

# Teleoperation interface design for the Mirte Master

CoR Group 1

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Ynze Visser

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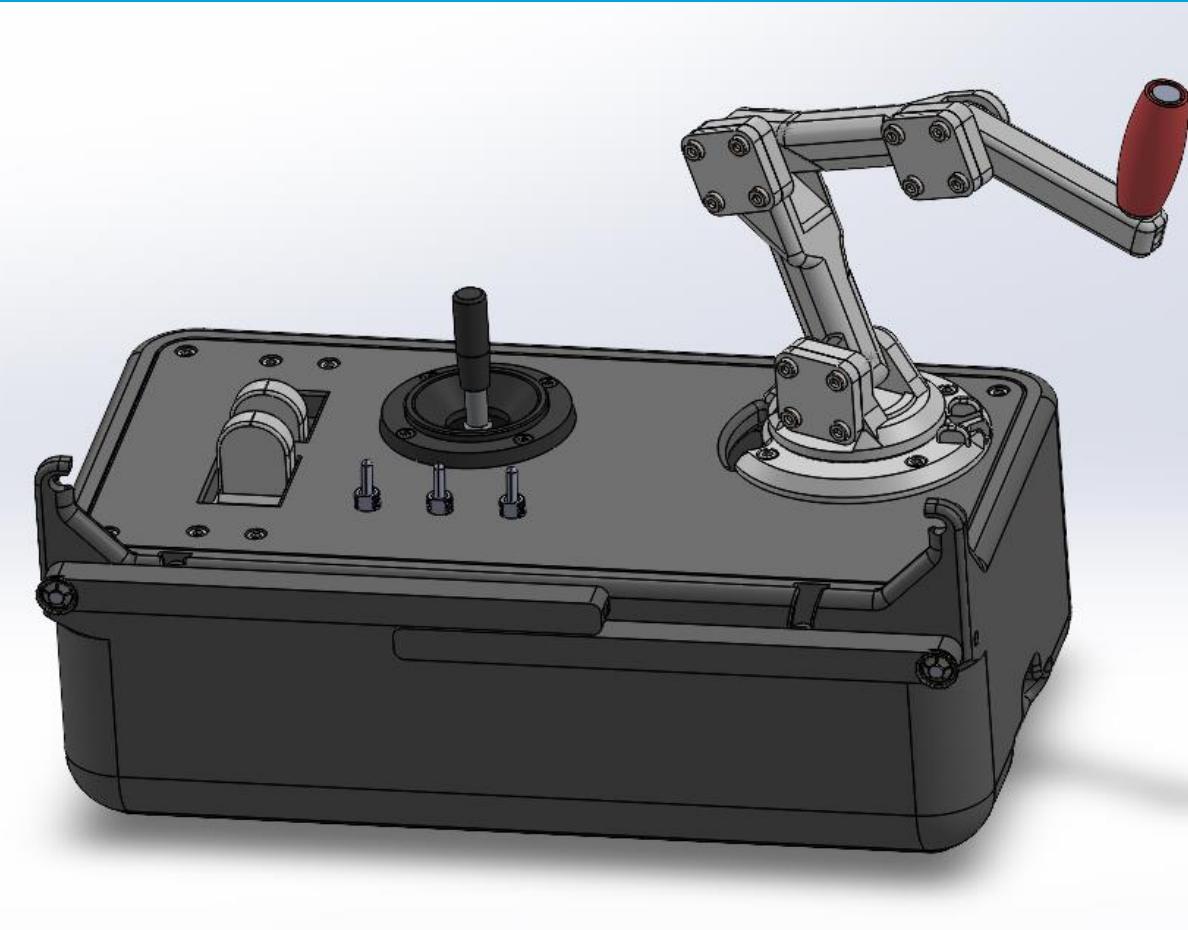


# Design requirements

- Intuitive design by offering 0th-order control for arm manipulation.
- Haptic feedback for the gripper.
- Portable design, meaning limited size and weight, and being non-wearable.

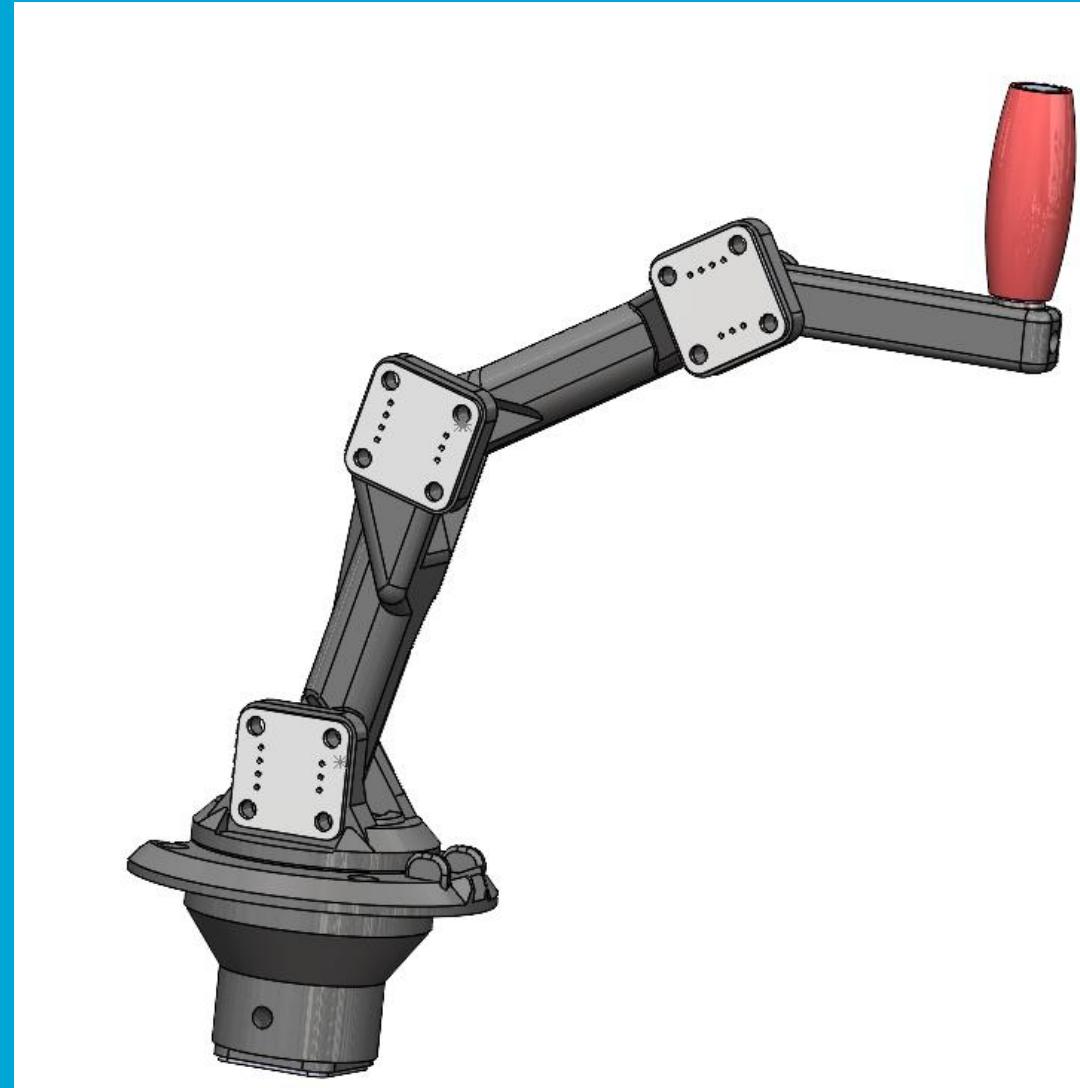
# Final design

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



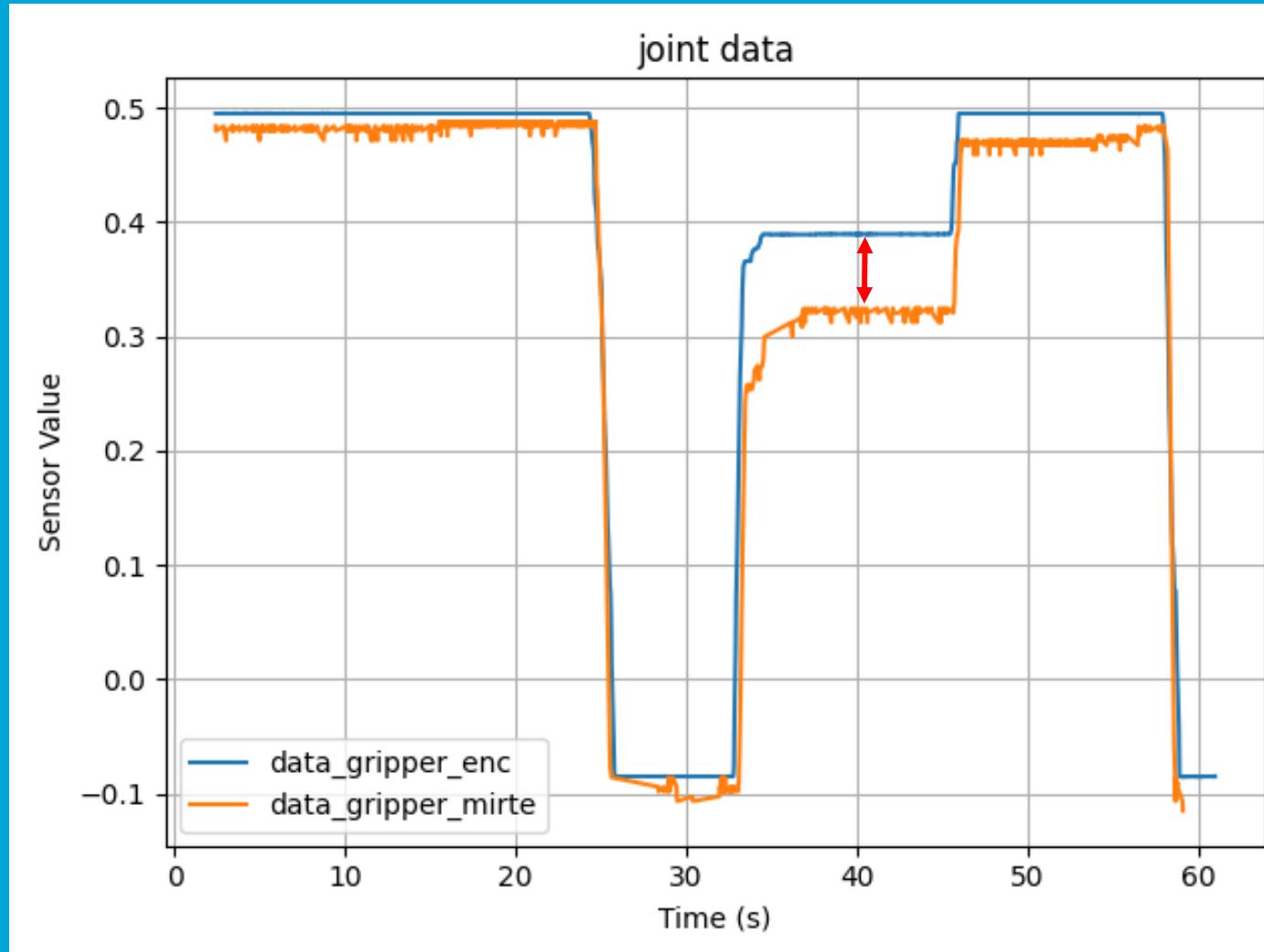
# Controller arm

- 4 DoF just like the Mirte arm.
- Encoders on each joint.
- Data mapped directly allowing master-slave control.



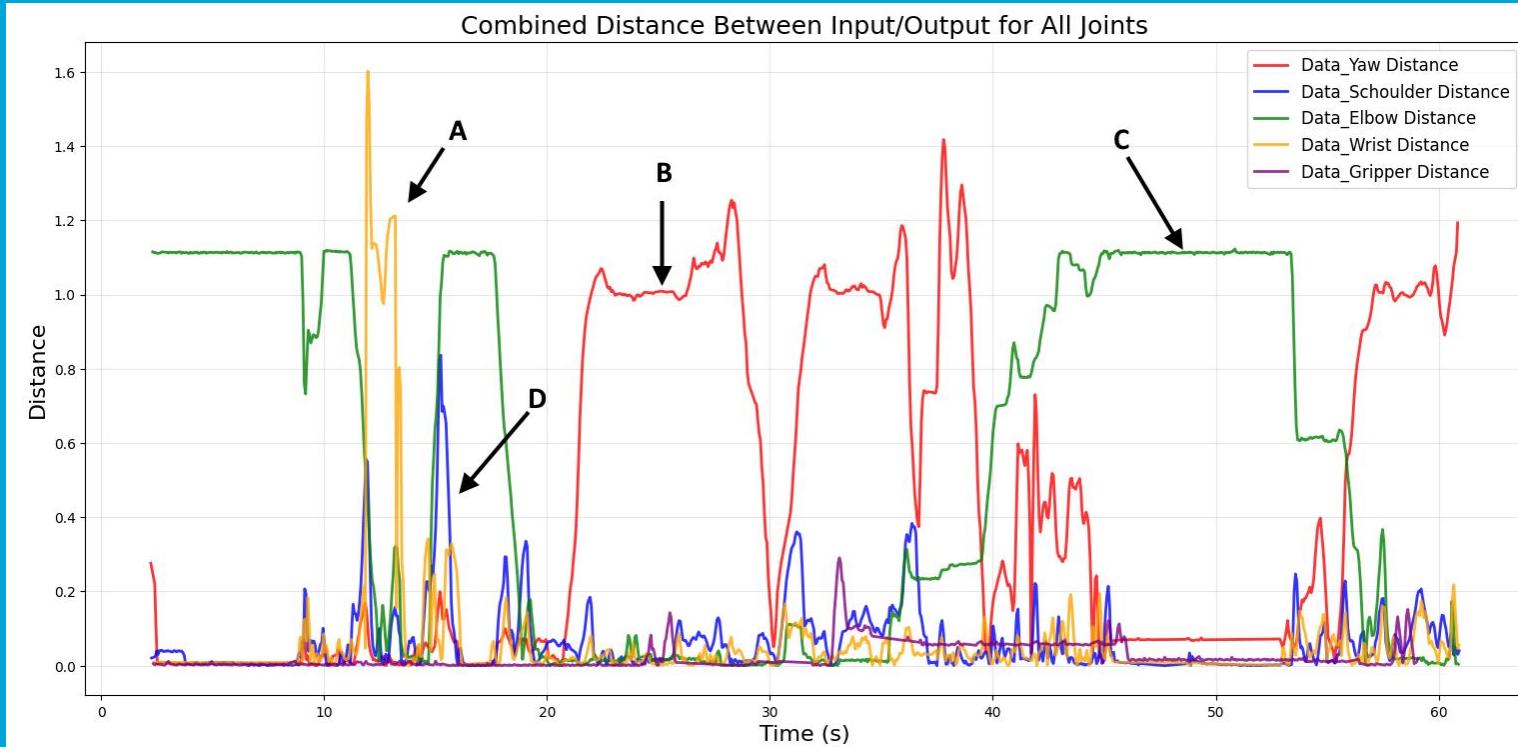
# Controller arm deviation

- Deviation: sent encoder data vs received servo data
- Deviation up to roughly 0.3 radians, excluding outliers.
- Outliers are result of illustration problems or design features



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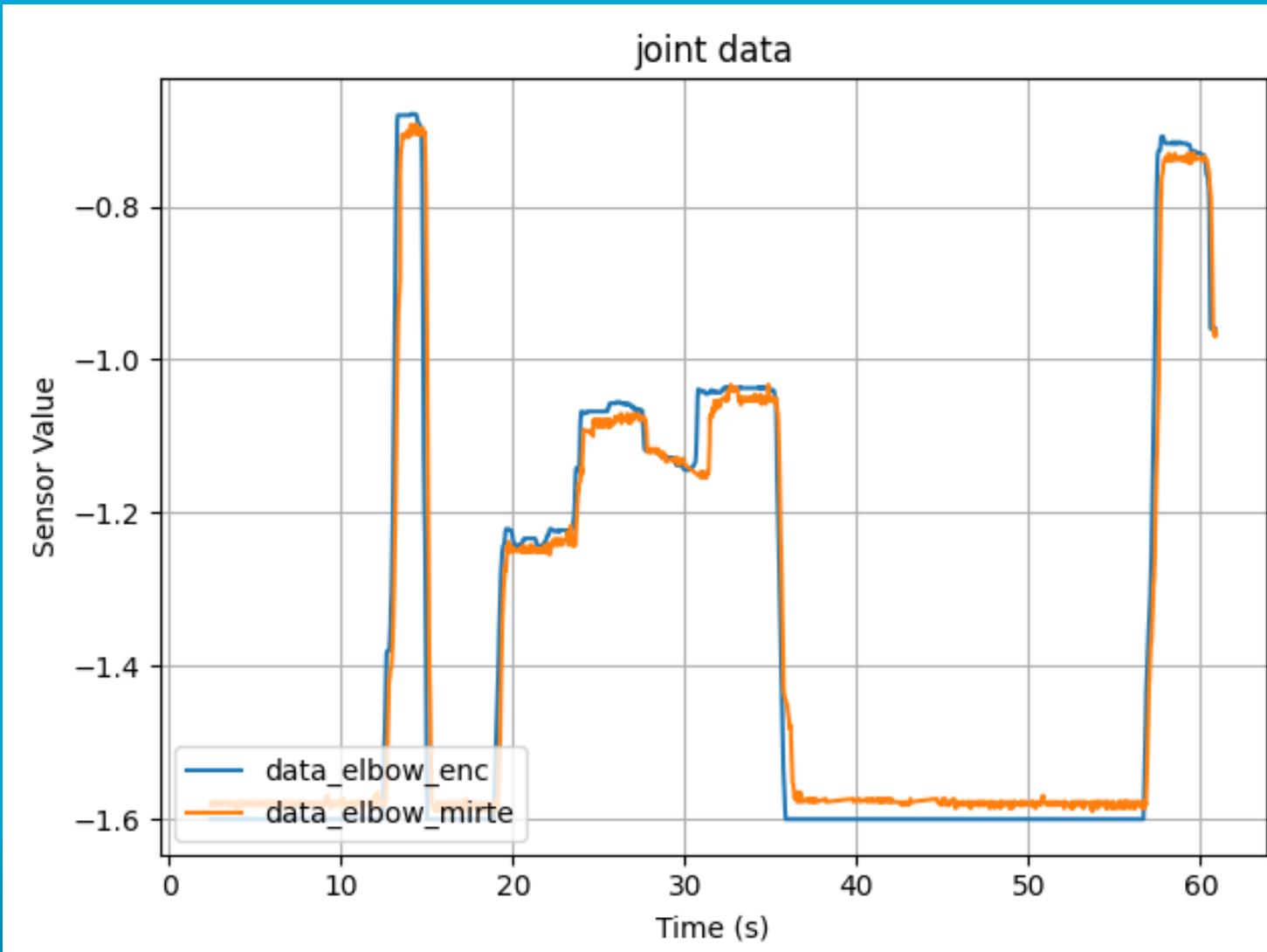


# Response Latency

The Latency experienced is minimal.

**Median delay** is in the order of magnitude of **0.05 seconds**.

All outliers seen here are due to the delay calculation, and do not align with the operator experience.

