Lab 3 Report - Group 18

Qinghua He - qh2297
Jaisel Singh - js6897
Huan Gu - hg2721

Assignment 1

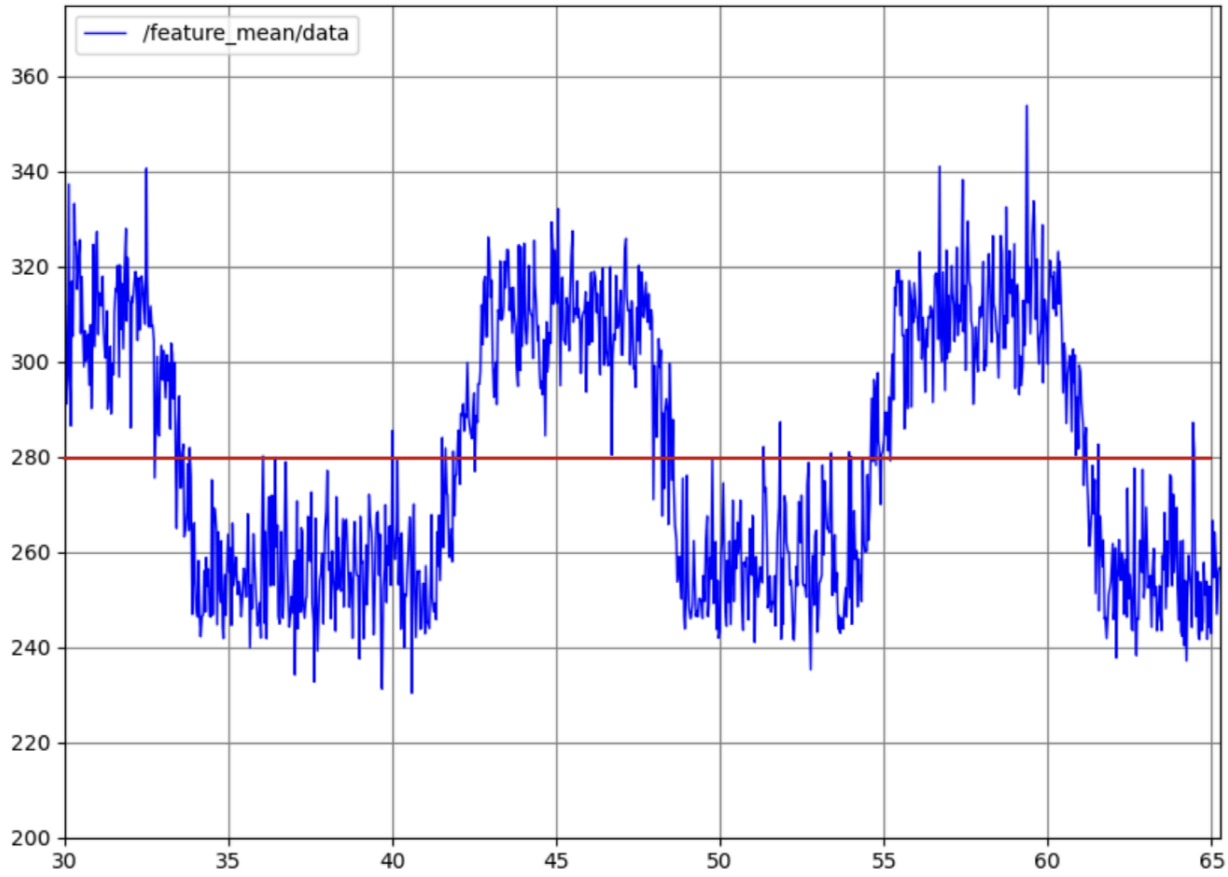
The vision pipeline that produces /feature_mean topic consist of **3 nodes**:

/camera_driver
/video_processor
/image_mean_feature_x

Assignment 2

- The detection of the open door algorithm works based on the feature mean topic that is within ROS2. The vision algorithm that is being used is the Shi-Tomasi corner-detection algorithm that is based on openCV library.
    - The ImageMeanFeatureX node Subscribes to /goodfeature/corners (receives detected image features). It then extracts the x-coordinates from all detected feature points and computes their mean (average x-position). It then publishes this mean value to /feature_mean.
- When the robot opens and moves through the door, the edges and features that are visible to the turtlebot3 robot move to the left with the opening door, and hence we notice that the feature-mean signal score (average x-position) decreases. This can also be seen in the image of the plot in Assignment 3.

