How to Make Your Robot

RURRET VERTINE

A Sample Self-instructional Project for CIMT 610

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WHAT'S IN THIS BOOKLET



WHAT DO YOU NEED FOR THIS TUTORIAL?





LEGO MINDSTORM NXT 2.0 (8547) A COMPUTER WITH NXT 2.0 SOFTWARE



A ROBO-CAR (CUSTOMIZED OR USE SHOOTERBOT*)

- □ I CAN CONNECT NXT TO COMPUTER
- 🗌 I CAN CREATE A NEW PROGRAM
- □ I CAN IDENTIFY SENSORS
- □ I CAN IDENTIFY PORTS
- □ I CAN USE ACTION BLOCKS (MOVE, WAIT, SOUND, DISPLAY)
- □ I CAN DOWNLOAD AND RUN PROGRAMS ON NXT

ALL SKILLS YOU NEED TO CONTINUE

* NXT has a tutorial for assembling your first bot. You can find it in HELP menu. BLANK PAGE

1. WHAT CAN A ROBO-CAR DO?



http://www.youtube.com/watch?v=123

In this example, we use a color sensor to detect the color of lines. If it detects green line, the car will say "Green" and continue moving. If it detects a red line, the car will say "Red" and stop at the redline. (You can view the video clip at http://www.youtube.com/watch?v=123.)



Figure 1 Color detector

Think about what does the robo-car do in the example?

Yes, it makes decisions.

Thank about what tool does the robo-car use to detect a condition in this example?

The answer is **sensor**. In this example, it uses a **color sensor** to detect different colors.

1. WHAT CAN A ROBO-CAR DO?



Figure 2 A Robot

This robot uses thousands of sensors to detect different conditions and then make his decision. Sensors let robots "know" the outer world, and let them be smarter. In this tutorial, you will learn how to use **SWITCH** blocks and sensors in LEGO MINDSTORM NXT 2.0.

Activity 1:

In this activity, you will identify the three types of sensors that will be used in this tutorial.

Please draw lines between pictures and names.



Color Sensor Ultrasonic Touch Sensor Sensor

If you are not sure about the type of sensors, please check the NXT manual.



"If I had 60 minutes to solve a problem, I'd spend 55 minutes defining it, and 5 minutes solving it."

---- Albert Einstein

This quote illustrates a very important point that before you solve a problem invest your time to understand the problem. In this tutorial, you will solve problems of conditional task. Sometimes, these problems are not well formatted, or with reluctant information. Therefore, the first step to solve these problems is to define problems in effective language structure, or present problems using a visual map.



Figure 3 Define problem

Activity 2:

Action tasks can be performed using action blocks.

Following are 7 tasks which a robo-car can do. Please check out the action tasks.

- □ l. Move forward
- 🛛 2. Stop
- □ 3. Wait for 5 seconds
- □ 4. Say "Green" and keep moving
- □ 5. Turn left
- □ 6. See a red ball
- □ 7. See an object 20 cm ahead

Condition and Action

The last two tasks in activity 2 are conditions not action tasks. Conditions are the situations when something happens.

Activity 3

Look at this statement:

If it rains, close the windows, otherwise keep the windows open.

There are condition and actions in this task. Can you find them?

Condition	Action

Action - close the windows & keep the windows open

YES or NO?

A condition has two results, Yes or No. The following image is a visual map for the raining problem.



Figure 4 ITE pattern

You can use IF...THEN...ELSE... (ITE) structure to define the problem. Put the condition after IF, put the action when the condition is true after THEN, put the action when the condition is false after ELSE. Make the problem looks like:

IF it rains, THEN close the windows,

ELSE keep the windows open.

Activity 4

Define the following problem:

When a robo-car detects red color $\ensuremath{\scriptstyle\neg}$ it will say "Red" and stop.



• ELSE do nothing

Activity 5

Define the following problem:

When a robo-car touches an object, it will say "Object" and stop.



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A switch block is used to make decisions.

A switch block can use time, variable, and sensor as conditions. It has two branch, one is for actions when the condition is YES, and the other is for actions when the conditions is NO.



Figure 4 Switch block

The left icon is the switch block icon on toolbox; and the right image is a switch block in a program. Like the pattern you used in previous section, a switch block has a condition block and two branches. The upper branch is used when condition is YES, and the lower branch is used when condition is NO.

In the whole tutorial, you will use three types of sensors as conditioner, color sensor, touch sensor, and ultrasonic sensor. The next sample will use a touch sensor.

Now, here is your problem:

IF the button on left touch sensor is pressed. THEN
say "object" and stop. ELSE do nothing.

Before you jump into the program, you have to do another thing, identify the port number of sensors.

A robo-car has one ultrasonic sensor, one color sensor, two touch sensors, and two motors. Sensors are connected to the number ports (figure 5), and motors are connected to the alphabet ports (figure L).



Figure 5 Port 1, 2, 3, and 4



Figure & Port Aı Bı and C

Record your connection in following table:

Table 1 Sensors and ports

Sensor/Motor	Left Touch	Right Touch	Color	Ultrasonic	Left Motor	Right Motor
Default Port No.	1	2	3	4	А	В
Your Port No.						