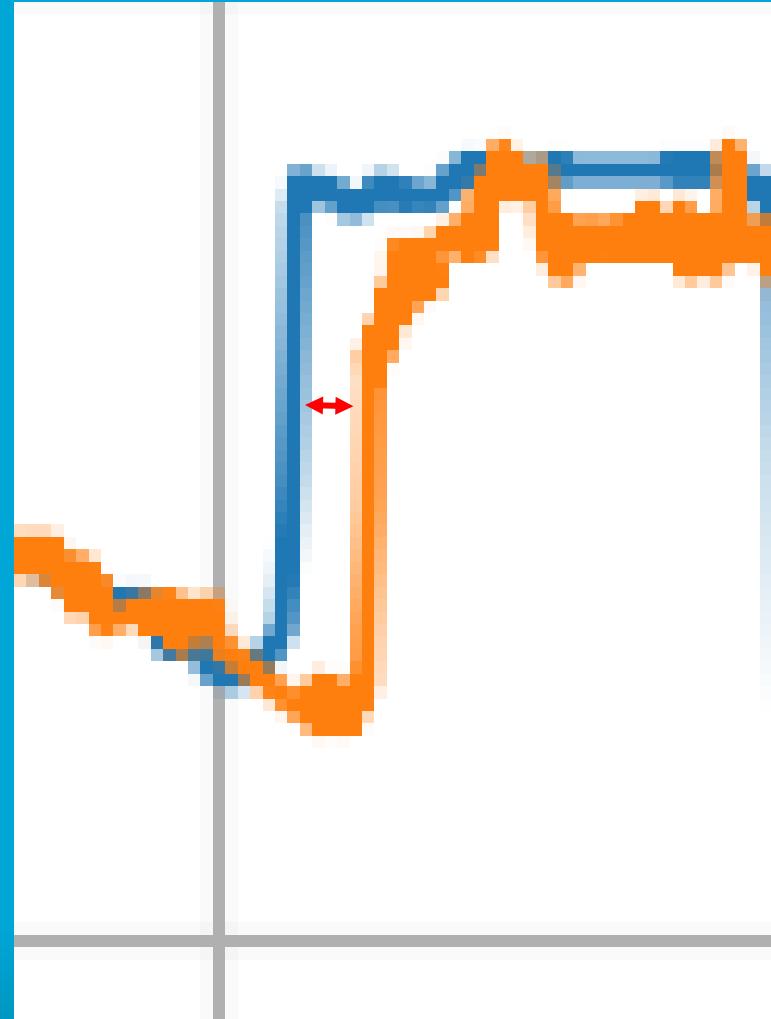


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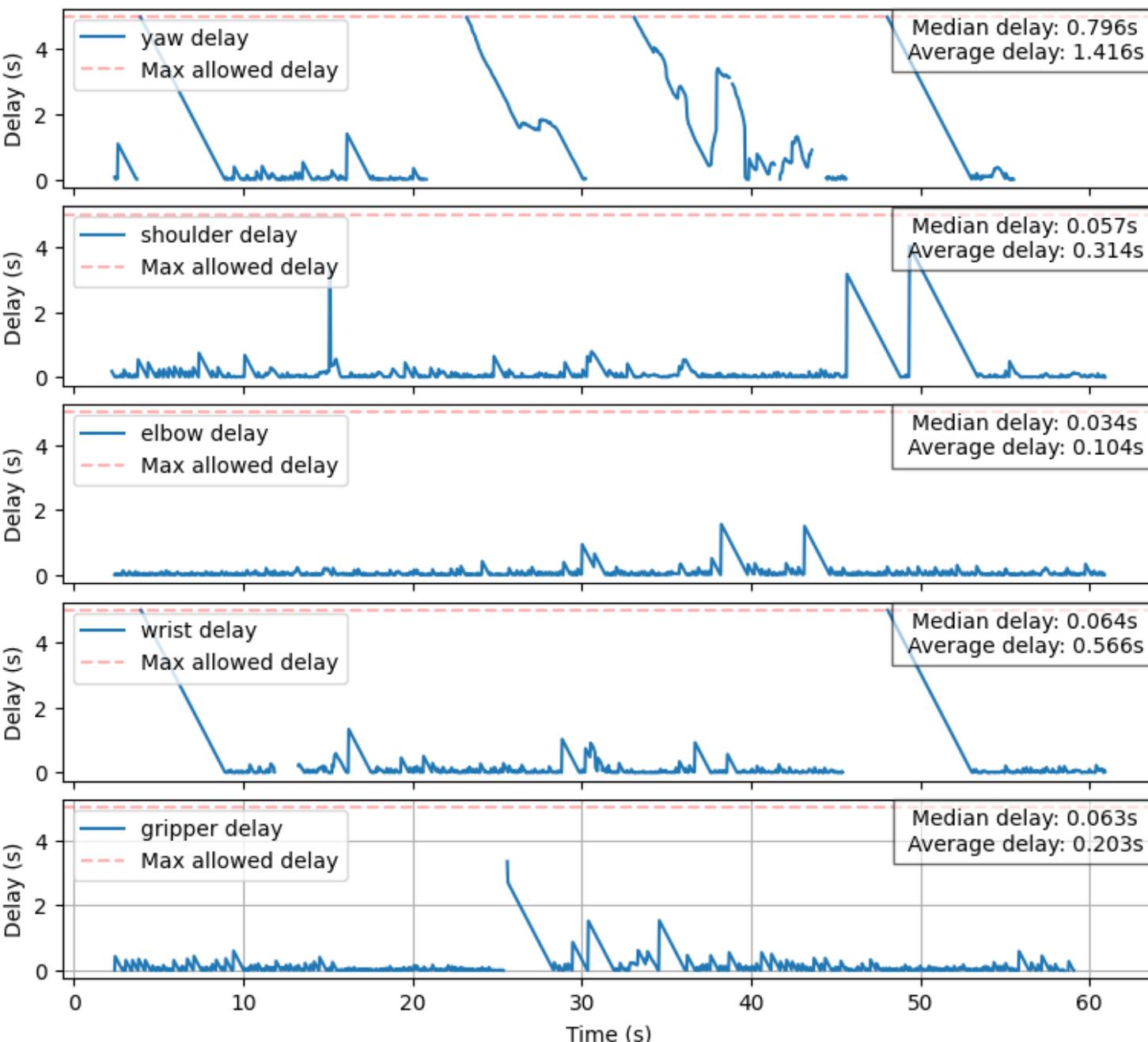
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Delay per Encoder Command per Joint

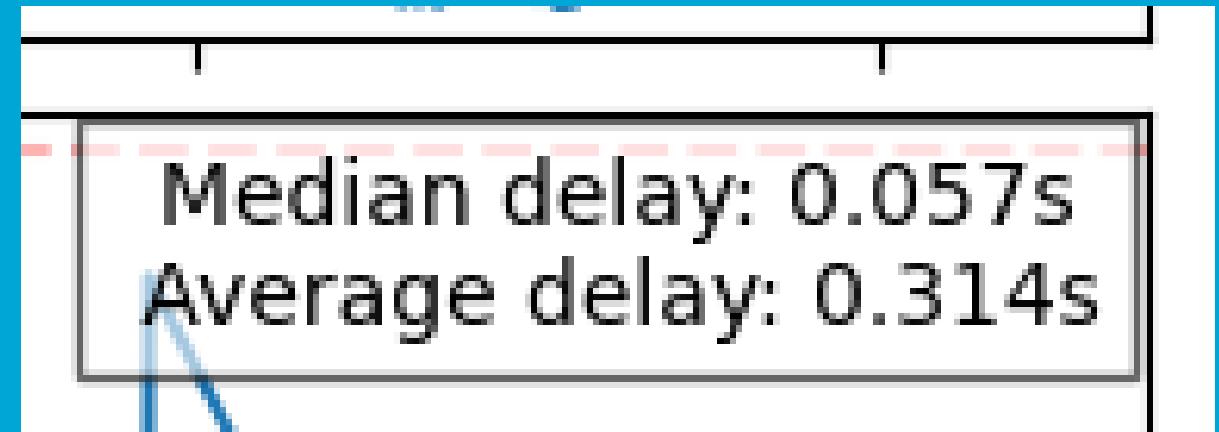


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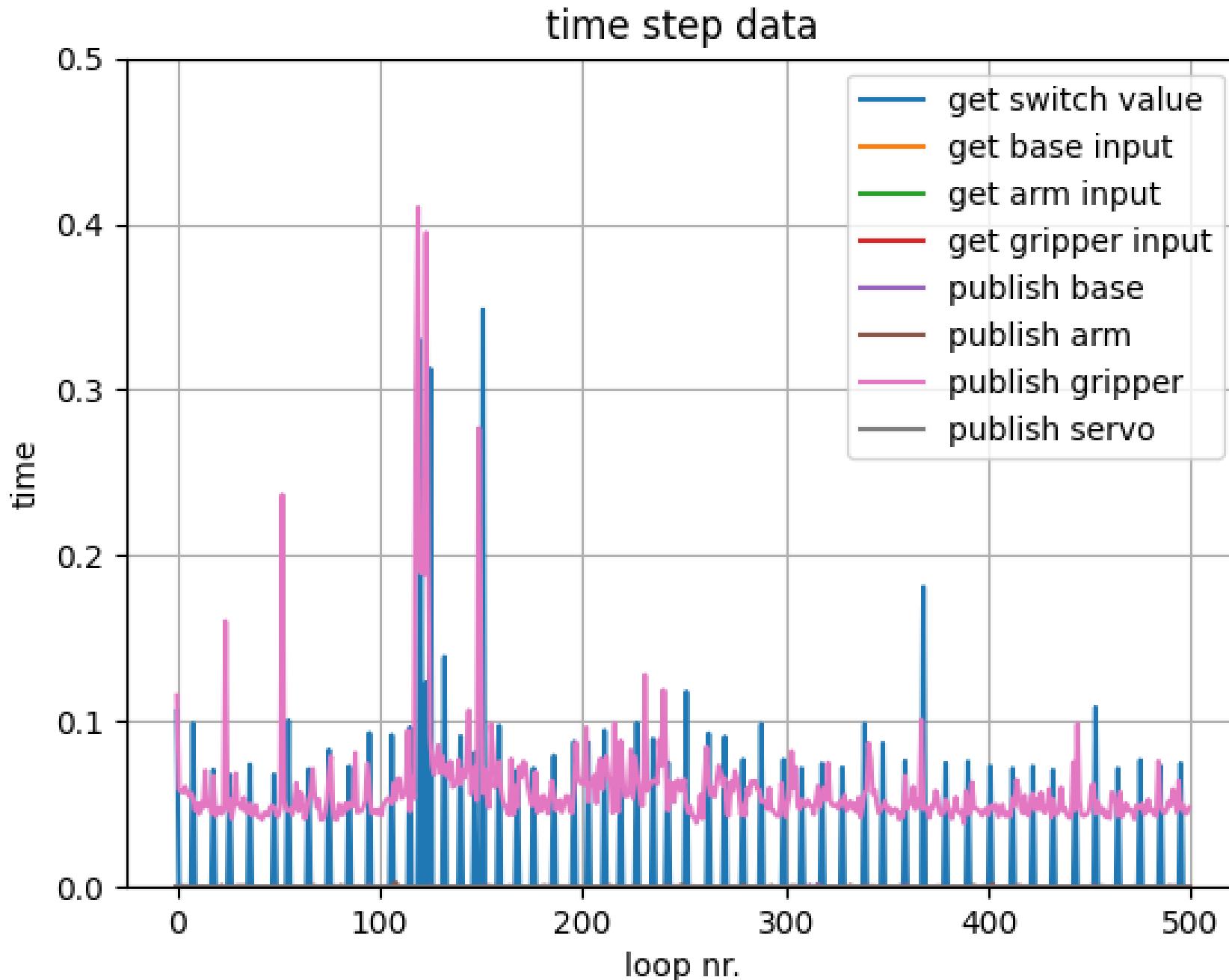
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# Control Loop Time Period

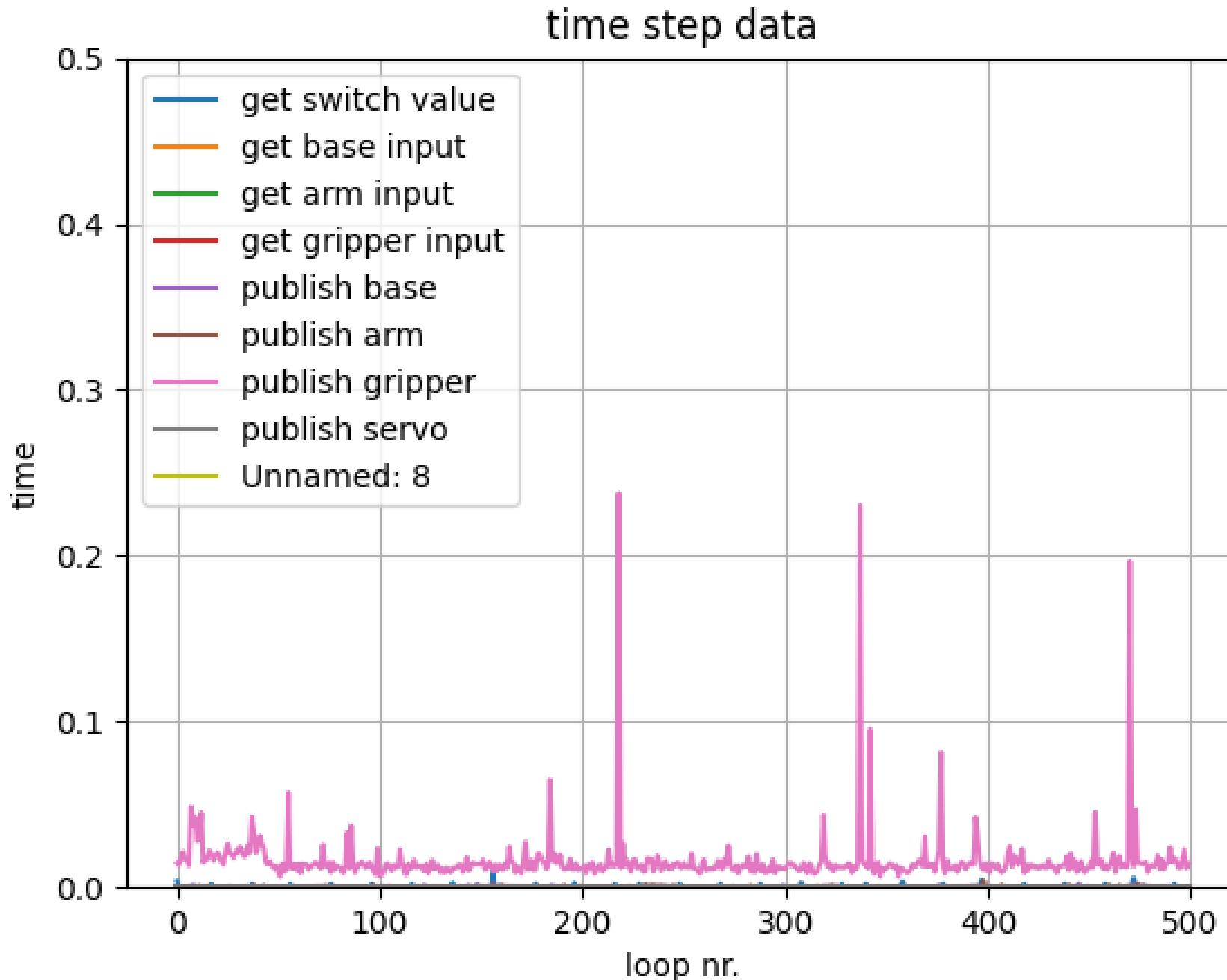


"Publish gripper" and "Get switch value" are services, so slower.

Changing the service to 'persistent' reduces the time.

```
#create the service,  
# serviceproxy is client side,  
# so for sending  
set_gripper_angle_service = rospy.ServiceProxy(  
    '/mirte/set_servoGripper_servo_angle',  
    SetServoAngle)
```

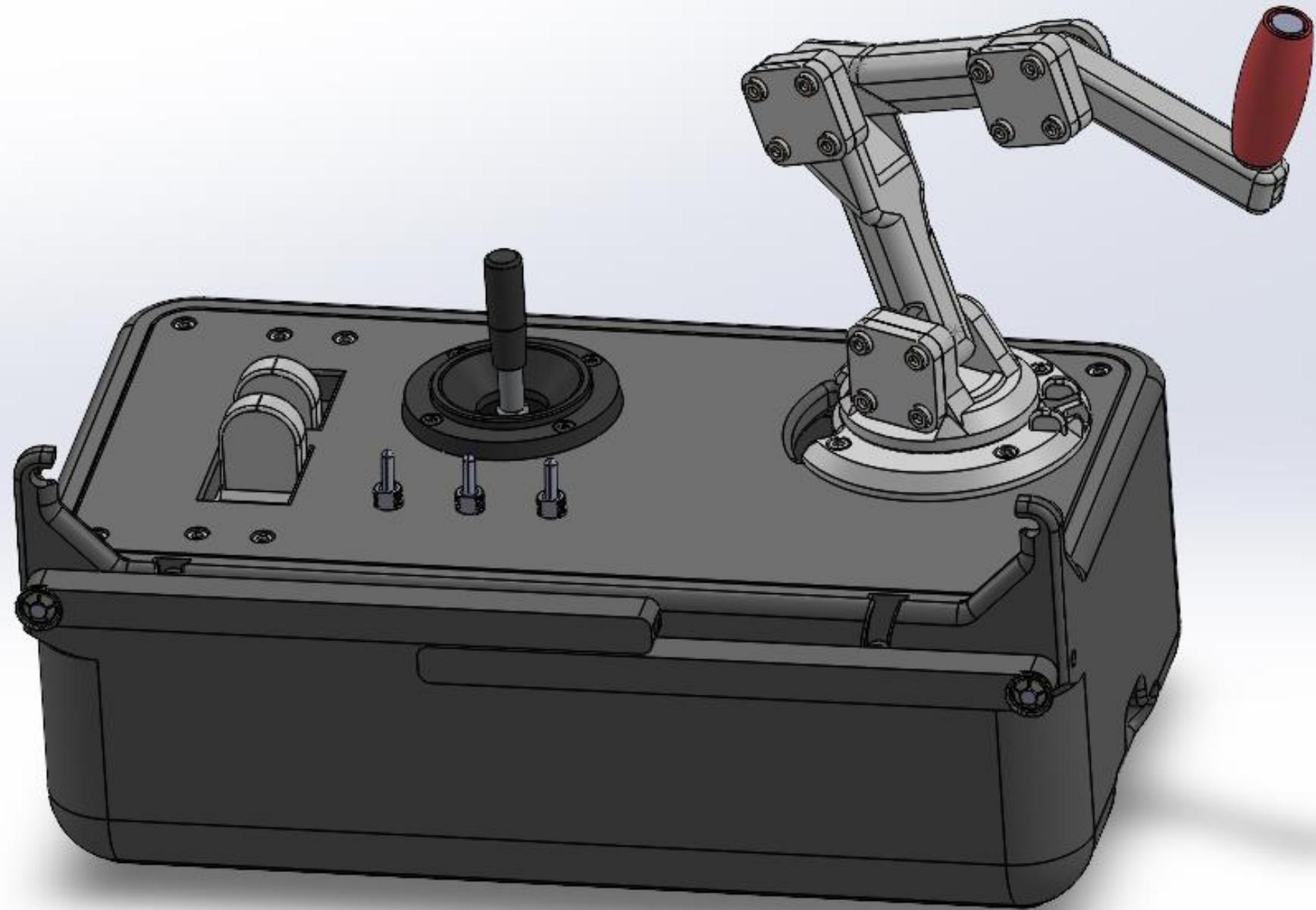
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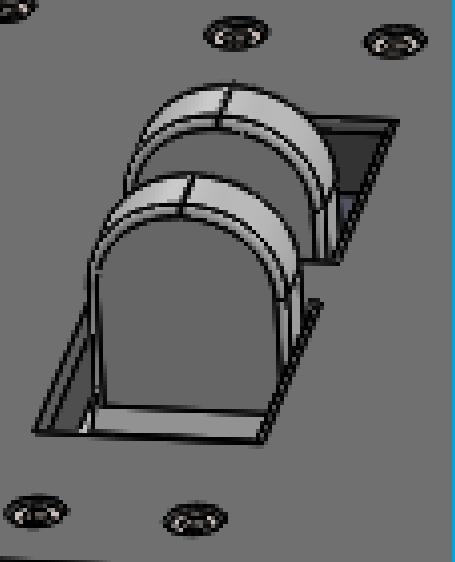


