Worksheet: Field of View

Introduction to Mobile Robotics > Field of View Exploration

This worksheet is provided for reference only. Be sure that you follow the steps in the online directions, and answer the questions at the appropriate times. Fill out all your answers on a separate sheet of paper.

Phase 1: Find Detection Boundary – Evaluate your Findings

1. Mentally "connect the dots" for the pattern of marks you made.
    i. Do your marks seem to follow any kind of pattern, trend or outline of a shape? If so, describe it.
    ii. What does this "outline" represent in terms of what the sensor can detect?

2. Locate the tracing that is farthest from the ultrasonic sensor. Place the object at this location again, and record the sensor's reading from the NXT's viewscreen.
    i. What is the maximum distance that the ultrasonic sensor could detect for this object?
    ii. Where was the object located in relation to the sensor at this distance?

3. Find the two points along the same horizontal line that are farthest apart. This is the farthest to the sides that your sensor can detect an object of this size.
    i. Is this "widest detection range" wider or narrower than the robot's physical width?
    ii. If the robot moves in a straight line, is the ultrasonic sensor's detection "width" sufficient to ensure that it will detect an object of this size before the robot runs into it? Hitting the very edge of the tire still counts as a collision!

Phase 2: Scale Model – Measure and Plot

Record your calculations:

4. What is the actual distance between two horizontal lines on the Graph Sheet?

5. What distance is represented by the gap between two lines on the Graph Sheet?

6. What is the scale (size ratio) between the graph paper distance and the physical distance it represents? Express your answer as a ratio in the format 1:__.

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Phase 2: Scale Down – Evaluate Your Findings

7. Look at your graph sheet.
   i. In what important ways is the scale model the same as the full-size pattern?
   ii. Are there any ways in which the scale model is not the same as the full-size pattern?
   iii. On the whole, do you feel that the scale model is an acceptable way to store the information from this experiment?

8. Recall the scale factor (size ratio) that you calculated in question 6.
   i. Explain what this scale factor means.
   ii. If two points on the full-size pattern were 22 cm apart, how far apart should they be on the scale model?
   iii. If two points measure 2.3 cm apart on your scale model, how far apart should they have been on the full-size pattern?

9. Locate the tracing that is farthest from the 0 cm marking on the graph sheet.
   i. Where was the object located in relation to the sensor at this distance?
   ii. Measure the distance from the 0 cm marking to the farthest marking. How far is it on the graph sheet?
   iii. Using your scale factor (size ratio), calculate how far the object should actually be. How far away should it be?
   iv. What is the maximum distance the Ultrasonic Sensor can detect a can-sized object, and in what direction must it be?

10. The NXT Ultrasonic Sensor has 2 modes that it switches between automatically: a short-range mode and a long-range mode.
   i. Is there any evidence of this switch happening in the pattern of the detection area? If so, what do you see that suggests there is some kind of mode switching happening?
   ii. At what distance does the transition from short-range mode to long-range mode appear to occur?
   iii. Why might a sensor need multiple modes of operation?

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Analysis and Conclusions: Conclusions & Exercises

Conclusions

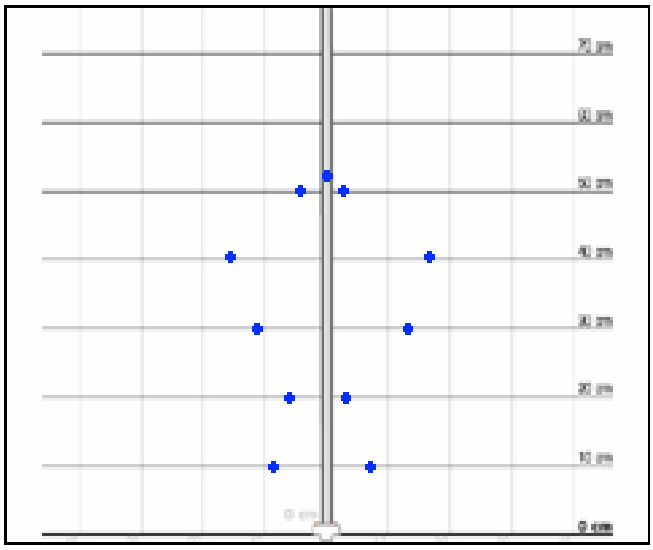
11. The ultrasonic sensor works by sending out high-frequency sound waves and measuring the amount of time it takes for the sound to reflect off an object and come back.

Explain the shape of the detectable area in terms of where and how far sound must travel in order to be sent out and received back.

Hint: Areas where the sensor could not detect an object mean that the sound waves did not reach those areas, did not return to the sensor from those areas, or were too weak to be detected by the time they returned.

12. Write a paragraph or two describing how you conducted your experiment, including step by step instructions so that someone could recreate your experiment in the future. Make sure to include instructions on how to store this data in a manageable from for future use.

Exercises



13. On the left is the data taken from a scientist's test of a similar ultrasonic sensor. She ran the experiment with the same method that you used, by sliding an object along until the sensor was able to detect it, and then marking that point.

i. What was the maximum range of her sensor, and in which direction did it occur?

ii. What was the widest part of the detection area, and how far from the sensor is it?

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14. Another, much larger, sensor was tested here, but the detection range was so big that the scale of the graph had to be changed.

i. What was the maximum range of her sensor, and in which direction did it occur?

ii. What was the widest part of the detection area, and how far from the sensor is it?

15. Sound travels approximately 340 m/s at sea level.

i. Identify the longest distance you detected an object in this exploration.

ii. How long did the ultrasonic wave take to reach the object? Remember that your readings are in cm.

iii. How long did it take for the wave to return to the sensor from the object?

iv. How long did the wave take to travel through the air, in total?

v. If the object had been 1 cm farther (the smallest increment the Ultrasonic rangefinder will detect), what would its sound wave travel time have been?

vi. What does this comparison tell you about the sensitivity of the timing circuitry in the NXT and the ultrasonic sensor?

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