Hochschule
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D2: Revised Requirements, Problem Breakdown & Task Allocation

Topic: Feedback Pouring with Kinova Arm

Software Development Project

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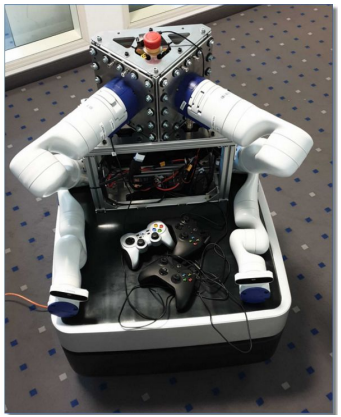
Problem Description

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

Title: US 2	Priority: Medium	Estimate:
User Story: **As a** user, **I want** the robot to identify the level of liquid/cereals inside the container **So that** it can accurately pour the specified quantity of liquid.		
Acceptance Criteria: **Scenario 2.1** The robot must be able to measure the current liquid/cereal level in the container.		

Title: US 3	Priority: High	Estimate:
User Story: **As a** user, **I want** the robot to estimate the weight of the liquid/cereals, **So that** it can safely pour the liquid and should be fast enough to control it.		
Acceptance Criteria: **Scenario 3.1** The robot must be able to estimate the weight of the liquid/cereals 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 it 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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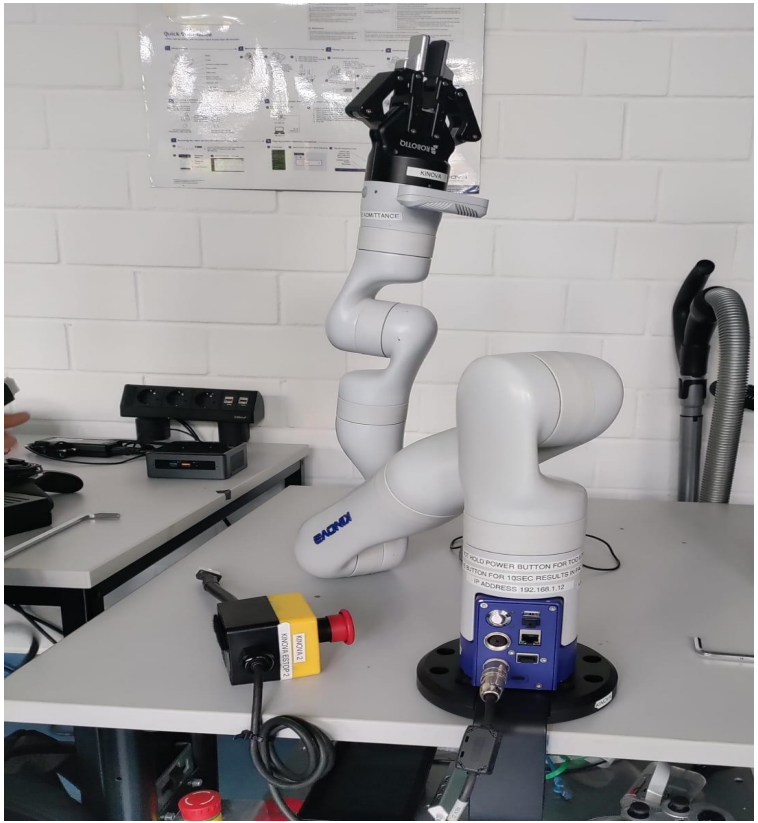
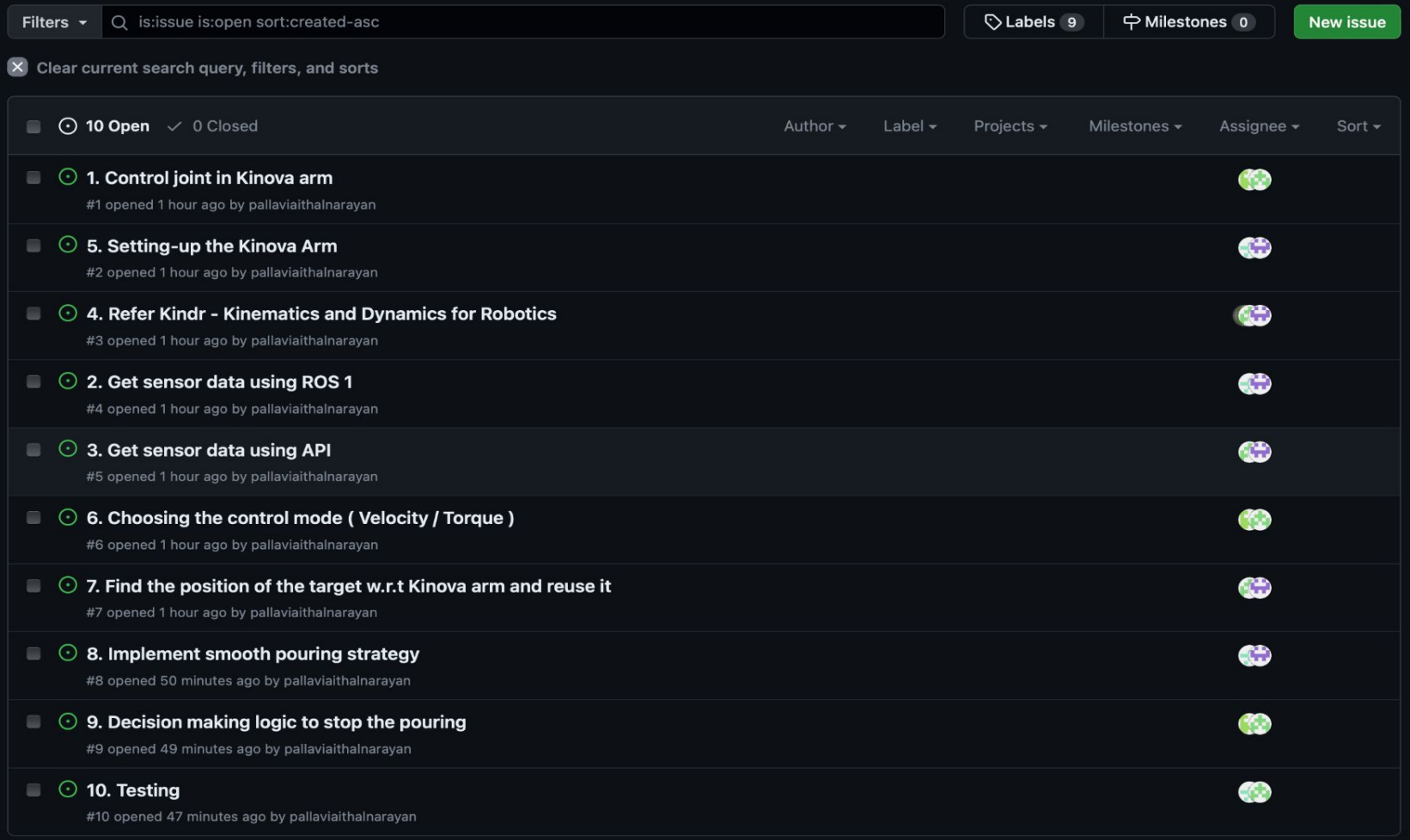
[1] Kortex API documentation, specifically on end effector wrench (named tool_external_wrench_force_*).
[2] GitHub and video
[3] Do et al. - 2016 & extension paper
[4] Narasimhan et al. – 2022