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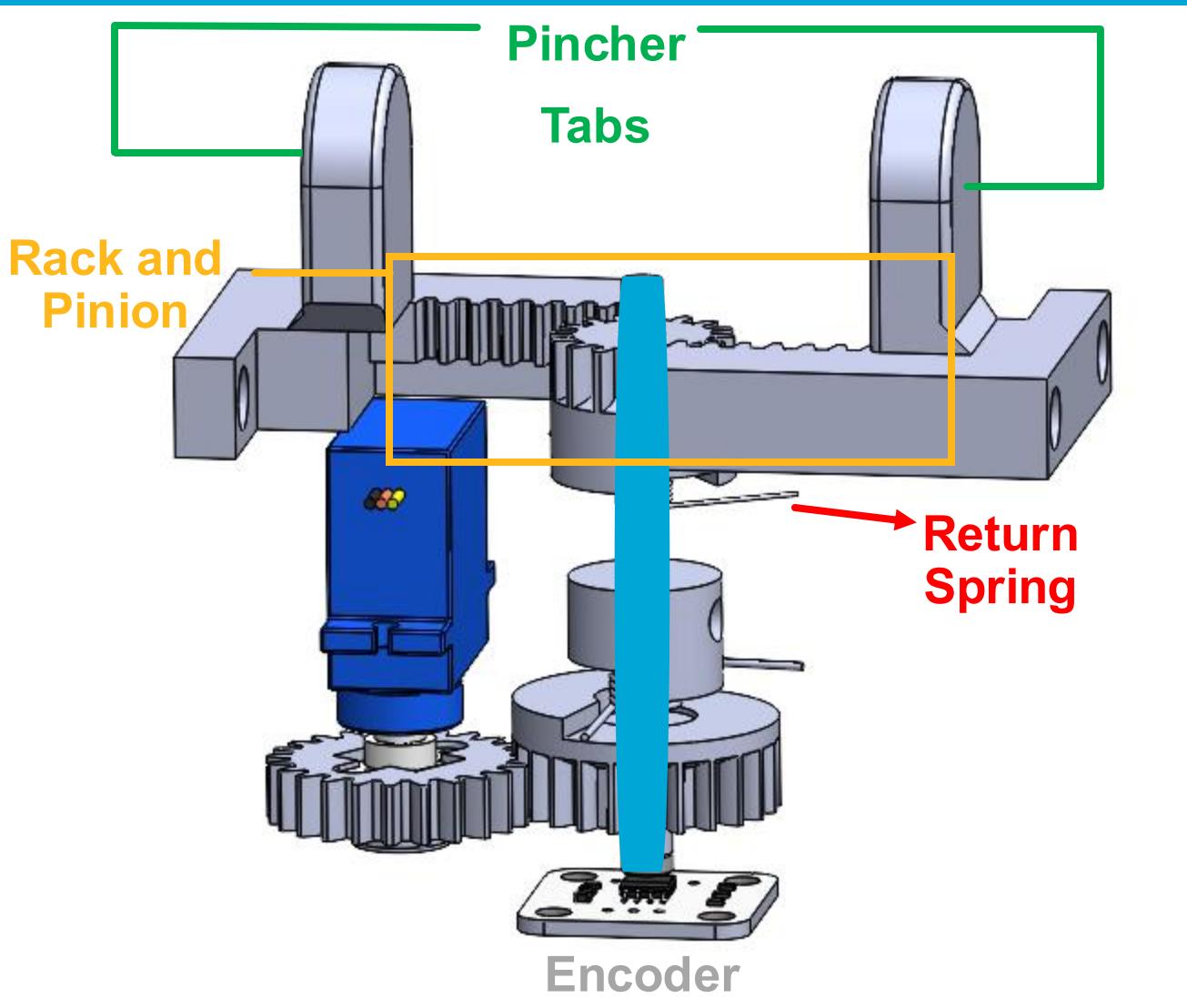
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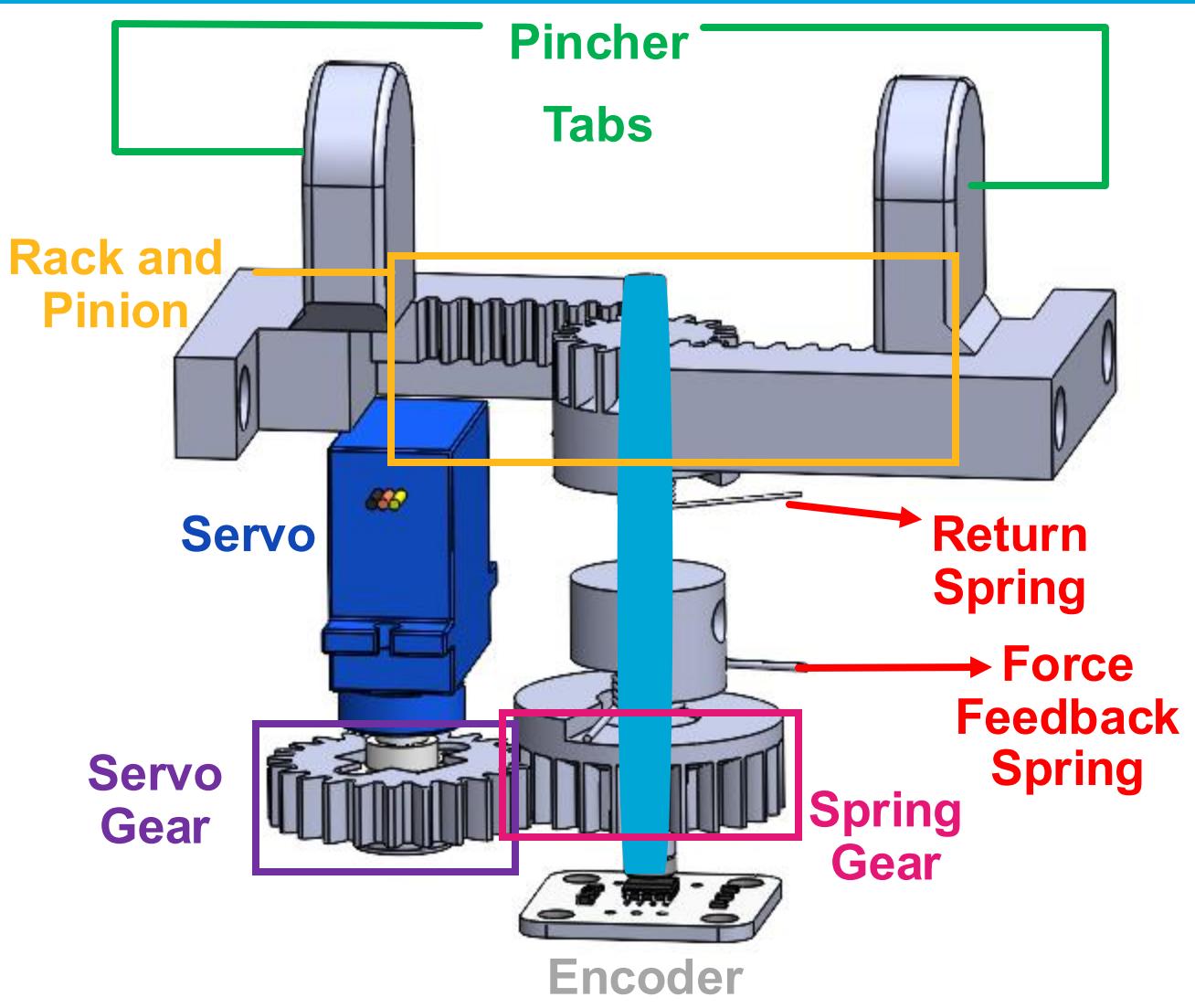




# Pincher (Mechanism)

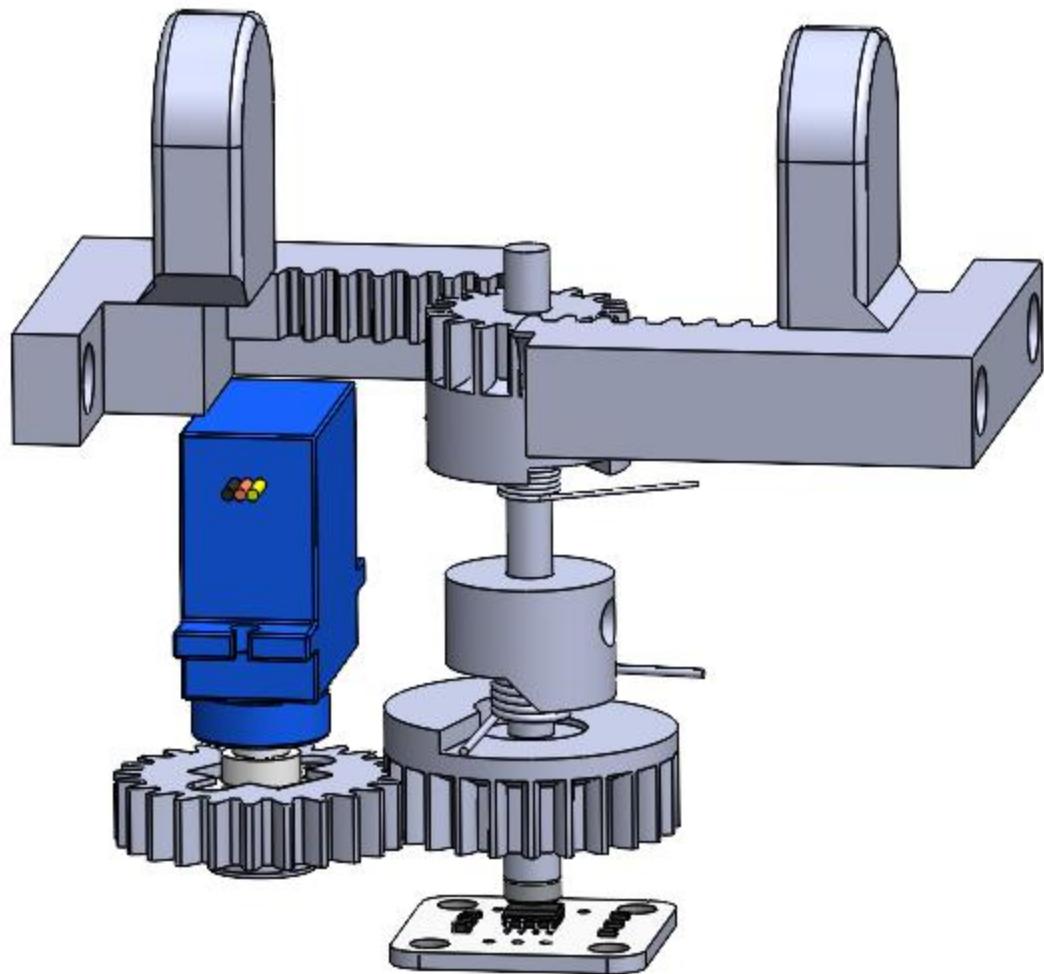


# Pincher (Force Feedback)



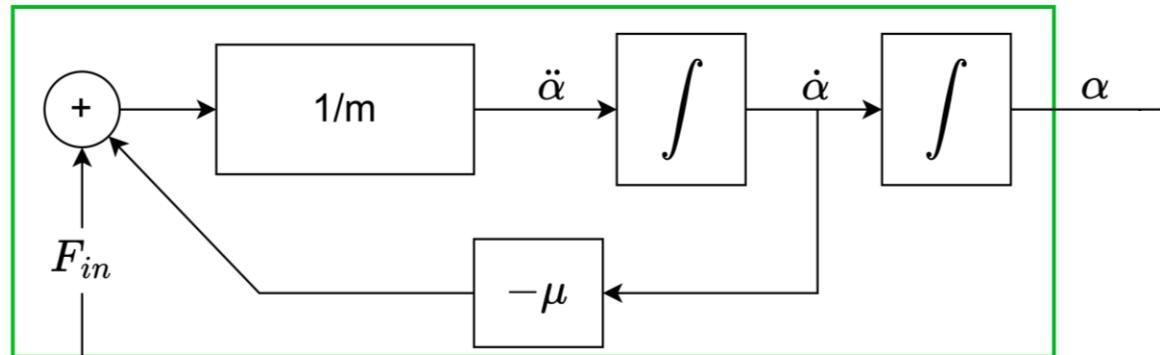
# Pincher (Series Elastic Actuation)

- Needed Actuators too large and expensive
- Spring ideally the same stiffness as the tomato
- Smaller servo has needed output

