

# Teleoperation interface for the Mirte Master

CoR Group 1

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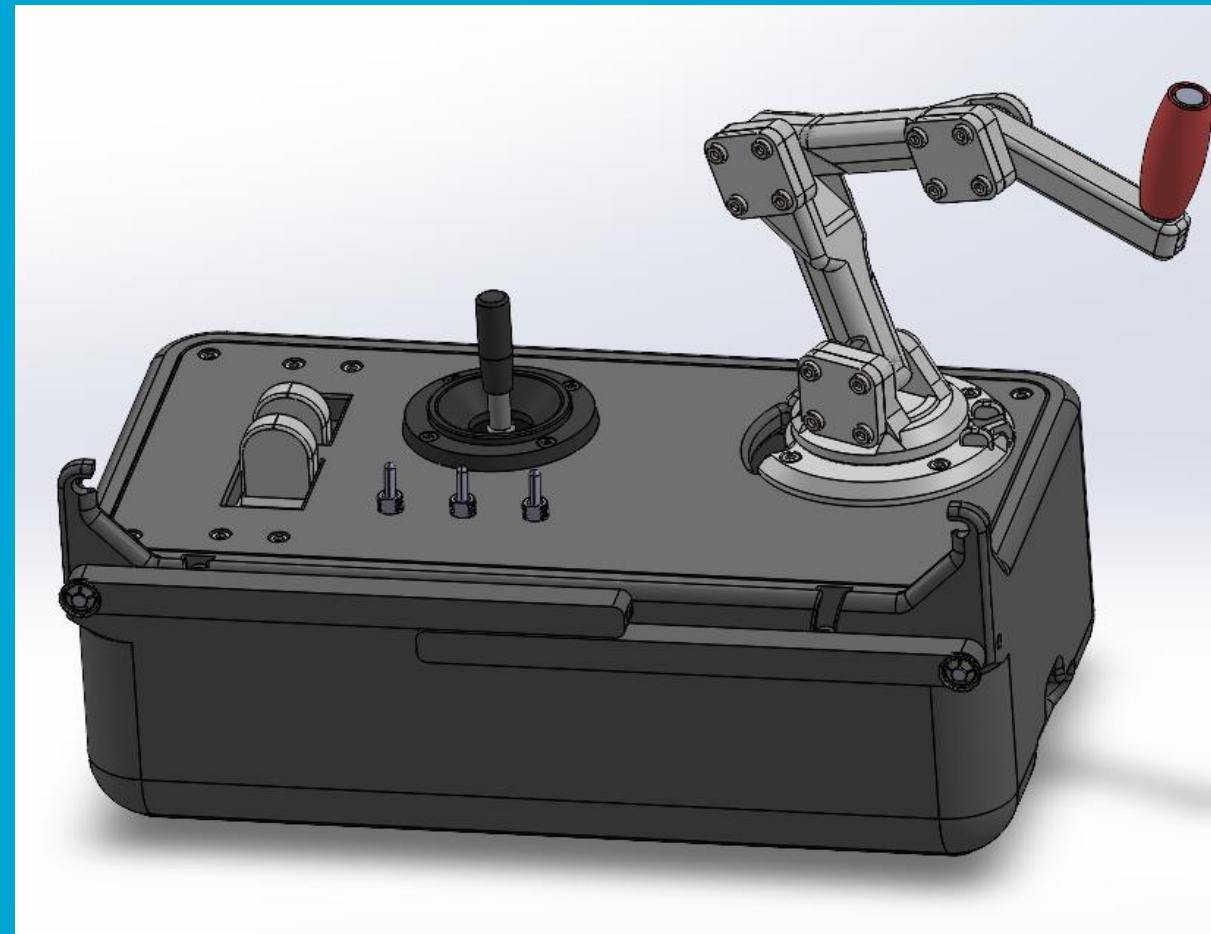


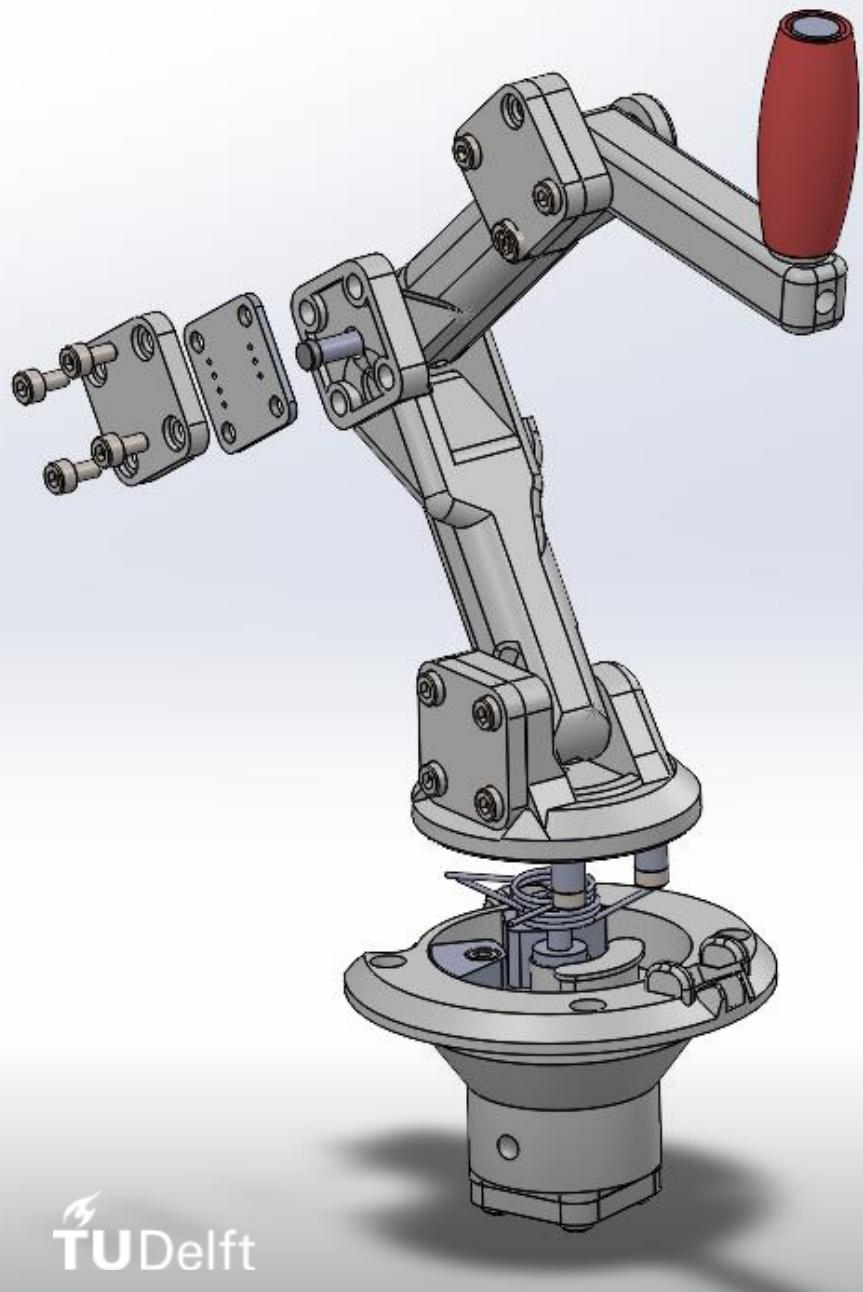
# Design requirements

- Intuitive design by offering **position-position** (0th-order) control for arm manipulation.
- **Force feedback** for the gripper, to feel the forces the Mirte gripper experiences.
- **Portable** design, meaning limited size and weight, and being non-wearable.

# Design

- Controller arm: Offers 0th-order manipulation, position input/output
- Joystick for drive control.
- Pincher mechanism with force/haptic feedback through series elastic actuator (SEA).
- Shoulder strap attachment for portability and physical freedom of operator.
- Switches: holonomic/angular, mirror Mirte arm.