Assignment 3

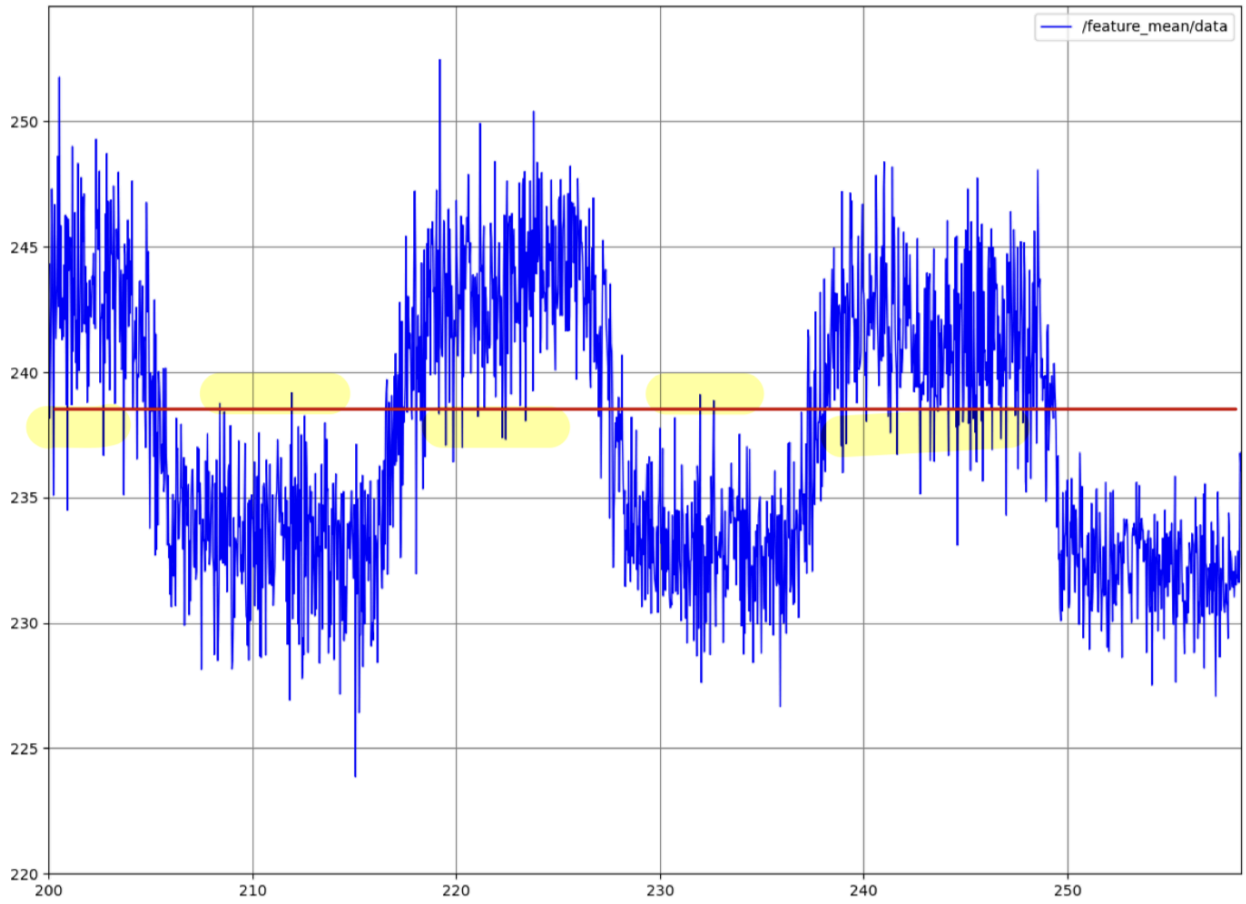


The threshold that would tell whether the door is open or closed could be **280** for the feature-mean signal, according to our plot.

Assignment 4

https://github.com/jaiselsingh1/prob_rob_labs_ros_2_group18/commit/2cc9eece2435ac83f2e18dfd81c8e5f3264c38b0

Assignment 5



From this figure, we can assume that the threshold value here would be **238**.

And then in the time window we collect **1000** data each for both states of the door.
The result shows that:
when the door is closed, signals above threshold= **958**, below threshold = **42**;
when the door is open, signals above threshold= **53**, below threshold = **947**.