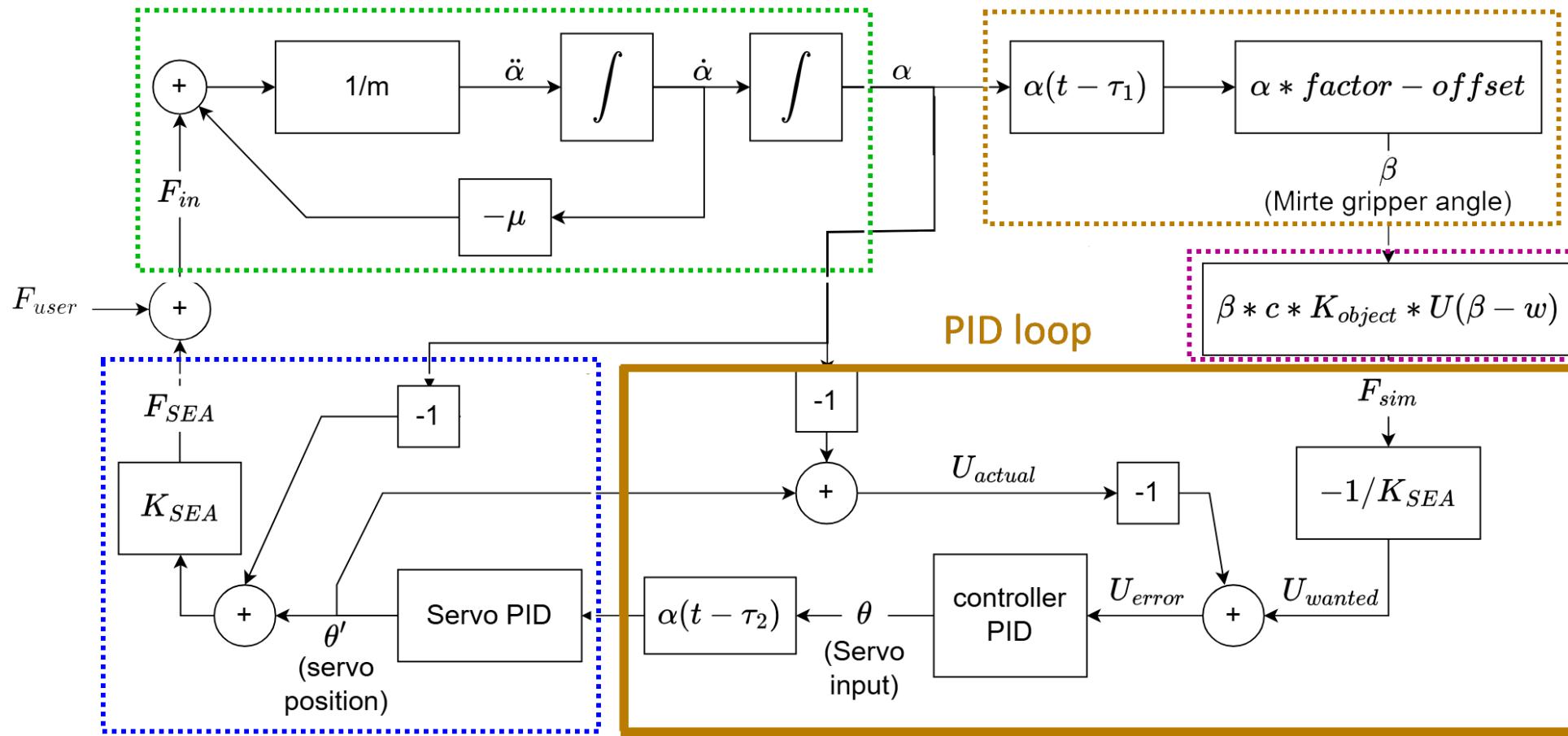


# Force feedback Controll loop

pincher mechanics



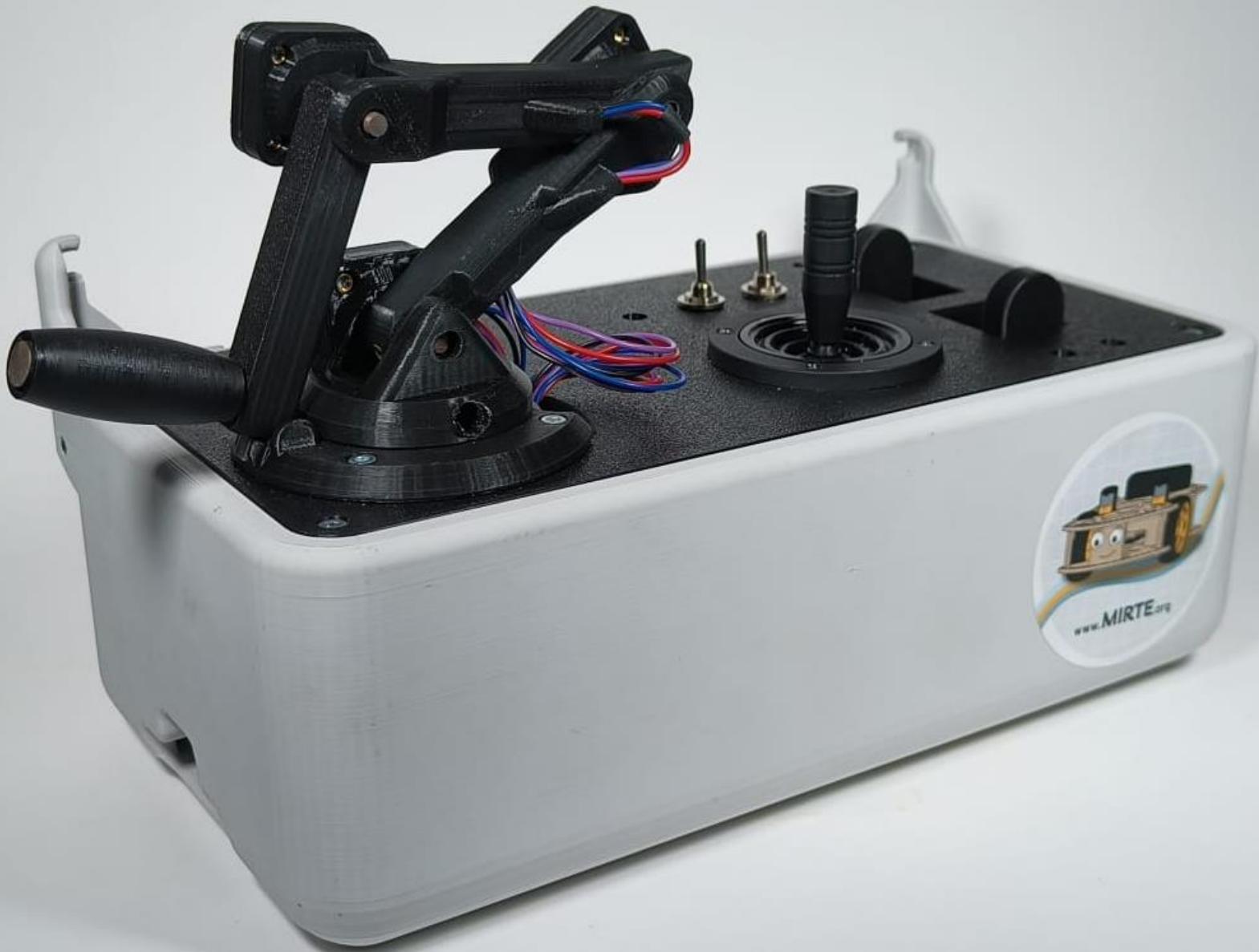
# Force feedback Controll loop



# Conclusion



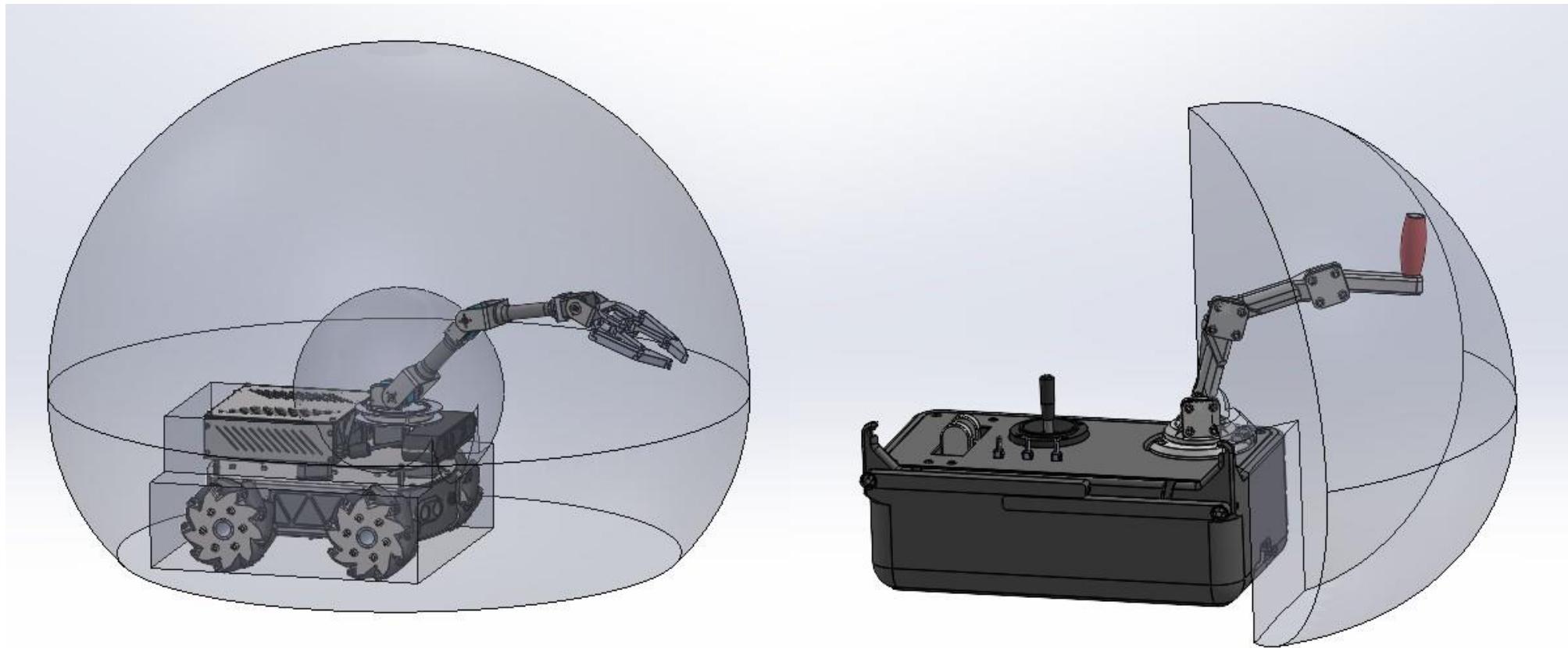
Time for  
Questions



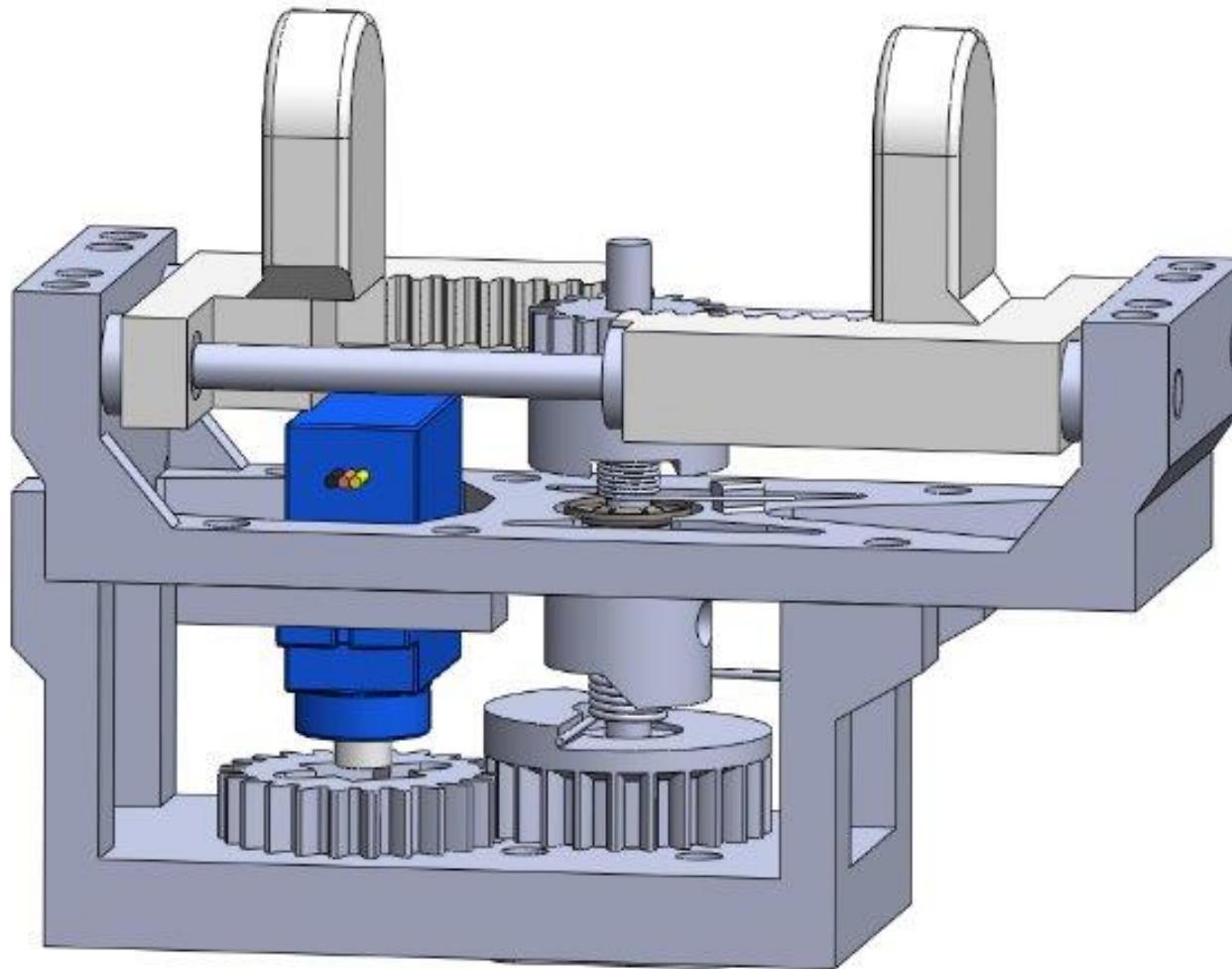


# Other visuals / slides

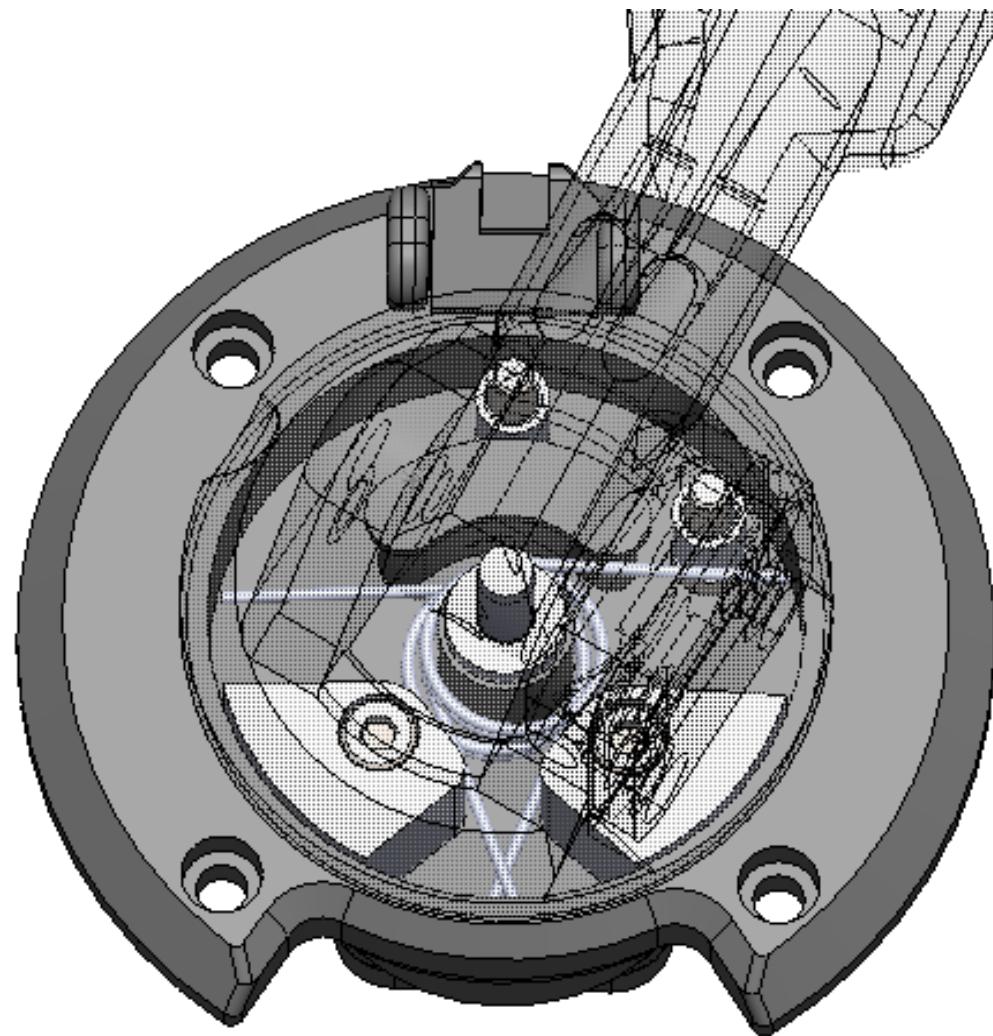
# Workspace Comparison of the MM and Controller Arm



