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CSE 360
Lidar Lab

1. **Measure the distance between the two anchor nodes with a tape measure, and compare this to the distance inferred through the segmentation process.**
   ANS: The LIDAR measured the origin of my frame at 2.2467 m with an angle of -0.2356 rad. Using the tape measure, the distance measured between the LIDAR and the origin was 2.24m.

   When resolved to X and Y coordinates wrt the LIDAR's frame, origin was at (2.1846, -0.5244). When measured with a tape measure, the origin was at (2.19, -0.53) wrt the LIDAR.

   When resolved to X and Y coordinates wrt the LIDAR's frame, the second point was at (3.6033, -1.9769). When measured with a tape measure, the point was at (3.59,-1.98).

   The second point was placed 2 m away from the origin. Based on the readings from the LIDAR, the two points seem to be 2.0304 m apart.

2. **For 5 different target positions, capture 100 consecutive measurements using your segmentation approach. Calculate the standard deviation of the x and y positions of the target (see the Matlab function std). What can you say about the LIDAR's precision?**
   ANS: The 100 consecutive measurements for the 5 positions are provided below. The standard deviation of the measurements for the 5 positions are as follows:

   - **Point(0.44, 0.40):**
     a) Standard deviation of x: 0.0022
     b) Standard deviation of y: 0.0015

   - **Point(0.395 ,-0.51):**
     a) Standard Deviation of x: 0.0014
     b) Standard Deviation of y: 0.0004

   - **Point(0, -0.24):**
     a) Standard deviation of x: 0.0020
     b) Standard deviation of y: 0.0010

- **Point(-0.28,0):**
    a) Standard deviation of x: 0.0022
    b) Standard deviation of y: 0.0016

- **Point(-0.275, 0.30):**
    a) Standard deviation of x: 0.0016
    b) Standard deviation of y: 0.0015

The standard deviation for these measurements are almost zero, which shows that the readings does not deviate much from the mean value. Therefore, we can conclude that the LIDAR's precision is very high

3. **For the same 5 different positions/scans, calculate the mean x-y positions (see the Matlab function mean). Compare this to ground truth estimates obtained from a tape measure. What can you say about the accuracy of the LIDAR system**
ANS: The 100 consecutive measurements for the 5 positions are provided below. The mean of the measurements for the 5 positions are as follows:

- **Point(0.44, 0.40):**
    a) Mean of 100 x values: 0.4448
    b) Mean of 100 y values: 0.4075

- **Point(0.395 ,-0.51):**
    a) Mean of 100 x values: 0.3970
    b) Mean of 100 y values: -0.5093

- **Point(0, -0.24):**
    a) Mean of 100 x values: 0.0040
    b) Mean of 100 y values: -0.2384

- **Point(-0.28,0):**
    a) Mean of 100 x values: -0.2814
    b) Mean of 100 y values: -0.0100

- **Point(-0.275, 0.30):**
    a) Mean of 100 x values: -0.2767
    b) Mean of 100 y values: 0.3017

The mean for these measurements are very close to what was actually measured with tape measure. Therefore, we can conclude that the LIDAR's accuracy is very high

READINGS FOR THE 5 POSITIONS OBTAINED FROM THE LIDAR

1. **Readings for Point(0.44, 0.40):**

100 consecutive readings of x:

0.4475	0.4475	0.4475	0.4475	0.4475	0.4475	0.4475	0.4516	0.4475	0.4475
0.4475	0.4475	0.4475	0.4475	0.4433	0.4433	0.4433	0.4433	0.4433	0.4433
0.4433	0.4433	0.4433	0.4433	0.4433	0.4475	0.4433	0.4475	0.4433	0.4475
0.4433	0.4433	0.4433	0.4433	0.4433	0.4433	0.4433	0.4475	0.4433	0.4433
0.4433	0.4433	0.4433	0.4433	0.4433	0.4433	0.4475	0.4433	0.4433	0.4433
0.4475	0.4433	0.4433	0.4433	0.4433	0.4433	0.4433	0.4433	0.4433	0.4433
0.4433	0.4433	0.4433	0.4475	0.4433	0.4433	0.4433	0.4475	0.4433	0.4433
0.4433	0.4475	0.4475	0.4433	0.4433	0.4433	0.4433	0.4433	0.4475	0.4433
0.4433	0.4433	0.4433	0.4516	0.4475	0.4433	0.4433	0.4433	0.4433	0.4475
0.4475	0.4475	0.4475	0.4433	0.4475	0.4475	0.4433	0.4433	0.4433	0.4433