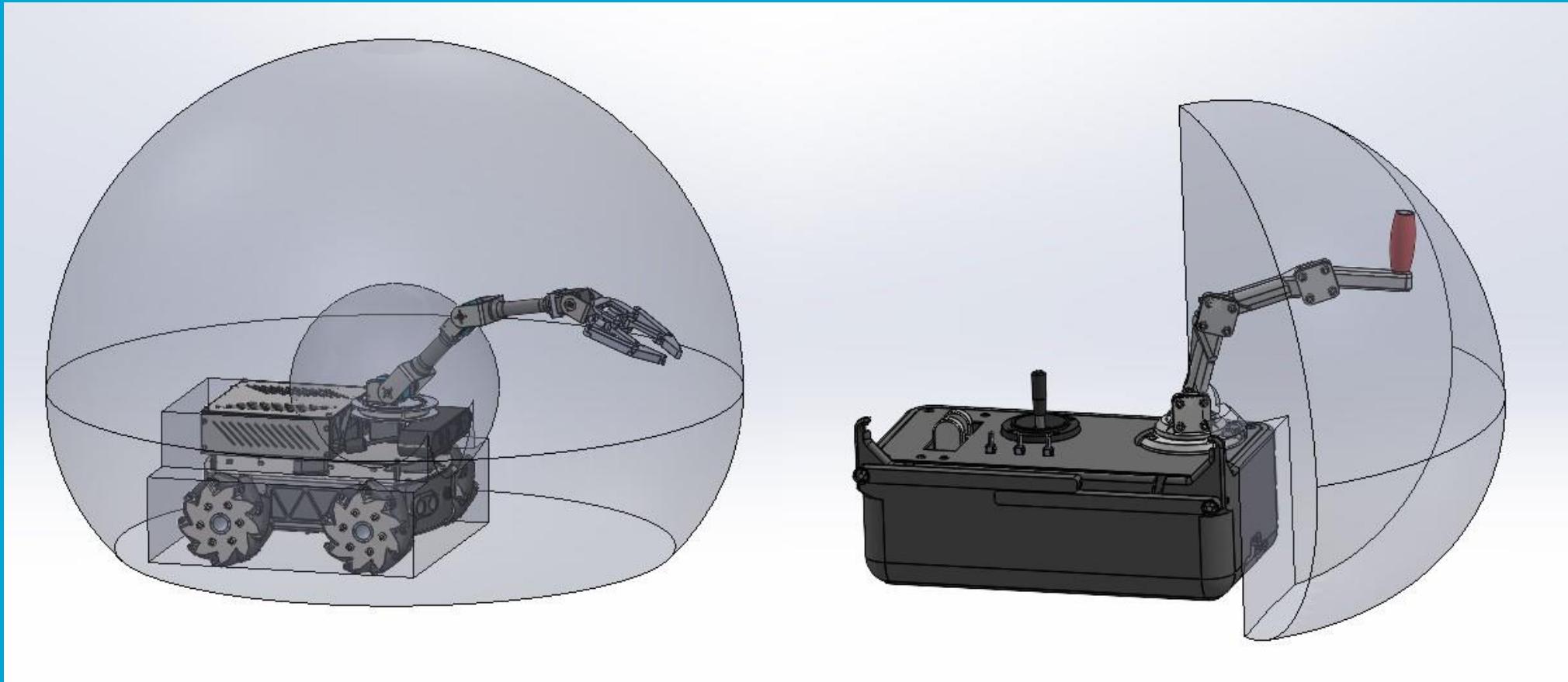


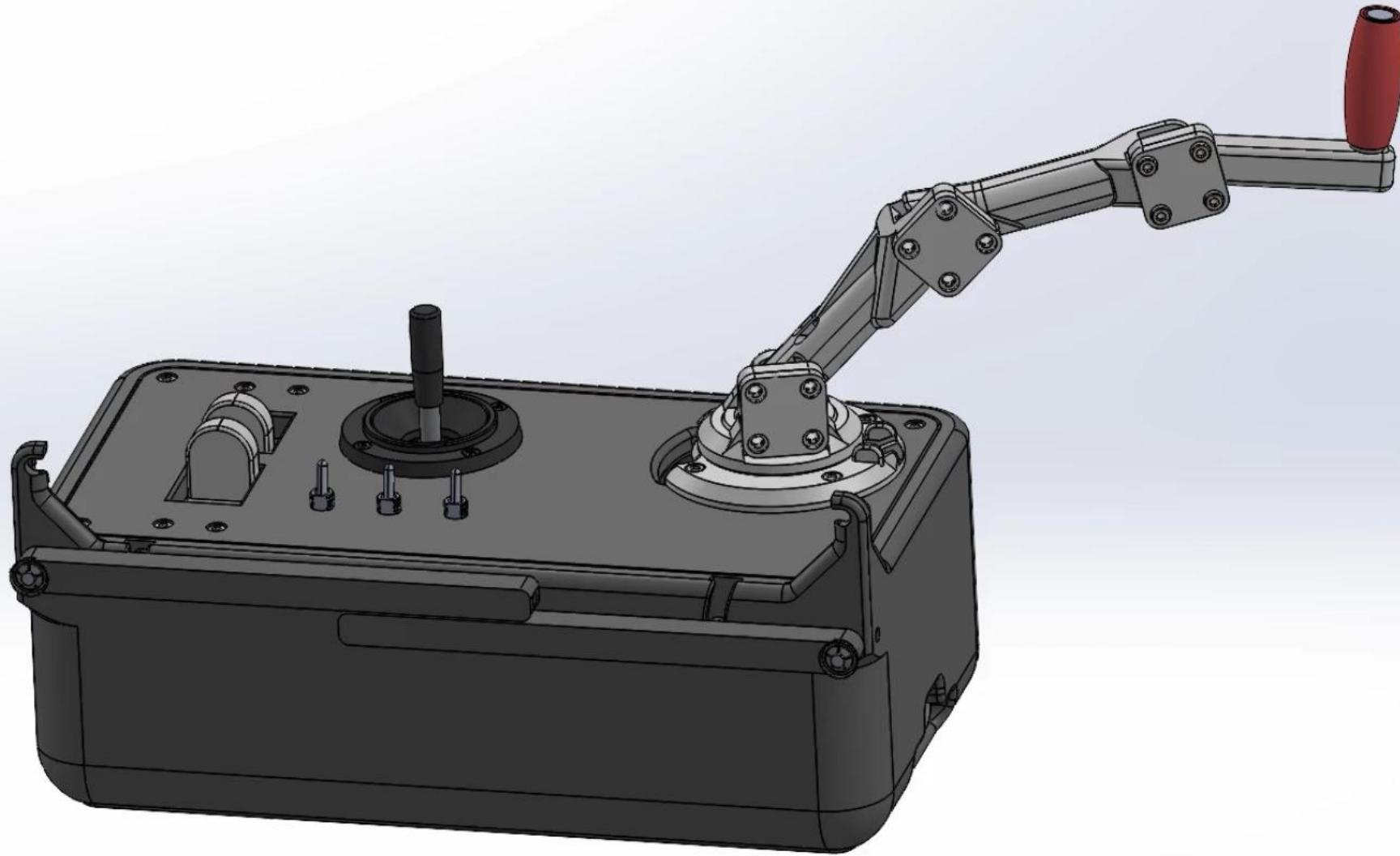


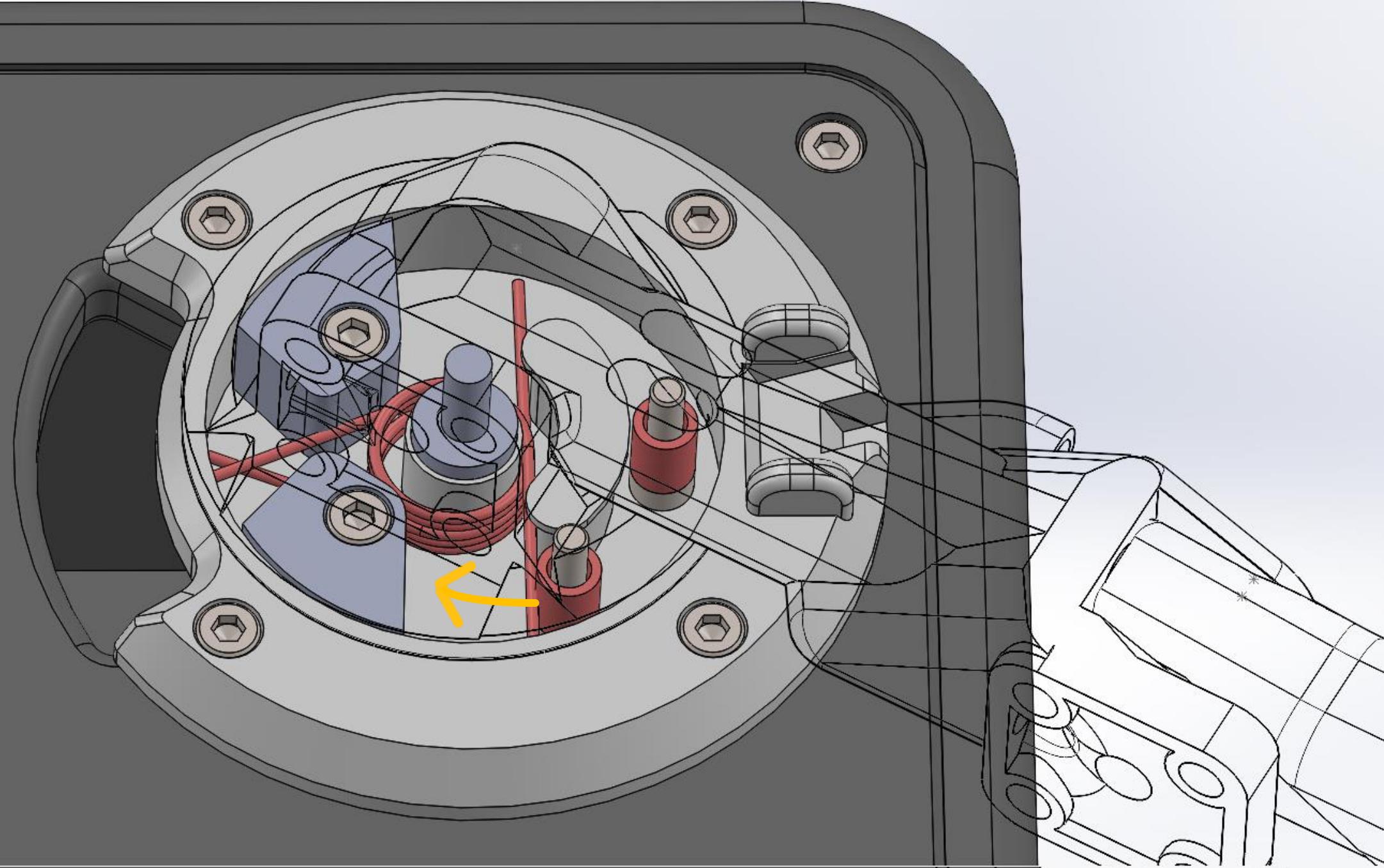
# Controller arm

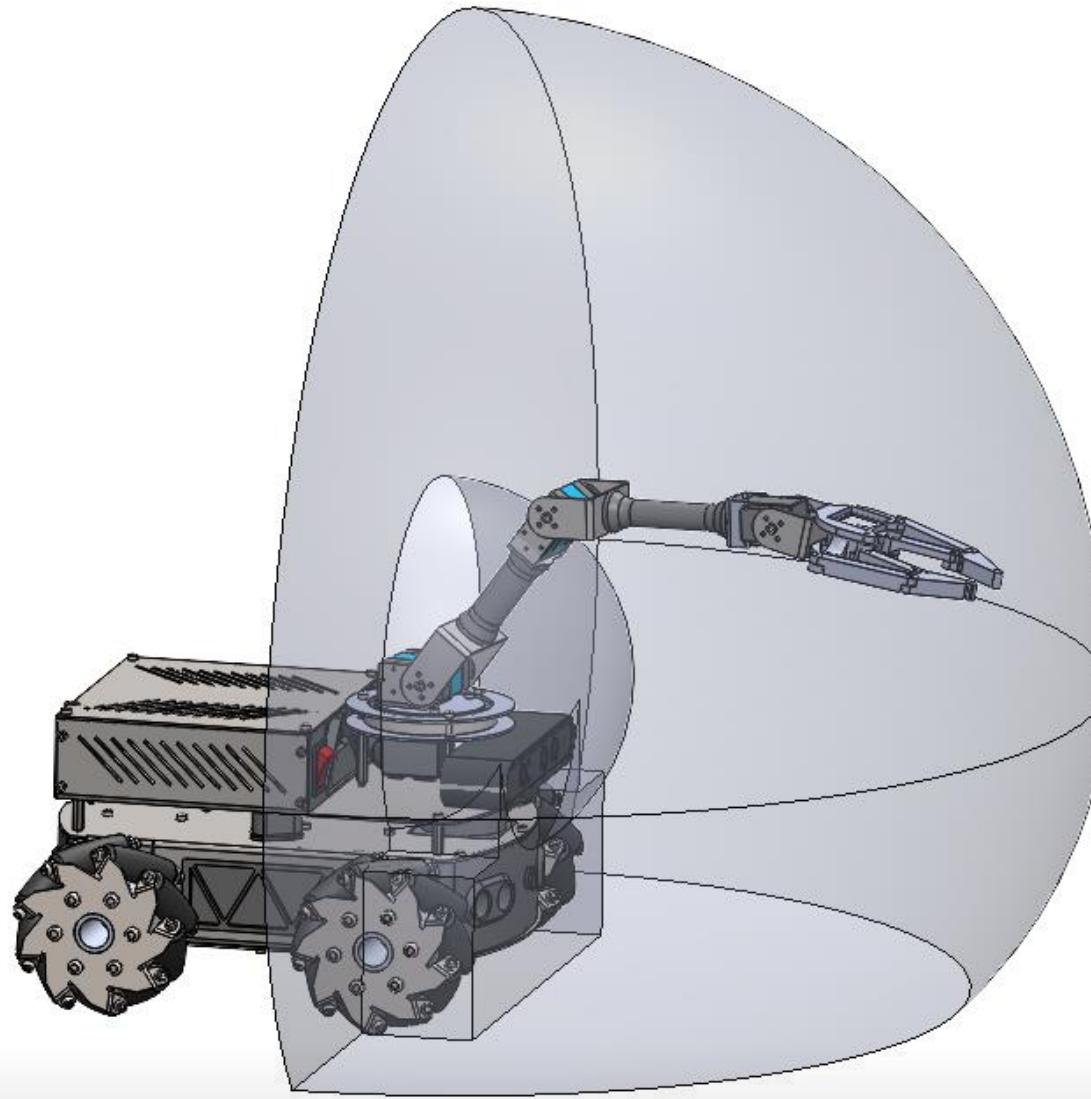
- Scaled down version of Mirte arm
- Position captured by angular sensors

# Workspace transformation



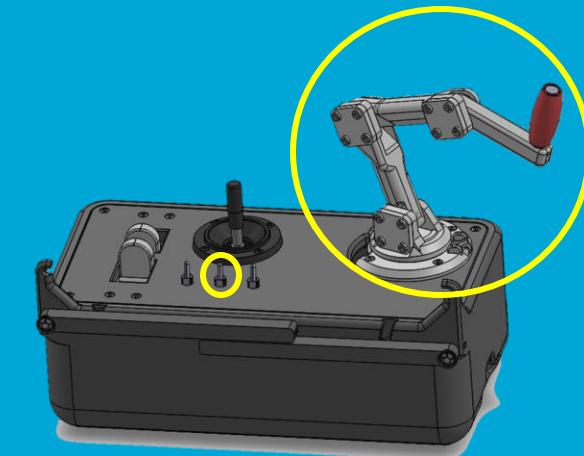
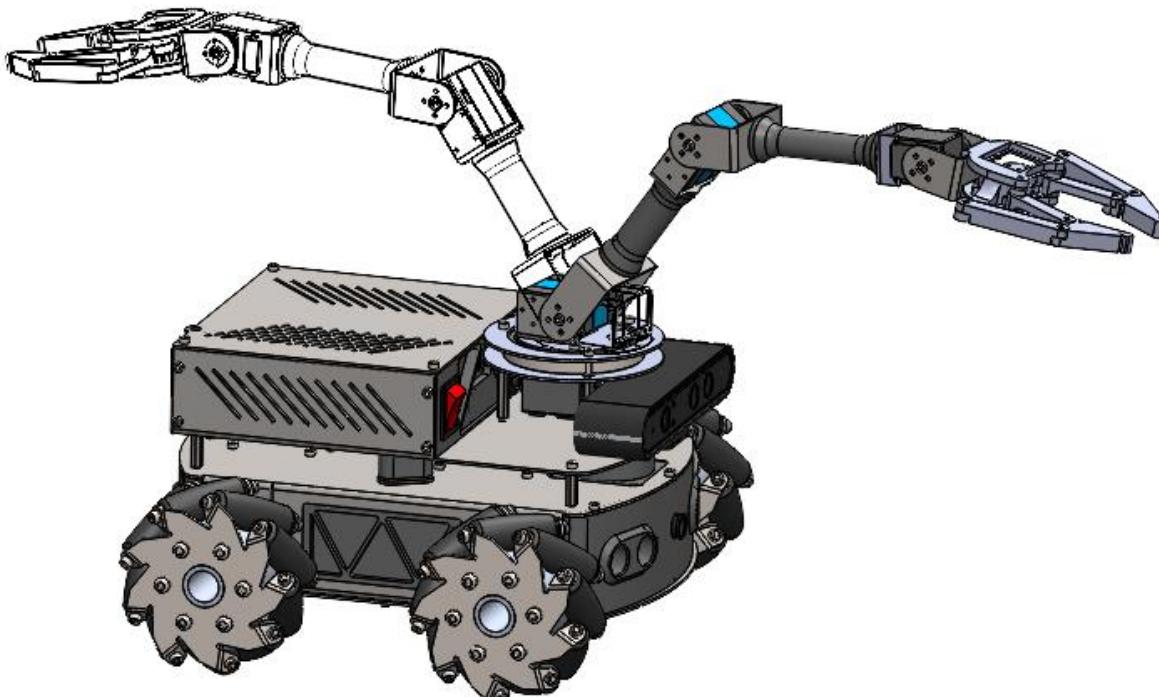


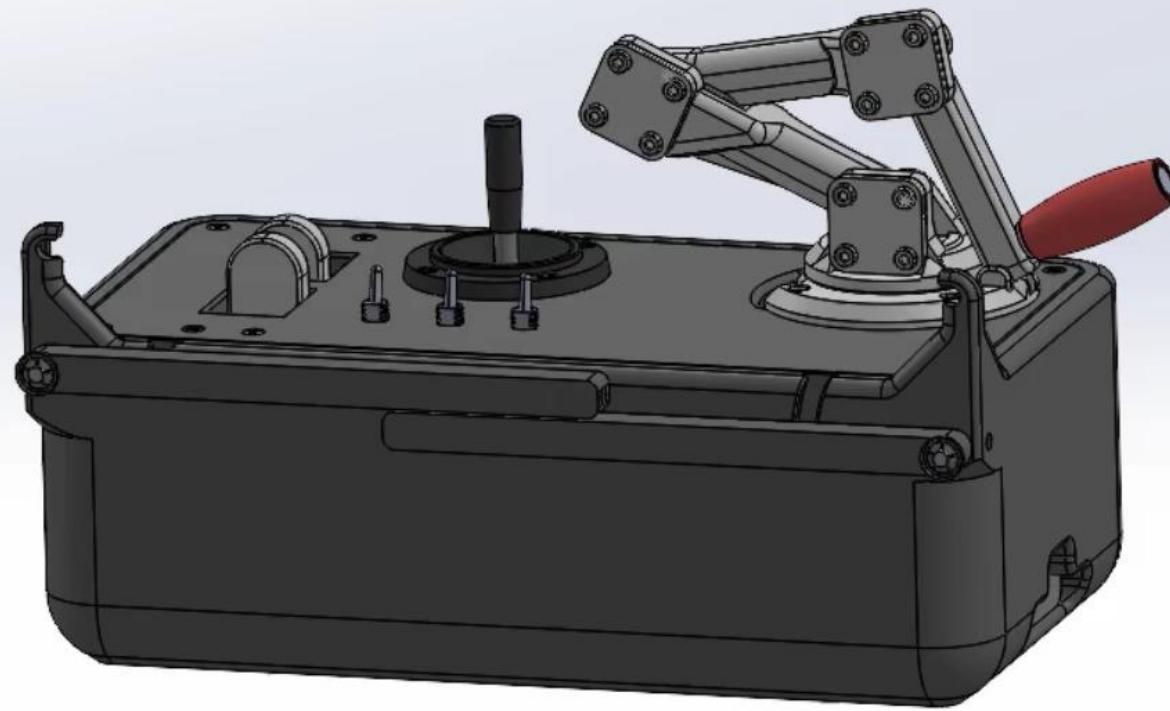




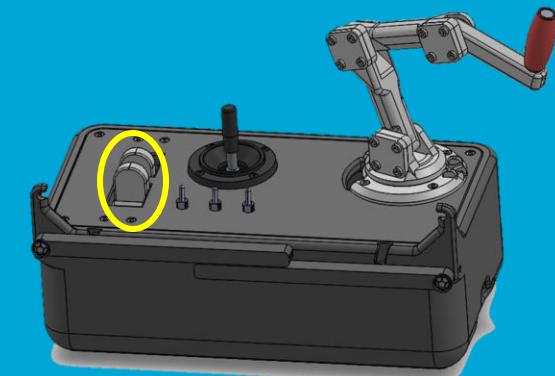
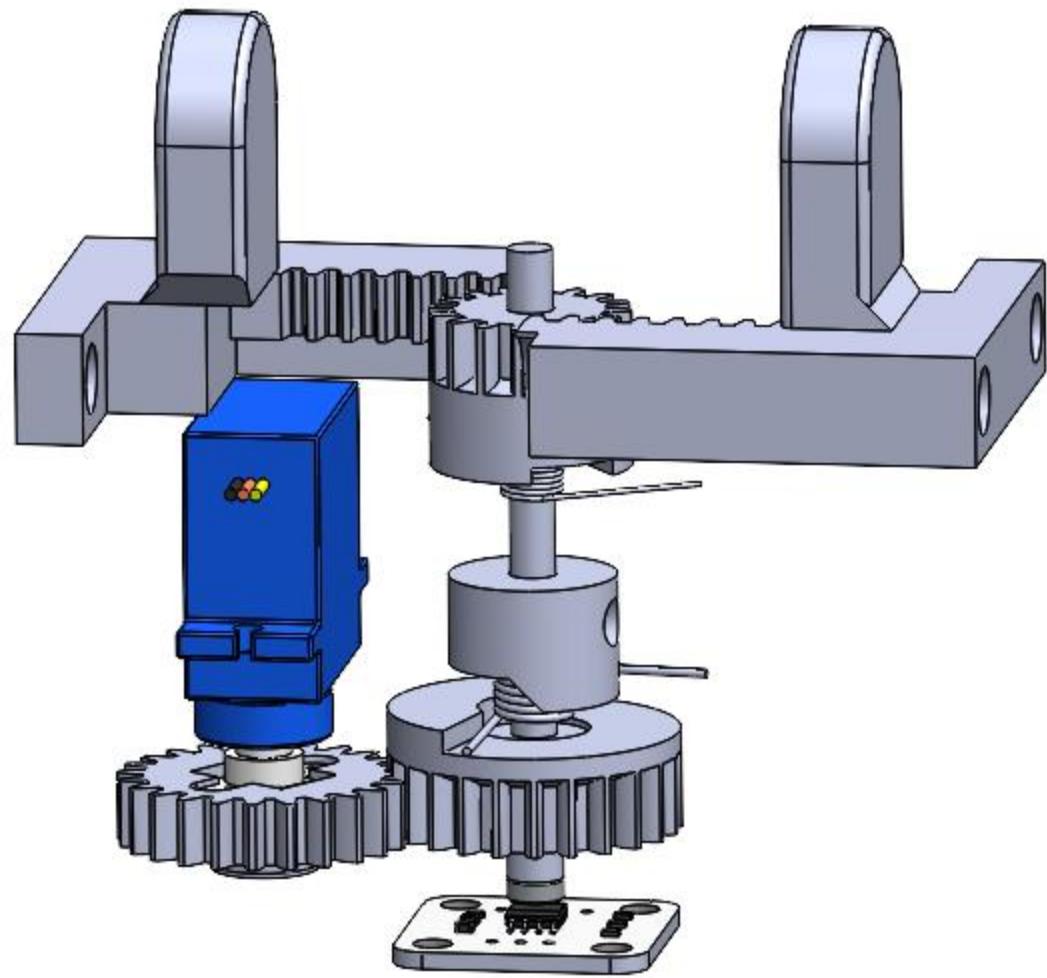
# Mirroring the arm

- Switch on the controller for mirroring the arm

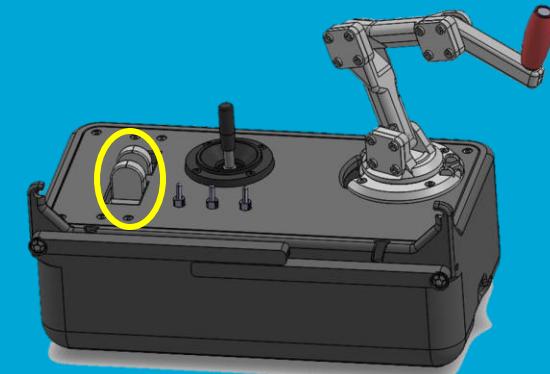
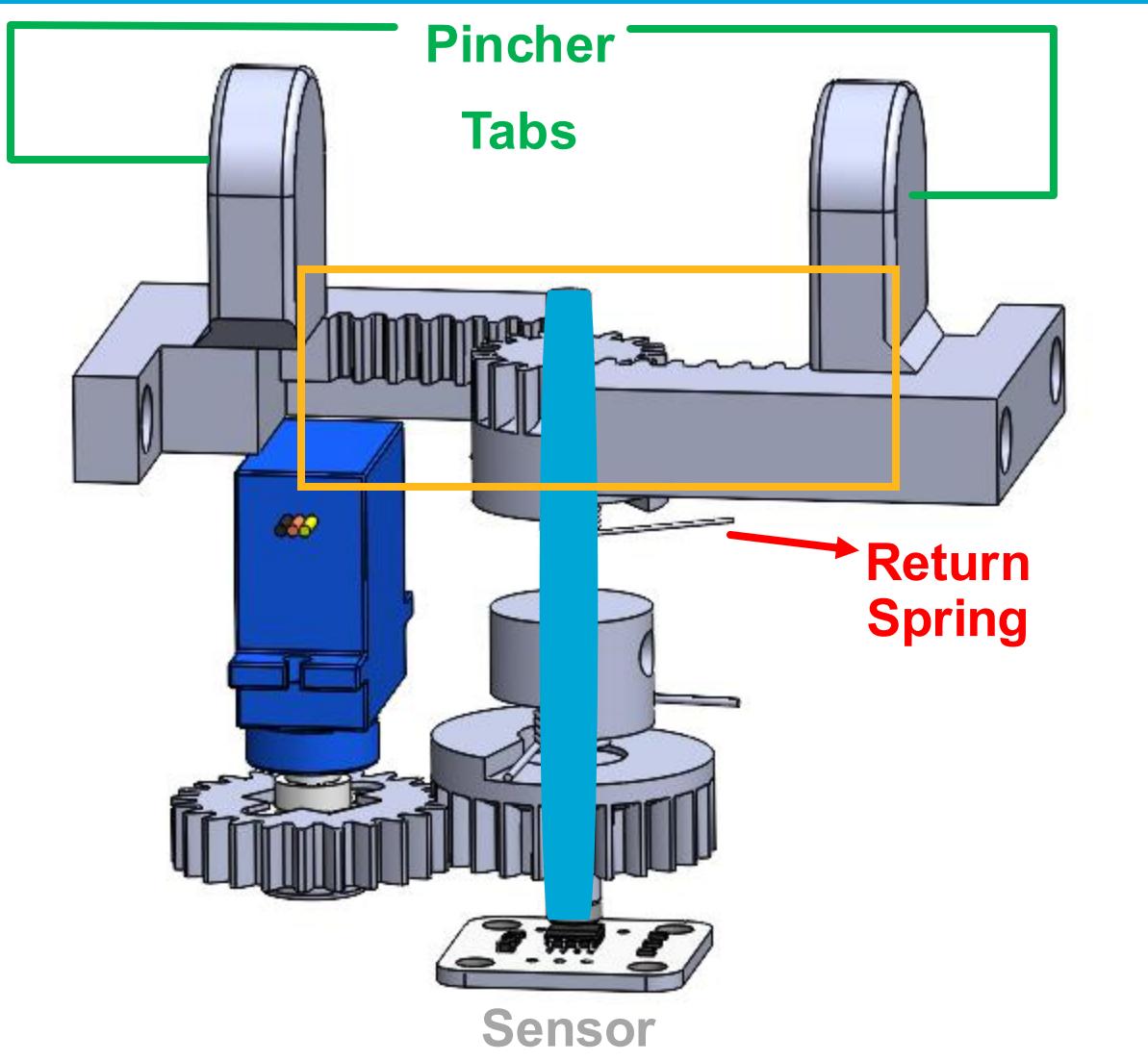


