Using the Vernier Adapter and Vernier Block with LEGO's MINDSTORMS Edu NXT V2.0 software

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Introduction

The Vernier NXT Adapter allows many of our analog ("-BTA") sensors to work as sensors on the LEGO® MINDSTORMS® NXT Robotics System. There are over 30 of these sensors for measuring everything from temperature to force to light level to UV level to pH. For a list of Vernier sensors that can be used with the adapter, check out www.vernier.com/nxt. The adapter started shipping in October 2007. They are sold by both LEGO and Vernier Software & Technology. The device is slightly larger than the LEGO sound sensor. Essentially there is a LEGO NXT socket on one end and a Vernier BTA socket on the other end. There is some signal-conditioning circuitry inside.

To use this adapter with LEGO MINDSTORMS software, you need to download and import the Vernier Sensor block. You can download it from www.vernier.com/nxt/downloads.html. You will need to import it into the LEGO MINDSTORMS software on your computer. This block allows you to choose which Vernier sensor you are using from a list and handles calibration of the sensor. It also lets you use the Vernier sensors in other programming blocks such as Loop, Switch, and Wait. The Vernier Sensor block works on either Windows or Macintosh.

With the release of the MINDSTORMS Edu NXT V2.0 Software in December 2008, we had to modify the Vernier Sensor block to be compatible with the new version. Our new book, STEM with Vernier and LEGO MINDSTORMS NXT book assumes that you are using this block. The new Vernier Sensor Block will not work with the old versions of LEGO MINDSTORMS software, such as versions 1.0 and 1.1. A version of the Vernier Sensor Block for the earlier versions is also available from the same download site. These instructions are about the 2.0 version of the Vernier Sensor Block and MINDSTORMS Edu NXT V2.0 Software.

This document covers installation and basic operation of the NXT with the Vernier Sensor Block. For more information about data collection using the NXT and the Vernier Sensor Block please consult the Vernier book *STEM with Vernier and LEGO MINDSTORMS® NXT, Appendix F*

There are also a number of movies of projects made with this adapter at http://www.vernier.com/nxt. You may want to check them out to give you ideas for projects.

Importing the Vernier Sensor Block into LEGO MINDSTORMS 2

To use this adapter you should use the Vernier Sensor block with LEGO MINDSTORMS software, you will need to download it from www.vernier.com/nxt/downloads.html . Choose the Vernier Sensor Block for LEGO MINDSTORMS 2. The block works on either Windows or Macintosh.

After you download it, you will need to import the block into NXT V2.0 Programming software on your computer. To install the Vernier Sensor block follow the procedure below:

Start NXT V2.0 Programming and choose Block Import and Export Wizard from the Tools menu. Choose Browse and navigate to the Vernier Sensor Block folder wherever you have downloaded it on your computer. Select Vernier Sensor and choose OK. After a few seconds, the words "Vernier Sensor" should appear as the name of the block to import. Click on the name "Vernier Sensor" and then change the Palette from Advanced to Sensor. We want to have the Vernier Sensor block to appear on the Sensor palette of NXT V2.0 Programming. With the words Vernier Sensor selected and the palette set for Sensor, click on Import. In a few seconds the Vernier Sensor block should be imported into your copy of NXT V2.0 Programming.

Using the Vernier Sensor Block

To use the Vernier Sensor block, choose the Complete Palette display option.

Click on the yellow Sensors palette and you should see the Vernier Sensor block, along with all the LEGO sensors. Drag the Vernier Sensor to the program area. When you click on the Vernier Block the configuration panel below is displayed. To use the Vernier Sensor block you need to specify which of the Vernier sensors you are using from the pull down sensors list.

Each Vernier sensor that works with the NXT adapter has at least one entry. In a few cases, a sensor has more than one range, and it has an entry for each range. Examples include the Dual-Range Force Sensor and Magnetic Field Sensor. The STS and TMP temperature probes support temperature measurement using the Fahrenheit scale with a separate entry.