So,
P(z=open | x =open) = 0.947
P(z=closed | x = open) = 0.053
P(z=open | x=closed) = 0.042
P(z=closed | x=closed) = 0.958

The example measurements that can create confusion are highlighted in the plot above.

Assignment 6

We choose the threshold of belief_open to be **0.999** here.

https://github.com/jaiselsingh1/prob_rob_labs_ros_2_group18/commit/4bf129623d28f76ecfa4564511ff0679f4221acf

```
[open_door_move_robot-1] [INFO] [1760048126.521138437] [open_door_move_robot]: Step 1: Opening the door
[open_door_move_robot-1] [INFO] [1760048126.533102986] [open_door_move_robot]: Feature mean: 233.8 z_open=True belief_open=0.000
[open_door_move_robot-1] [INFO] [1760048126.566883174] [open_door_move_robot]: Feature mean: 236.0 z_open=True belief_open=0.011
[open_door_move_robot-1] [INFO] [1760048126.604264674] [open_door_move_robot]: Feature mean: 236.8 z_open=True belief_open=0.193
[open_door_move_robot-1] [INFO] [1760048126.621035022] [open_door_move_robot]: Step 1: Opening the door
[open_door_move_robot-1] [INFO] [1760048126.636407689] [open_door_move_robot]: Feature mean: 235.2 z_open=True belief_open=0.844
[open_door_move_robot-1] [INFO] [1760048126.672443916] [open_door_move_robot]: Feature mean: 237.4 z_open=True belief_open=0.992
[open_door_move_robot-1] [INFO] [1760048126.693456522] [open_door_move_robot]: Feature mean: 237.1 z_open=True belief_open=1.000
[open_door_move_robot-1] [INFO] [1760048126.721423484] [open_door_move_robot]: Step 1: Opening the door
[open_door_move_robot-1] [INFO] [1760048126.721875666] [open_door_move_robot]: Door open command published (belief_open=1.000 >= 0.999)
[open_door_move_robot-1] [INFO] [1760048126.726616563] [open_door_move_robot]: Feature mean: 235.7 z_open=True belief_open=1.000
```

Assignment 7

prob_rob_labs_ros_2_group18 / prob_rob_labs / src / flaky_door_opener / flaky_door_opener.py

Code | Blame | 46 lines (37 loc) · 1.22 KB

```python

    max_torque = 5.0
    torque_hold = 10

class FlakyDoorOpener(Node):

        def __init__(self):
            super().__init__('flaky_door_opener')
            self.log = self.get_logger()
            self.pub_torque = self.create_publisher(
                Float64, '/hinged_glass_door/torque', 1)
            self.sub_command = self.create_subscription(
                Empty, '/door_open', self.handle_command, 1)
            self.torque = 0
            self.torque_counter = 0

        def handle_command(self, _):
            if self.torque == 0:
                self.torque = random.choice([1.0, 0.0, 0.0, 0.0, 0.0]) * max_torque
                self.torque_counter = 0
            elif self.torque_counter < torque_hold:
                self.torque_counter += 1
            else:
                self.torque = 0.0
            self.log.info(f'door open requested using torque {self.torque}')
            self.pub_torque.publish(Float64(data=self.torque))

        def spin(self):
            rclpy.spin(self)
```

Firstly, we did 100 consecutive measurements to estimate the probability of door opening when commanded. The results are as follows.
000000 11111111111 000000 11111111111 0 11111111111 0000000000000 11111111111 00000 11111111111 00 11111111111 0 (0 - not open - 34 times, 1 - open - 66 times)

Based on the results of our 100 consecutive measurements, the probability of door opening when commanded could be about **66/100 = 0.66**.
We also noticed that if the door opens when commanded, it will be sure to open after the following 10 commands (open 11 consecutive times).

Secondly, we analyzed the code in flaky_door_opener.py and hoped to deduce what the actual probability is. It seems to be **1/5 = 0.20**, as there's only one "1.0" in the random choices of five.

However, after a detailed check, we found that with "torque_hold = 10", it does have a probability of 0.2 to open the door with "max_torque = 5", but then the non-zero torque will be held 10 times and turn 0 in the following command for sure, which accords with our observation.
So, what we have now is:
0.2 - open - 11 open + 1 not open
0.8 - not open - 1 not open
The real actual probability would be **(0.2*11) / (0.2*12+0.8*1) = 2.2 / 3.2 = 0.6875**,
which proves that we did quite good measurements and estimation.