You will use these port numbers later.

Suppose you have your left touch sensor connected on port 1. Go through following steps to make the robo-car say "Object" when the button on your left touch sensor is pressed.

Step 1. Drag and drop a Loop block to the default sequence.





Step 2. Drag and drop a Switch block into the Loop block.



Figure & Switch block

Step 3. Click the Switch block. Choose "Sensor" in the Control filed (options will change depends on what you choose here). Then, choose "Touch Sensor" in the Sensor field.





Figure 10 Touch sensor parameters 1

Figure 9 Touch sensor

Step 4. In Port field, check the port number which is connected to the left touch sensor. By default, it will use port 1. Then, check "Pressed" in Action field.



Figure 11 Touch sensor parameters 2

Step 5. Put a Sound block on the upper branch of the switch block and choose the "Object" sound file (When you click the sound file, the robo-car will play the sound file for tesing). Then, put a Stop block after it. These actions will perform when the condition is YES, which means the button of the left touch sensor was pressed.



Figure 12 Sound block

Sound	Action:	💿 🗰 Sound File	O 🕑 Tone	🗋 File:	Object Detected
	Control:	💿 ▶ Play	🔿 📕 Stop		Ocof
94	dl Volume:	<u>aff</u> -	_ <u>all</u> 75		Orange
	Punction:	🗆 🧐 Repeat		Wait:	☑ X Wait for Completion

Figure 13 Sound block parameters

The lower branch of the switch block is for actions when the condition is not happened. In this sample, keep it empty, because there are no actions for it.

Step L. Save the program as "touchleft.nxt". Download and run the program on the robo-car.

Step 7. Testing. Press the button on left touch sensor. Do you hear the robo-car say "Object"? If not, go back and check every steps.



Figure 14 Touch demo



http://www.youtube.com/watch?v=123

Conclusion

In this section, you have been presented a procedure for a conditional task.

- 1.Define the problem in ITE pattern. (You did it in activity
 5)
- 2.Add a Loop block to keep the Switch block working repeatedly. (step 1)
- 3.Add a Switch block. (step 2)
- 4.Set Condition type to "Sensor"; select "Touch Sensor" in sensor type field. (step 3)
- 5.Set parameters for touch sensor. (step 4 and 5)
- 6.Save and test the program. (step 6 and 7)

Activity 6

Create a new program named "touchright.nxt" and finished the task: IF the button on right touch sensor is pressed. THEN say "object" and stop. ELSE do nothing. (Use the testing method in step 7 to test your program.



http://www.youtube.com/watch?v=123

In a real situation, you might use multiple sequences to finish your task. For example, a robo-car might need to detect colors or objects when it is moving, like the sample you saw at the beginning of this tutorial.

Activity 7

Redefine the problem of the sample at the beginning of this tutorial:

A robo-car is moving forward.

IF the robo-car	THEN
ı ELSE	·
IF the robo-car	THEN
¬ ELSE	•

. IF the robo-car detects a red line. THEN play sound "Red" and stop. ELSE do nothing.

IF the robo-cac detects a green line. THEN play sound "Green". ELSE do

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In this problem, which sensor you will use? which port does it connected?

Go through following steps to make the robo-car detect color lines.

Step 1. Drag and drop a Move block on the default sequence.



Figure 15 Move block

Step 2. Select the Move block. Check port A and B for left and right motors (according to table 1 on page 11). The direction is UP; keep steering in middle (means no steering); set power to 50%, so the car won't move too fast; set duration to Unlimited, so the car will keep moving until a Stop action performed.



Figure 16 Move block parameters

Step 3. Drag and drop a Loop block below the Move block (figure 17).



Figure 17 Parallel sequences

Step 4. Move your mouse over the starting point, the mouse point will change to a wire connector. Press left button and hold it, then move the sequence connector over the sequence of the Loop block. The two sequences will connect automatically (figure 17).



Parallel sequences will execute at the same time. You can create a parallel sequence from start point or in the middle of a sequence. If you would like know more, you can use "Content and Index..." in "Help" menu.



Step 5. Drag and drop a Switch into the Loop block (figure 18).

Figure 18 Switch block

Step L. Select the Switch block. Then, choose "Sensor" in Control field, choose "Color Sensor" in Sensor field, check port 3 (or the port that connect your color sensor in table 1 on page 11), choose "Color Sensor" in Action field, choose "Inside Range" in Compare field, move the slide bar to select the green color (figure 19).



Figure 19 Color sensor parameters

Step 7. Put a Sound block (figure 20) on the upper branch of the switch block and choose the "Green" sound file (figure 21).



Figure 20 Sound block

Sound	Action:	Sound File	O 🍌 Tone	🗁 File:	i i	Green Grev	U
	Control:	💿 ▶ Play	🔿 📕 Stop			Have A Nice Day Hello	
0.4	dl Volume:	<u>atl</u> -	<u>all</u> 75			Hooray	⊡
	Punction:	🗆 🧐 Repeat		🛛 Wait:	🕑 😥 Wai	it for Completion	

Figure 21 Sound block parameters

Step 8. Drag and drop another Switch into the Loop block (figure 22).



