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Homework 2

MAE 4180 / 5180
2020-Feb-04

Problem 1

1) To start this problem I drew an arc with length d and angle θ in the body fixed reference frame

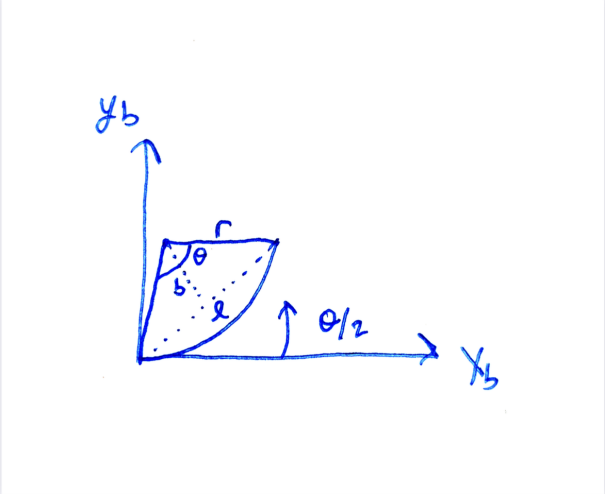

Figure 1: Instantaneous Measurement Graph in Body Frame

From that, we can solve for the radius r

$$r = \frac{d}{\theta} \tag{1}$$

with the assumption that θ is not equal to 0. Not, we solve for the length ℓ by dividing the arc into two equal triangles with length b and height .

$$\ell = 2 \times r \times \cos\frac{\theta}{2} \tag{2}$$

Finally, we can convert this length into the global coordinates to solve for x, y, and θ of the robot:

$$x = x_0 + \ell \times \cos\left(\frac{\theta}{2} + \theta_0\right) \tag{3}$$

$$y = y_0 + \ell \times \sin\left(\frac{\theta}{2} + \theta_0\right) \tag{4}$$

where θ_0 is the initial robot rotation relative to the inertial frame.

With the case that θ is 0:

$$x = x_o + d \times \cos\left(\theta_0\right) \tag{5}$$

$$y = y_0 \tag{6}$$

Finally, the final rotation of the robot, θ_f is

$$\theta_f = \theta_0 + \theta \tag{7}$$

2) Completed on Matlab

3)

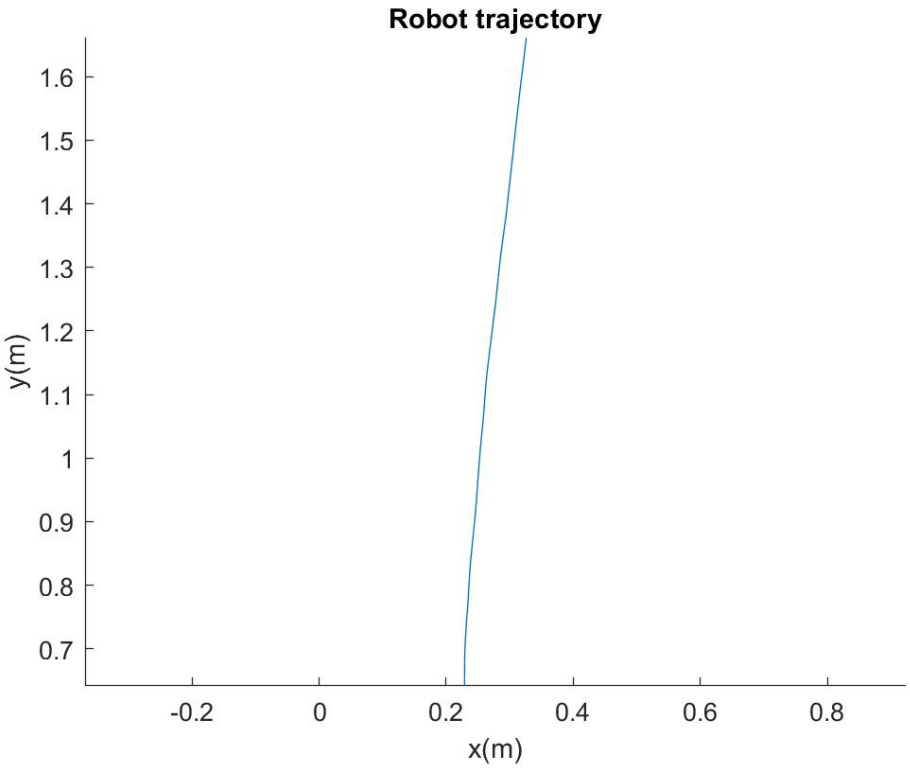

Figure 2: Plot of Robot Position Using Integrated Odometry

5)

