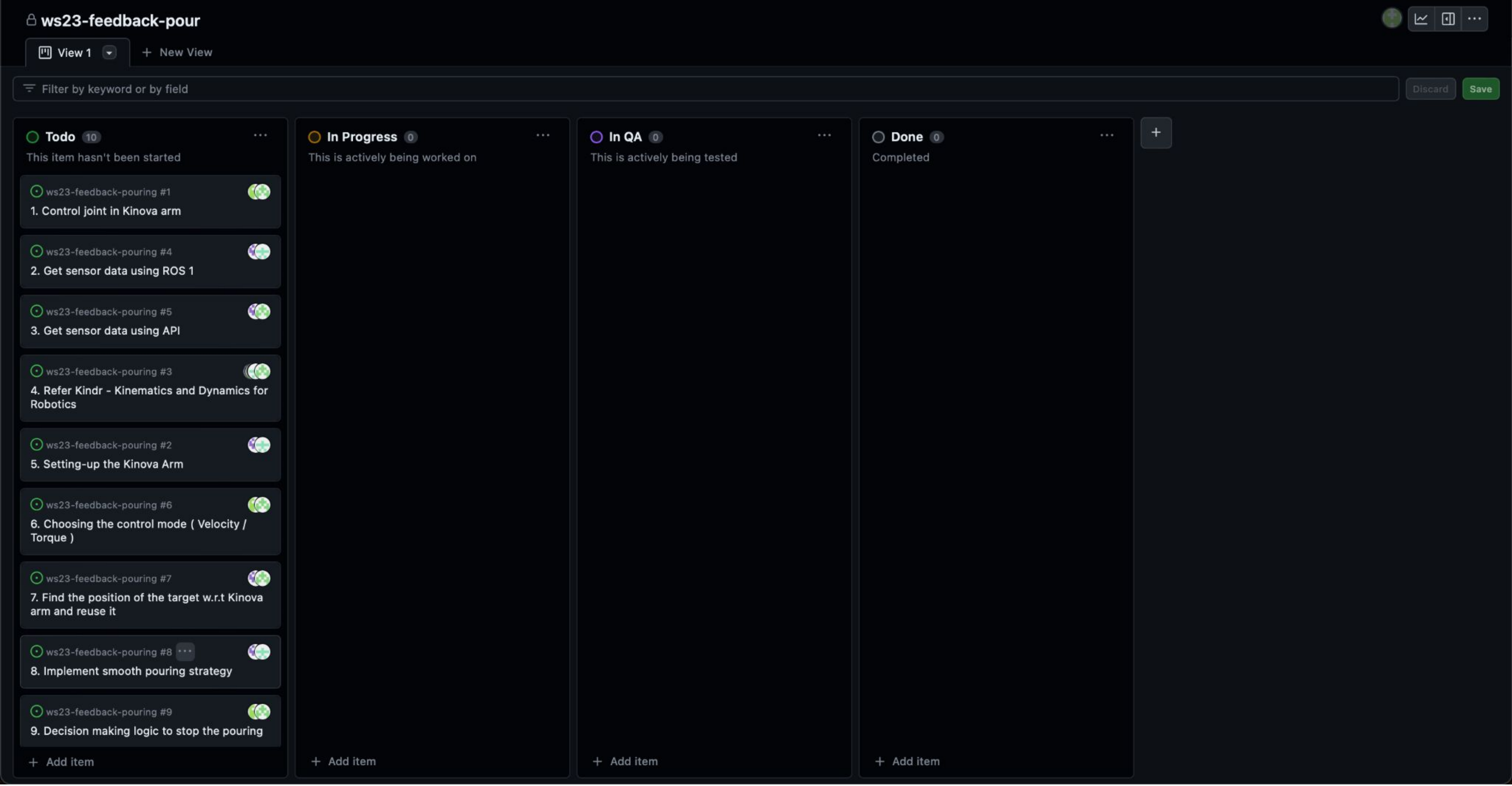


Github Link: https://github.com/HBRS-SDP/ws23-feedback-pouring/issues



Github Link: https://github.com/orgs/HBRS-SDP/projects/6

Thank you