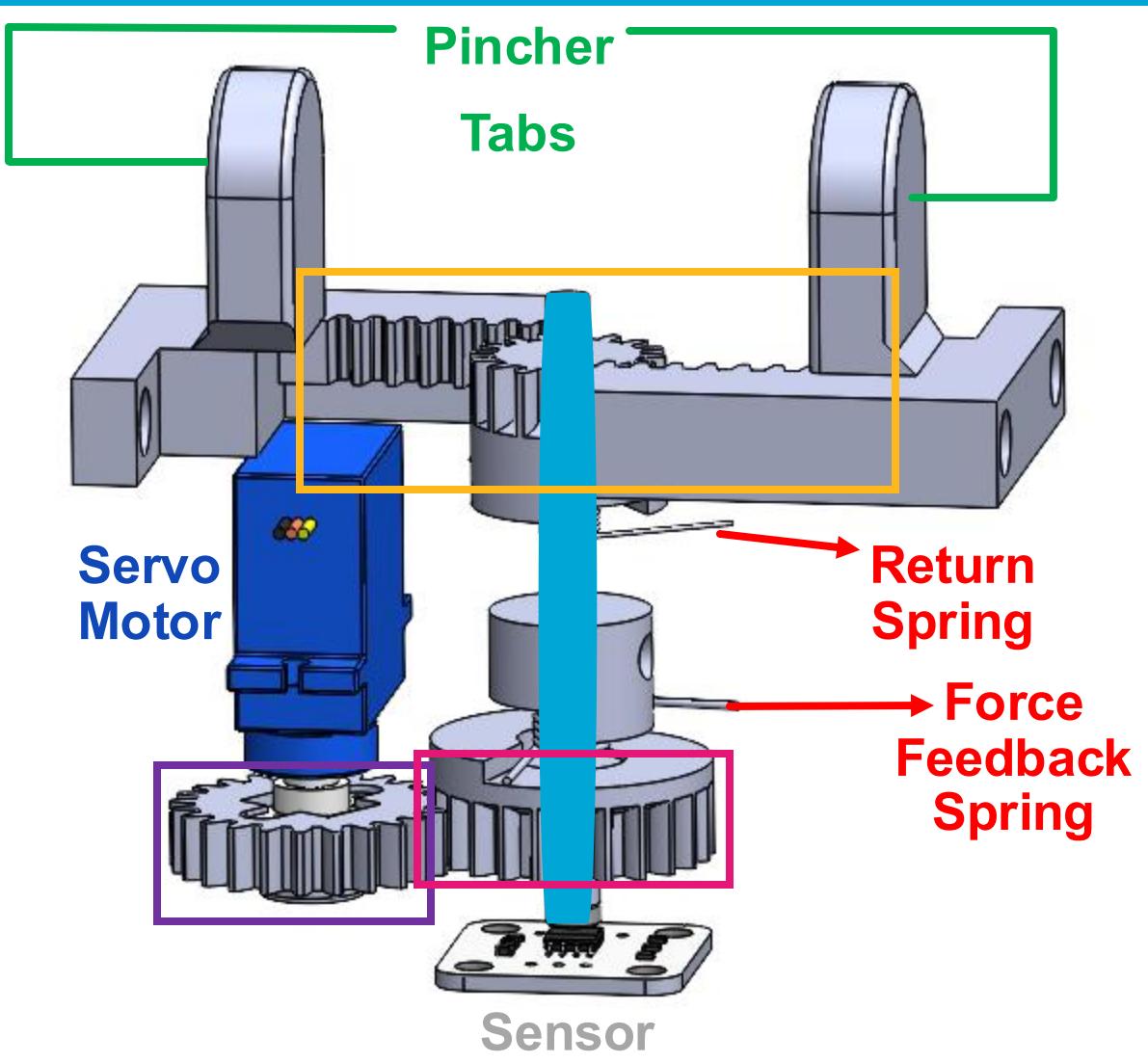


# Pincher



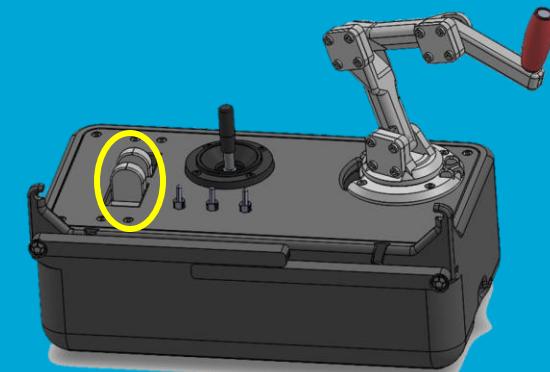
# Pincher (Mechanism)





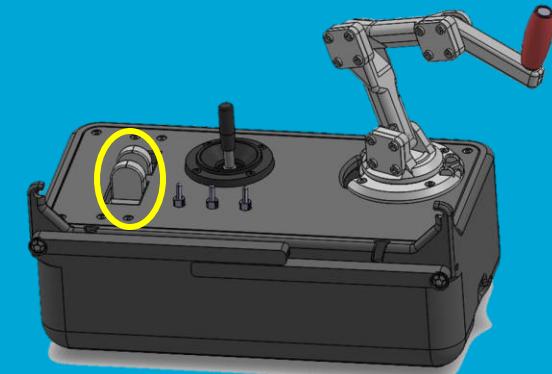
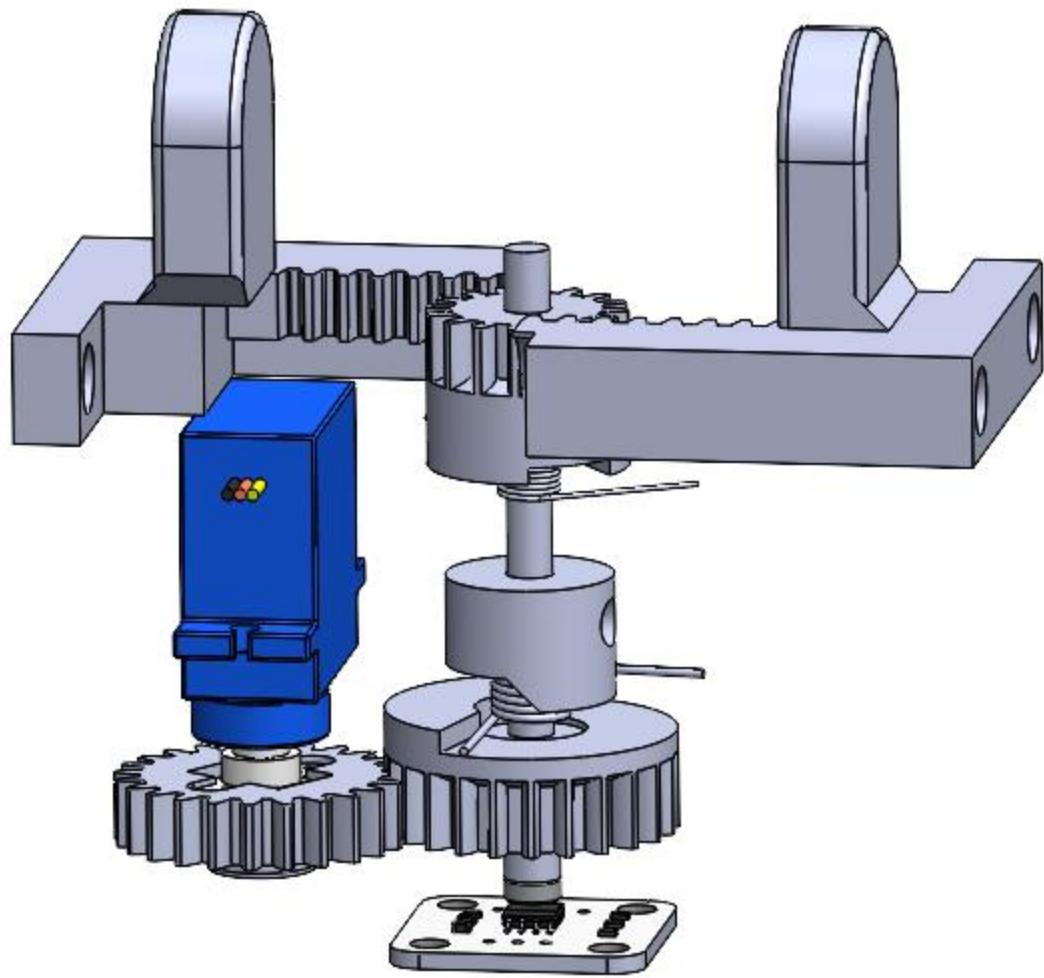
## Pincher (Force Feedback)

- Series Elastic Actuator
- Force Data is Missing
- Simulator

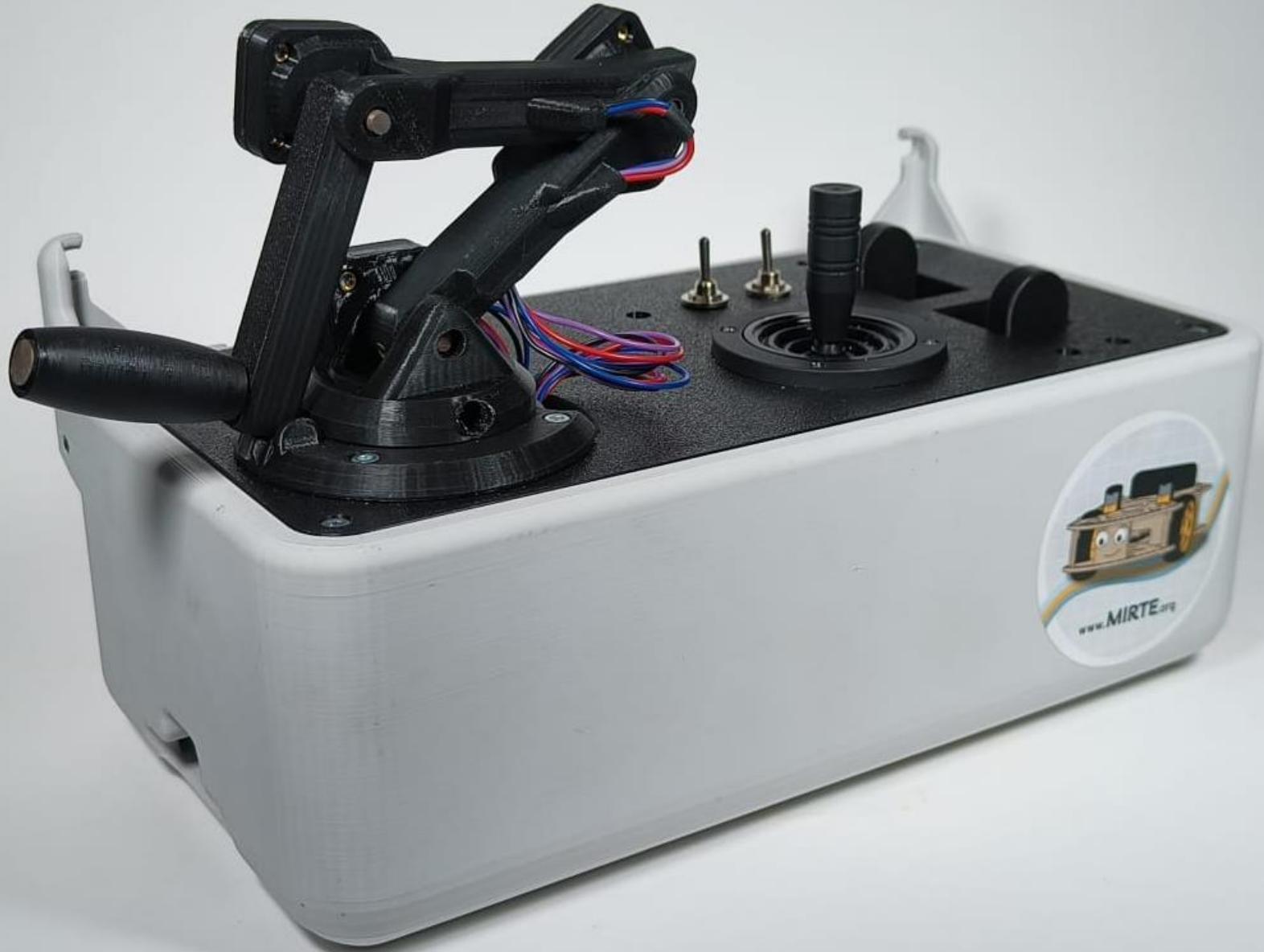


# Pincher (Improvements)

- Force Sensor on the Mirte Master
- Instability issues due to delay and overshoot



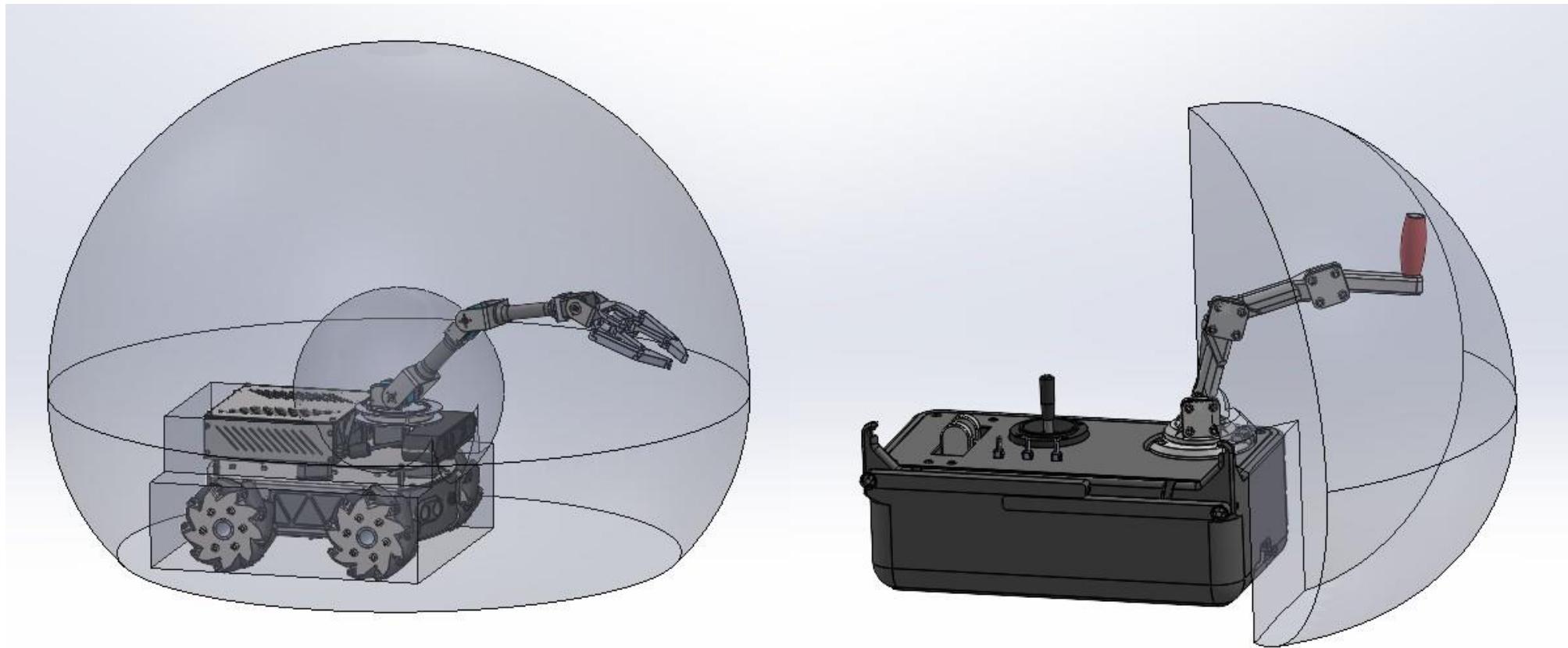
# Demo



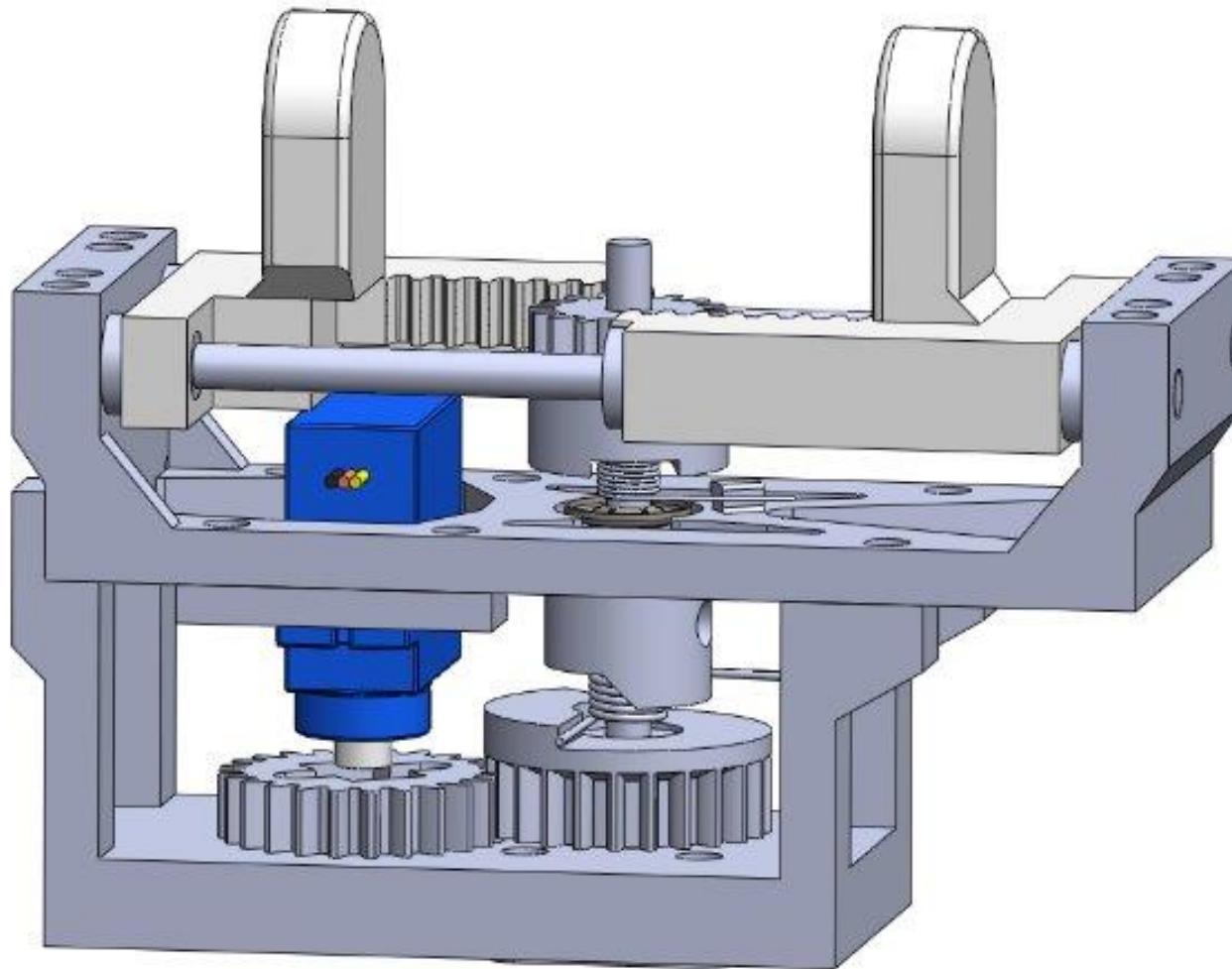
# Questions?