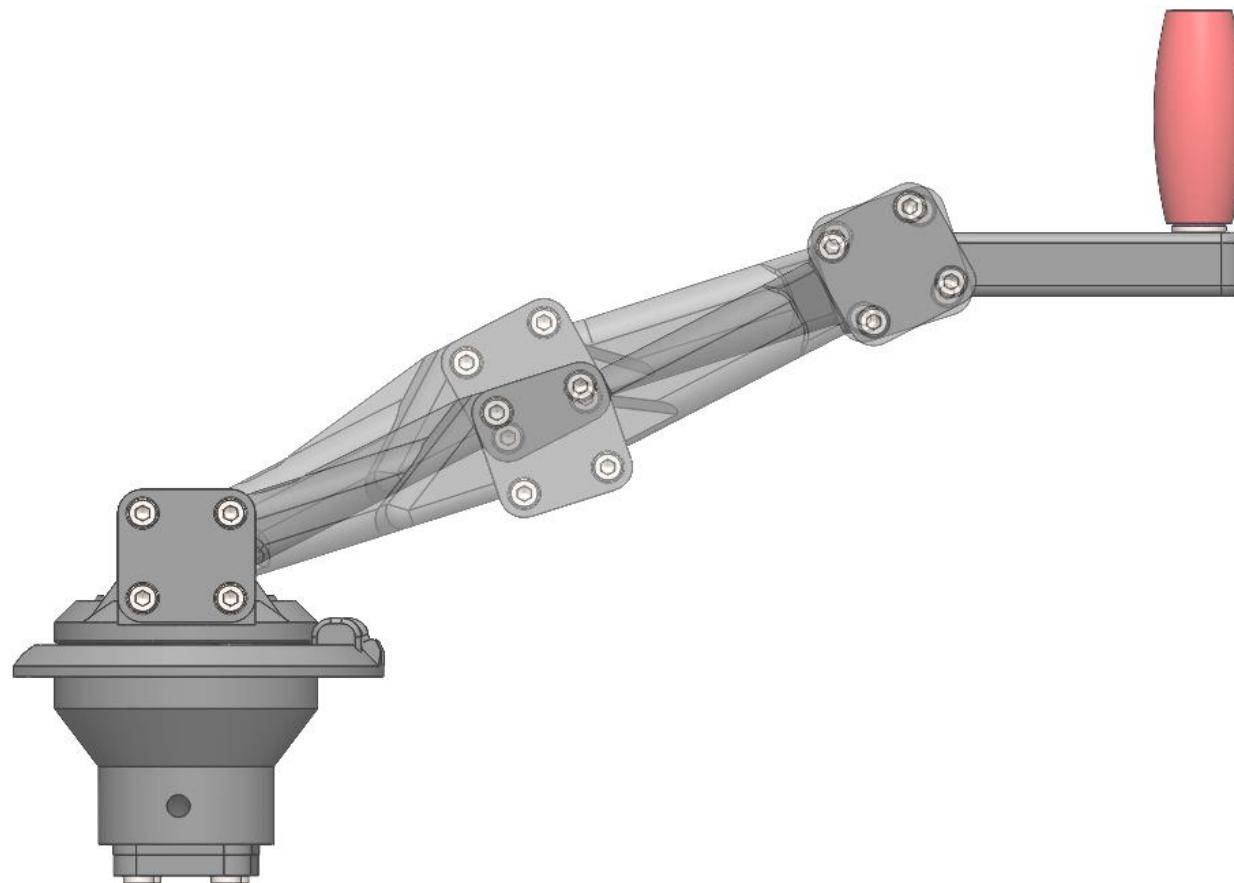
# Pincher render



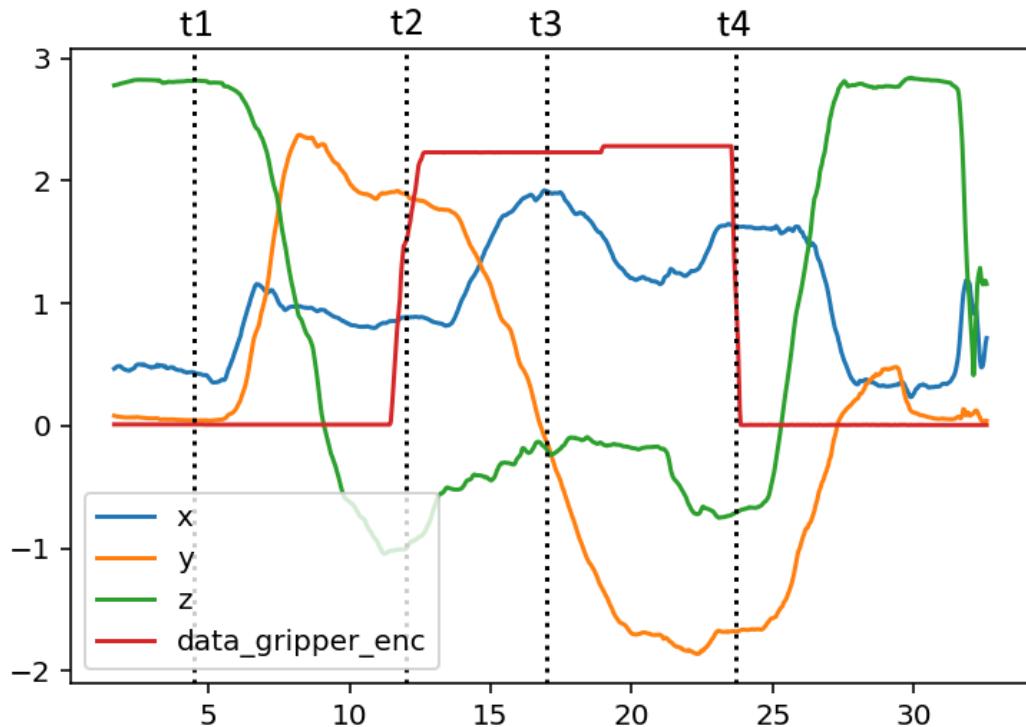
# Yaw springsystem render



# Elbow dead zone



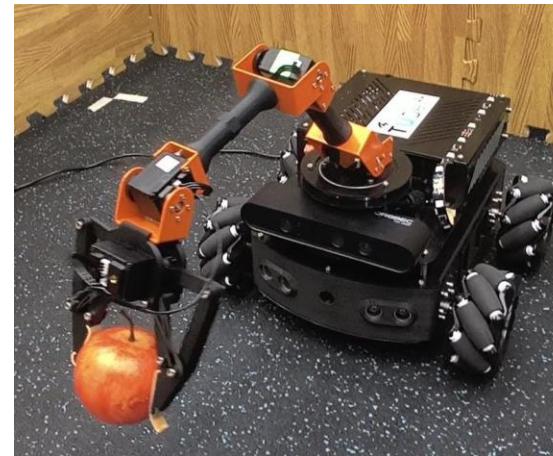
# Pick and place graph with snapshots



t1



t2

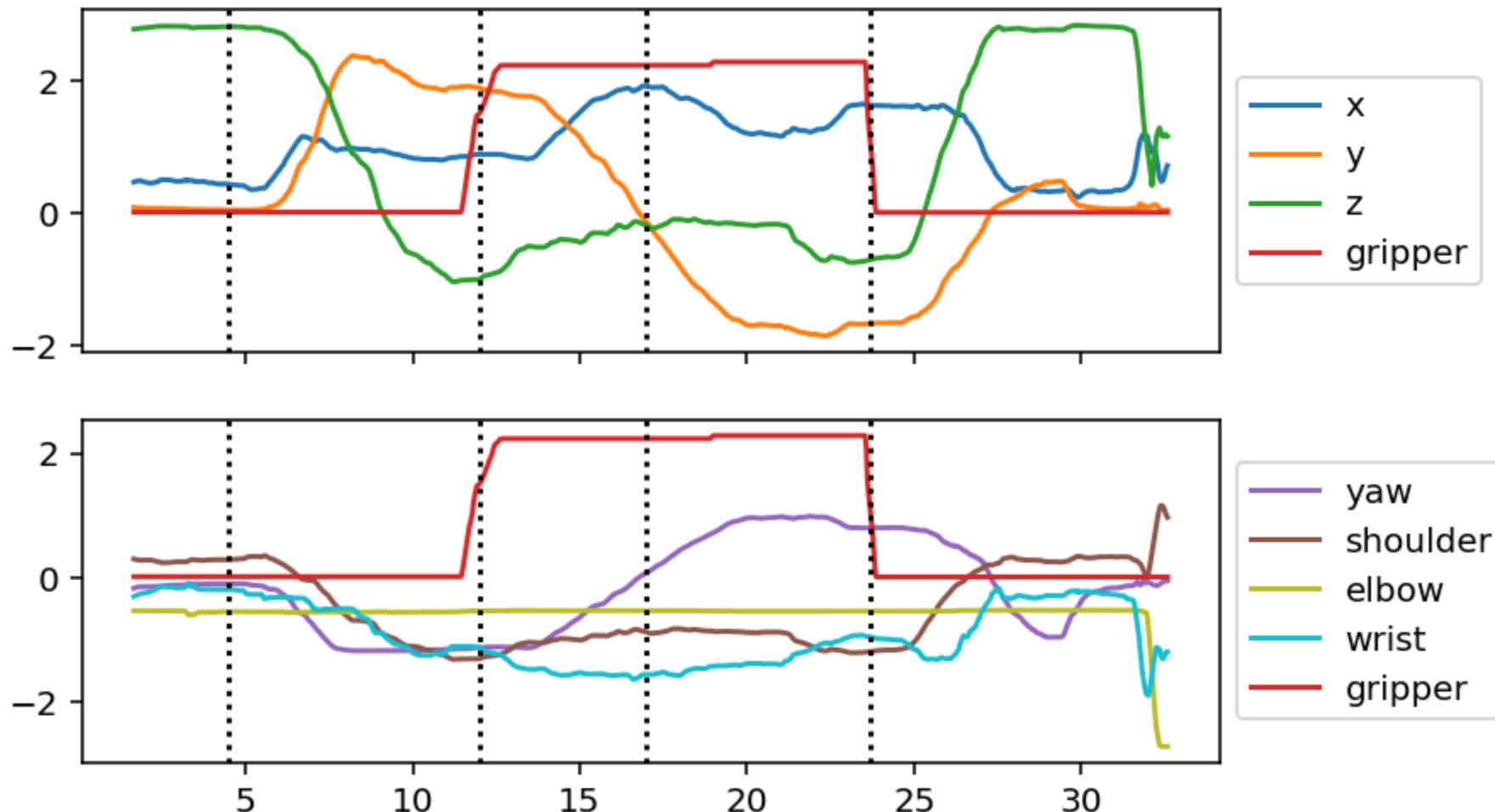


t3



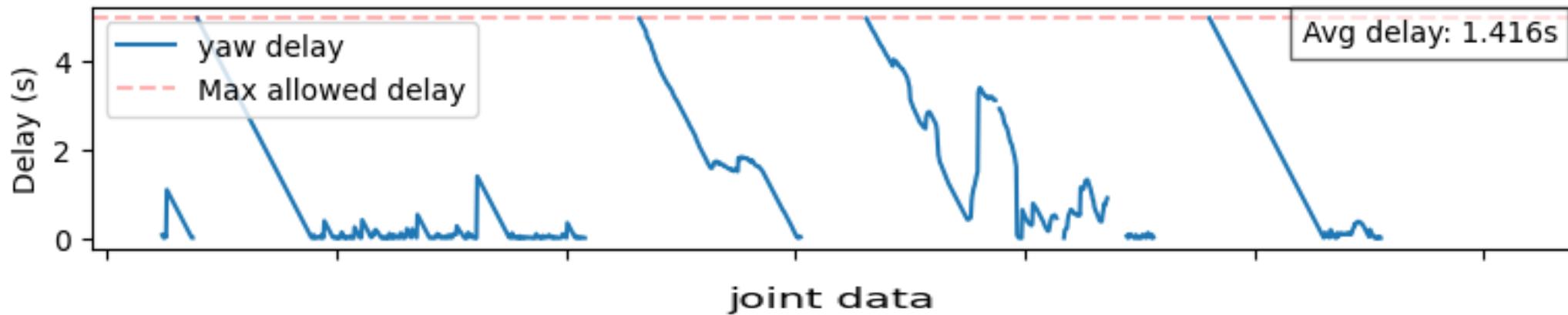
t4

# Pick and place joint angle graph

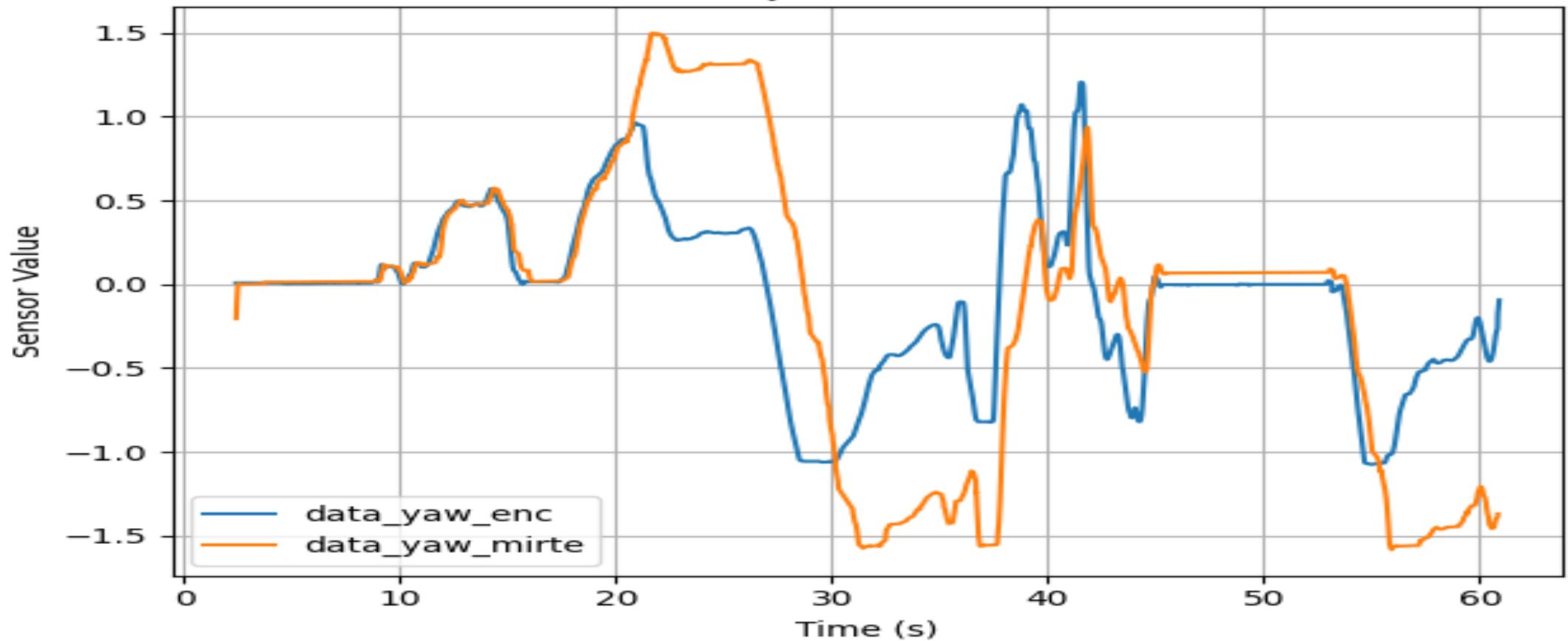


## Delay analysis per joint - Yaw

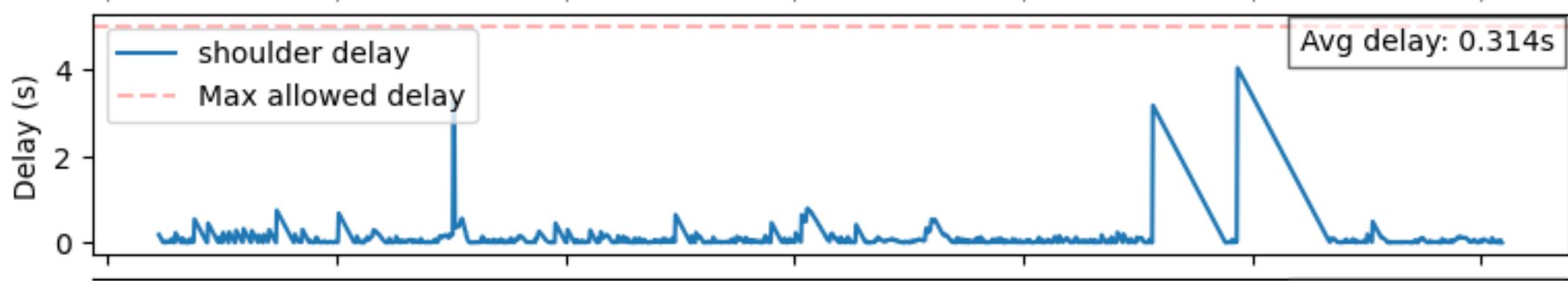
### Delay per Encoder Command per Joint



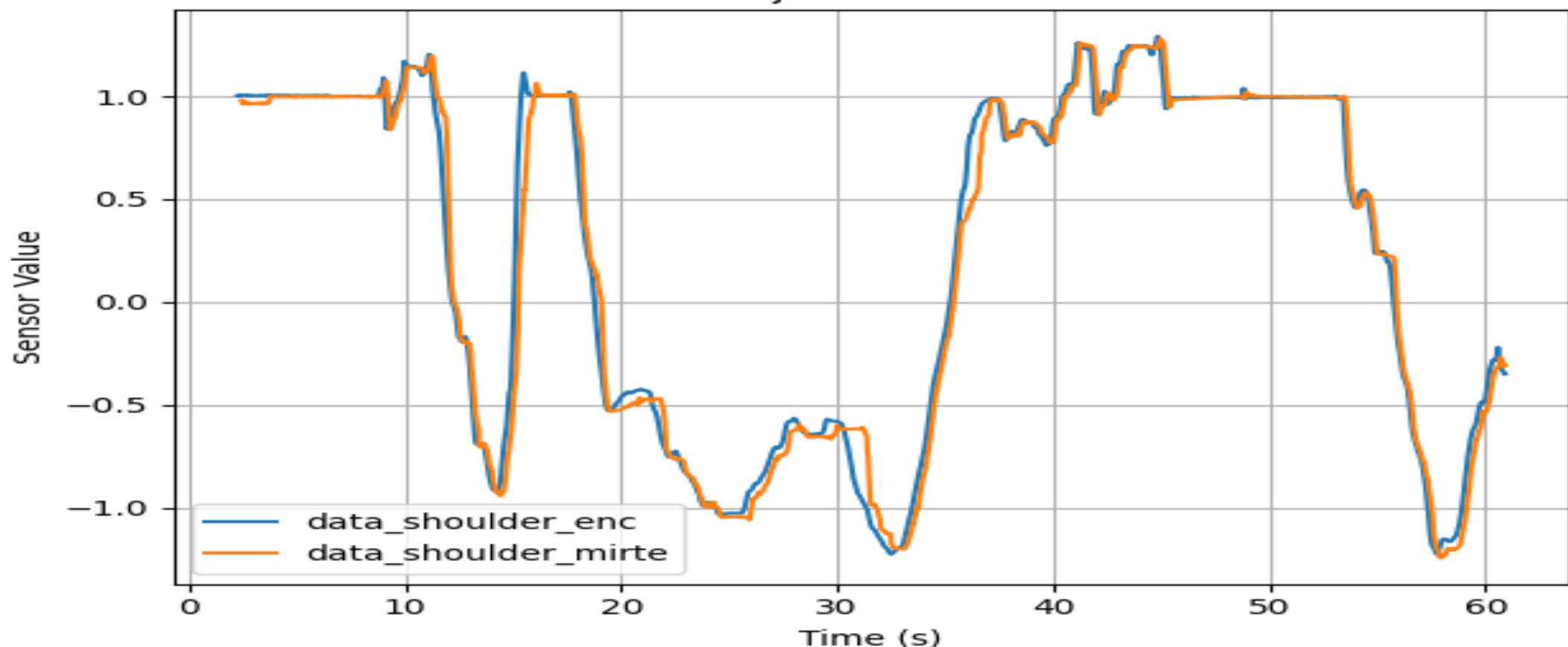
joint data



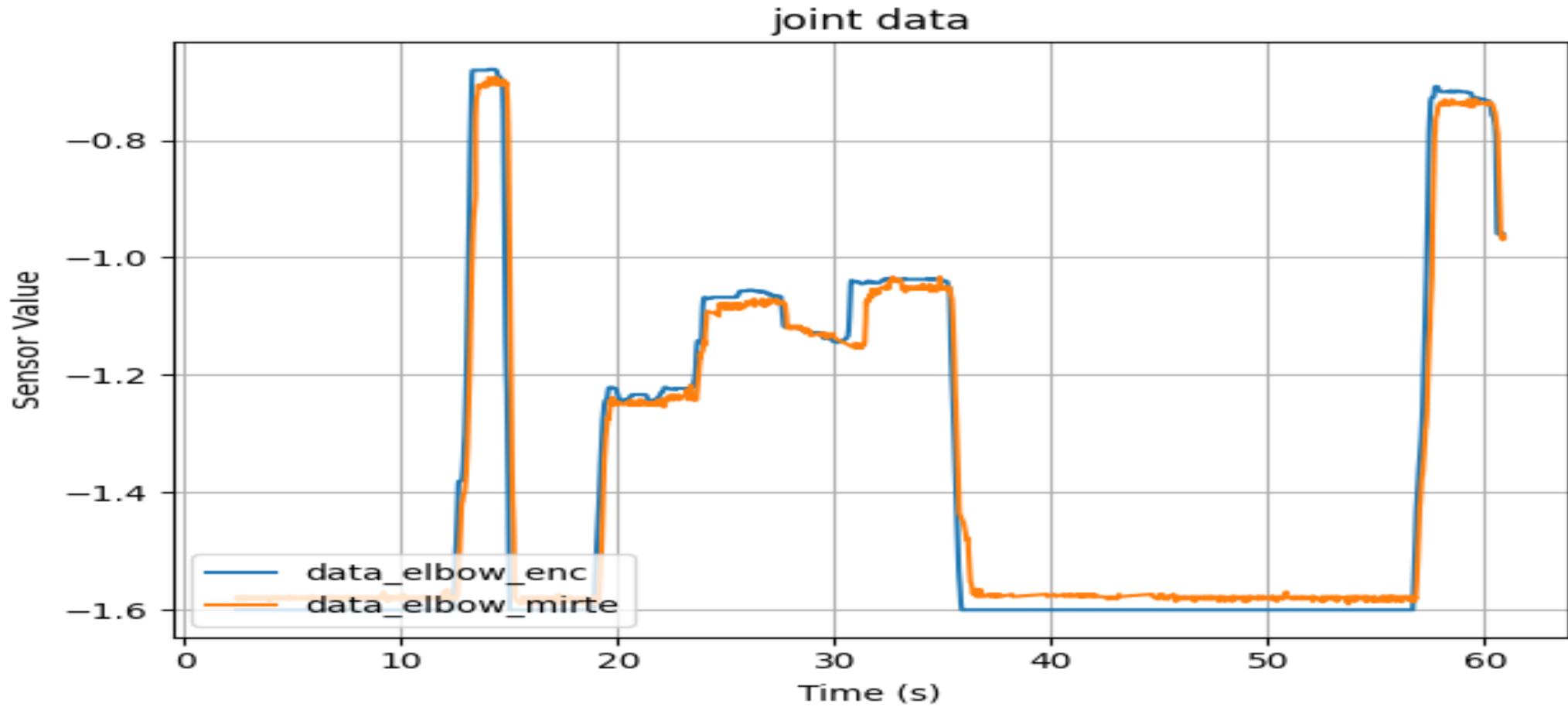
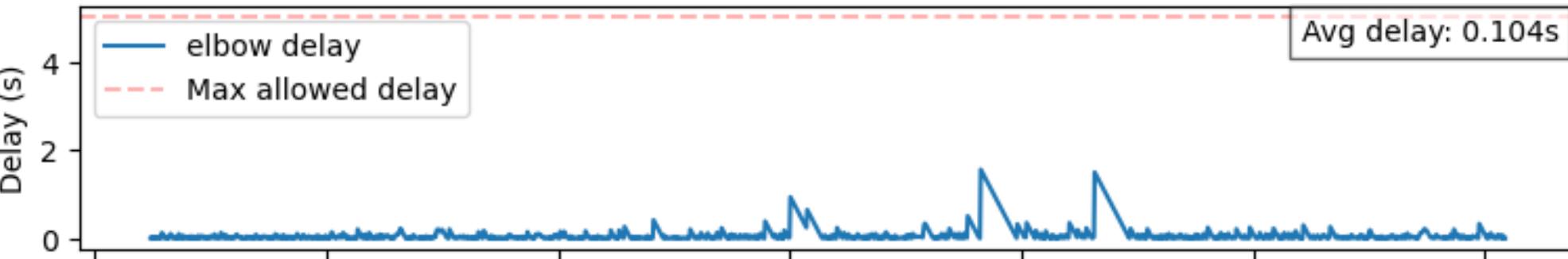
# Delay analysis per joint - Shoulder



