University of Colorado - Boulder

Lab 4: Mapping

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Lab Section 012, Group: name_group

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I. Question 1

Q: Roughly how much time did your group spend programming this lab?

A: About two hours was spent programming this lab.

II. Question 2

Q: The display is setup with 300 rows and 300 columns to cover a 1m x 1m area. What is the spatial resolution of each pixel in the map? Show how you arrived at your answer to get credit.

A: There are 300 pixels to each dimension, and 1m to each dimension. Because it's a square we only have to calculate the spatial resolution along one dimension, as it will be the same along the other dimension. We can calculate it by dividing our dimension by our resolution.

$$\text{res} = \frac{1\ [\text{m}]}{300\ [\text{pixels}]} = 0.0033\ \left[\frac{\text{m}}{\text{pixel}}\right] = 3.3\ \left[\frac{\text{mm}}{\text{pixel}}\right]$$

To get the 2D resolution we square the result.

$$\text{res}^2 = \left(0.0033\ \left[\frac{\text{m}}{\text{pixel}}\right]\right)^2 = 1.11e-05\ \left[\frac{\text{m}^2}{\text{pixel}}\right]$$

III. Question 3

Q: How would mapping be affected if the odometry is not perfect and has errors?

A: The map itself would begin to shift in the world frame, because converting into world frame coordinates uses data from the odometry. However, the LIDAR has no reliance on the odometry, so while the world frame map wouldn't have the correct coordinates or orientation, the mapping of objects drawn *relative* to the robot would remain accurate to the accuracy of the LIDAR.

IV. Question 4

Q: How could you choose a good resolution for your map? Elaborate on what happens if your resolution is too low or too high.

A: If resolution is too low, the robot would not accurately map the shape of objects it detects. If the resolution is too high, the processor of the robot may not be able to map as fast as data is taken in, or the sensor may not provide enough data to adequately fill out the map. A good resolution would be dependent on hardware, so a good rule of thumb could be to find the highest resolution that our processor can handle, then divide that resolution to provide some margin of error.

V. Question 5

Q: You have been using the starting line to perform "loop closure", recognizing where the robot is to reset its odometry and prevent localization drift. How can you use the LIDAR sensor to accomplish a similar goal?

A: The starting line solution for loop closure relied on "image detection" to close the loop. That is, it detected the image of a horizontal line to close the loop. This works because there is one horizontal line on our track, the starting line. Similarly, if we were to find some set of objects to detect that only occur once in our track, we can use those to close the loop as well. It would require some margin due to the inaccuracy of the sensor, but if we set it to recognize (based on readings taken at the starting line) the pattern of two cylinders on the left, two boxes (third out of line of sight) and a cylinder to the right, wall straight ahead, it would be possible to close the loop with the LIDAR sensor.