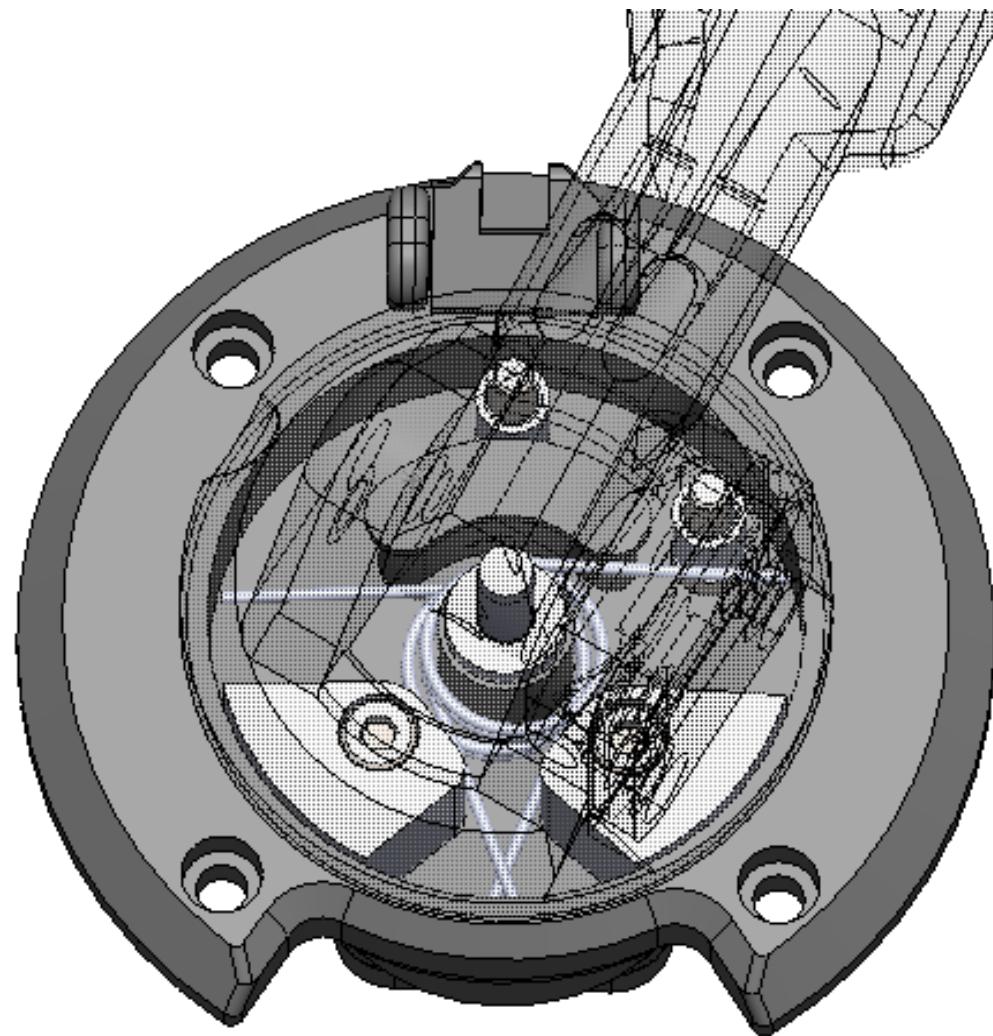
# Workspace Comparison of the MM and Controller Arm