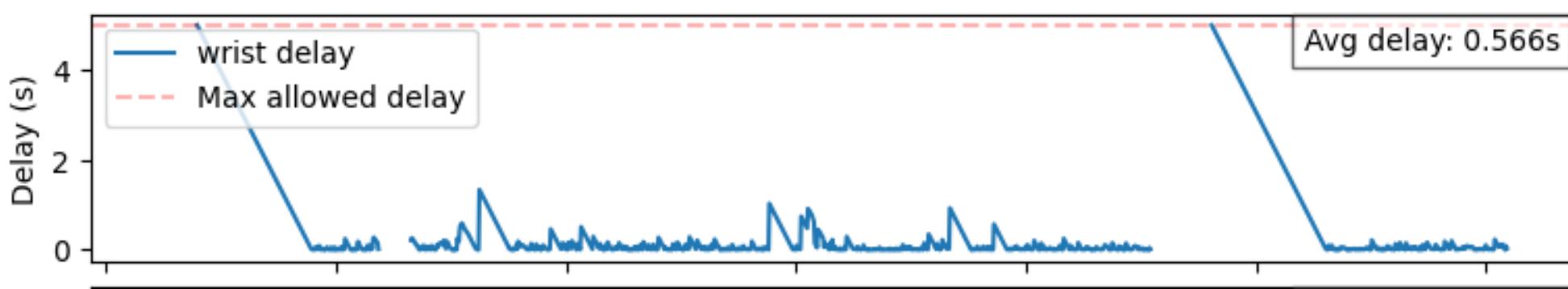
joint data



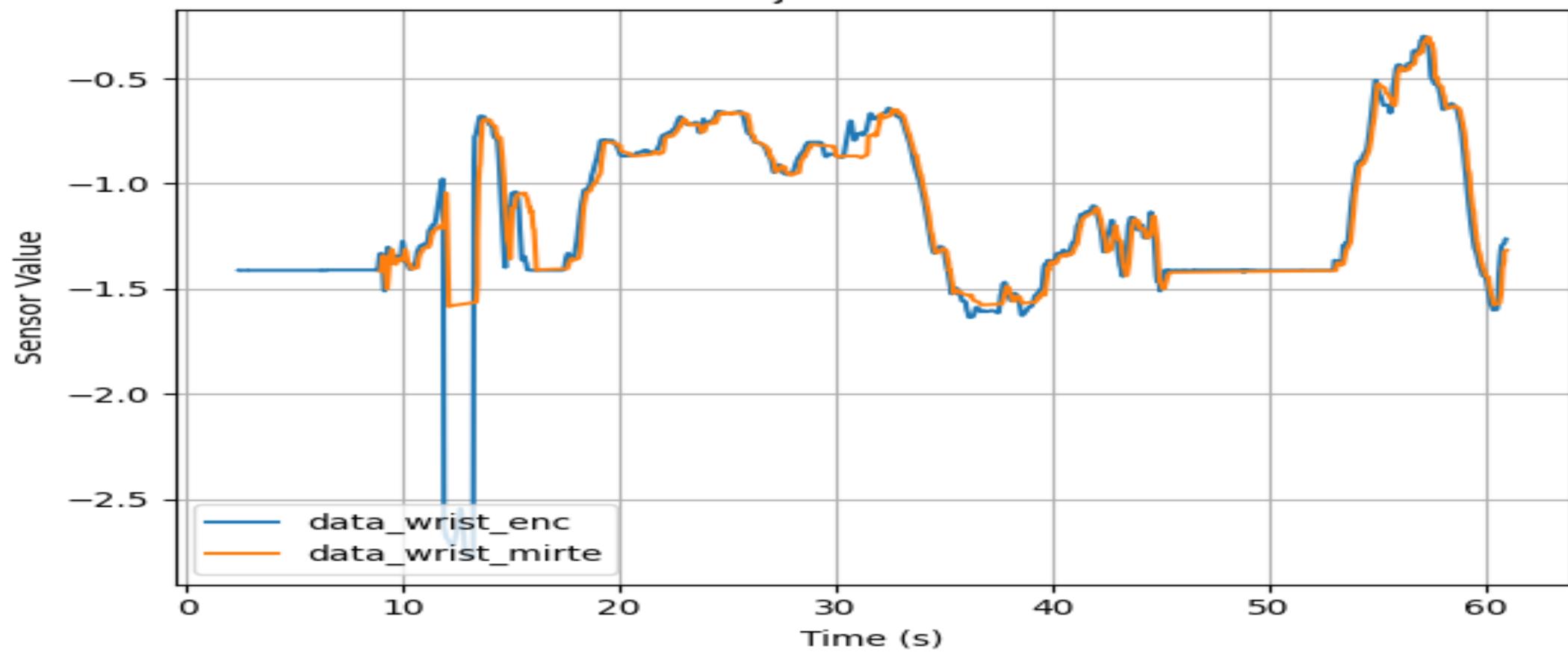
## Delay analysis per joint - Elbow



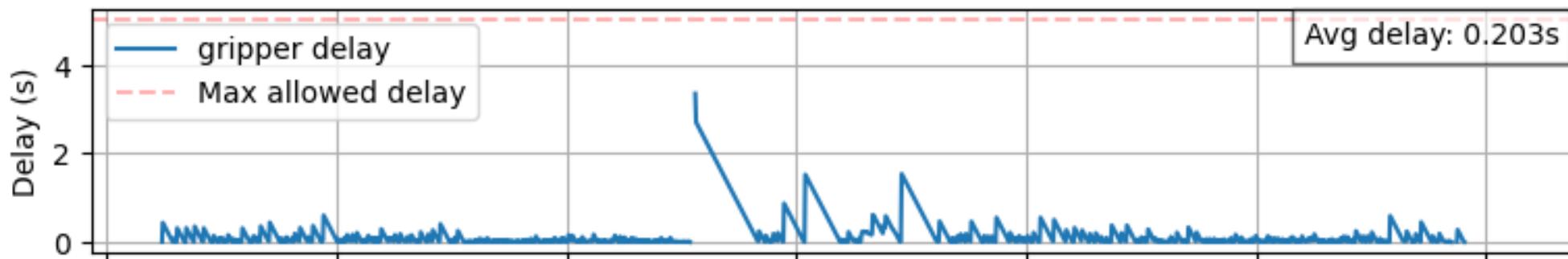
## Delay analysis per joint - Wrist



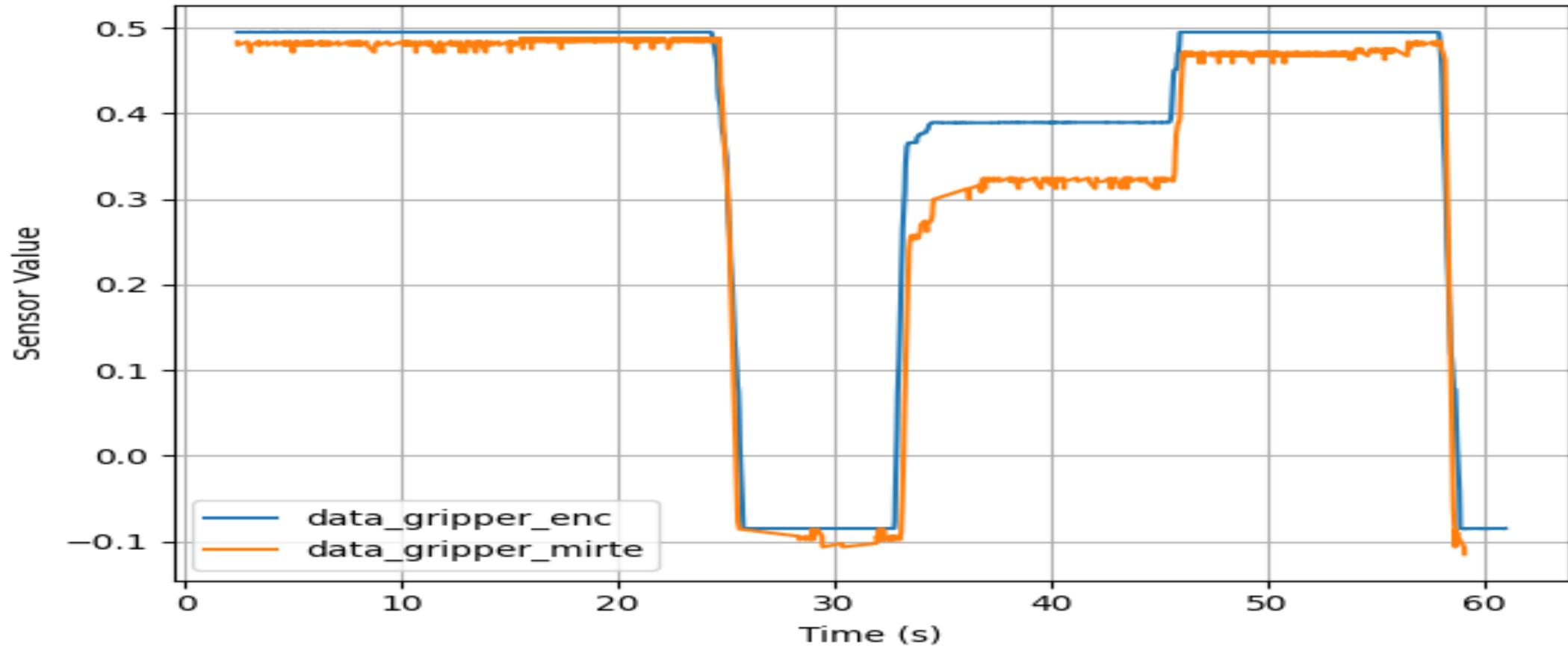
joint data



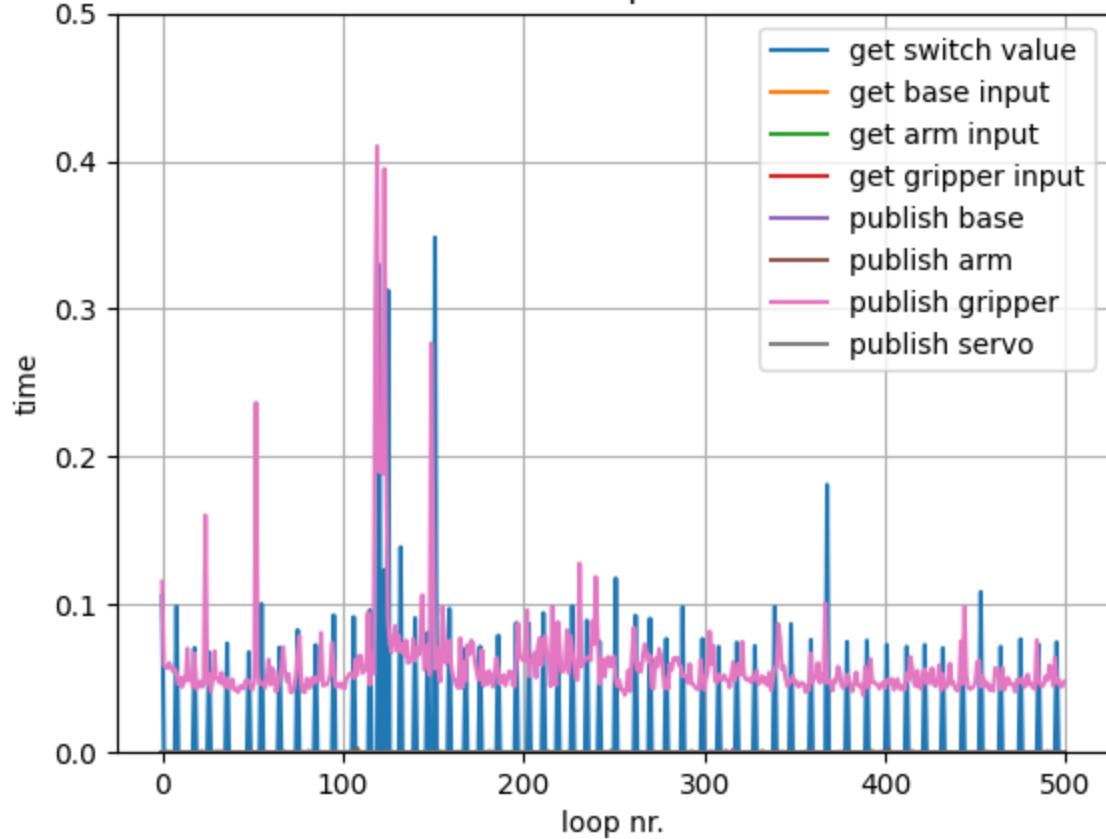
## Delay analysis per joint - Gripper



joint data



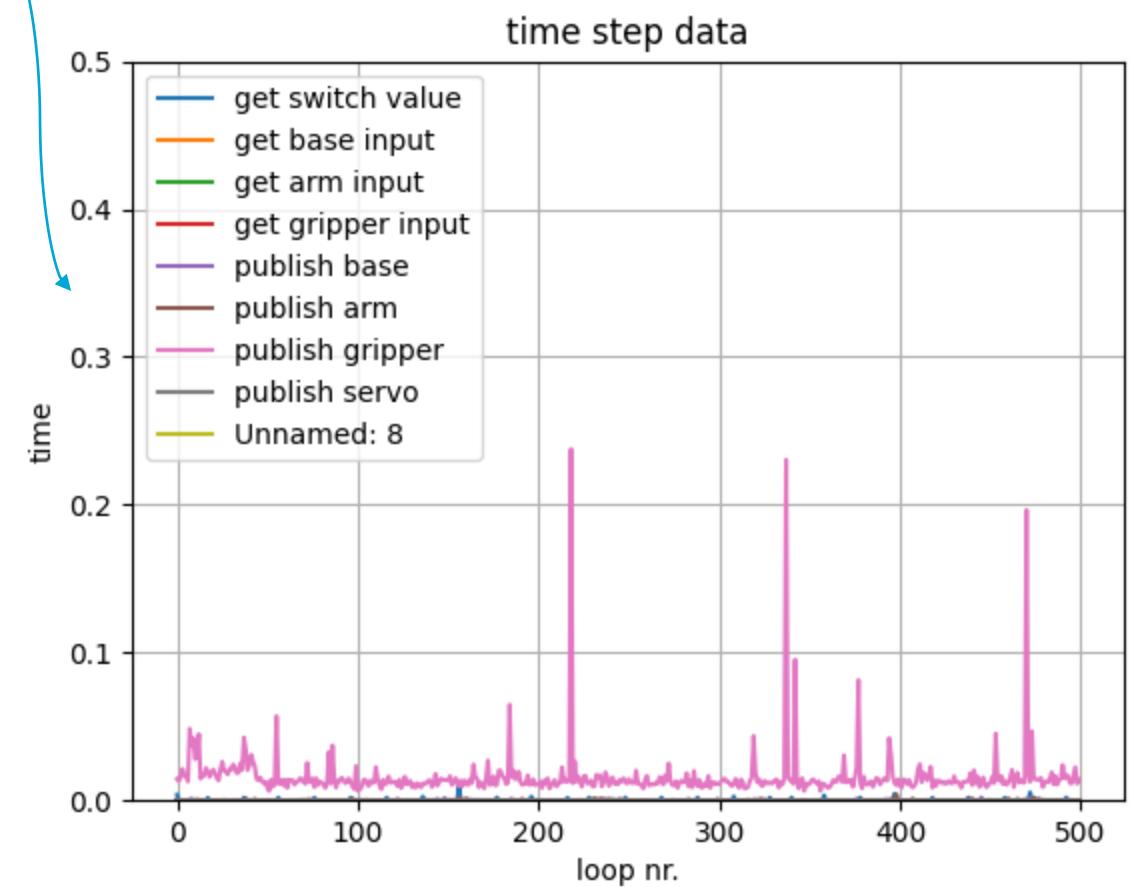
time step data



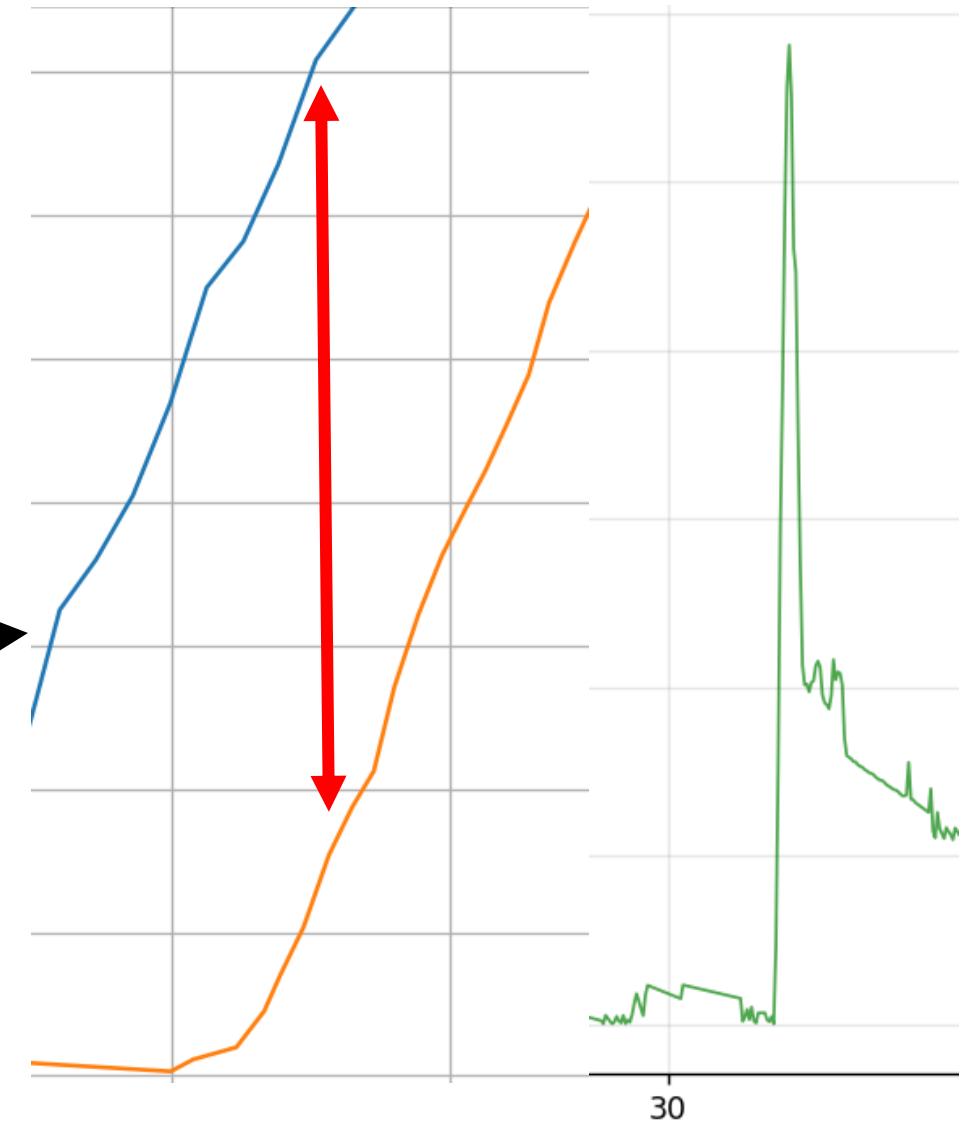
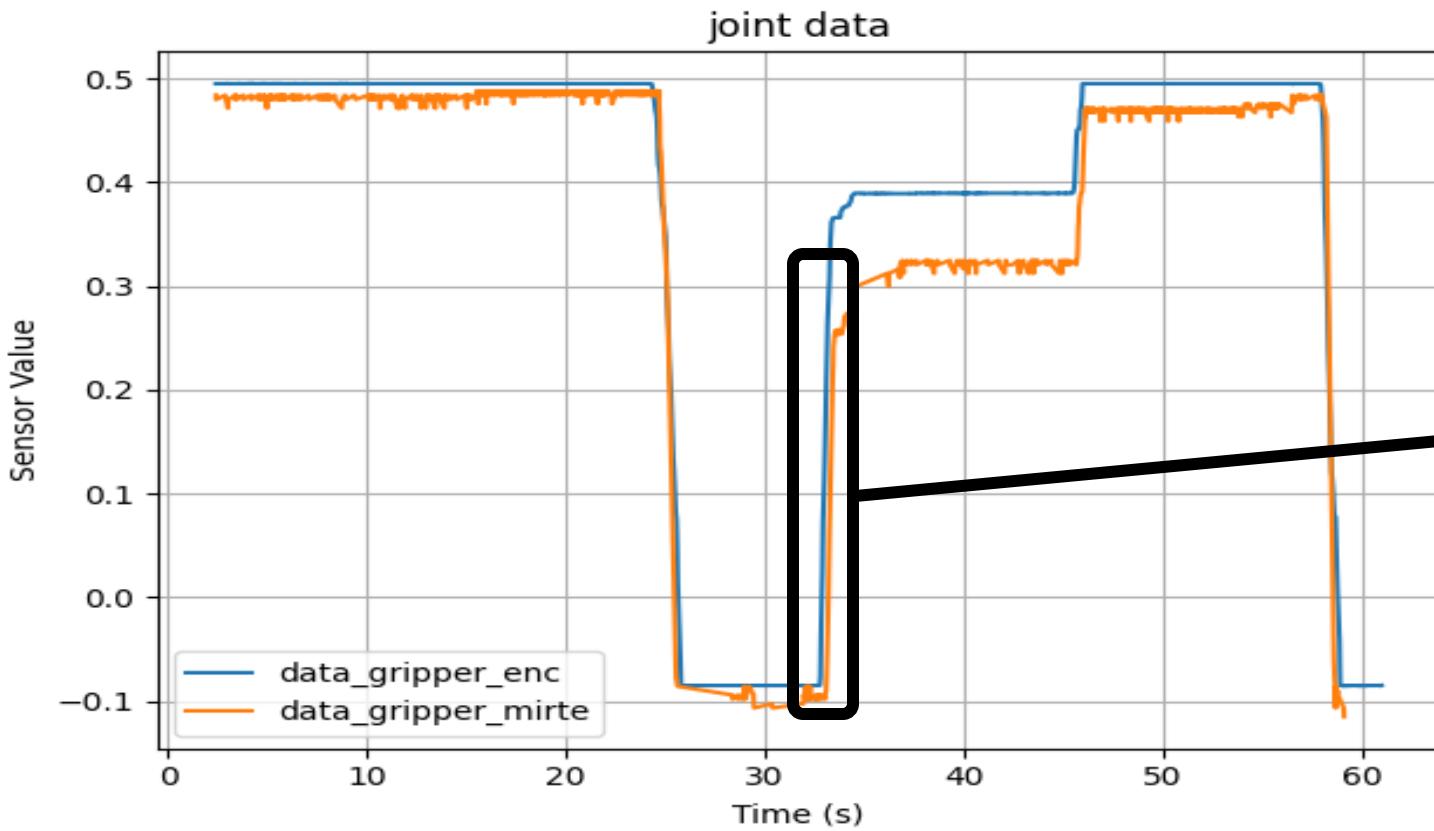
**Duration of steps in control loop.**

Before 'persistent'

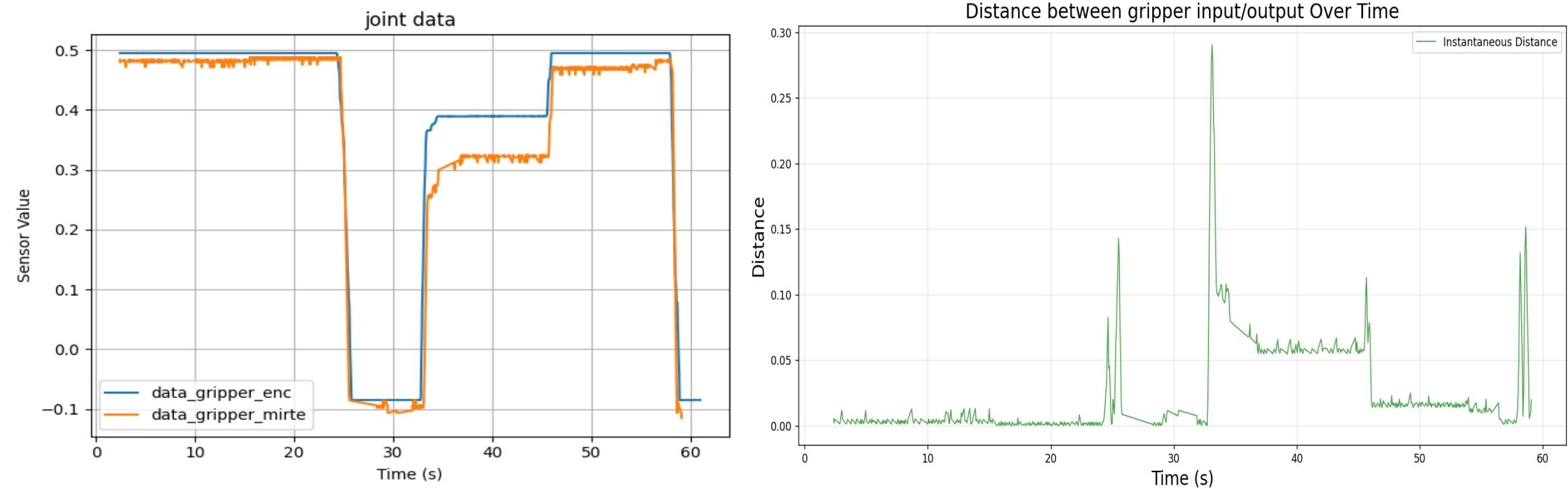
After 'persistent'



