Skill Builder 1: Brightness Sensor

THE ON RAMP TO ROBOTICS WITH TI-INNOVATOR™ SYSTEM (TI-NSPIRE CX)

Overview:

In challenge one, students use the Hub brightness sensor to inform the color and brightness of the Rover's color LED. During the second challenge, students use the brightness sensor to stop the forward motion of the Rover when the intensity becomes greater than a preset threshold value. Finally in the third challenge, students spin their Rover in a full circle while monitoring the brightness sensor and find the angular position within the circle where the brightness is greatest.

Goals:

Students will:

1. Use the BRIGHTNESS sensor in the TI Innovator Hub within their Rover to measure light intensity.
2. use the control structures:
    a. For…EndFor
    b. While…EndWhile
    c. If…Then…EndIf

Background:

Light can be described as an electromagnetic wave. One property of that wave is frequency, which is how fast it vibrates up and down; the human eye perceives this as the color of the light. Another property of the wave is the amplitude, which is how much energy the wave possesses; the human eye perceives this as the brightness of the light. The human eye possesses millions of photoreceptors in the retina that are sensitive to both color and intensity. Engineers and scientists have discovered semiconductor materials that are sensitive to light intensity. These materials are used to build light intensity sensors that are used in many electronics technologies that require a response to the surrounding brightness. For example, a computer screen may dim in response to how bright the room is. The TI Innovator Hub that is inserted into the Rover has a light brightness sensor. If you look closely at the Hub within the Rover, you will see a small window with the word BRIGHTNESS printed below. This sensor detects intensity only, not color. A TI-BASIC program can read this sensor value with a range from 0 (dark) to 16383 (bright). You could read the Hub's BRIGHTNESS sensor within a TI-BASIC program and use it to control the motion of the Rover!

Hub Command	Example	Behavior
READ BRIGHTNESS	Send "READ BRIGHTNESS"	This Hub command reads the light intensity of the BRIGHTNESS sensor located on the TI-Innovator Hub at the rear of the Rover and returns that reading to the calculator when the program requests it with the Get command.
Get variable	Get *b*	The Get command retrieves the value returned to the calculator from the Hub after a READ command is issued. In this example, the brightness measurement is stored in the variable named *b*.
RANGE BRIGHTNESS min max	Send "RANGE BRIGHTNESS 0 255"	The RANGE command scales the output of a sensor to minimum and maximum values. In the example, the values of BRIGHTNESS are scaled between 0 and 255.
SET RV.COLOR red green blue	Send "SET RV.COLOR 255 128 0"	This command sets the three primary colors of the RGB LED, in this example, the appearance of the LED will be yellow since the red is set fully bright (at a value of 255) the green is set to medium and the blue is set off (at a value of 0).
eval(variable or expression)	Send "SET RV.COLOR 0 0 eval(b)"	When the eval(b) command is inserted into the Hub command that sets the RGB LED, the blue channel will be set with the value contained within the variable name *b*. That is, *b* is evaluated and then substituted into the command. The eval command can also be used to evaluate expressions.
RV STOP	Send "RV STOP"	Stops the Rover immediately.

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Setup Rover:	Supplies:
Students may work in groups of two or three. Choose an area to work that has at least 2 meters of clear uniform floor space. During these challenge, the room lights should be reduced to avoid bright ambient lighting. During the final challenge, a strip of tape should be placed on floor as the reference from which angle is measured.	• Lights: small LED flashlights • Drive Mats (optimal) • Masking tape

Student Activity	Teacher Activity

Challenge 1: Write a program that makes the RV.COLOR LED bright blue when you shine a bright light into the BRIGHTNESS sensor and then a soft blue when the light in the room is dim.	**Guidance during challenge 1:**
	
	Review the Rover commands needed for this activity.
	
	• Unit 1 Skill Builder 2 review:
	    o The For…EndFor command sets up a loop to repeat the enclosed lines of code as many times as stated in the command.
	       For i,0,10
	        …
	        …
	       EndFor
	    o The DispAt displays a prompt and variable value at a specified line on the display.
	       DispAt 3, "Brightness =", *b*
	    o The Wait command halts the TI BASIC program for the specified number of seconds.
	       Wait 2
	• This challenge requires the use of the RV.COLOR command to set the red, green, and blue (RGB) color led. This LED is in the upper left corner of Rover by the fuel gauge. The three primary colors within the LED may be mixed in proportions that yield the appearance of many secondary and tertiary colors. The command for setting the color of the LED to blue is:
	    o Send "SET RV.COLOR 0 0 255"
	• Alternatively, the RGB LED can be set to a soft blue with the command
	    o Send "SET RV.COLOR 0 0 128"
	• The values for each color channel range from 0 to 255, where 0 is off and 255 is maximum brightness.
	• Use the RANGE command to scale the BRIGHTNESS value to 0 to 255 so that it can be used to set the blue channel of the RGB LED using the eval() command.
	    o Send "SET RV.COLOR 0 0 eval(b)"

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Sample Code:

```
Define c1()=
Prgm
Send "CONNECT RV"
Send "RANGE BRIGHTNESS 0 255"
For i,1,500
  Send "READ BRIGHTNESS"
  Get b
  DispAt 3,"Brighness =",b
  Send "SET RV.COLOR 0 0 eval(b)"
EndFor
EndPrgm
```

*Please see the associated sample program, c1, in the file named "Unit 2 Skill Builder 1 Example Programs.tns" as a reference if help is needed.