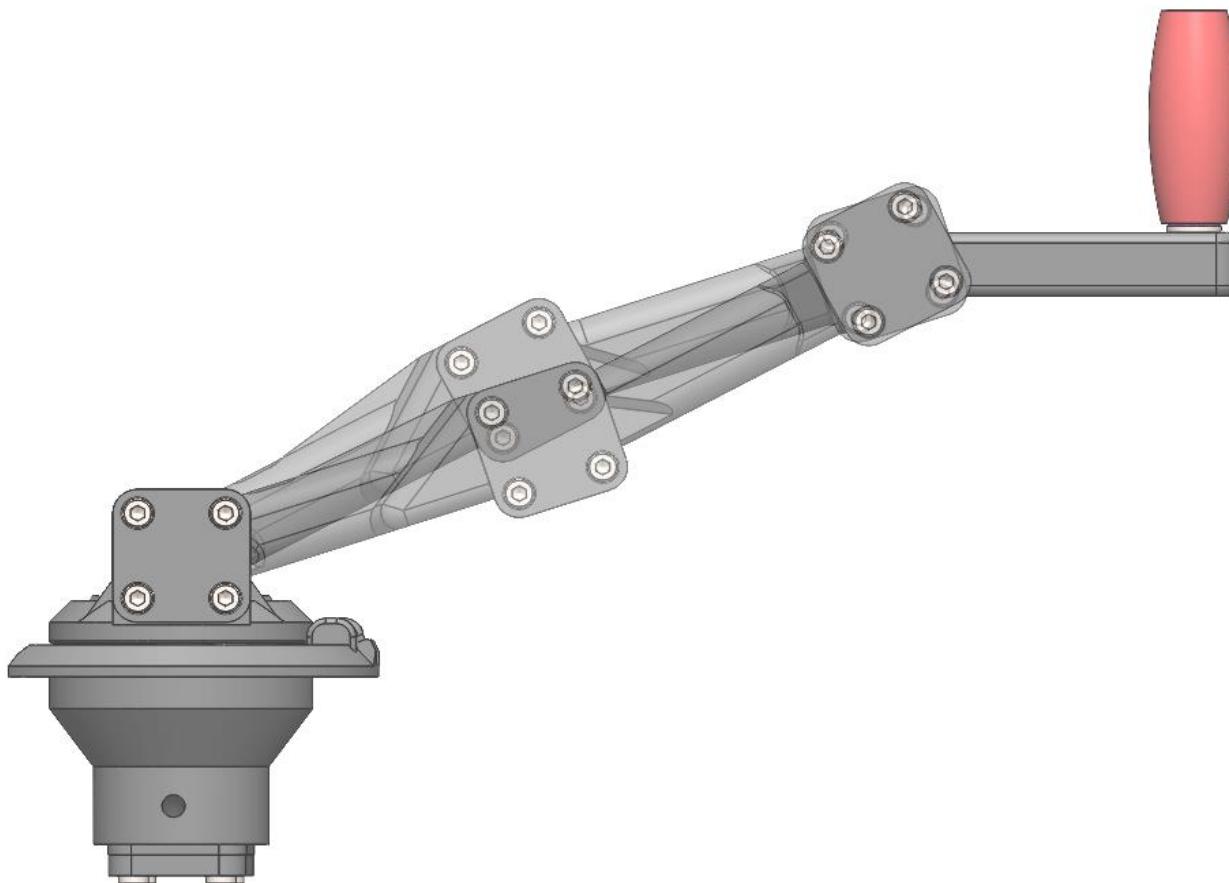
# Pincher render



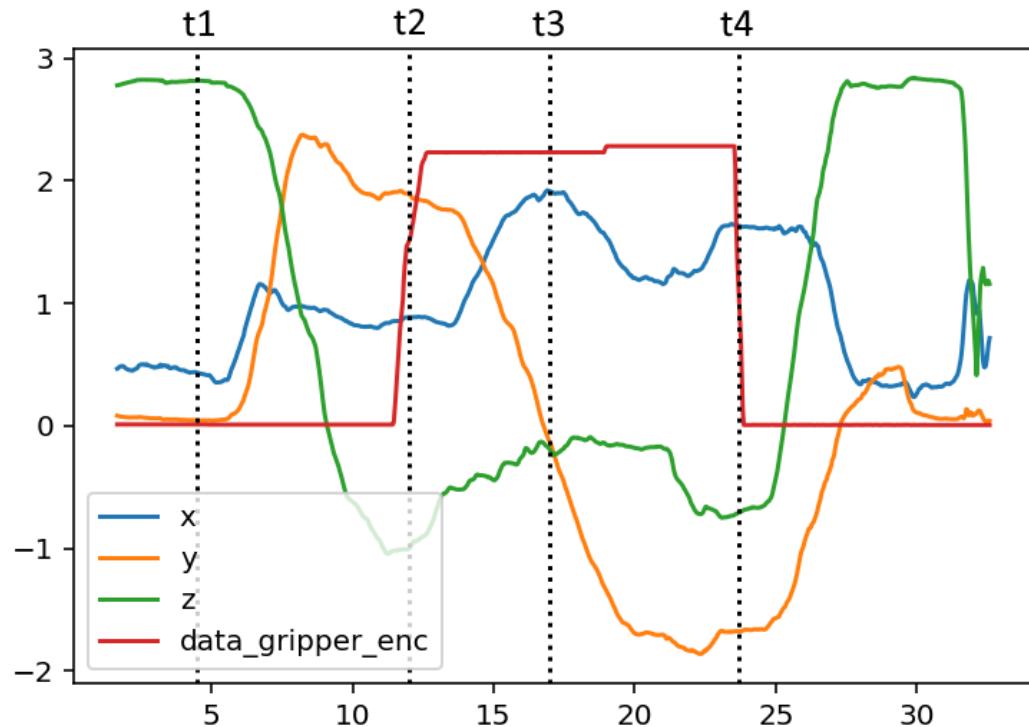
# Yaw springsystem render



# Elbow dead zone



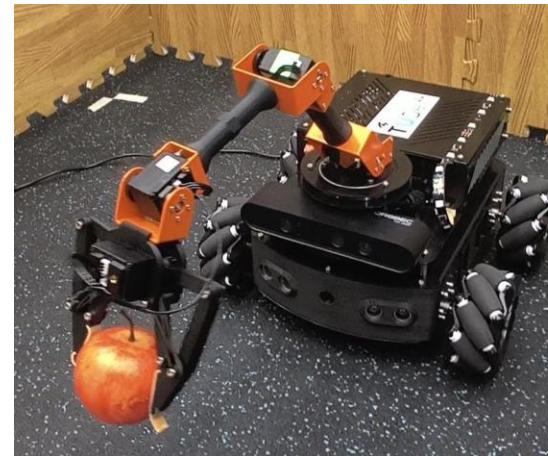
# Pick and place graph with snapshots



t1



t2

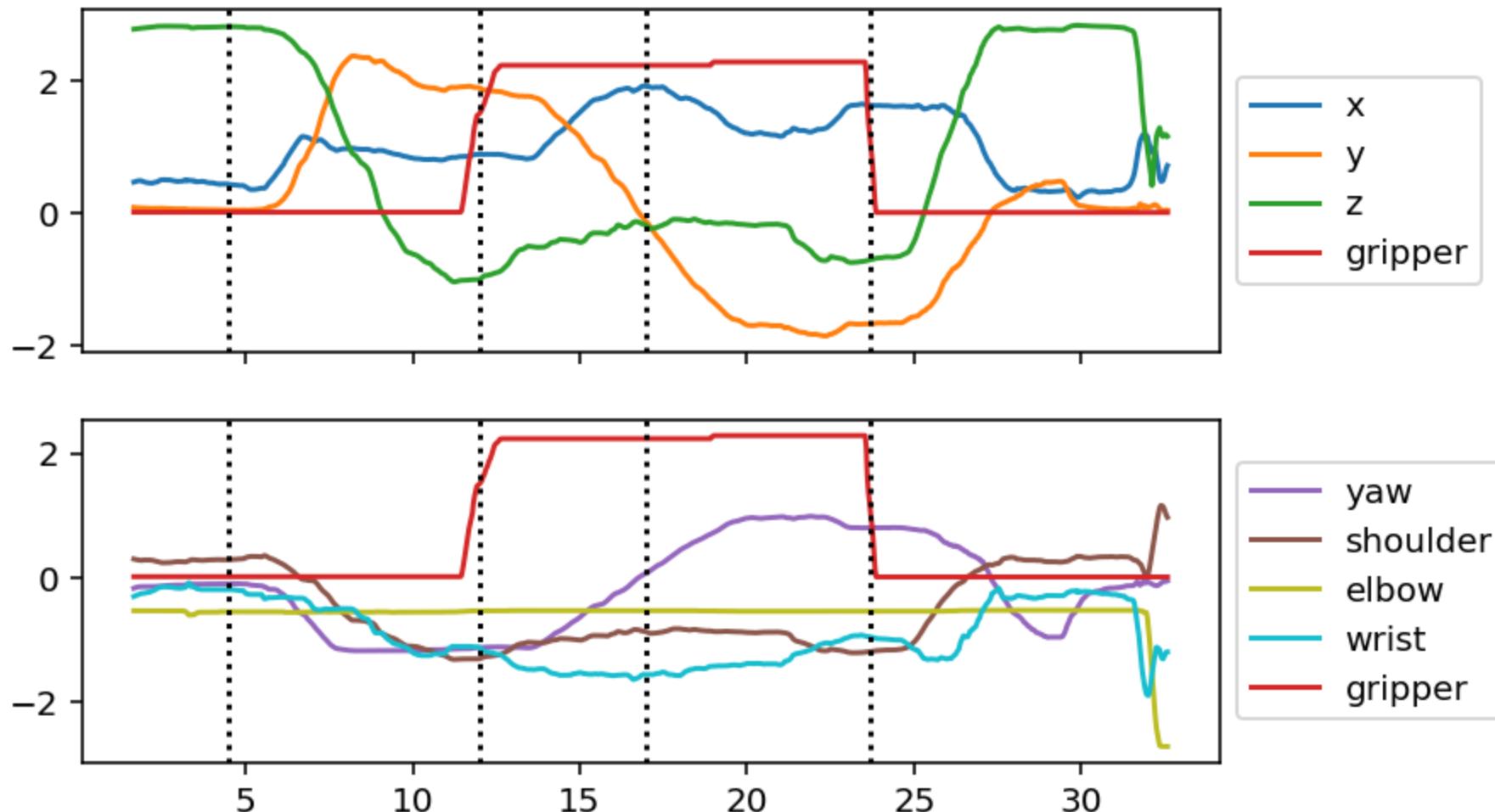


t3



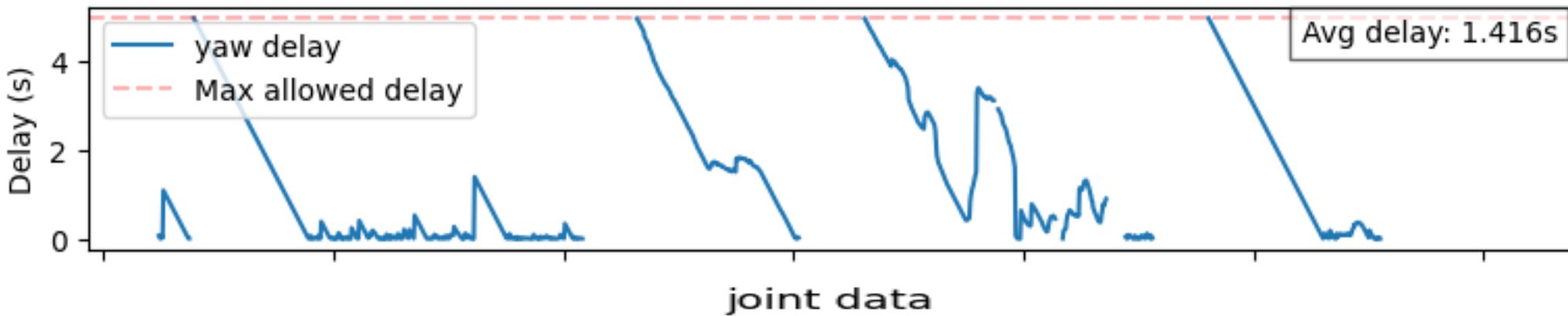
t4

# Pick and place joint angle graph

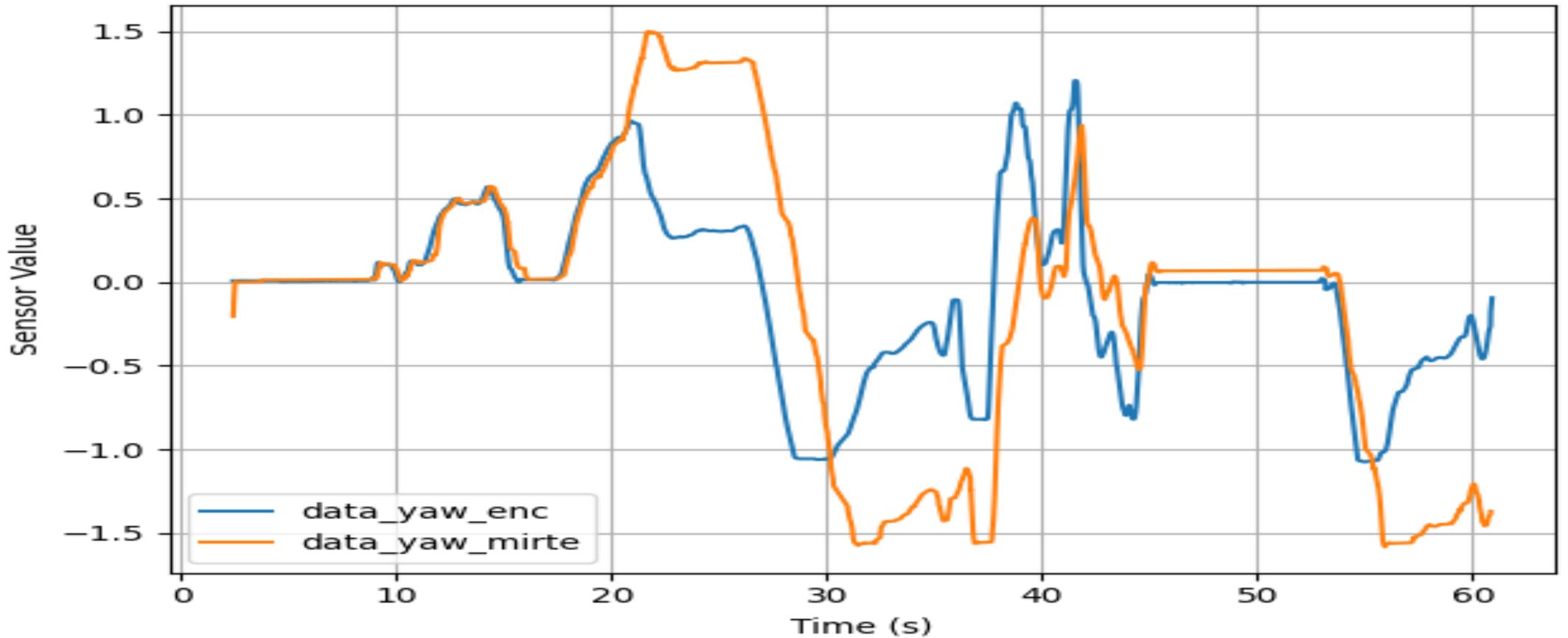


## Delay analysis per joint - Yaw

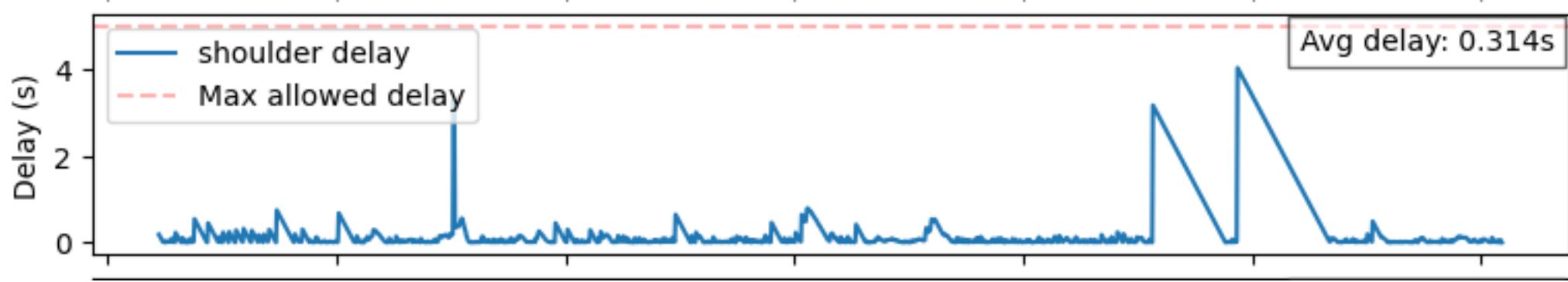
### Delay per Encoder Command per Joint



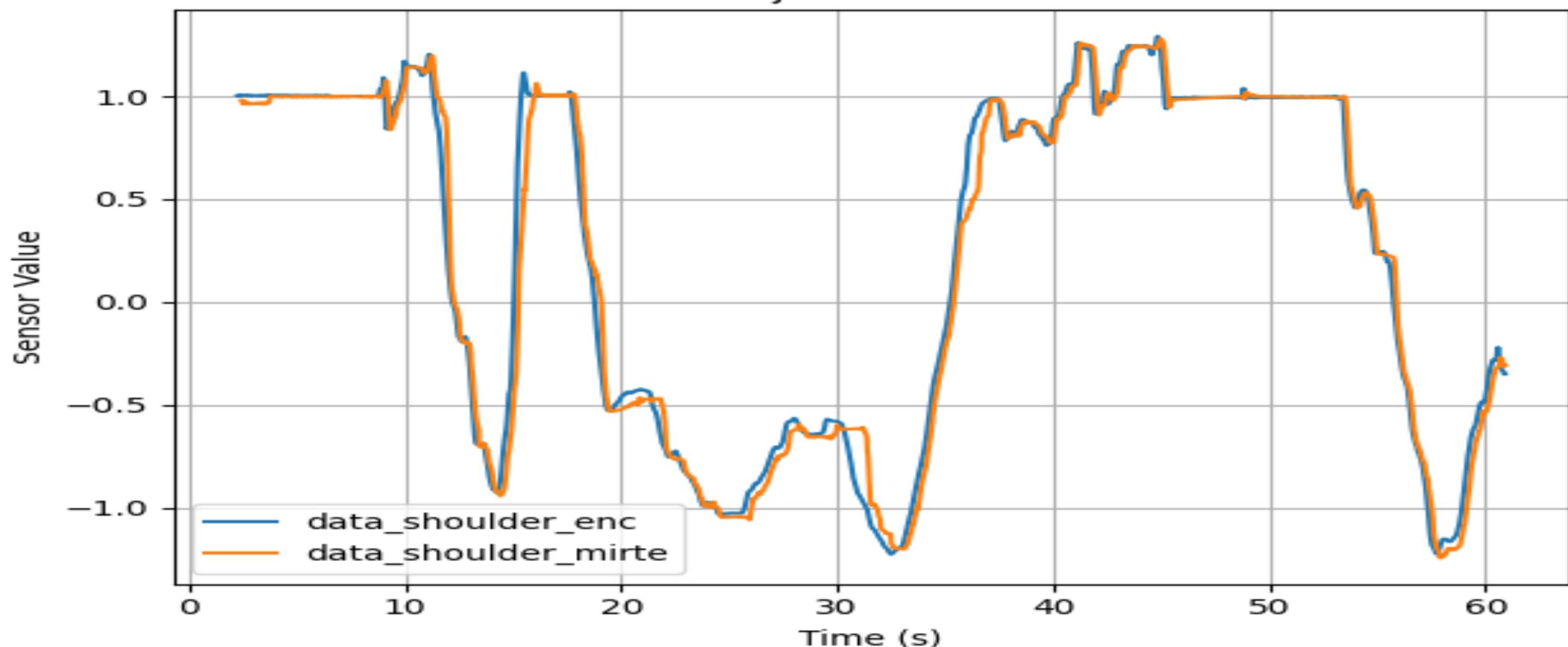
joint data



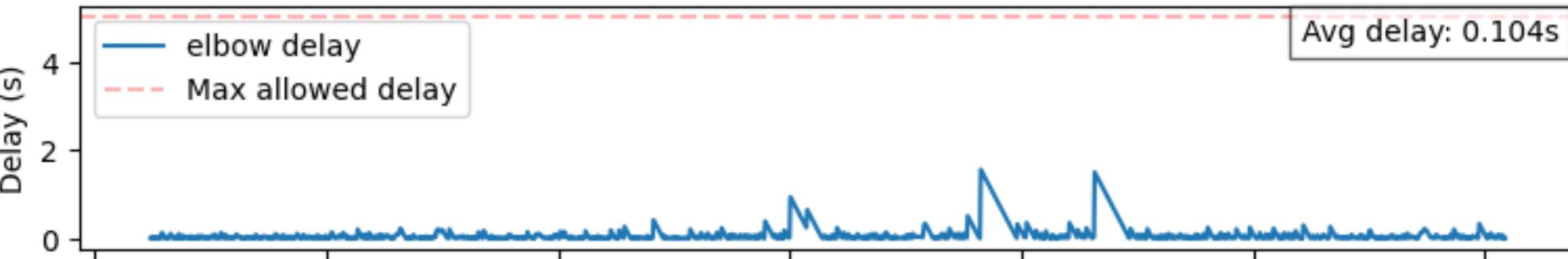
# Delay analysis per joint - Shoulder



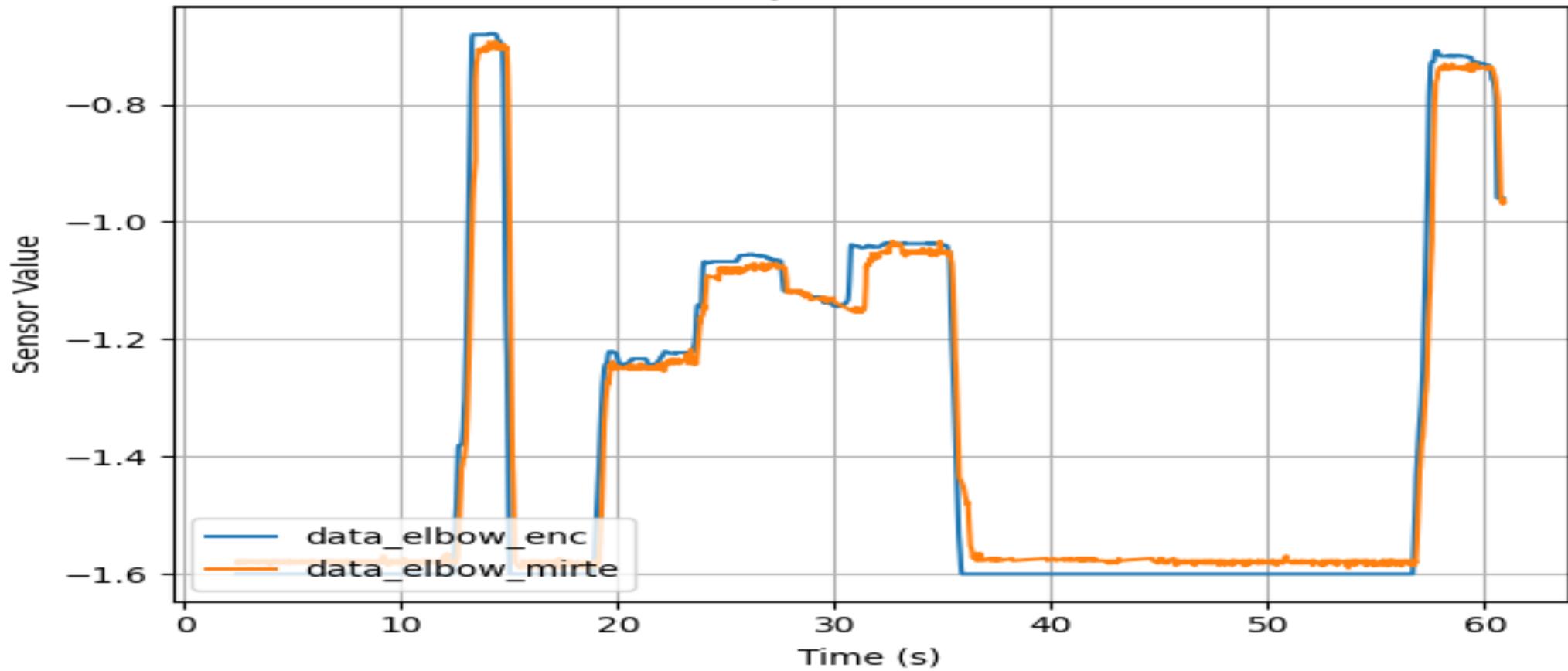