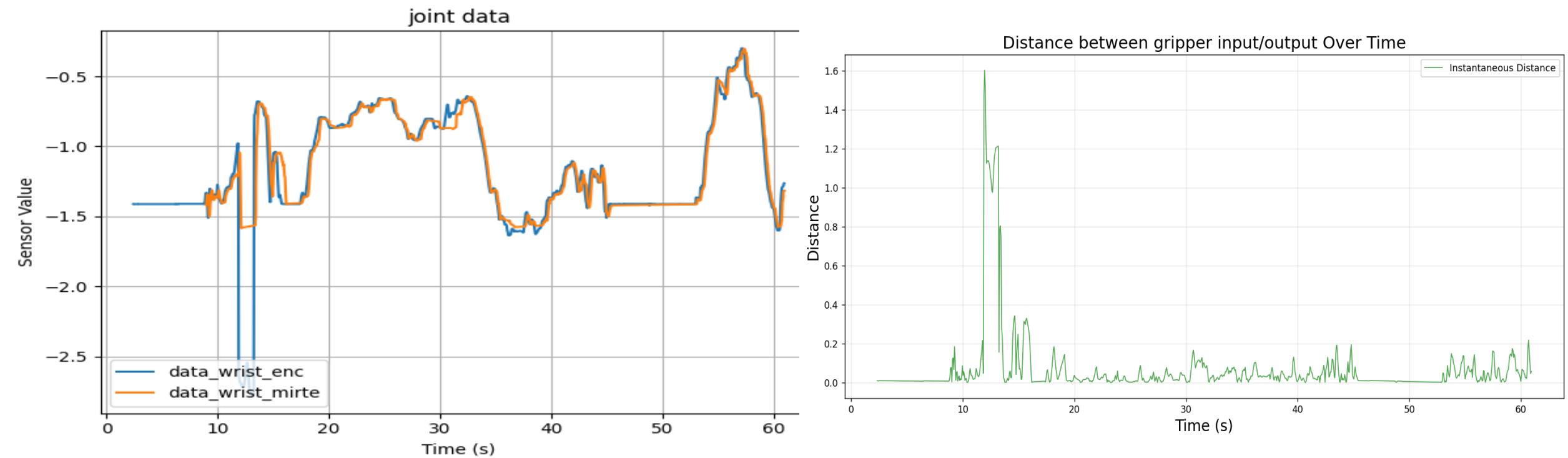
# Deviation stark increase



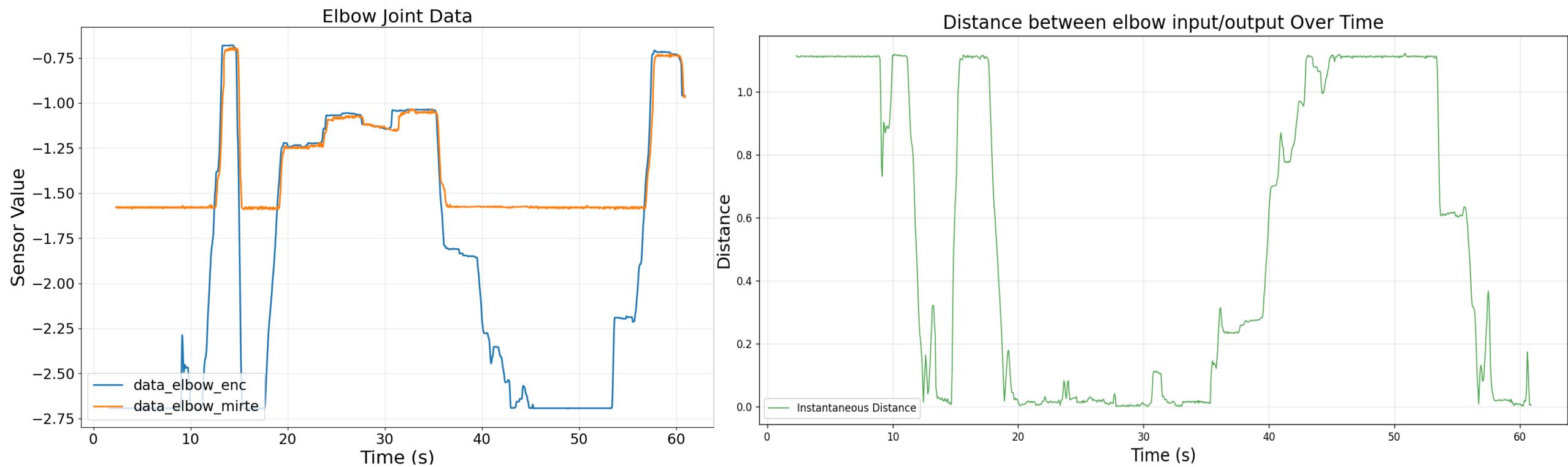
# Deviation graph gripper



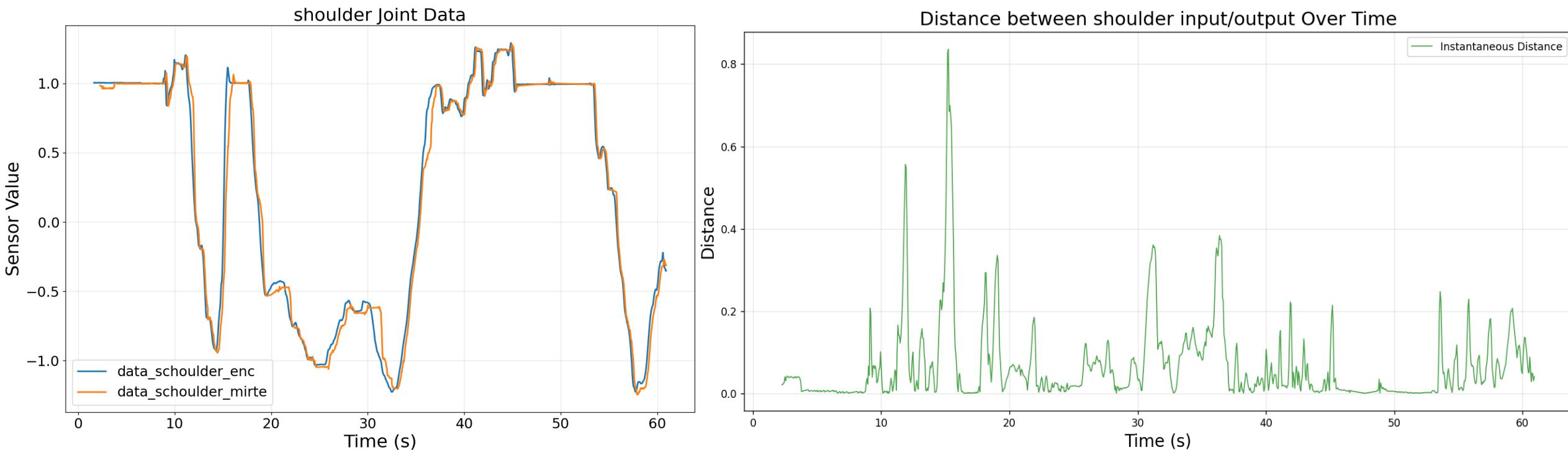
# Deviation graph wrist



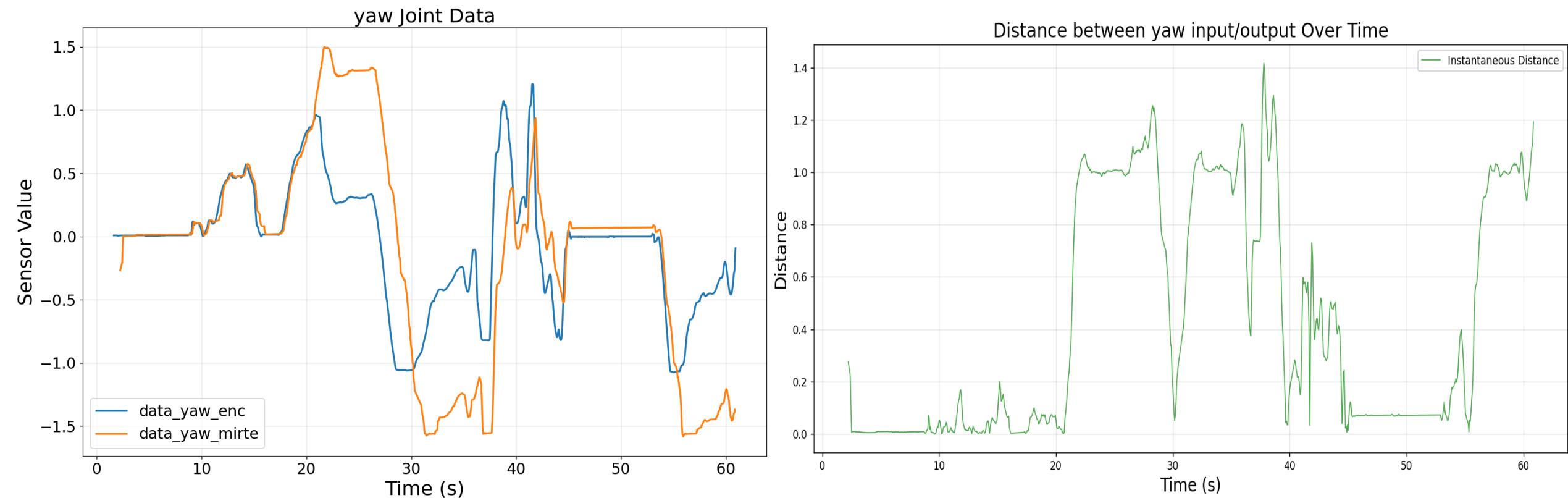
# Deviation graph elbow



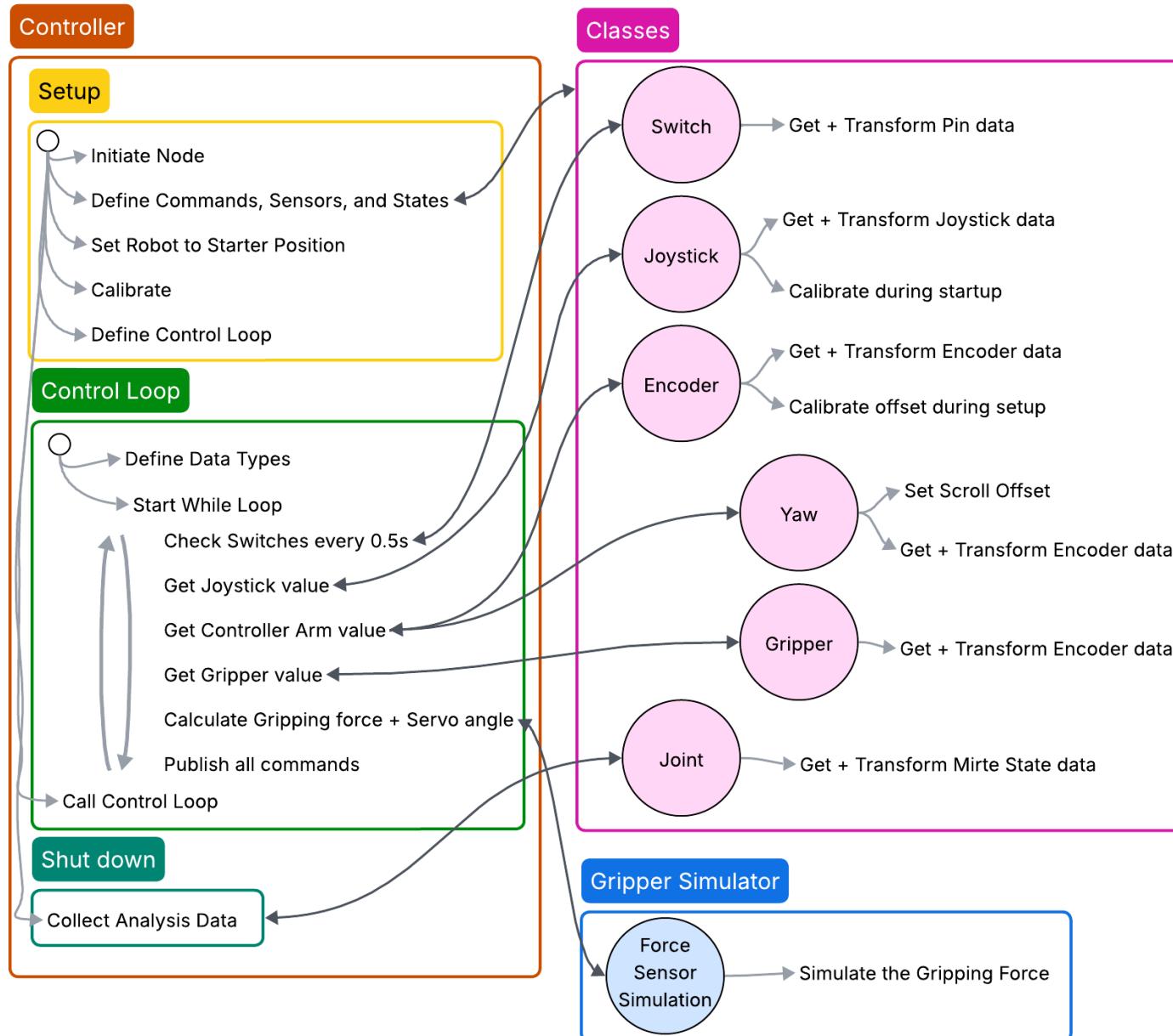
# Deviation graph shoulder



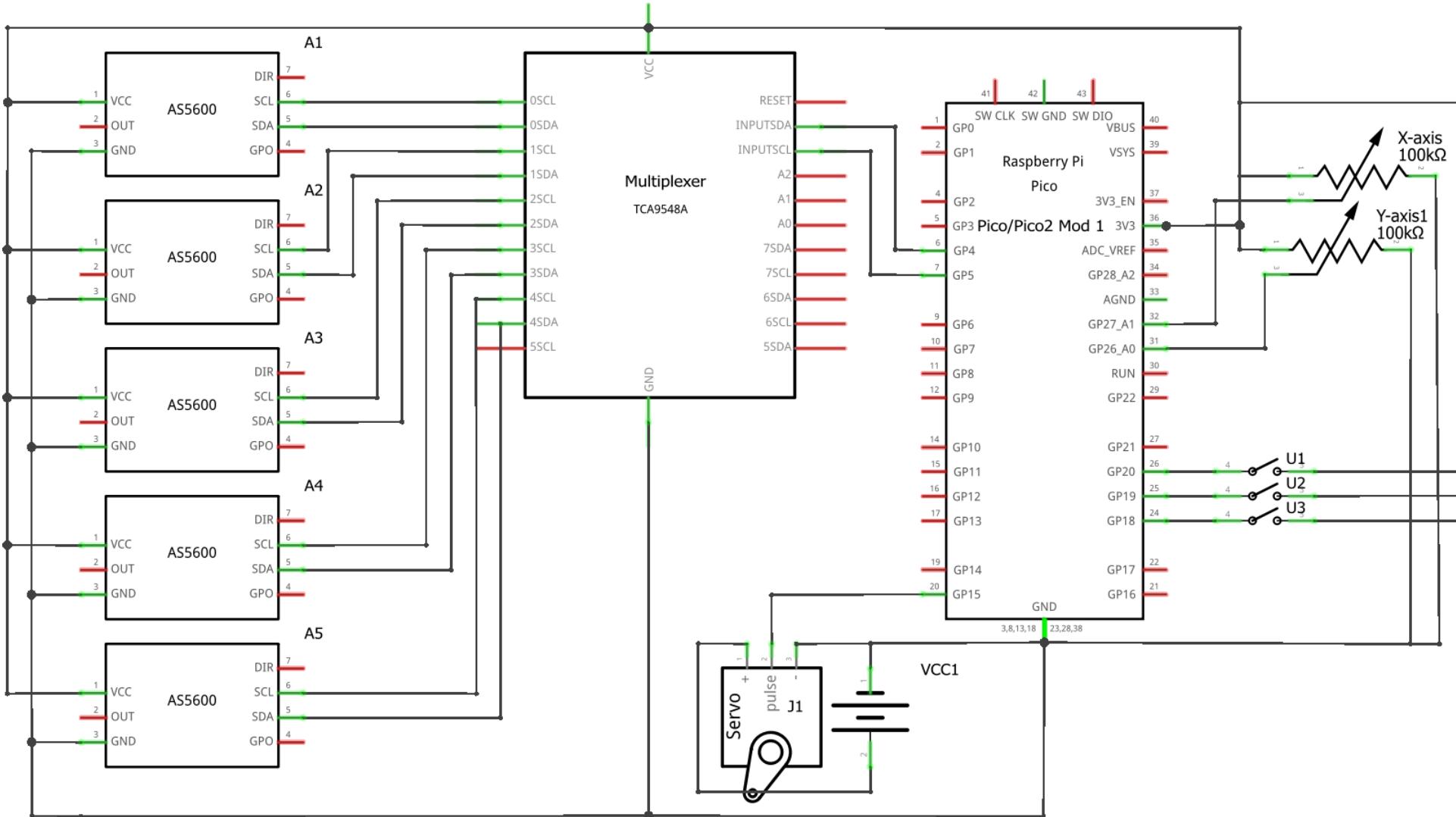
# Deviation graph yaw



# Software diagram

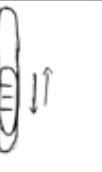
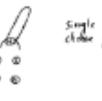
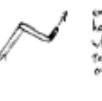
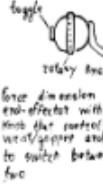
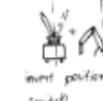


# Electrical diagram

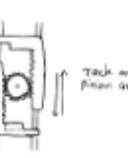
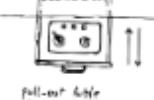
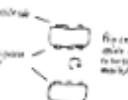
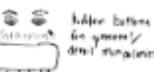
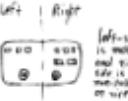
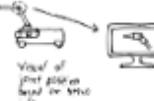


fritzing

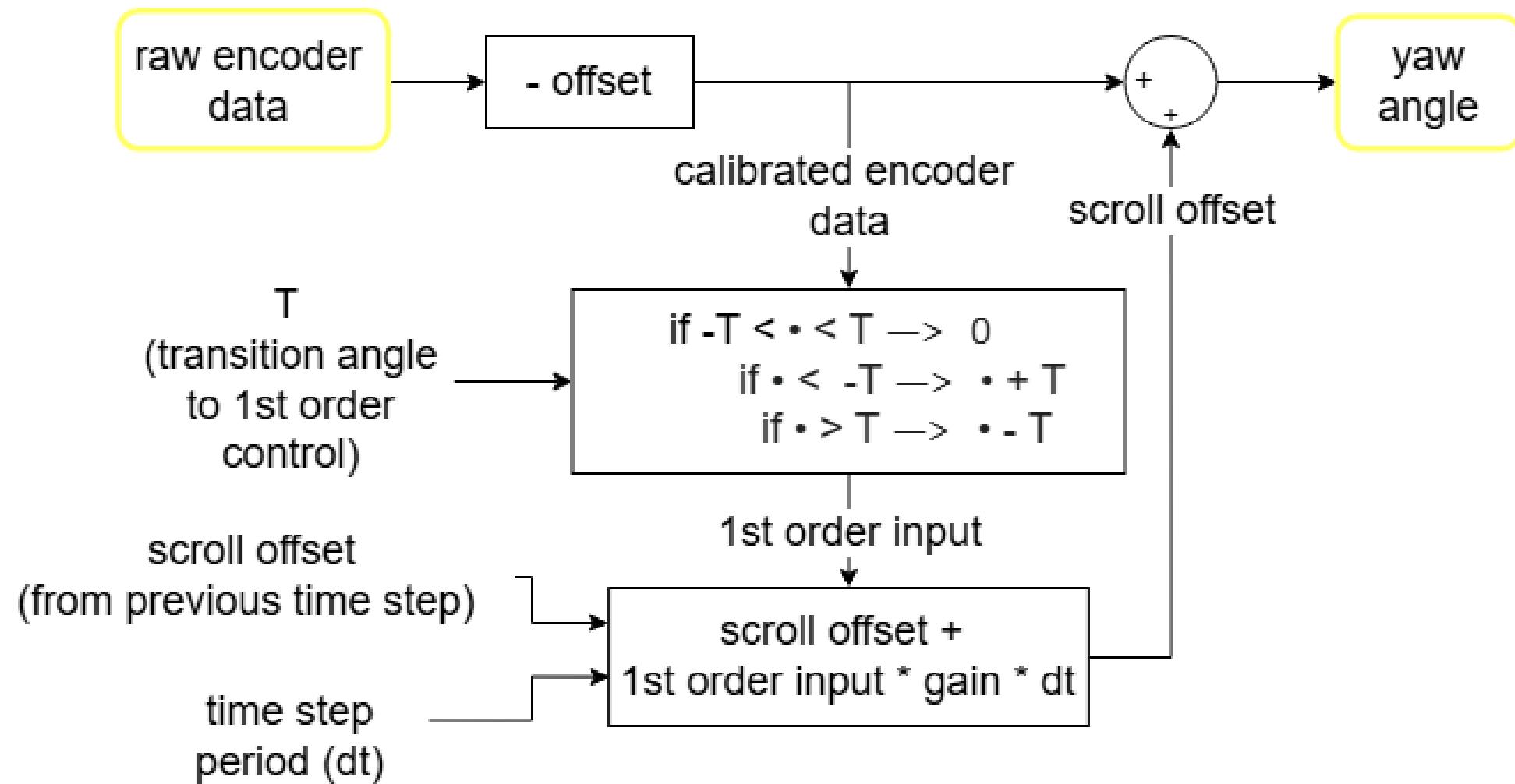
# Morphological chart

	Speed	 Switching between two speeds	 joystick pressure sensitivity	 accelerator pedal	 scroll wheel	 slide button
Base	Direction	 mouse ball	 tilt controls	 driving device through housing cap		 wrist + pressure sensitivity for speed
		 single turning direction				
Arm Position	Combined Solutions	 single controllable 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/gripper and toggle to switch between the two	 end effector with slide button for wrist angle	
	Shoulder Yaw Joint	 single turning direction		 left right		
	Shoulder Pitch Joint	 small model with no yaw	 small model with limited yaw	 invert position with switch		
	Elbow and Wrist Joint	Already covered in Combined Solutions				