You also need to make sure that the correct Port is selected. By default, Port 1 will be selected. Once you make the connection to an NXT (by USB or Bluetooth) the reading from the sensor will be displayed in the configuration panel, both numerically and on a meter.

To display a value on the NXT screen, including the proper units, use blocks connected as shown below:

To display a sensor reading on the NXT screen, you can wire the Sensor Reading (Text) connector on the data hub of the Vernier Sensor Block directly to the Text input of the Display block. Displaying sensor readings this way has the advantage of displaying the value with appropriate decimals and units. You can also use the traditional NXT programming technique of wiring the Sensor Reading output on the Vernier Sensor Block to a Number to Text block to the Text input of the Display block. However, units will not be displayed, and the number will always be rounded to two decimal places.

Note that all the Loop, Wait, and Switch blocks work fine using the Vernier Sensor. You just choose Sensor from the Control pull-down menu, and then Vernier Sensor from the Sensor pull-down menu. The threshold can be set as you would expect. Below is a simple program that displays the reading from a Dual-Range Force Sensor, Makes a sound if the force is greater than a threshold, and loops until the force is less than a threshold.
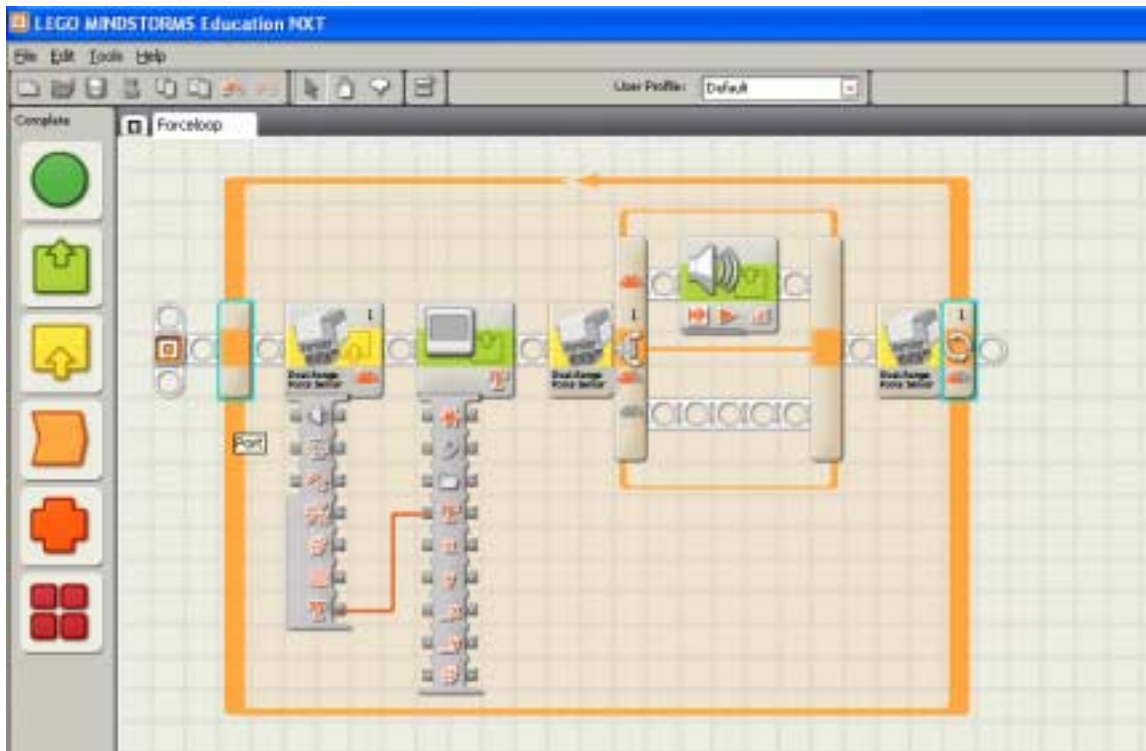
Zero/Calibrate with the Vernier Sensor Block

Using the Action control, you can set the Vernier Sensor Block to Zero/Calibrate. This provides a simple way for you to adjust the calibration of the sensor you are using. For example, if an accelerometer is not reading 0 m/s^2 acceleration when it is at rest, you can adjust it so it correctly reads zero. The zero calibration will be applied when used in a program or in Data Logging. However, it does not adjust the reading in the configuration panel.