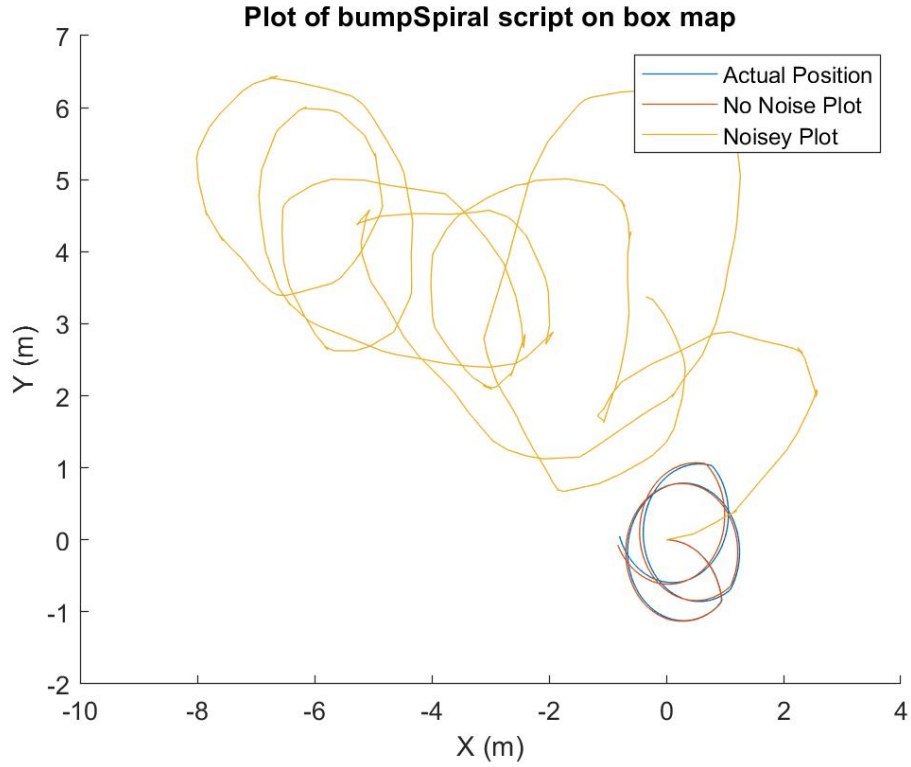

Figure 3: Plot of Robot Position using Integrated Odometry with Augmented Data

6) The integration of the odometry worked very well for the duration of the robot's run and matched almost identically. I expected this to work very well because of the number of data points the program had and with no inaccuracy.

7) With such a large sensor noise, the quality of the localization was so low that it was completely unusable. With a sensor that had a minimal error associated with it, this localization can be accurate enough depending on the application.

8) There are a few errors associated with any sensor measurements. One of these errors occurs due to tire slipping while turning. Additionally, if the robot accidentally bumps into to a wall with the tires spinning, the odometry will be off until it recalibrates with some reference frame.

Problem 2

1) Completed on Matlab

2) Completed on Matlab

3)