Challenge 2: Write a program that drives the Rover backward until the BRIGHTNESS light level sensor reads a value above 25%.

Guidance during challenge 2:

- This challenge requires the use of a new programing control structure While…EndWhile and a new Rover command "RV STOP".
  - The While…EndWhile control structure will repeat enclosed commands while the associated expression is true. For example, the following code will repeat as long as the value stored in the variable x is not equal to 1. As soon as x is changed and is equal to 1, the loop will exit and the statement after the EndWhile will execute.
    - While $x \neq 1$

      …

      EndWhile
  - "RV STOP" command takes immediate action when the program encounters the statement. This brings Rover to a halt. This command may be used to stop Rover when the BRIGHTNESS level reaches a predetermined trigger value.
  - Calculator programs send commands to the Rover. The communication happens quickly. In some situations, the Rover receives drive commands before previous drive commands have been completed. The Rover stores the drive commands in a to-do list (queue) to execute one after the

other until the list is empty. The RV STOP command overrides the to-do list of drive commands and immediately halts the Rover. In this challenge, the Rover is given a drive command that takes a long time to complete, drive backward for 10 meters. While the Rover is driving the brightness level is being checked in a While loop. When the brightness level gets above a certain value the While loop check will be false and the program exits the loop. Then the command just after EndWhile is executed. In this case the command is Send "RV STOP", which causes the Rover to immediately halt.

o In this challenge, the program continuously reads the BRIGHTNESS sensor in a While…EndWhile loop until the brightness exceeds 25% (or a different trigger value), which causes the program to exit the While loop and execute the next command after the end of the loop, RV STOP.

Sample Code:

```
Define c2()=
Prgm
Send "CONNECT RV"
b:=0
Send "RV BACKWARD 10 M"
While b<25
  Send "READ BRIGHTNESS"
  Get b
  DispAt 3,"Brightness=",b
  Wait 0.5
EndWhile
Send "RV STOP"
EndPrgm
```

*Please see the associated sample program, c2, in the file named "Unit 2 Skill Builder 1 Example Programs.tns" as a reference if help is needed.

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Challenge 3:

- Write a program that causes Rover to turn by steps in a full circle searching for the brightest position on the circle.
- Once the rover has completed a full circle while reading brightness levels, the rover should then turn back to the brightest position.

Brightness sensor
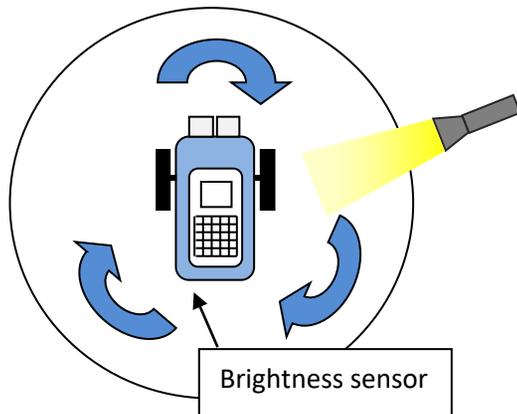
Guidance during challenge 3:

- This program uses the If…Then…Endif statement to check if the current brightness measurement is greater than all previous values. The program will update the variable, *maxb*, with the brightest value. The associated variable, *angleatmax*, will also be updated so the system knows the angle at which the brightest reading was found.

- The program should also use a For EndFor loop to sweep through the full turn. This should be done in several steps. Each step through the loop should contain a turn, a BRIGHTNESS measurement, and an If…Then…Endif to check for maximum brightness.

Sample Code:

```
Define c3()=
Prgm
Send "CONNECT RV"
maxb:=0
angleatmax:=0
For n,1,24
  Send "RV RIGHT 15"
  Wait 2
  Send "READ BRIGHTNESS"
  Get b
  If b>maxb Then
    maxb:=b
    angleatmax:=n*15
  EndIf
EndFor
Send "RV.RIGHT eval(angleatmax)"
EndPrgm
```

*Please see the associated sample program, c3, in the file named "Unit 2 Skill Builder 1 Example Programs.tns" as a reference if help is needed.