joint data



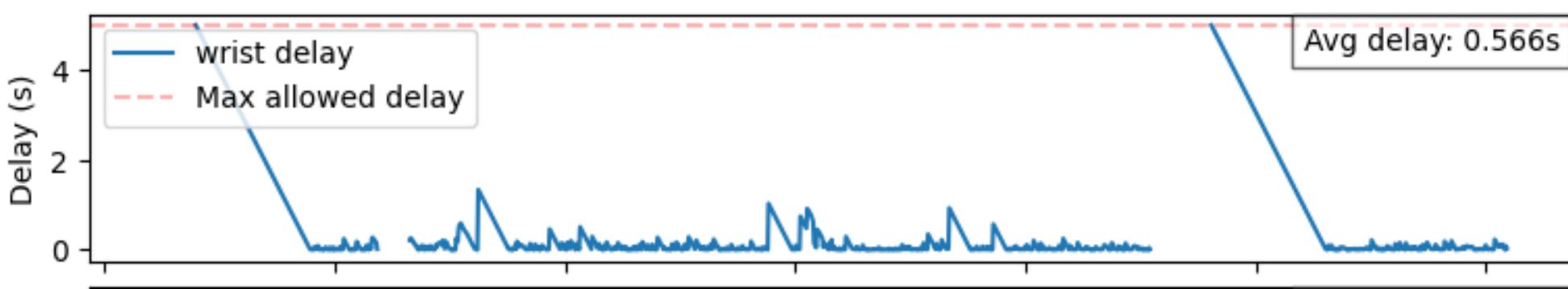
## Delay analysis per joint - Elbow



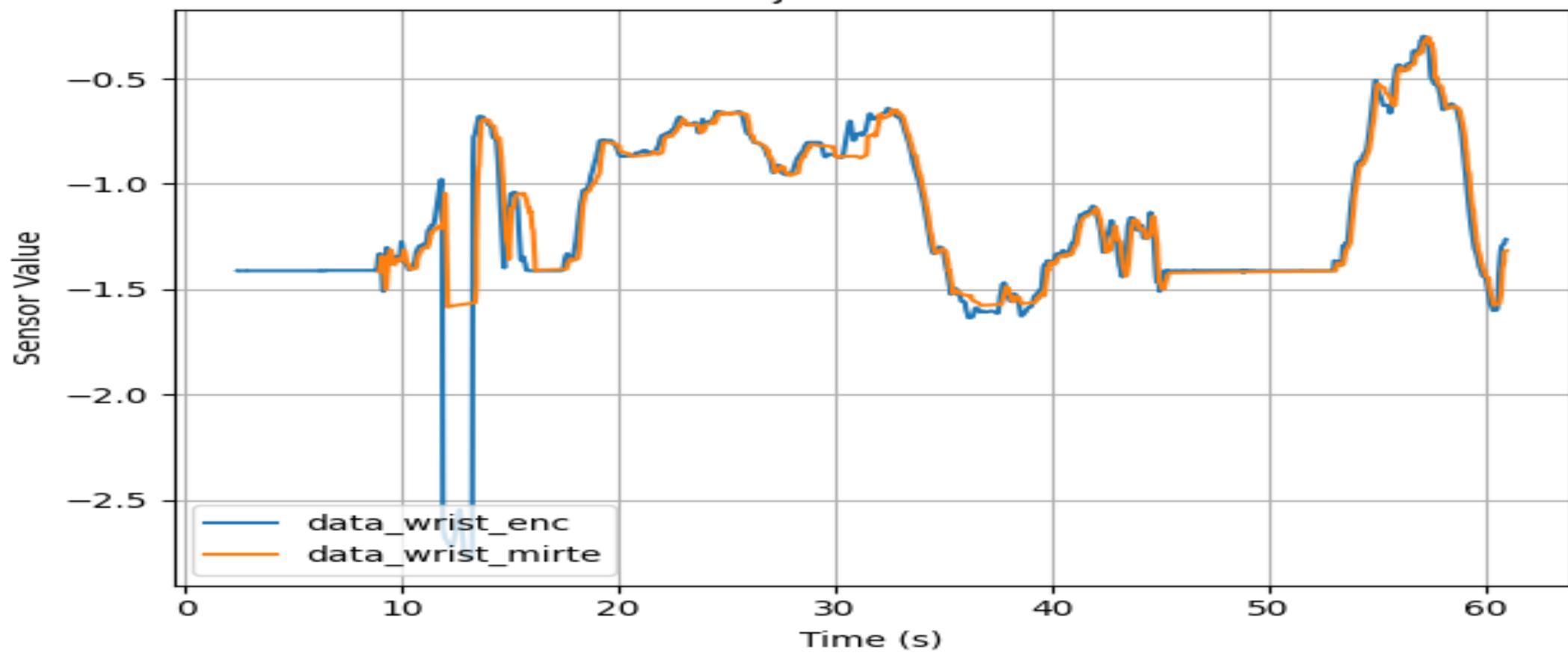
joint data



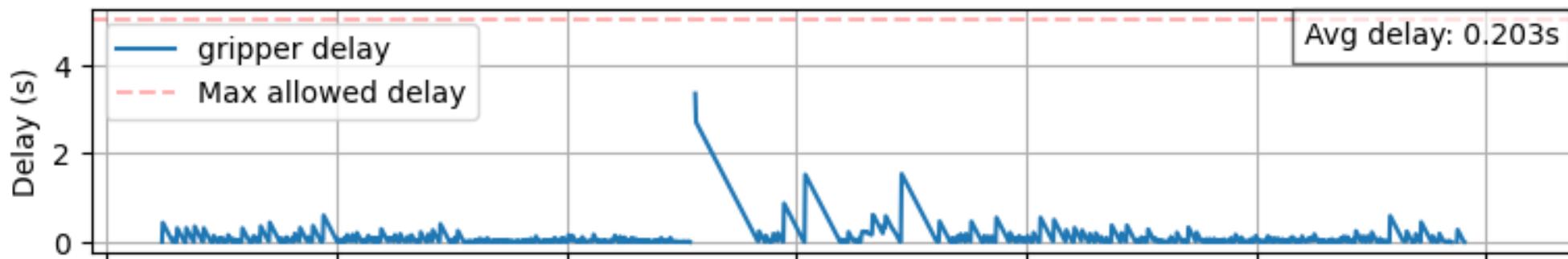
## Delay analysis per joint - Wrist



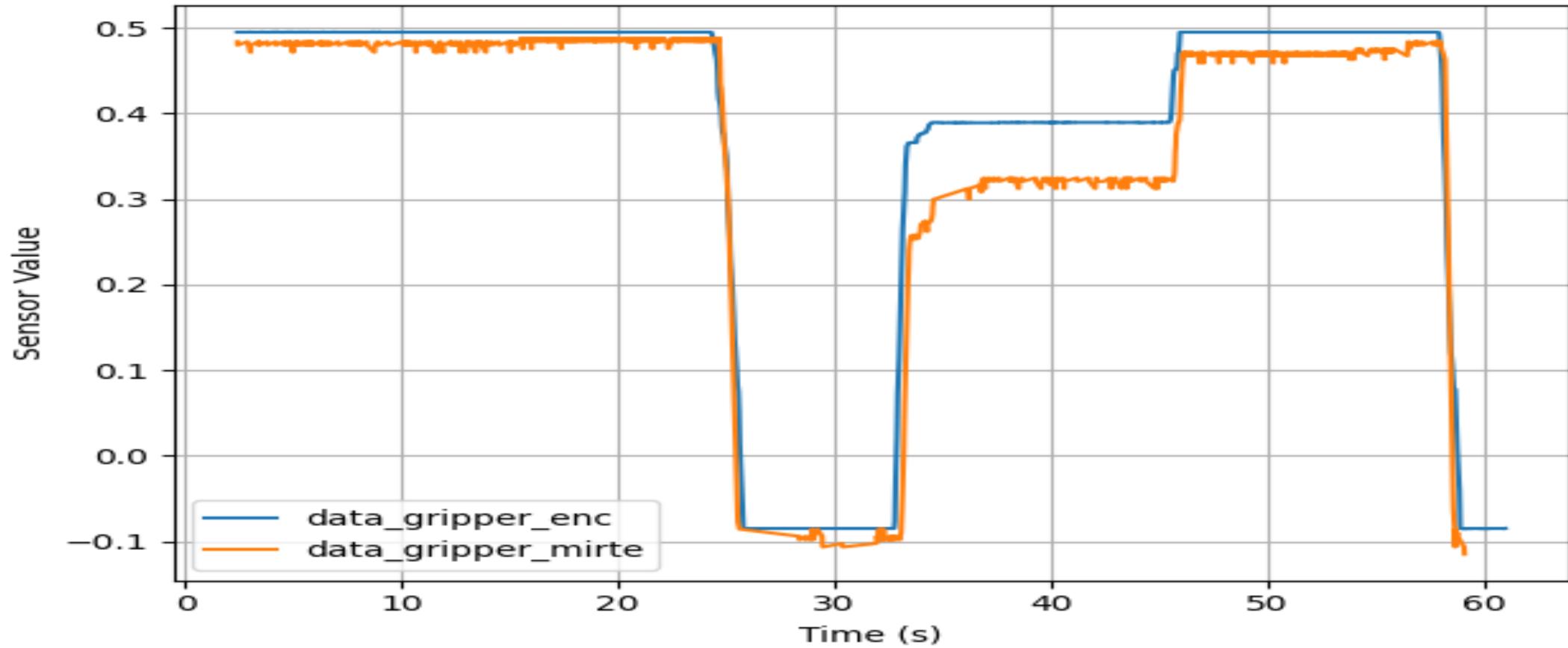
joint data



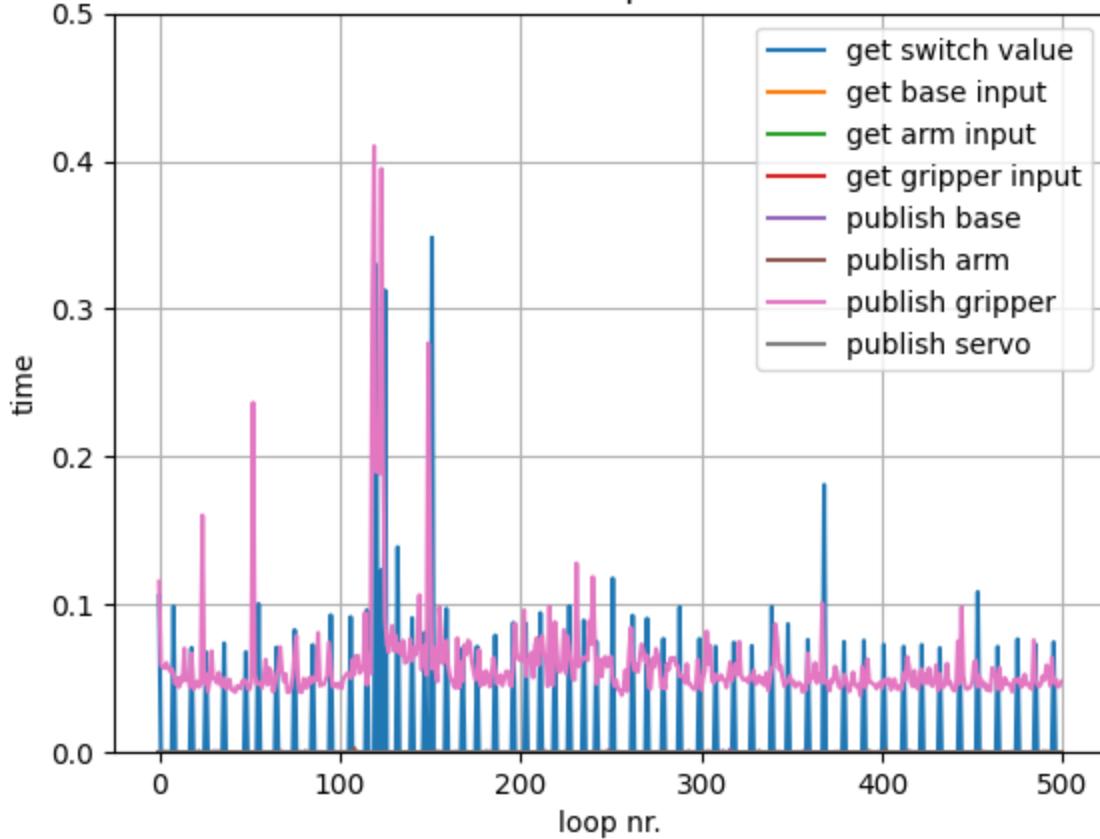
## Delay analysis per joint - Gripper



joint data



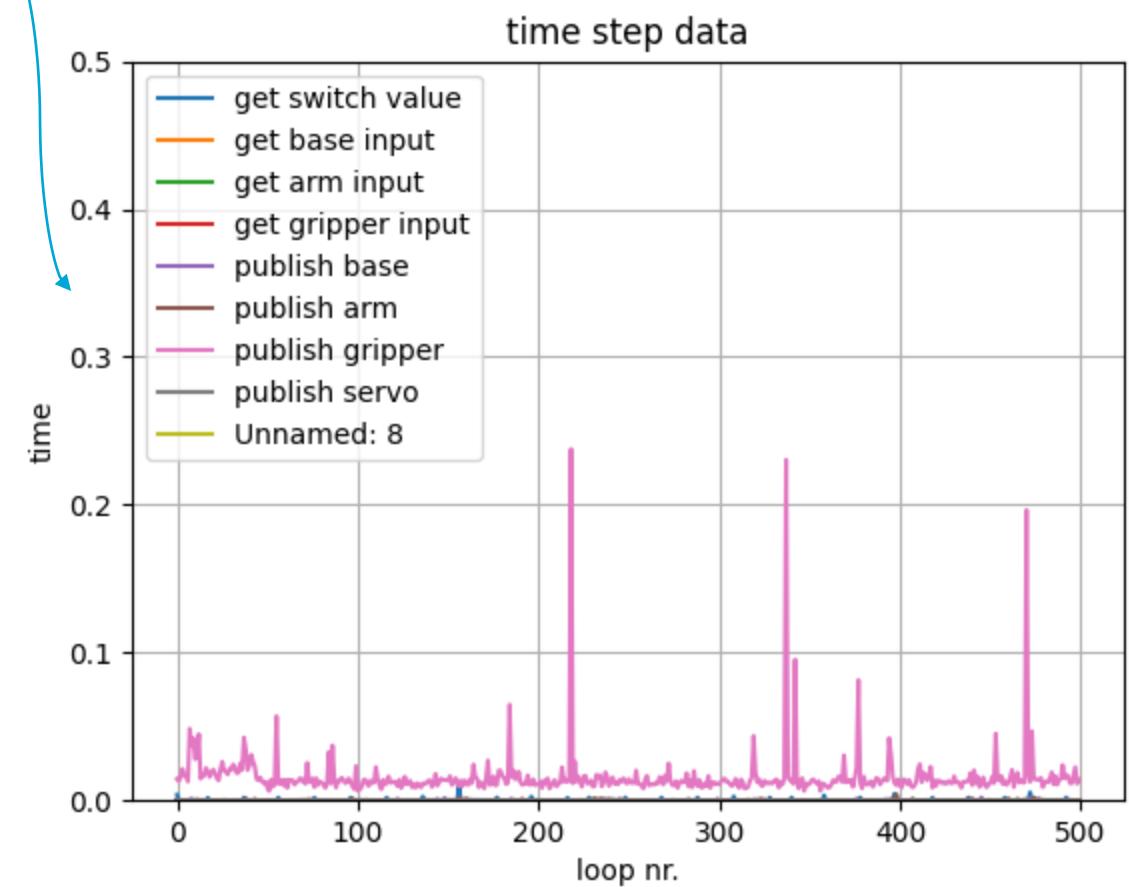
time step data



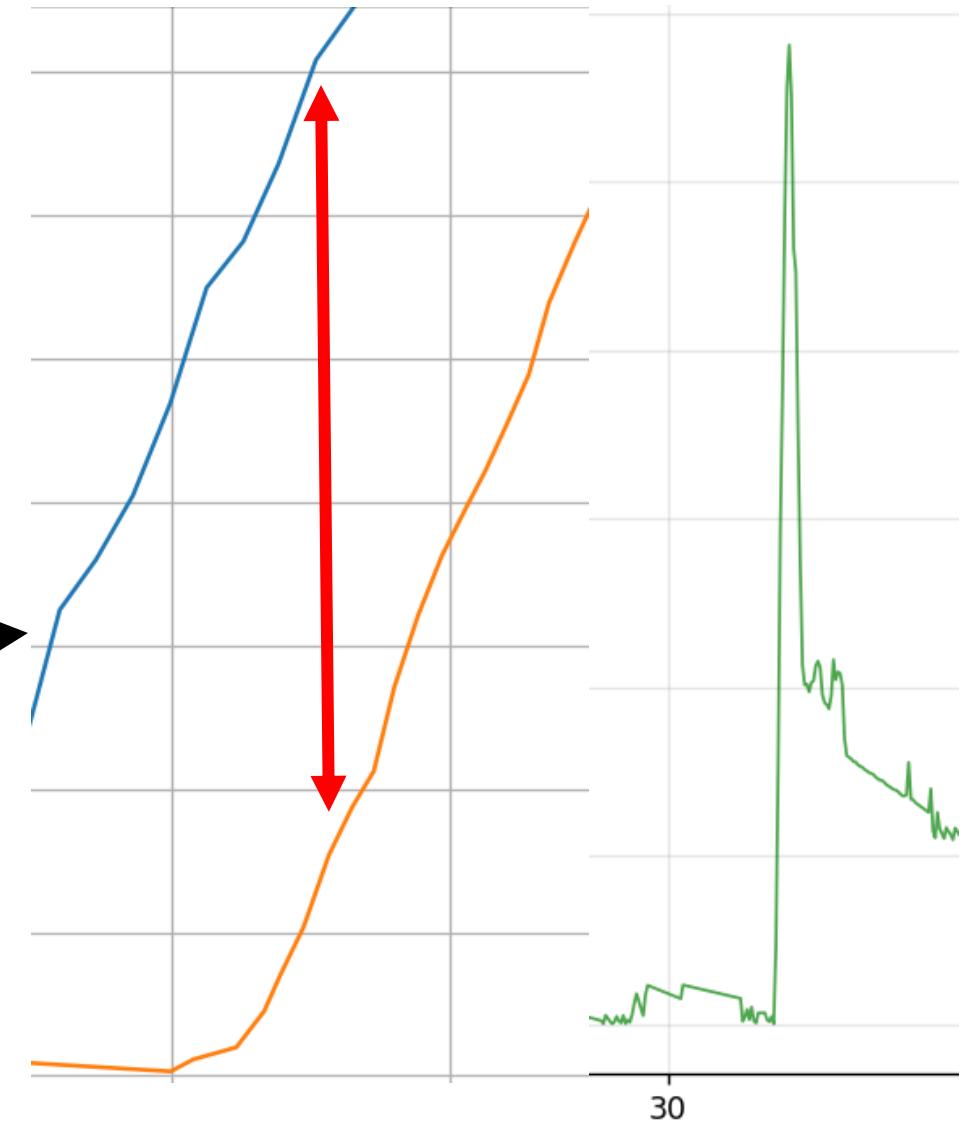
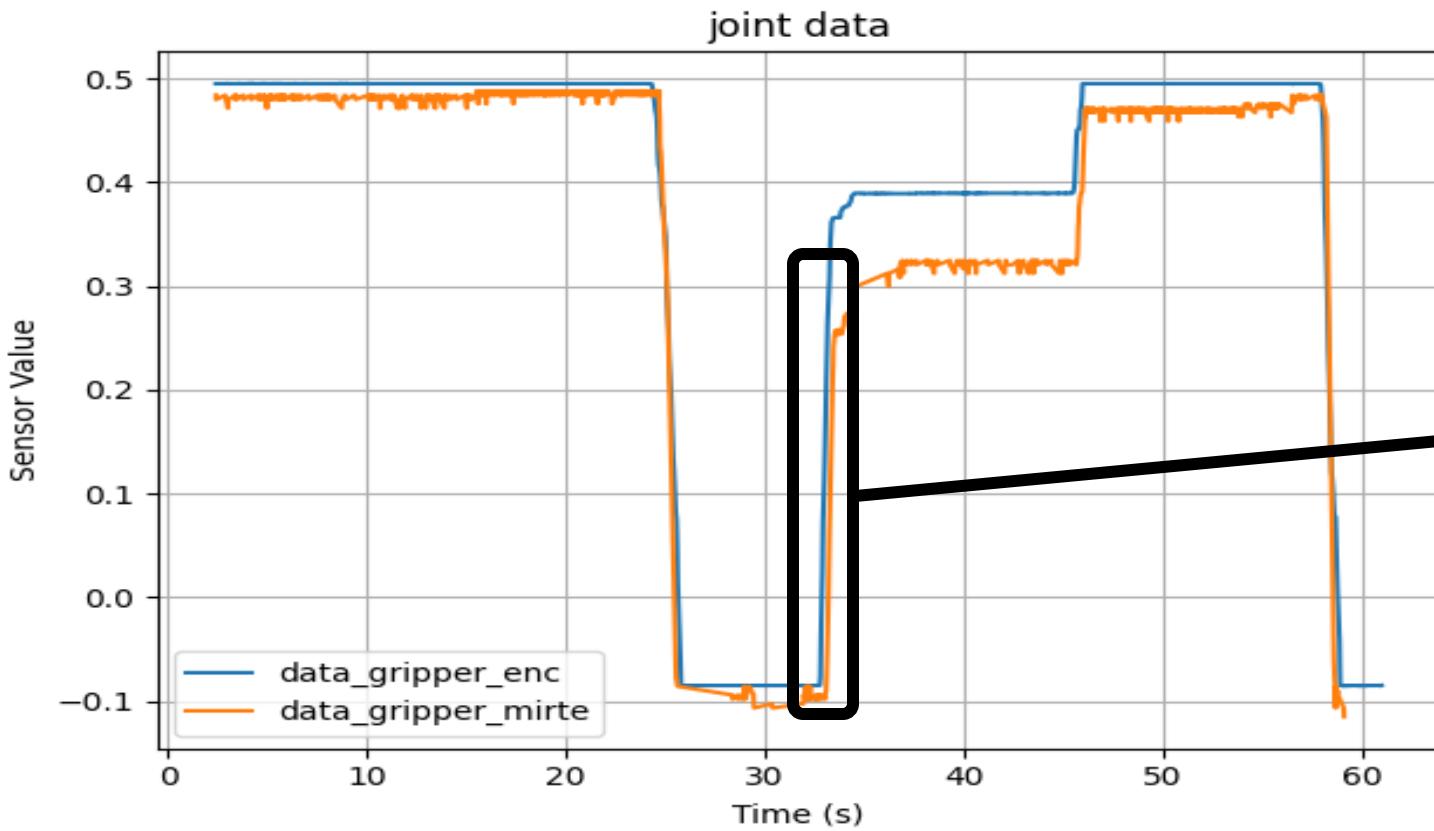
**Duration of steps in control loop.**

Before 'persistent'

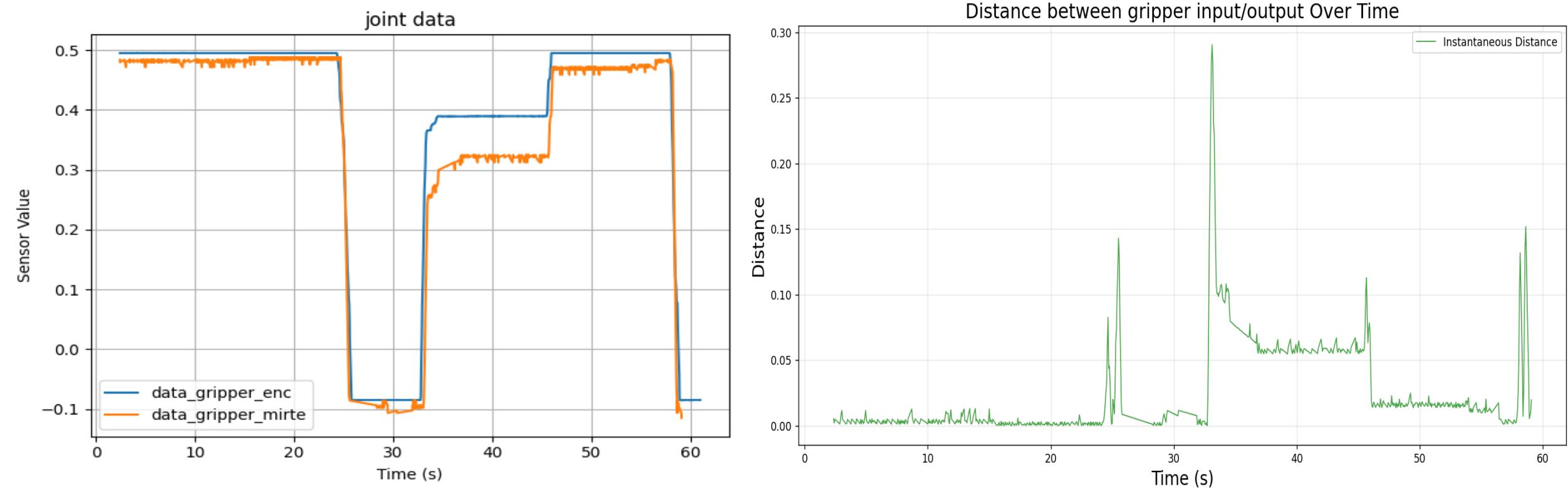
After 'persistent'