100 consecutive readings for y:

0.4094	0.4094	0.4094	0.4094	0.4094	0.4094	0.4094	0.4122	0.4094	0.4094
0.4094	0.4094	0.4094	0.4094	0.4066	0.4066	0.4066	0.4066	0.4066	0.4066
0.4066	0.4066	0.4066	0.4066	0.4066	0.4094	0.4066	0.4094	0.4066	0.4094
0.4066	0.4066	0.4066	0.4066	0.4066	0.4066	0.4066	0.4094	0.4066	0.4066
0.4066	0.4066	0.4066	0.4066	0.4066	0.4066	0.4094	0.4066	0.4066	0.4066
0.4094	0.4066	0.4066	0.4066	0.4066	0.4066	0.4066	0.4066	0.4066	0.4066
0.4066	0.4066	0.4066	0.4094	0.4066	0.4066	0.4066	0.4094	0.4066	0.4066
0.4066	0.4094	0.4094	0.4066	0.4066	0.4066	0.4066	0.4066	0.4094	0.4066
0.4066	0.4066	0.4066	0.4122	0.4094	0.4066	0.4066	0.4066	0.4066	0.4094
0.4094	0.4094	0.4094	0.4066	0.4094	0.4094	0.4066	0.4066	0.4066	0.4066

Mean of 100 x values: 0.4448
Mean of 100 y values: 0.4075
Standard deviation of x: 0.0022
Standard deviation of y: 0.0015

2. **Readings for Point(0.395 ,-0.51):**

100 consecutive readings of x:

0.4009	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977
0.3977	0.3977	0.3977	0.3977	0.3945	0.3977	0.3977	0.3977	0.3977	0.3977
0.3945	0.3977	0.3945	0.3977	0.3977	0.3945	0.3977	0.3945	0.3945	0.3945
0.3977	0.3977	0.3977	0.3977	0.3945	0.3977	0.3945	0.3977	0.3977	0.3945

0.3977	0.3945	0.3945	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977	0.3945
0.3945	0.3945	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977
0.3977	0.3977	0.3977	0.3945	0.3945	0.3977	0.3977	0.3977	0.3977	0.3945
0.3945	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977	0.3977
0.3977	0.3977	0.3977	0.3977	0.3945	0.3977	0.3945	0.3945	0.3977	0.3977
0.3977	0.3945	0.3977	0.3977	0.3977	0.3945	0.3977	0.3977	0.3977	0.3977

100 consecutive readings for y:

-0.5082	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091
-0.5091	-0.5091	-0.5091	-0.5091	-0.5100	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091
-0.5100	-0.5091	-0.5100	-0.5091	-0.5091	-0.5100	-0.5091	-0.5100	-0.5100	-0.5100
-0.5091	-0.5091	-0.5091	-0.5091	-0.5100	-0.5091	-0.5100	-0.5091	-0.5091	-0.5100
-0.5091	-0.5100	-0.5100	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5100
-0.5100	-0.5100	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091
-0.5091	-0.5091	-0.5091	-0.5100	-0.5100	-0.5091	-0.5091	-0.5091	-0.5091	-0.5100
-0.5100	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091	-0.5091
-0.5091	-0.5091	-0.5091	-0.5091	-0.5100	-0.5091	-0.5100	-0.5100	-0.5091	-0.5091
-0.5091	-0.5100	-0.5091	-0.5091	-0.5091	-0.5100	-0.5091	-0.5091	-0.5091	-0.5091

Mean of 100 x values: 0.3970
Mean of 100 y values: -0.5093
Standard Deviation of x: 0.0014
Standard Deviation of y: 0.0004

3. **Readings for Point(0, -0.24):**

100 consecutive readings for x:

0.0033	0.0062	0.0033	0.0062	0.0062	0.0062	0.0062	0.0062	0.0033	0.0062
0.0033	0.0092	0.0033	0.0062	0.0062	0.0062	0.0033	0.0033	0.0033	0.0062
0.0033	0.0062	0.0033	0.0062	0.0033	0.0092	0.0062	0.0062	0.0033	0.0062
0.0033	0.0003	0.0033	0.0033	0.0062	0.0062	0.0033	0.0033	0.0033	0.0033
0.0033	0.0033	0.0033	0.0062	0.0033	0.0033	0.0033	0.0033	0.0033	0.0003
0.0062	0.0003	0.0003	0.0033	0.0033	0.0033	0.0092	0.0033	0.0033	0.0033
0.0033	0.0062	0.0062	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033
0.0033	0.0062	0.0003	0.0003	0.0003	0.0033	0.0062	0.0003	0.0062	0.0033
0.0033	0.0033	0.0033	0.0033	0.0033	0.0062	0.0033	0.0033	0.0033	0.0033
0.0062	0.0062	0.0003	0.0033	0.0062	0.0003	0.0033	0.0003	0.0033	0.0033

100 consecutive readings for y:

-0.2387	-0.2372	-0.2387	-0.2372	-0.2372	-0.2372	-0.2372	-0.2372	-0.2387	-0.2372
-0.2387	-0.2358	-0.2387	-0.2372	-0.2372	-0.2372	-0.2387	-0.2387	-0.2387	-0.2372
-0.2387	-0.2372	-0.2387	-0.2372	-0.2387	-0.2358	-0.2372	-0.2372	-0.2387	-0.2372
-0.2387	-0.2402	-0.2387	-0.2387	-0.2372	-0.2372	-0.2387	-0.2387	-0.2387	-0.2387
-0.2387	-0.2387	-0.2387	-0.2372	-0.2387	-0.2387	-0.2387	-0.2387	-0.2387	-0.2402
-0.2372	-0.2402	-0.2402	-0.2387	-0.2387	-0.2387	-0.2358	-0.2387	-0.2387	-0.2387
-0.2387	-0.2372	-0.2372	-0.2387	-0.2387	-0.2387	-0.2387	-0.2387	-0.2387	-0.2387
-0.2387	-0.2372	-0.2402	-0.2402	-0.2402	-0.2387	-0.2372	-0.2402	-0.2372	-0.2387
-0.2387	-0.2387	-0.2387	-0.2387	-0.2387	-0.2372	-0.2387	-0.2387	-0.2387	-0.2387
-0.2372	-0.2372	-0.2402	-0.2387	-0.2372	-0.2402	-0.2387	-0.2402	-0.2387	-0.2387

Mean of 100 x values: 0.0040
Mean of 100 y values: -0.2384
Standard deviation of x: 0.0020
Standard deviation of y: 0.0010

4.Readings for Point(-0.28,0):

100 consecutive readings for x:

-0.2819	-0.2819	-0.2846	-0.2765	-0.2846	-0.2819	-0.2819	-0.2819	-0.2792	-0.2819
-0.2819	-0.2819	-0.2846	-0.2792	-0.2819	-0.2819	-0.2846	-0.2819	-0.2792	-0.2819
-0.2819	-0.2819	-0.2819	-0.2792	-0.2819	-0.2792	-0.2819	-0.2846	-0.2792	-0.2819
-0.2792	-0.2846	-0.2819	-0.2819	-0.2846	-0.2819	-0.2819	-0.2819	-0.2819	-0.2846
-0.2792	-0.2846	-0.2846	-0.2819	-0.2792	-0.2819	-0.2819	-0.2765	-0.2765	-0.2819
-0.2819	-0.2846	-0.2792	-0.2765	-0.2819	-0.2819	-0.2819	-0.2792	-0.2846	-0.2765
-0.2846	-0.2792	-0.2819	-0.2792	-0.2819	-0.2819	-0.2846	-0.2819	-0.2765	-0.2819
-0.2792	-0.2819	-0.2846	-0.2792	-0.2792	-0.2819	-0.2792	-0.2819	-0.2792	-0.2792
-0.2846	-0.2792	-0.2819	-0.2792	-0.2819	-0.2846	-0.2792	-0.2819	-0.2819	-0.2846
-0.2819	-0.2792	-0.2792	-0.2846	-0.2792	-0.2819	-0.2819	-0.2819	-0.2819	-0.2846

100 consecutive readings for y:

-0.0103	-0.0103	-0.0123	-0.0064	-0.0123	-0.0103	-0.0103	-0.0103	-0.0084	-0.0103
-0.0103	-0.0103	-0.0123	-0.0084	-0.0103	-0.0103	-0.0123	-0.0103	-0.0084	-0.0103
-0.0103	-0.0103	-0.0103	-0.0084	-0.0103	-0.0084	-0.0103	-0.0123	-0.0084	-0.0103
-0.0084	-0.0123	-0.0103	-0.0103	-0.0123	-0.0103	-0.0103	-0.0103	-0.0103	-0.0123
-0.0084	-0.0123	-0.0123	-0.0103	-0.0084	-0.0103	-0.0103	-0.0064	-0.0064	-0.0103
-0.0103	-0.0123	-0.0084	-0.0064	-0.0103	-0.0103	-0.0103	-0.0084	-0.0123	-0.0064
-0.0123	-0.0084	-0.0103	-0.0084	-0.0103	-0.0103	-0.0123	-0.0103	-0.0064	-0.0103
-0.0084	-0.0103	-0.0123	-0.0084	-0.0084	-0.0103	-0.0084	-0.0103	-0.0084	-0.0084

-0.0123	-0.0084	-0.0103	-0.0084	-0.0103	-0.0123	-0.0084	-0.0103	-0.0103	-0.0123
-0.0103	-0.0084	-0.0084	-0.0123	-0.0084	-0.0103	-0.0103	-0.0103	-0.0103	-0.0123

Mean of 100 x values: -0.2814
Mean of 100 y values: -0.0100
Standard deviation of x: 0.0022
Standard deviation of y: 0.0016

5.Readings for Point(-0.275, 0.30):

100 consecutive values for x:

-0.2751	-0.2751	-0.2751	-0.2775	-0.2800	-0.2726	-0.2751	-0.2726	-0.2775	-0.2775
-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2775
-0.2775	-0.2775	-0.2800	-0.2775	-0.2775	-0.2751	-0.2775	-0.2751	-0.2775	-0.2800
-0.2775	-0.2775	-0.2775	-0.2726	-0.2775	-0.2775	-0.2775	-0.2775	-0.2751	-0.2775
-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2800	-0.2775	-0.2775	-0.2775
-0.2751	-0.2775	-0.2751	-0.2751	-0.2775	-0.2775	-0.2751	-0.2775	-0.2775	-0.2775
-0.2751	-0.2751	-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2775	-0.2751
-0.2775	-0.2751	-0.2775	-0.2726	-0.2751	-0.2726	-0.2775	-0.2775	-0.2775	-0.2775
-0.2751	-0.2775	-0.2775	-0.2775	-0.2751	-0.2775	-0.2751	-0.2751	-0.2751	-0.2751
-0.2775	-0.2751	-0.2751	-0.2751	-0.2726	-0.2775	-0.2775	-0.2751	-0.2775	-0.2775

100 consecutive values for y:

0.3032	0.3032	0.3032	0.3010	0.2987	0.3054	0.3032	0.3054	0.3010	0.3010
0.3010	0.3010	0.3010	0.3010	0.3010	0.3010	0.3010	0.3010	0.3010	0.3010
0.3010	0.3010	0.2987	0.3010	0.3010	0.3032	0.3010	0.3032	0.3010	0.2987
0.3010	0.3010	0.3010	0.3054	0.3010	0.3010	0.3010	0.3010	0.3032	0.3010
0.3010	0.3010	0.3010	0.3010	0.3010	0.3010	0.2987	0.3010	0.3010	0.3010
0.3032	0.3010	0.3032	0.3032	0.3010	0.3010	0.3032	0.3010	0.3010	0.3010
0.3032	0.3032	0.3010	0.3010	0.3010	0.3010	0.3010	0.3010	0.3010	0.3032
0.3010	0.3032	0.3010	0.3054	0.3032	0.3054	0.3010	0.3010	0.3010	0.3010
0.3032	0.3010	0.3010	0.3010	0.3032	0.3010	0.3032	0.3032	0.3032	0.3032
0.3010	0.3032	0.3032	0.3032	0.3054	0.3010	0.3010	0.3032	0.3010	0.3010

Mean of 100 x values: -0.2767
Mean of 100 y values: 0.3017
Standard deviation of x: 0.0016
Standard deviation of y: 0.0015