Assignment 8

The measured probability of door opening when commanded is **0.66** in Assignment 7.

Code:

https://github.com/jaiselsingh1/prob_rob_labs_ros_2_group18/commit/f9ee06a8e9ad59816945aae9a99cf348d97cf431

Video:

https://youtu.be/YL6ml5KJz1M

```
[open_door_move_robot-1] [INFO] [1760111491.690767905] [open_door_move_robot]: pred=0.825 post=0.825
[open_door_move_robot-1] [INFO] [1760111491.691446777] [open_door_move_robot]: Attempted /door_open (belief=0.825)
[open_door_move_robot-1] [INFO] [1760111491.692494730] [open_door_move_robot]: pred=0.817 post=0.817
[open_door_move_robot-1] [INFO] [1760111491.761861543] [open_door_move_robot]: pred=0.809 post=0.189
[open_door_move_robot-1] [INFO] [1760111491.862064887] [open_door_move_robot]: pred=0.188 post=0.013
[open_door_move_robot-1] [INFO] [1760111491.962774135] [open_door_move_robot]: pred=0.012 post=0.001
[open_door_move_robot-1] [INFO] [1760111492.063895954] [open_door_move_robot]: pred=0.001 post=0.000
[open_door_move_robot-1] [INFO] [1760111492.163644247] [open_door_move_robot]: pred=0.660 post=0.097
[open_door_move_robot-1] [INFO] [1760111492.165102166] [open_door_move_robot]: Attempted /door_open (belief=0.097)
[open_door_move_robot-1] [INFO] [1760111492.264615194] [open_door_move_robot]: pred=0.096 post=0.006
[open_door_move_robot-1] [INFO] [1760111492.364626693] [open_door_move_robot]: pred=0.006 post=0.000
[open_door_move_robot-1] [INFO] [1760111492.465447623] [open_door_move_robot]: pred=0.000 post=0.000
[open_door_move_robot-1] [INFO] [1760111492.567373873] [open_door_move_robot]: pred=0.000 post=0.000
[open_door_move_robot-1] [INFO] [1760111492.665508219] [open_door_move_robot]: pred=0.660 post=0.097
[open_door_move_robot-1] [INFO] [1760111492.666702522] [open_door_move_robot]: Attempted /door_open (belief=0.097)
[open_door_move_robot-1] [INFO] [1760111492.766624054] [open_door_move_robot]: pred=0.096 post=0.705
[open_door_move_robot-1] [INFO] [1760111492.867130575] [open_door_move_robot]: pred=0.698 post=0.114
[open_door_move_robot-1] [INFO] [1760111492.966595495] [open_door_move_robot]: pred=0.112 post=0.741
[open_door_move_robot-1] [INFO] [1760111493.066542685] [open_door_move_robot]: pred=0.733 post=0.132
[open_door_move_robot-1] [INFO] [1760111493.165938885] [open_door_move_robot]: pred=0.704 post=0.116
[open_door_move_robot-1] [INFO] [1760111493.166933510] [open_door_move_robot]: Attempted /door_open (belief=0.116)
[open_door_move_robot-1] [INFO] [1760111493.266953961] [open_door_move_robot]: pred=0.115 post=0.007
[open_door_move_robot-1] [INFO] [1760111493.366049236] [open_door_move_robot]: pred=0.007 post=0.000
[open_door_move_robot-1] [INFO] [1760111493.467484928] [open_door_move_robot]: pred=0.000 post=0.000
[open_door_move_robot-1] [INFO] [1760111493.566465140] [open_door_move_robot]: pred=0.000 post=0.000
[open_door_move_robot-1] [INFO] [1760111493.667168952] [open_door_move_robot]: pred=0.660 post=0.097
[open_door_move_robot-1] [INFO] [1760111493.668000766] [open_door_move_robot]: Attempted /door_open (belief=0.097)
[open_door_move_robot-1] [INFO] [1760111493.766898206] [open_door_move_robot]: pred=0.096 post=0.006
[open_door_move_robot-1] [INFO] [1760111493.867606486] [open_door_move_robot]: pred=0.006 post=0.000
[open_door_move_robot-1] [INFO] [1760111493.967630334] [open_door_move_robot]: pred=0.000 post=0.000