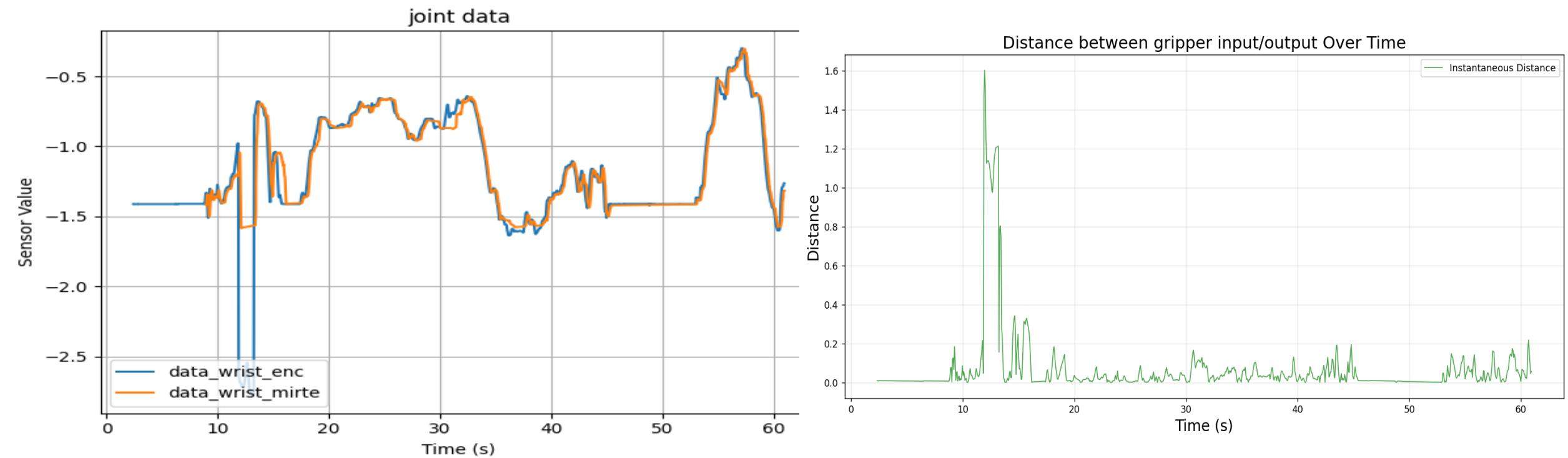
# Deviation stark increase



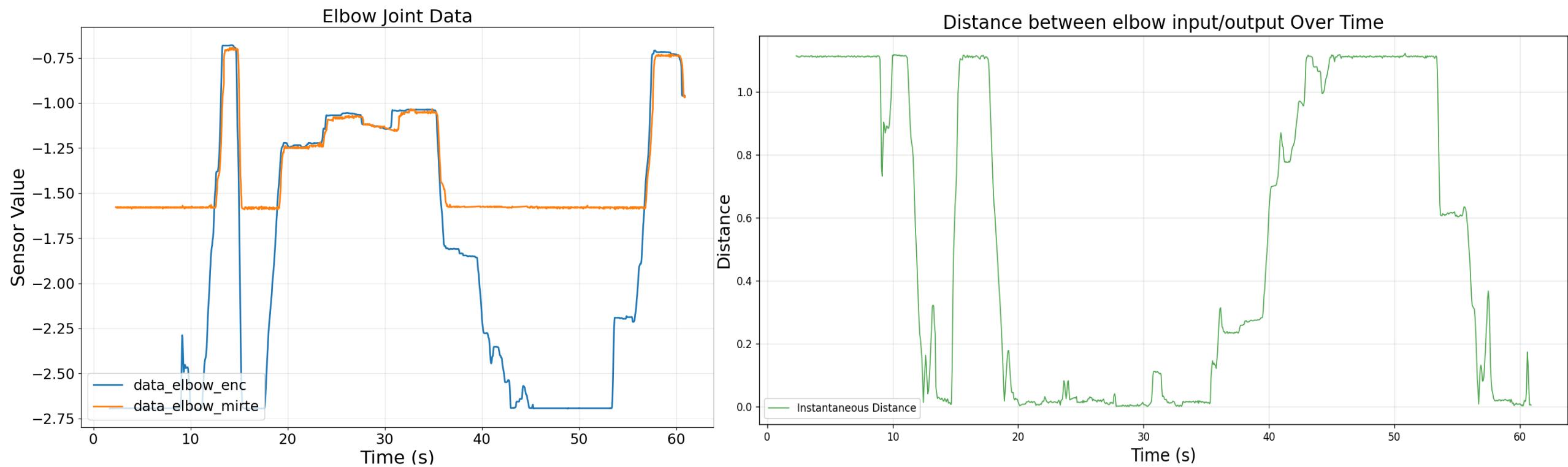
# Deviation graph gripper



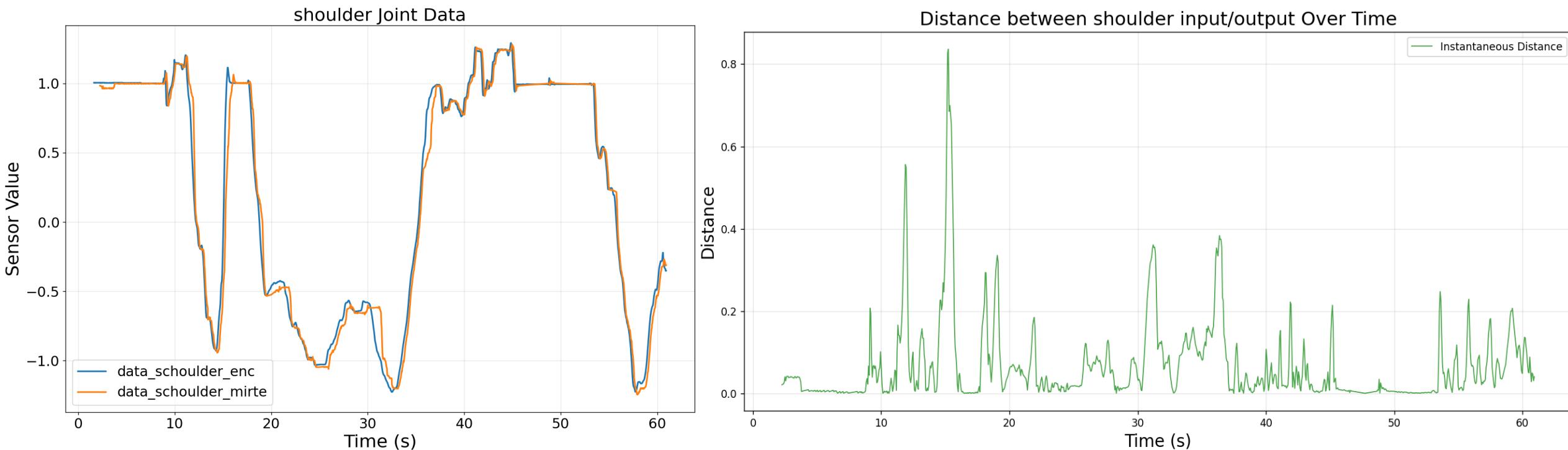
# Deviation graph wrist



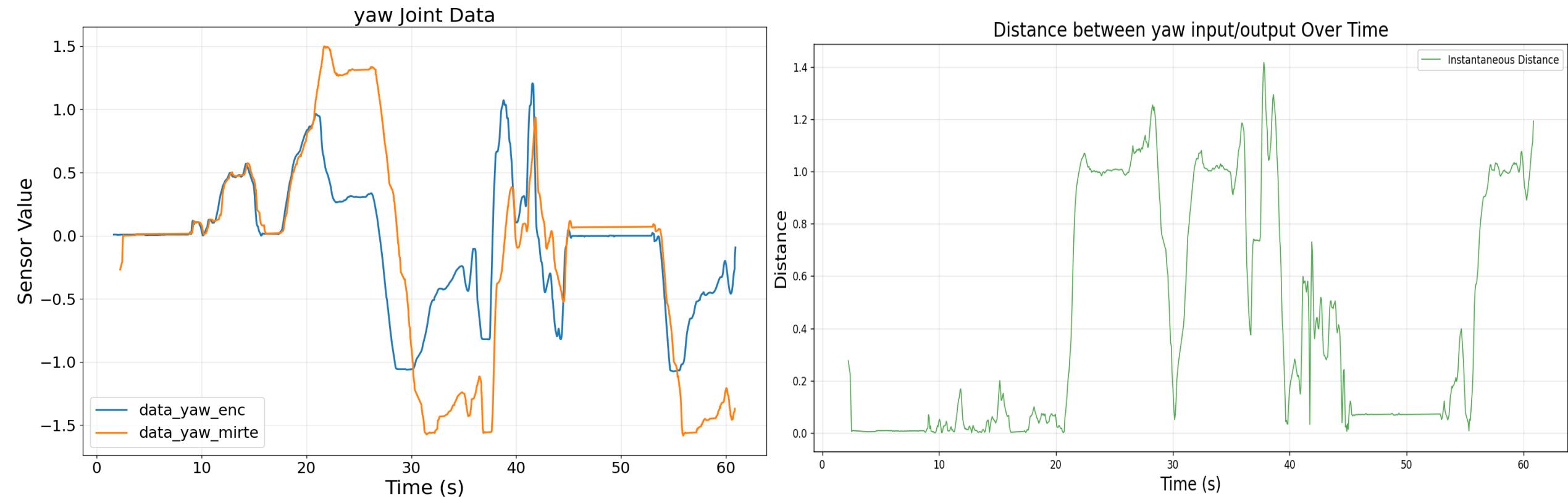
# Deviation graph elbow



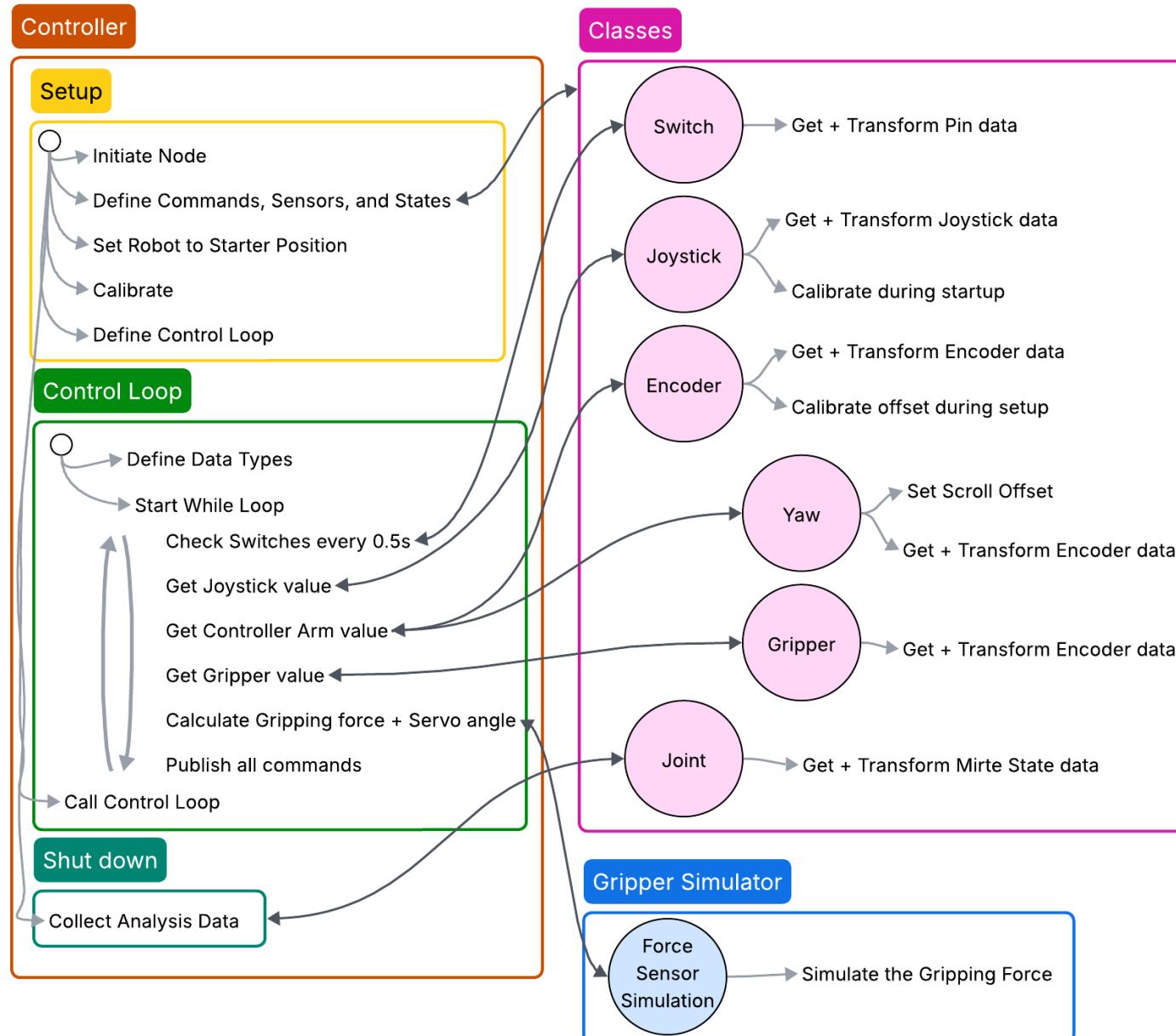
# Deviation graph shoulder



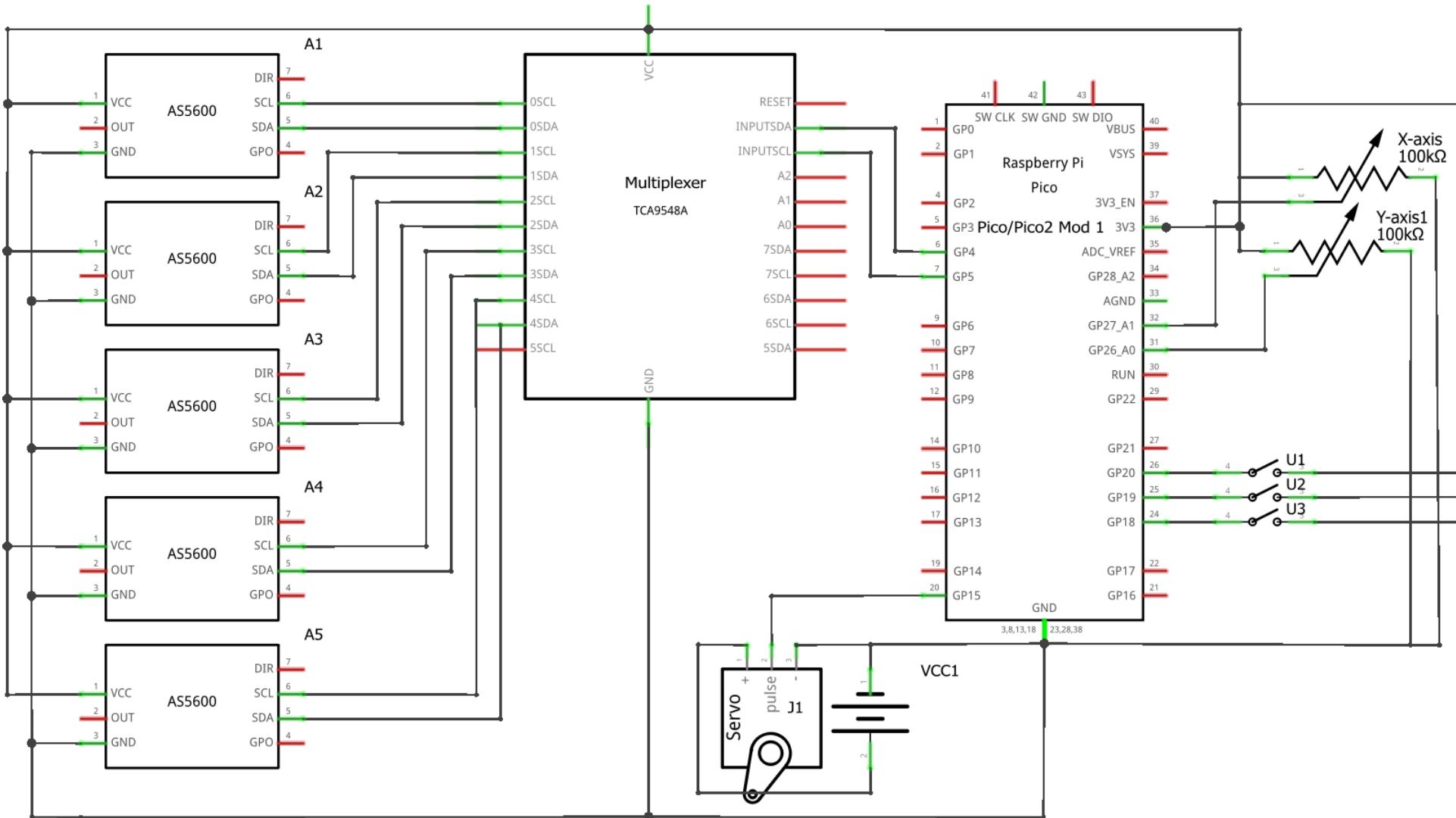
# Deviation graph yaw



# Software diagram

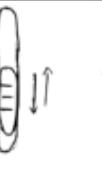
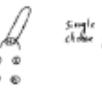
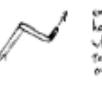
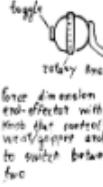