Build a program with a Vernier Sensor Block at the beginning. Choose Zero/Calibrate on this block. When you download and run the NXT program, have the accelerometer oriented as you plan to use it and at rest. When this block of the program executes, the reading will be adjusted so that the acceleration is defined as 0. It is important to note that this adjustment will not affect the live reading shown in the configuration panel. However, it will be used by NXT programs and will change readings displayed on the NXT and in files saved on the NXT. It also affects readings shown in NXT 2.0 Data Logging. This calibration will be used in all instances of the Vernier Sensor Block that are configured with the same type of sensor. This applies even in different programs. The calibration is saved as VernierSensorXX.cal file on the NXT. The XX refers to the sensor number. There are only two ways to get rid of this calibration adjustment.

1. One is to delete the VernierSensorXX.cal file from the NXT memory. You can do this by clicking on the Manage Memory button of the NXT controller, select the file, and delete it.

2. Another way to delete this calibration file and restore the default calibration is to use the Reset action of the Vernier Sensor Block. Write a short program containing the Vernier Sensor Block with the Sensor set for the type of sensor you are working with. Set the Action to Reset. Download and run the program on the NXT. This will delete the modified calibration file associated with the sensor.

This same calibration concept works for all sensors except the Stainless Steel Temperature Probe (TMP-BTA) and the Surface Temperature Probe (STS-BTA). For the pH Sensor (PH-BTA), zeroing has a special procedure, which is explained below.

Zero/Calibrate with a pH Sensor

Since there is no such thing as 0 pH, we have an alternative way to adjust the calibration of the Vernier pH Sensor. This calibration adjustment depends on the use of a pH 7 buffer. This is a solution available in most science classrooms that is made to have a pH of exactly 7.0. Have the student build a program with Vernier Sensor Block, set for pH, at the beginning. Choose Zero/Calibrate on this block. When you download and run the NXT program, have the pH Sensor in the pH 7 buffer. When this block of the program executes, the reading will be adjusted so that the pH reads exactly 7.0. This adjustment will take effect in the programs that you write and in Data Logging, but will not show in the readings on the configuration panel.

Limitations of the Calibration/Zero Option

As mentioned above, calibration applies to all Vernier Sensor Blocks with this same Sensor setting. This means you should be cautious in using the Zero/Calibration action when you have two Vernier sensors of the same type in one program. In addition, the calibration affects readings in a program or in Data Logging, but not the readings displayed in the configuration panel.

Customizing the Vernier Sensor Block

The Vernier Sensor Block may be customized for particular usage in a number of ways. These changes require changing the text file, Vernier Sensor Calibrations.txt, which is in the Vernier Sensor Block folder, saving it, and then importing the Vernier Sensor Block again.

Displaying a Limited Set of Sensors

The Vernier Sensor Block can be set up to show only selected sensors in all of the pull down menus as follows:

1. Go to the folder where you have saved the Vernier Sensor Block on your computer.

2. Open the folder and select document "Vernier Sensor Calibrations.txt"

3. Open the document. You can use a text processor or a spreadsheet-type program.

4. The rightmost column of the document, "Installed", allows you to customize the pull-down list to reflect the sensors you have. Only sensors with a "1" in the Installed column will appear in the pull-down sensor list. As the file is shipped, a "1" appears by all sensors. To remove a sensor from the list, change the "1" in this column to a "0."

5. Save and close the modified document.

6. Start NXT 2.0 Programming and re-import the Vernier Sensor Block using the Block Import and Export Wizard from the Tools menu.

More Information

For information on how to adjust the calibration of sensors used with the Vernier Sensor block, see the separate document, Adjusting Calibrations.doc.

For information on Vernier products, check out http://engineering.vernier.com and www.vernier.com/nxt .

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