Figure 22 Second switch block

Step 9. Select the Switch block. Then, choose "Sensor" in Control field, choose "Color Sensor" in Sensor field, check port 3 (or the port that connect your color sensor in table 1 on page 11), choose "Color Sensor" in Action field, choose "Inside Range" in Compare field, move the slide bar to select the red color (figure 23).



Figure 23 Second color sensor parameters

Step 10. Put a Sound block (figure 24) on the upper branch of the switch block and choose the "Object" sound file (figure 25) . Then, put a Stop block after it (figure 24) .



Figure 24 Stop block



Figure 25 Second sound block paramters

Step 11. Save the program as "touchleft.nxt". Download and run the program on the robo-car.

Step 12. Testing. Put the robo-car on a test pad which has a green line and a red line. You can make a green line on the standard test pad paralleled with the red line. First round, let the robo-car detect green line first; second round, let the robo-car detect the red line first. Please review the video file online.



http://www.youtube.com/watch?v=123

Remember what we just did?

Table 2 Common steps for a conditional task

Steps	Tasks
ľ	Determine the type of condition.
2	Drag and drop a Switch block onto a new thread.
З	Select "sensor" for Control.
4	Select the sensor type determined in step 1 for Sen- sor.
5	Select the port which is connected to the sensor in step 4.
6	Drag and drop action blocks onto upper branch to perform the action when the condition is true
7	Drag and drop action blocks onto lower branch to perform the action when the condition is false.
ß	Download and run the program on a robo-car.

The steps in table 2 are the common steps to solve a conditional task problem. Some steps might need to be adjusted.

Activity &

 $\mathsf{Now}_{\texttt{l}}$ try a task by yourself. When you finished, check the online video.

A robo-car goes forward. When the robo-car detects that there is an object 20cm ahead, it says "Object detected" and stops.



http://www.youtube.com/watch?v=123

CONCLUSION

In this tutorial, you have learned to:

- Identify conditions and actions in a task
- Define a conditional task with ITE structure
- Determine a condition's type and the sensor's type
- Recognize the Switch block in common palette
- Use parallel sequences
- Solve conditional task problem using Switch block

CHECK YOUR UNDERSTANDING

Time: 35 minutes

Name: _____ Date: _____

Section #	Section I	Section I	Section III	Total
Score				

Section I: Multiple Choices

Direction: In this section, you will choose the best answer for each question.

1.() Which one of the following tasks is a conditional task?

A.Display a picture on screen.

B.When sees a red ball, says red.

C.Play a sound.

D.Go forward, don't stop.

2.() Which one of the following blocks is Switch block?

Β.





C.





3.() Which one of the following conditions is a touch condition?
A. When the robo-car sees a red line, it stops.
B. When the robo-car sees an object, it stops.
C. When the robo-car conflicts with an object, it stops.
D. When the robo-car runs 2 minutes, it stops.
4.() Which one of the following actions needs a Loop block to repeat?
A. Play a sound for so times.
C. When a button pressed, stop the car.

D.Go forward, never stop.

5.() Which one of the following blocks is a Loop block?





CHECK YOUR UNDERSTANDING

- 6. () Which one of the following loops will use a touch sensor to stop?
 - A.A robo-car will play a sound for 50 times.
 - B.A robo-car will display a picture for 5 minutes.
 - C.A robo-car will always say "Green" when it sees a green ball until it sees a red ball.
 - D.A robo-car will shoot balls until a touch sensor button pressed.

Section II: Short answer

Direction: In this section, you will answer the question using one sentence.

7. Use the following condition-action pair to compose an ITE sentence:

Condition: touches an object; Action: says "Object".

B. Rewrite the following task in to an ITE sentence: A robo-car will move forward. When the robo-car sees any object in 20cm, it will say "Object" and stop.

CHECK YOUR UNDERSTANDING

Section III: Operation

Direction: In this section, you will be asked to design a program to complete a task. You can use NXT software and run the program on a robo-car.

9. Design a program to perform following task. You will use a robo-car to finish the task.

A robo-car goes forward. When the left touch sensor touched an object, it will backward for 5cm, and turn 45 degree to right, then move forward. When the right touch sensor touched an object, it will backward for 5 cm, and turn 45 degree to left, then move forward.

Table 3 Answer sheet

Q#	Grade Guidelines	Available Points	Your Points
г	В	5	
2	C	5	
З	C	5	
4	В	5	
5	В	5	
6	D	5	
7	If car touches an object (2.5), then it will say "object". (2.5)	5	
8	If car sees an object in 20cm (3.5), then it will say "object" and stop (3.5), else it will con- tinue to move forward. (3)	10	
9	Give a self-evaluation based on the video at http://www.youtube.com/watch?v=123	55	

Valkı L. (2010). The LEGO MINDSTORM NXT 2.0 discovery book - a beginner's guide to building and programming robots. San Franciscoı CA: No Starch Press.

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