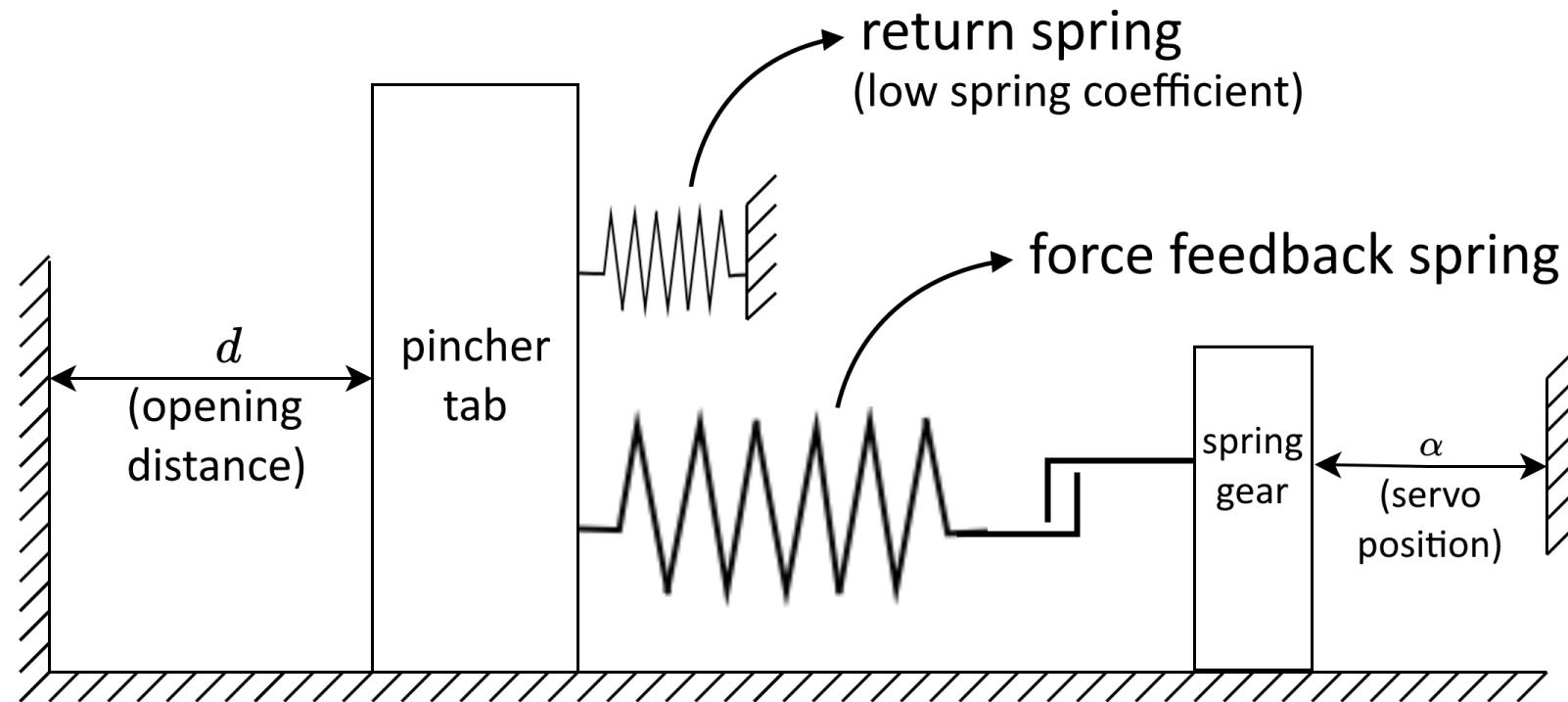
# Morphological chart

Gripper	Gripper				
					
					
	Force Feedback				
General	Casing				
	Button layout				
	Controller mobility				
	State Observing				
					

# Yaw control blockdiagram



# Diagram of Series Elastic Actuator in Pincher



# Video of entire use

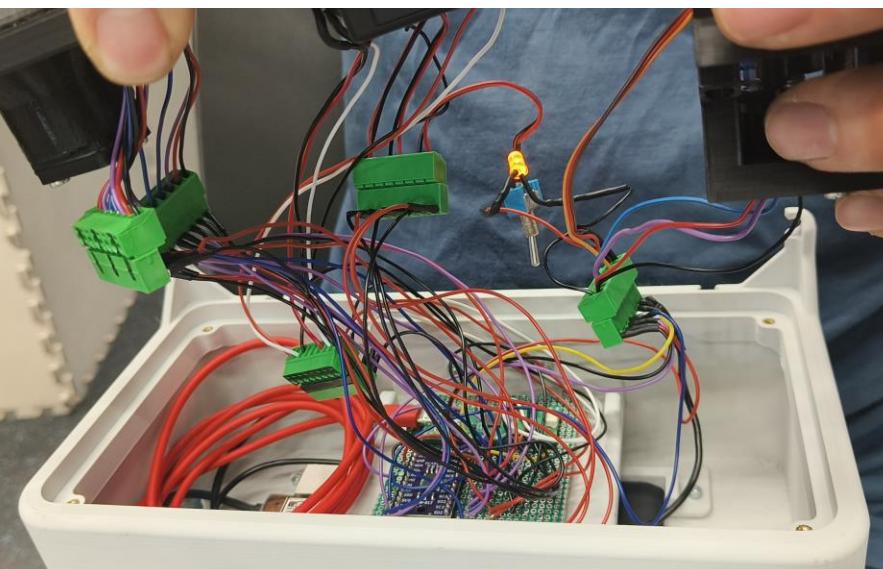
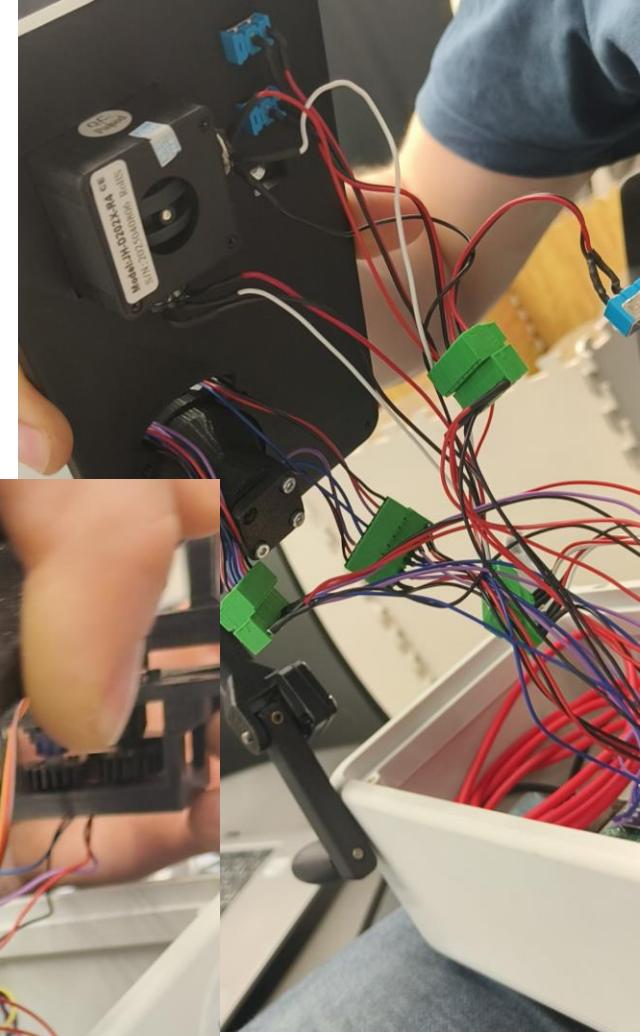
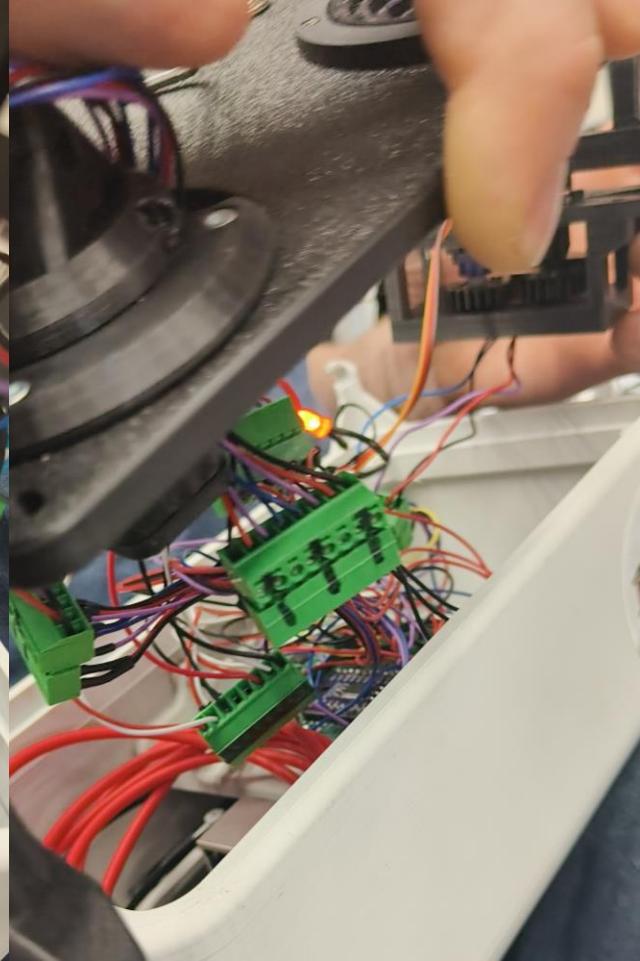
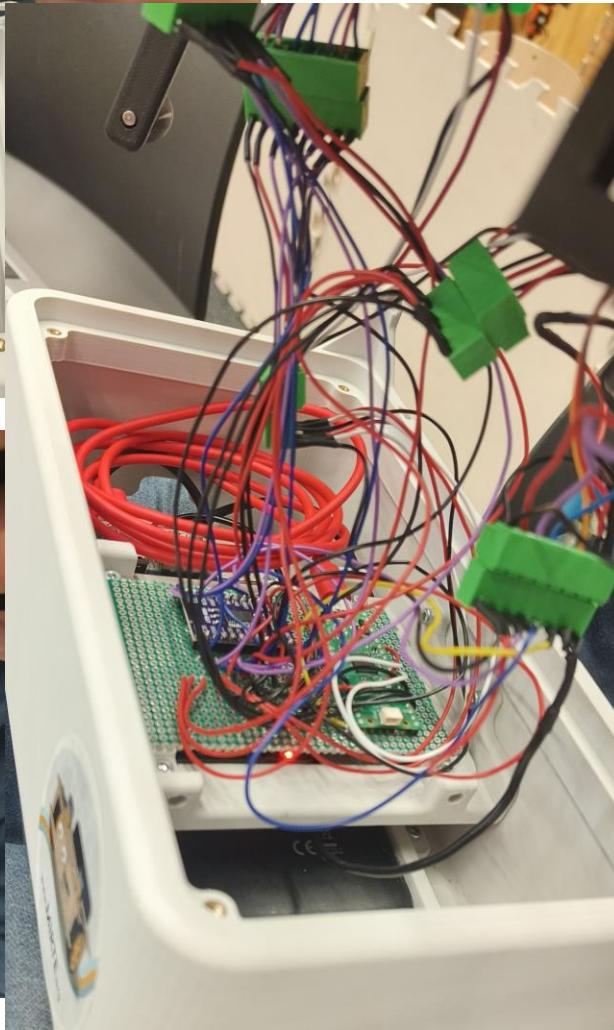
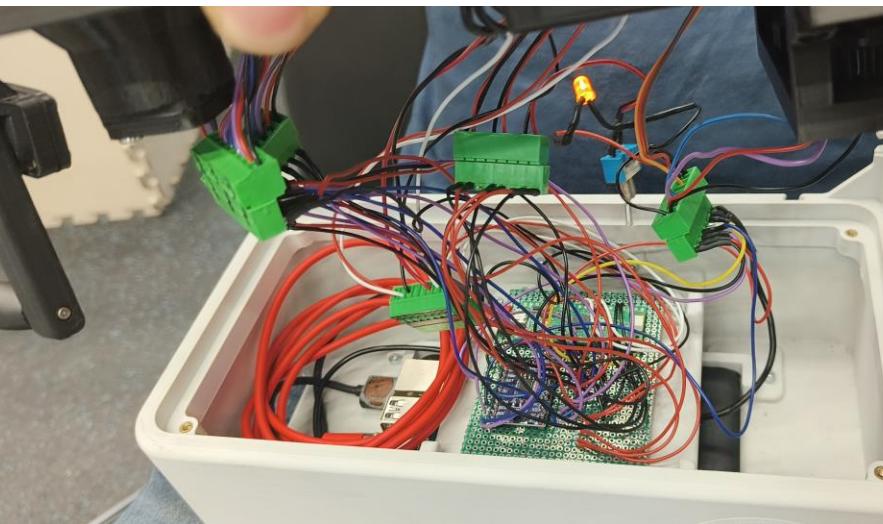


# Video of first time use



# Video of inner working pincher

# Image of inner electronics



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

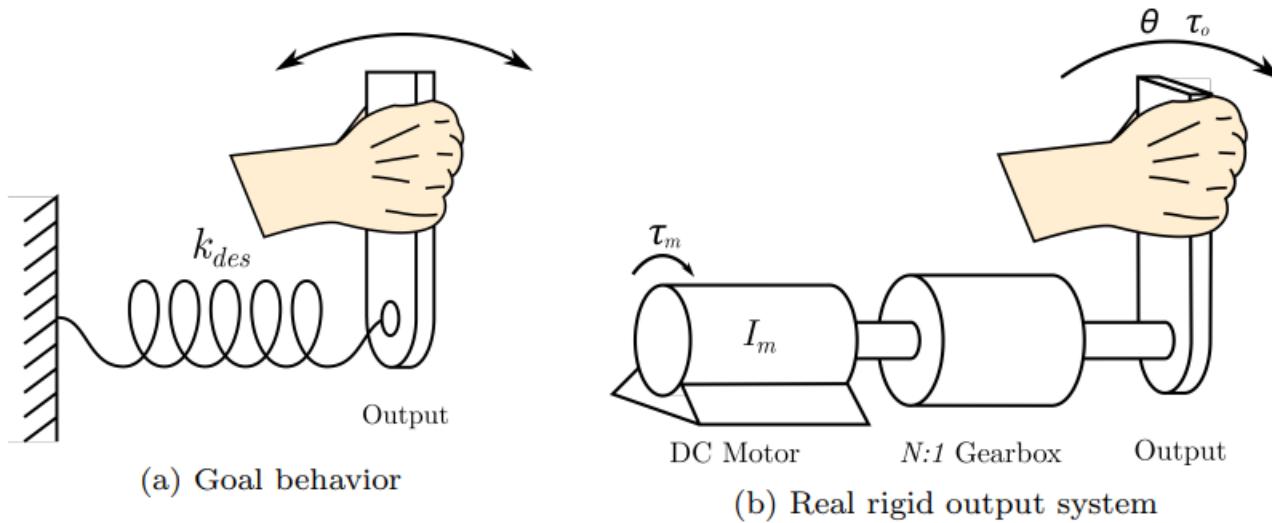
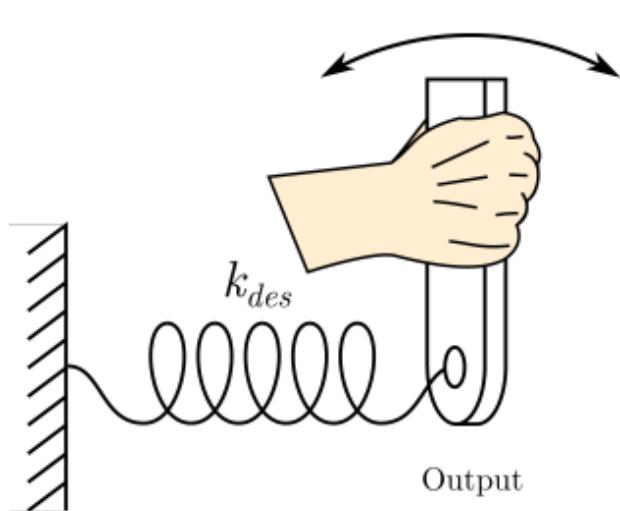
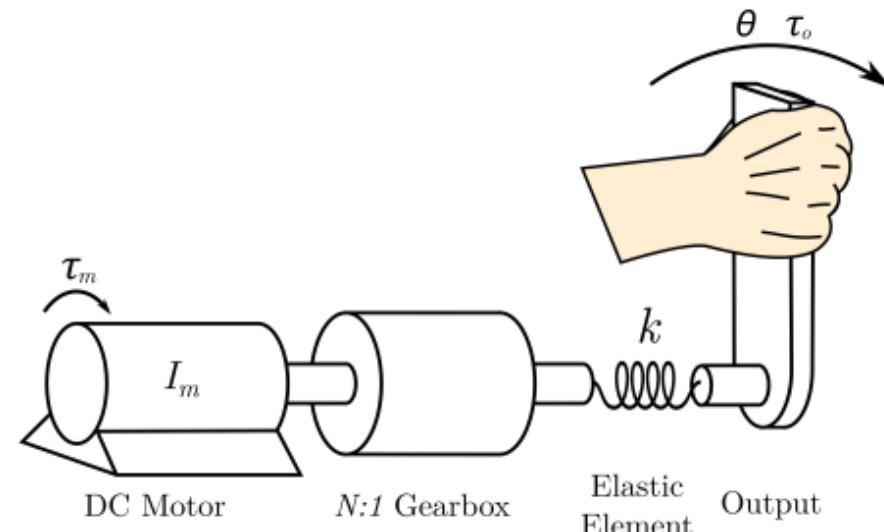


Image Source: Series Elastic Actuators., J. Hurst., 2020.,  
[https://mime.engineering.oregonstate.edu/research/drl/\\_documents/hurst\\_2020.pdf](https://mime.engineering.oregonstate.edu/research/drl/_documents/hurst_2020.pdf)

# 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)