LEGO® MINDSTORMS® NXT Lab 2

This lab introduces the touch sensor and ultrasonic sensor which are part of the Lego Mindstorms NXT kit. The ultrasonic sensor will be inspected to gain an understanding of its functionality. Then a simple application is provided that will cause the Tribot to avoid obstacles using both the touch sensor and the ultrasonic sensor. The final challenge will take the application a step further by using the claws to move small objects out of the Tribot's way.

Lab Summary

A. Use the Lego Mindstorms NXT software to monitor the touch and ultrasonic sensors
B. Create a program to enable the Tribot to avoid obstacles in its path
C. (Challenge) Have the Tribot move short obstacles out of its path

Software

- Lego Mindstorms NXT

Hardware

- Lego Mindstorms NXT Tribot

Part A: Monitoring the Touch Sensor and Ultrasonic Sensor

1. Open the Lego Mindstorms NXT software on your computer
2. Using a USB Cable, connect the Tribot to a USB port on your computer
3. Press the Power button of the Mindstorms NXT Tribot
4. Create a new project by selecting File >> New
5. Detect the Robot by clicking on the NXT Window button on the lower right of the screen

6. Click on your robot and then click on Connect
7. Switch to the Complete Palette view at the bottom left side of the NXT window

8. From the Sensor subpalette, place a Touch Sensor block on the sequence beam

9. Click on the Touch Sensor, and notice the current state of the sensor in the bottom right corner of the screen
10. Press the Touch Sensor on the Tribot and notice that the state of the sensor changes

Question:

i) How far in percentage with 0% meaning not pressed and 100% meaning fully pressed do you have to push the sensor for it to register on the sensor screen?

11. From the Sensor palette, place an Ultrasonic Sensor block onto the Sequence Beam
12. Click on the Ultrasonic Sensor block. Notice that the sensor observation window values change when you move objects in front of the sensor.

Questions:

i) What is the maximum distance that an object can be detected?

ii) What is the minimum height that the object must be in order for the object to be detected?
iii) What is the maximum angle that the object can be placed from the center line of the sensor and still have it be detected?

13. Close the program without saving changes

Part B: Detect and Avoid Obstacles

1) In the User Profile drop-down box select your profile
2) Select File >> New to create a new program
3) Save the program as Lab2.rbt
4) Switch to the Complete palette view
5) Click the Common palette and then select the Move block
6) Place the Move block onto the sequence beam, and configure it as shown:

![Move Block Configuration]

This block will command the claws to partially open on the Tribot.

7) Select the Loop block in the Flow palette
8) Place the Loop block at the end of the sequence beam, and leave it in its default configuration as shown:

![Loop Block Configuration]

9) Select the Switch block in the Flow palette
10) Place the Switch block inside the Loop structure onto the sequence beam
11) Click on the Switch block, and configure it as shown:
The final configuration thus far should look like the following:

12) Place another **Move** block inside the “flower” or “object less than ten inches” case of the **Switch** block
13) Configure the new **Move** block as shown:

14) Select a **Wait** block from the Flow palette
15) Place the **Wait** block to the right of the **Move** block that was recently placed inside the **Switch** block and configure it as shown:

16) Switch to the “mountain” or “object greater than ten inches” case of the **Switch** block
17) Place another **Move** block inside this case onto the sequence beam and configure it to move forward at a power of 50 as shown:
Questions

i) What do you suspect the Tribot will do if the program is downloaded and run?

ii) Are there any objects that the ultrasonic sensor cannot detect? If so, give some examples. If not, then why?

18) Place another **Switch** block inside the while loop, but after the first Switch block onto the sequence beam
19) Configure the Switch block as shown:

20) Place a **Sound** block from the Action palette inside the “pressed” case of the second Switch block
21) Click on the Sound block to configure it to play a sound as shown:
22) Place a **Move** block after the Sound block inside the Switch block and configure it as shown:

23) Place another **Move** block after the recently placed Move block inside the second Switch block, and configure it as shown:

Nothing will go inside of the “Released” case of the second Switch block

24) Place another **Switch** block inside the Loop block after the second Switch block

25) Click on the new Switch block to configure it as shown:

26) Place a Move block inside the new Switch block in the “sound detected” case, and configure it as shown:
This block will close the claws before the program finishes.

27) Place a **Stop** block from the Flow palette after the recently placed Move block. Nothing will go in the “sound not detected” case of the third Switch block.

The final program should look like the following:

![Program Diagram]

**Note:** The Switch blocks in the image were flattened for the sake of showing both cases in the image. You can toggle between these views by toggling the “Flat View” Display control found in the configuration window of the Switch block.

28) Save your work, and download the program to the NXT Robot.
29) Make sure that the claws on the Tribot are fully closed and in front of the Tribot. There is a third motor at the bottom of the Tribot that controls the claws. Rotate the black spoke that is attached to this motor to move the claws to the front of the Tribot.
30) Run the program. The robot should open its claws so that the touch sensor bar is exposed. Then it should move forward in a straight line until the Ultrasonic sensor detects an object within 10 inches. When it detects the object, it should turn until the object is no longer detected, and then move forward again. If the robot happens to run into an object that is too short to be detected by the ultrasonic sensor, then the object should depress the Touch sensor bar. This would cause the robot to back up, turn left, and resume motion. The robot should say “object” when the touch sensor bar is depressed. If the robot detects a loud noise, the claws should close and it should stop running.

**Part C: (Challenge) Move Small Objects Instead of Avoiding Them**

The objective of this challenge is to expand on the functionality of Part B. Instead of avoiding small objects detected by the touch sensor, command the robot move short objects out of its way. When a short object is detected, have the robot grab the object with the claws, move it out of the way, and then continue on in the intended direction. Use the colored balls that came with your kit for the short objects.

Instead of using the sound sensor to stop the program use the square, orange Enter button that is on the NXT block.