**Robotics**

**Practical 5: Probabilistic Motion and Sensing**

**Question 2: Sonar Calibration**

1. *When placed facing and perpendicular to a smooth surface such as a wall, what are the minimum and maximum depths that the sensor can reliably measure? Rotate the robot and sensor so that it faces the wall at an angle. What is the maximum angular deviation from perpendicular to the wall at which it will still give sensible readings?*

**Depth**: - minimum = 6 cm

- maximum = 163 cm

**Angular deviation**: maximum = 50°

1. *Do the sonar depth measurements have any systematic (non-zero mean) errors? To test this, set up the sensor at a range of hand-measured depths (20cm, 40cm, 60cm, 80cm, 100cm) from a wall and record depth readings. Are they consistently above or below what they should be?*

|  |  |
| --- | --- |
| Depth | Value recorded |
| 20 | 22 |
| 40 | 41 |
| 60 | 61 |
| 80 | 81 |
| 100 | 102 |

According to our readings, the values are constantly above what they should be, which means the sonar depth measurements have systematic errors.

1. *What is the accuracy of the sonar sensor and does it depend on depth? At each of two chosen hand-measured depths (40cm and 100cm), make 10 separate depth measurements (each time picking up and replacing the sensor) and record the values. Do you observe the same level of scatter in each case?*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R8 | R10 |
| 40 cm | 41 | 41 | 41 | 40 | 41 | 41 | 42 | 41 | 41 | 41 |
| 100 cm | 102 | 102 | 101 | 101 | 102 | 101 | 101 | 102 | 101 | 101 |

We can conclude the sonar sensor is very accurate for the 2 distances, as the readings above show. We have noticed that the level of scatter between 40 cm and 100 cm depth is similar. Hence, the accuracy of the sonar sensor does not depend on depth at these particular distances.

1. *In a range of general conditions for robot navigation, how often do you think your sonar gives garbage readings very far from ground truth? How would you model this in a probabilistic filter?*

Our sonar rarely gives readings very far from ground truth in a range of general conditions for robot navigation. In particular, the experiments we undertook show that this happens only when the distance is out of the range (6, 163) (minimum and maximum values at which the sonar sensor gives reliable measures – according to 1). This result can be modeled as a Gaussian distribution.