[open_door_move_robot-1] [INFO] [1760111494.066972625] [open_door_move_robot]: pred=0.000 post=0.000
[open_door_move_robot-1] [INFO] [1760111494.168510903] [open_door_move_robot]: pred=0.660 post=0.097
[open_door_move_robot-1] [INFO] [1760111494.170016720] [open_door_move_robot]: Attempted /door_open (belief=0.097)
[open_door_move_robot-1] [INFO] [1760111494.269039297] [open_door_move_robot]: pred=0.096 post=0.006
[open_door_move_robot-1] [INFO] [1760111494.368509871] [open_door_move_robot]: pred=0.006 post=0.000
```

```
[open_door_move_robot-1] [INFO] [1760111497.173578615] [open_door_move_robot]: Attempted /door_open (belief=0.097)
[open_door_move_robot-1] [INFO] [1760111497.273290121] [open_door_move_robot]: pred=0.096 post=0.006
[open_door_move_robot-1] [INFO] [1760111497.372826079] [open_door_move_robot]: pred=0.006 post=0.000
[open_door_move_robot-1] [INFO] [1760111497.471925552] [open_door_move_robot]: pred=0.000 post=0.007
[open_door_move_robot-1] [INFO] [1760111497.572384363] [open_door_move_robot]: pred=0.007 post=0.138
[open_door_move_robot-1] [INFO] [1760111497.672778853] [open_door_move_robot]: pred=0.706 post=0.117
[open_door_move_robot-1] [INFO] [1760111497.673947385] [open_door_move_robot]: Attempted /door_open (belief=0.117)
[open_door_move_robot-1] [INFO] [1760111497.772433463] [open_door_move_robot]: pred=0.116 post=0.007
[open_door_move_robot-1] [INFO] [1760111497.873125880] [open_door_move_robot]: pred=0.007 post=0.000
[open_door_move_robot-1] [INFO] [1760111497.972900173] [open_door_move_robot]: pred=0.000 post=0.009
[open_door_move_robot-1] [INFO] [1760111498.072682636] [open_door_move_robot]: pred=0.009 post=0.000
[open_door_move_robot-1] [INFO] [1760111498.172890829] [open_door_move_robot]: pred=0.660 post=0.978
[open_door_move_robot-1] [INFO] [1760111498.174079014] [open_door_move_robot]: Attempted /door_open (belief=0.978)
[open_door_move_robot-1] [INFO] [1760111498.273598901] [open_door_move_robot]: pred=0.968 post=0.625
[open_door_move_robot-1] [INFO] [1760111498.375690028] [open_door_move_robot]: pred=0.619 post=0.082
[open_door_move_robot-1] [INFO] [1760111498.475330972] [open_door_move_robot]: pred=0.082 post=0.005
[open_door_move_robot-1] [INFO] [1760111498.574602783] [open_door_move_robot]: pred=0.005 post=0.000
[open_door_move_robot-1] [INFO] [1760111498.677627074] [open_door_move_robot]: pred=0.660 post=0.097
[open_door_move_robot-1] [INFO] [1760111498.679775039] [open_door_move_robot]: Attempted /door_open (belief=0.097)
[open_door_move_robot-1] [INFO] [1760111498.773825150] [open_door_move_robot]: pred=0.096 post=0.006
[open_door_move_robot-1] [INFO] [1760111498.874650732] [open_door_move_robot]: pred=0.006 post=0.000
[open_door_move_robot-1] [INFO] [1760111498.975862193] [open_door_move_robot]: pred=0.000 post=0.000
[open_door_move_robot-1] [INFO] [1760111499.074967299] [open_door_move_robot]: pred=0.000 post=0.000
[open_door_move_robot-1] [INFO] [1760111499.174139994] [open_door_move_robot]: pred=0.660 post=0.978
[open_door_move_robot-1] [INFO] [1760111499.175344379] [open_door_move_robot]: Attempted /door_open (belief=0.978)
[open_door_move_robot-1] [INFO] [1760111499.273588942] [open_door_move_robot]: pred=0.968 post=0.999
[open_door_move_robot-1] [INFO] [1760111499.274966761] [open_door_move_robot]: Belief 0.999 >= 0.99, proceeding to move
[open_door_move_robot-1] [INFO] [1760111512.392321420] [open_door_move_robot]: Done
```