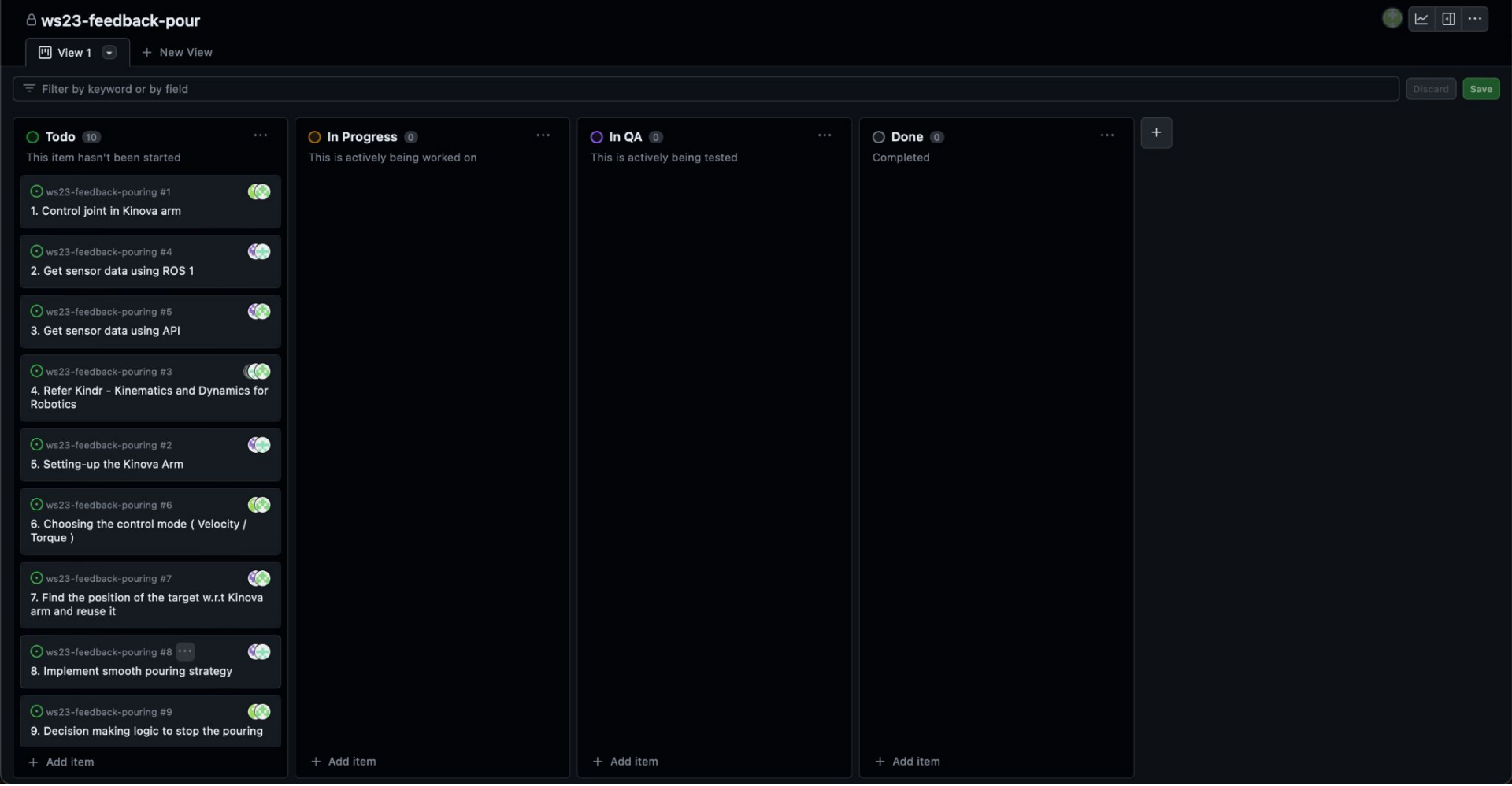


Kinova arm setup on the table

Activities
rviz
Sat Oct 28 18:52
100 %
RViz*
File Panels Help
Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Displays
Global Options
Fixed Frame base_link
Background Color 48; 48; 48
Frame Rate 30
Default Light
Global Status: Ok
Grid
TF
Status: Ok
Show Names
Show Axes
Show Arrows
Marker Scale 1
Marker Alpha 1
Update Interval 0
Frame Timeout 15
Filter (whitelist)
Filter (blacklist)
Frames
All Enabled
base_link
bracelet_link
camera_color_frame
camera_depth_frame
camera_link
end_effector_link
forearm_link
half_arm_1_link
half_arm_2_link
left_inner_finger
left_inner_finger_pad
left_inner_knuckle
Add
Duplicate
Remove
Rename
Time
Pause
Synchronization: Off
ROS Time: 1698511973.86
ROS Elapsed: 73.11
Wall Time: 1698511973.90
Wall Elapsed: 73.11
Reset
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel:: Zoom. Shift: More options.
31 fps



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



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

Thank you