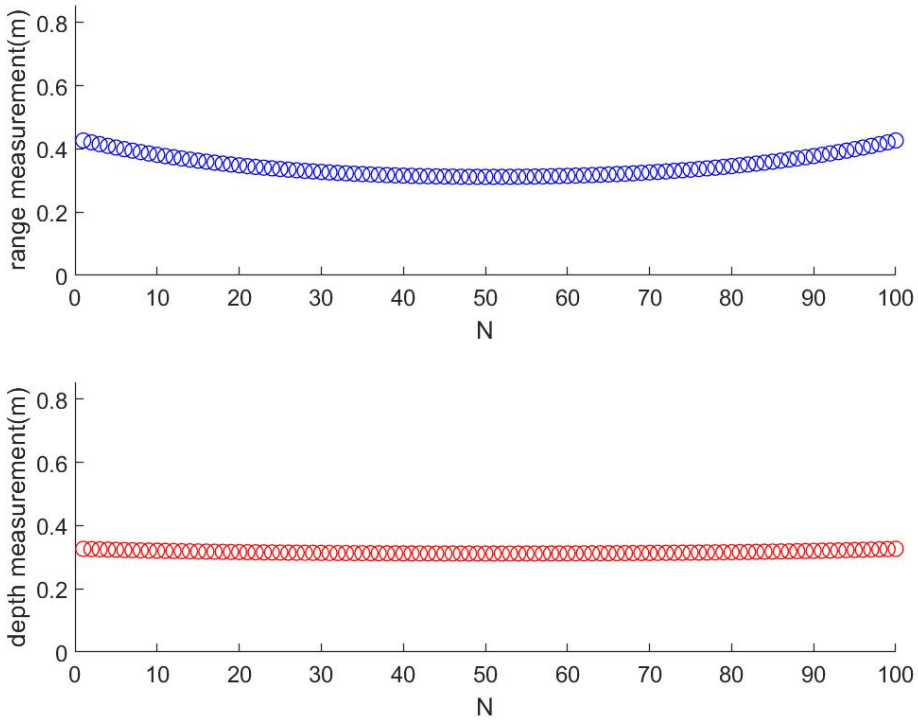

Figure 4: Test Function to Plot the Range and Depth

4) Completed on Matlab, I used a Standard Deviation of .2 for the depth readings!

5) Completed on Matlab

6) In the depth measurements and prediction, I expected the two plots to be much closer than they actually were. To be honest, I have no metric of what ".2" standard deviation means when applied to a data filter in Matlab. I tested with a deviation of 2 and the plot was extremely fuzzy and not representative of the actual movement. If there was no data error, the plots would be nearly identical.

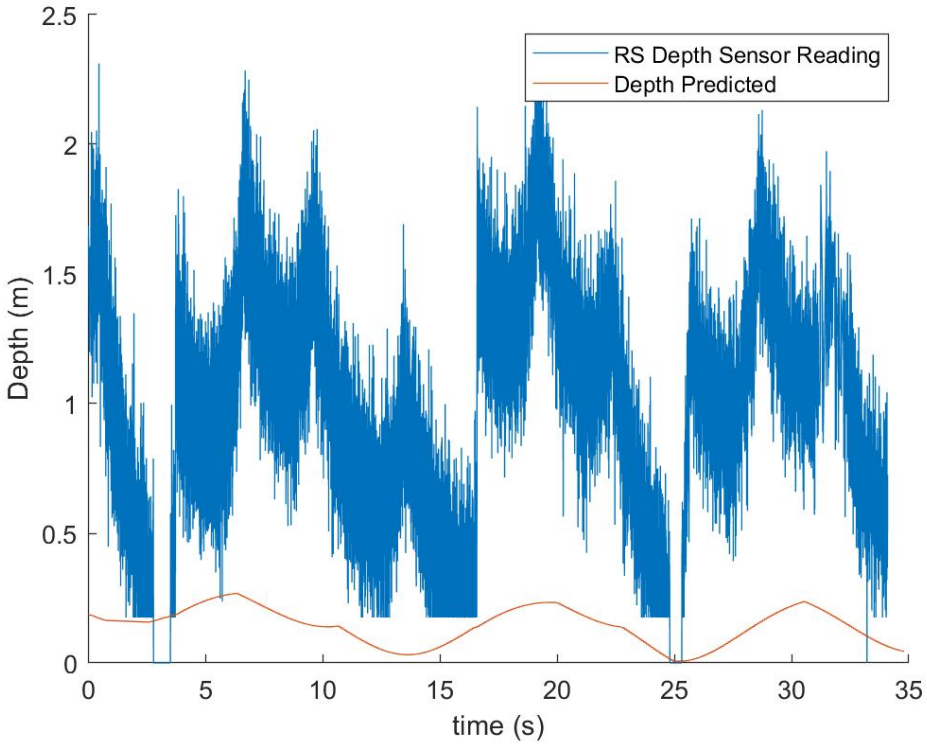

Figure 5: Plot of the Depth for Predicion and Actual