# Electrical diagram

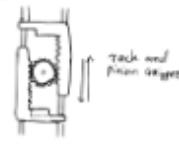
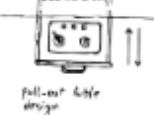
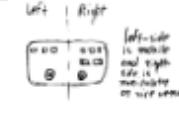
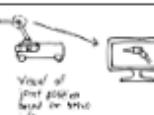


fritzing

# Morphological chart

Base	Speed	 Switching between two speeds	 joystick pressure sensitivity	 accelerator pedal	 scroll wheel	 slide button
	Direction	 mouse ball	 tilt controls	 driving device through turning cap	 wrist + pressure sensitivity for speed	
		 single turning direction				
Arm Position	Combined Solutions	 single controller elbow joint	 for every joint + controller	 standard excavator joint	 end effector with scroll wheel	
		 end effector hold flex pen which can rotate about own axis	 small model master slave and variants	 force dimension delta 3 end-effector with rotary knobs the master's wrist/grip and toggle to switch between the two	 end effector with slide button for wrist angle	
	Shoulder Yaw Joint	 single turning direction	 joystick pressure sensitivity	 left right		
Elbow and Wrist Joint	Shoulder Pitch Joint	 small model with no yaw	 small model with limited yaw	 invert position with switch		
	Already covered in Combined Solutions					

# Morphological chart

Gripper	Gripper	 Single button with force actuator	 finger with force sensor	 scissor like mechanism gripper	 dumb hand gripper	 two hands with distance sensor
		 glove	 track and pinion gripper			
		 vibration feedback	 magnet		 single force feedback	 no haptic feedback gripping and release
	Force Feedback			 finger with force sensor		
General	Casing	 pull-out slide design	 modular casing removable base fixable side panel removable side panel	 protective film and protection		
	Button layout	 tilting buttons for gravity dual thumbstick	 left right left-side is up for left stick and right-side is up for right stick middle is up for both sticks	 toggle switch for switch between two surfaces		
	Controller mobility	 N-Grip middle grip	 shoulder strap	 sit down station		
	State Observing	 carrot for present	 TV screen	 crane for present	 crane for visual	 walking next to it
		 visual of first place based on GPS info				

# Failure of Gearmotor to Emulate a Spring due to Inertia and Torque Limits

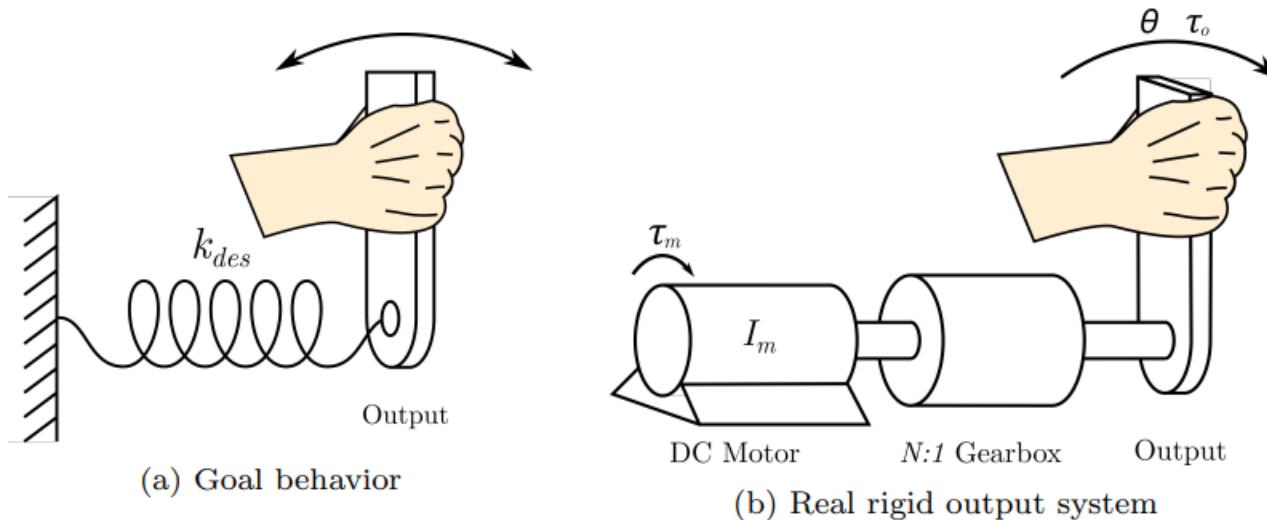
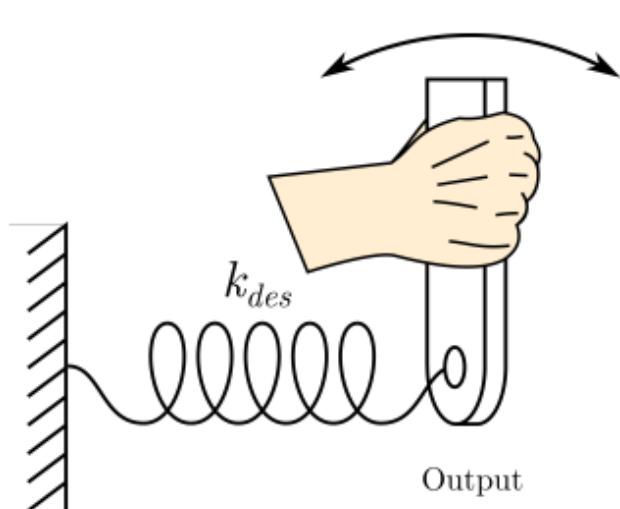
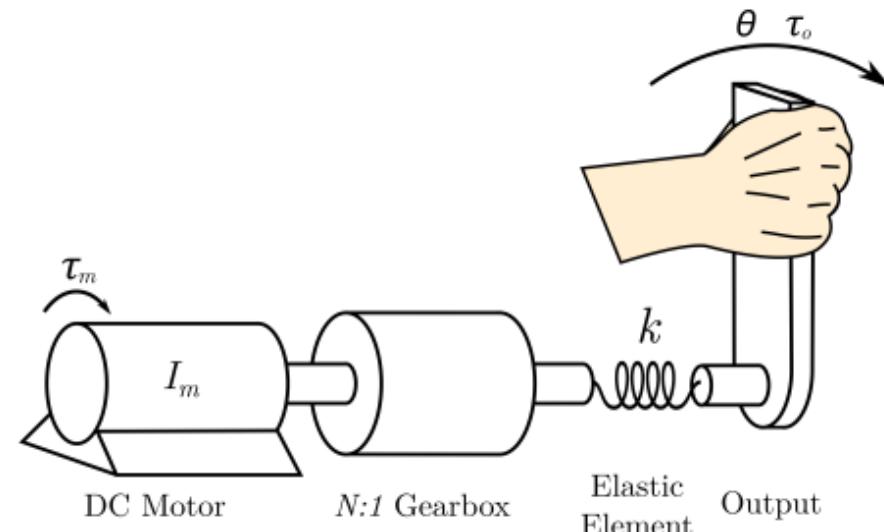


Image Source: Series Elastic Actuators., J. Hurst., 2020.,  
[https://mime.engineering.oregonstate.edu/research/drl/\\_documents/hurst\\_2020.pdf](https://mime.engineering.oregonstate.edu/research/drl/_documents/hurst_2020.pdf)

# Gearmotor with Series Elastic Actuation



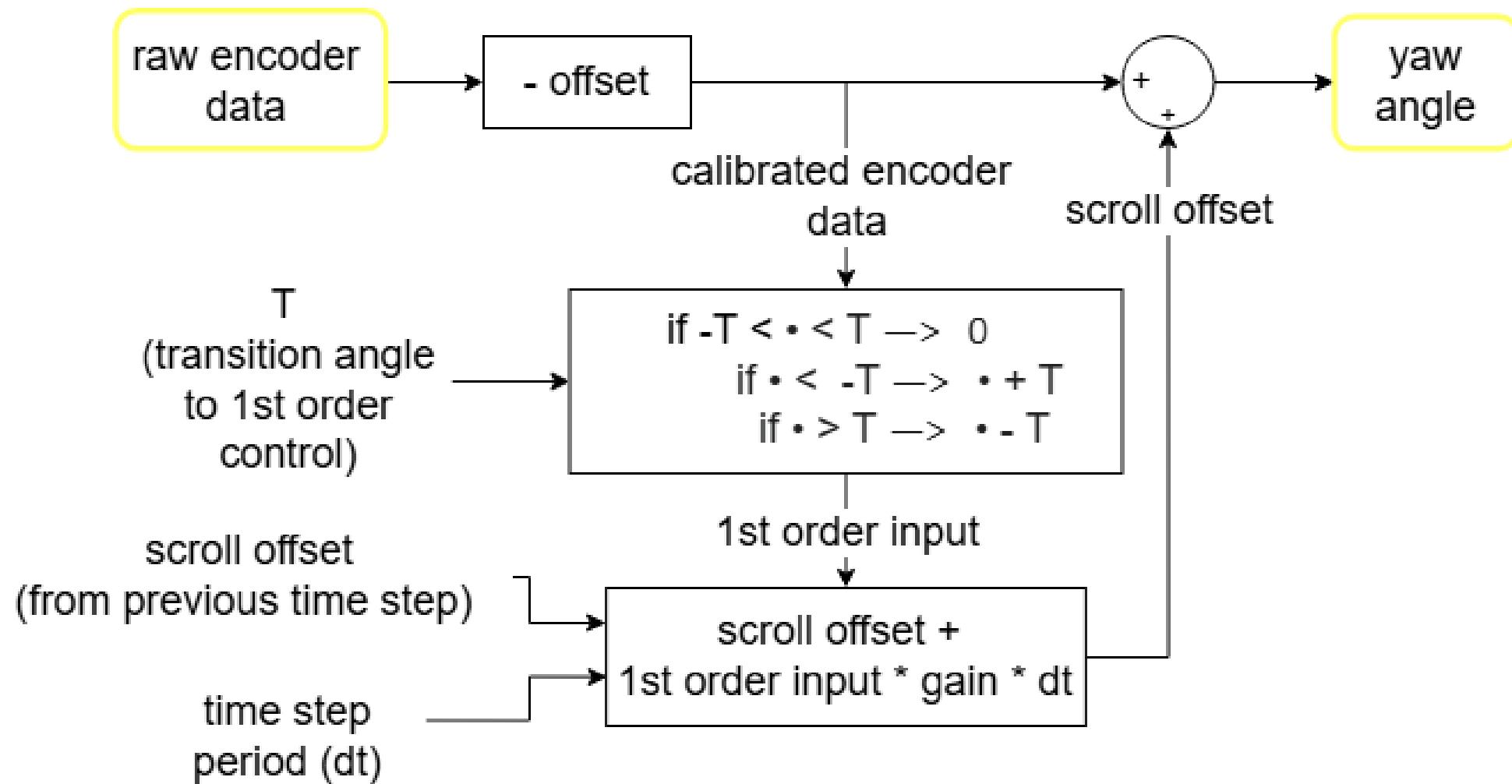
(a) Goal behavior



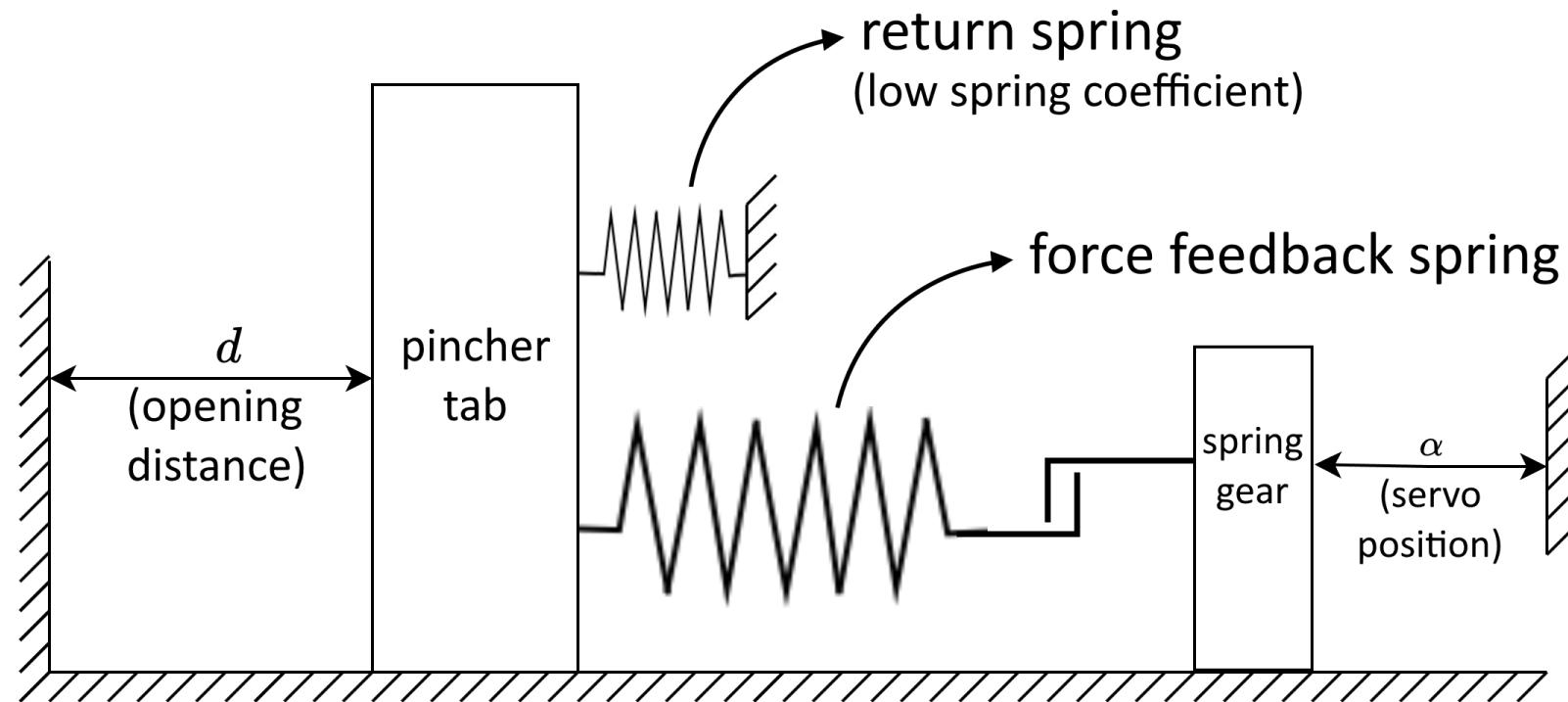
(b) Real series elastic system

Image Source: Series Elastic Actuators., J. Hurst., 2020.,  
[https://mime.engineering.oregonstate.edu/research/drl/\\_documents/hurst\\_2020.pdf](https://mime.engineering.oregonstate.edu/research/drl/_documents/hurst_2020.pdf)

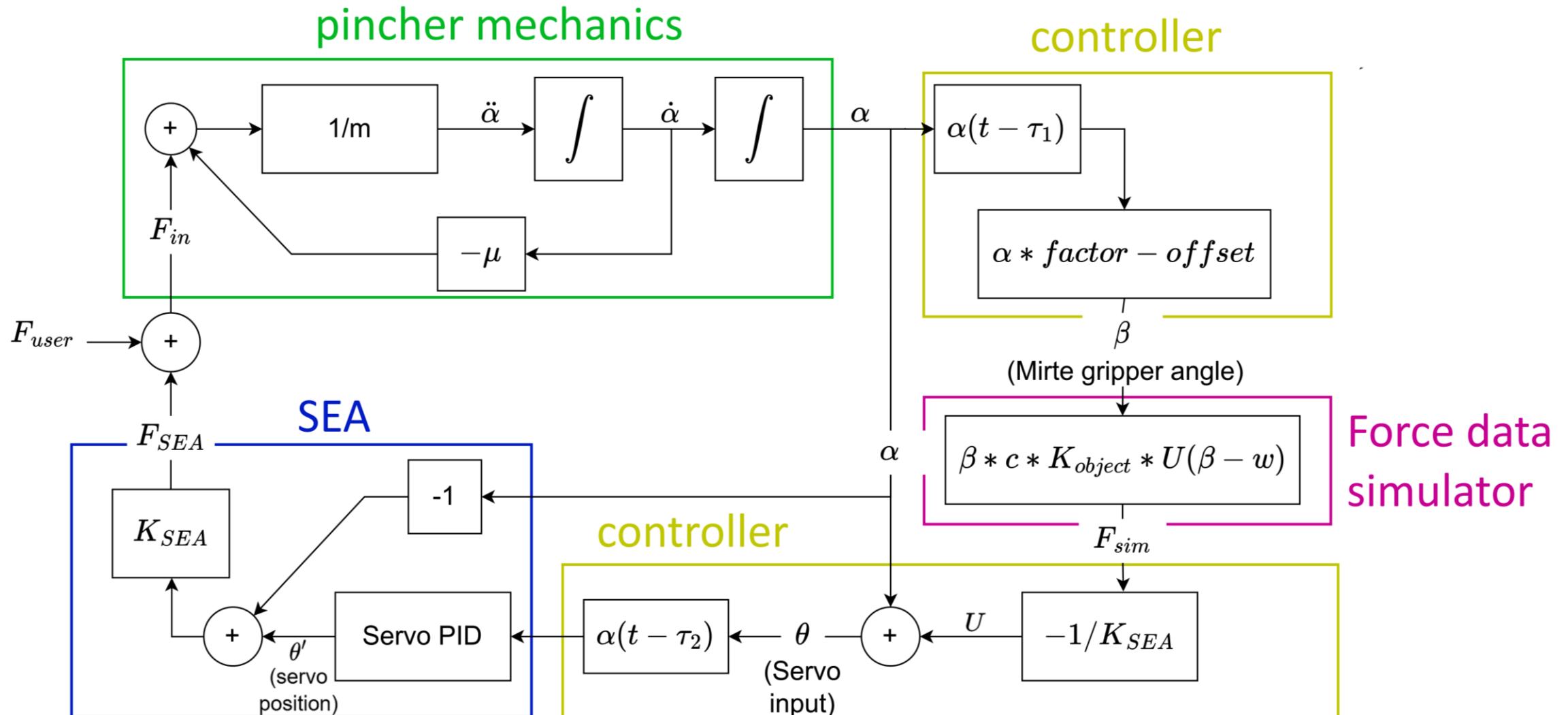
# Yaw control blockdiagram



# Diagram of Series Elastic Actuator in Pincher



# Force feedback Controll loop



# Force feedback Controll loop

