Vernier Engineering Projects

with LEGO® MINDSTORMS® Education EV3

Vernier

Contents

Projects

Appendices

Projects by Sensor

		Hand Dynamometer	pH	Temperature	Soil Moisture	UVB	Differential Voltage	Dual-Range Force	Gas Pressure	Magnetic Field
0	Introductory Project: Robot Walker	1*								
1	Data Display and Acidity Tester		1						1‡	
2	Plant Waterer				1					
3	Audio Assistant							1		
4	String Tension Tester							1		
5	Aquarium Monitor		1	1						
6	Cartesian Diver								1	
7	Sunscreen Tester					1				
8	Battery Tester						1			
9	Solar Tracker						1			
10	Magnet Detector									1
11	Compass									1
12	Minesweeper									1
13	Shell Game									1

* A Dual-Range Force Sensor can be used for the Introductory Project if you do not have a Hand Dynamometer.

‡ The Data Display section of this project is written for the Gas Pressure Sensor, but it can be performed with any of the sensors used in this book.

Getting Started Using the EV3 and Vernier Sensors

1. Connect a Vernier analog sensor to the BTA socket on a Vernier NXT Sensor Adapter (see Figure 1). Note that this adapter is compatible with both the EV3 and NXT Intelligent Bricks.

Figure 1

2. Connect a LEGO cable to the other end of the adapter, and then connect the adapter to Input Port 1, 2, 3, or 4 on the EV3.

3. Make sure the EV3 is connected to the computer (via USB or Bluetooth® technology) and turned on.

4. Start the LEGO® MINDSTORMS® Education EV3 software and open a new programming project.

5. Import the Vernier Sensor Block into the software (see *Appendix E* for detailed instructions).

You are now ready to start designing your first robotics-controlled project. Pick one of the projects from the table of contents or skip to *Appendix F* for more programming instructions.

Plant Waterer

OVERVIEW

All living things need water to survive, especially plants. Since plants are about 90% water by weight, they will physically wilt if they do not get enough water. The type of plant, its age, and its environment determine the amount of water it needs every day. A *succulent* or drought-tolerant plant (such as a cactus) requires less water than a non-succulent plant because a succulent has thick leaves and stems that can retain moisture. Light, temperature, humidity, and soil type also affect the amount of water plants use every day. Many homeowners install automatic watering systems to keep their lawns and gardens green during the summer. Sprinklers turn on in the early morning and stay on for a pre-set period of time. However, a watering system based on time is not a healthy solution for house plants. Their soil can quickly become saturated, which can be as bad as not enough water.

DESIGN REQUIREMENTS

In this project, your challenge is to design and build a sensor-controlled watering system for a potted house plant. Your device should automatically water the plant when the soil is too dry and stop when the soil is wet. You will use a Vernier Soil Moisture Sensor to monitor the moisture level of your plant's soil. The soil will be considered "too dry" when the moisture level falls below 20%, and sufficiently "wet" when the moisture level rises above 28%. When building your device, you should incorporate easy access to a refillable water reservoir. Prior to operation, you must bury the sensor in the plant soil by hand. The sensor will remain in the soil for the life of the system.

MATERIALS

- Vernier Soil Moisture Sensor
- Vernier NXT Sensor Adapter
- LEGO Pneumatic Hand Pump
- plastic water bottle
- 2-hole stopper
- pneumatic tubing
- potted plant

TIPS

- For best results, use fresh potting soil in your plant pots. Dirt with high clay content does not allow water to percolate quickly through the soil.
- Avoid building a device that automatically inserts the sensor into the soil as this could damage the sensor. Instead, bury the sensor in the plant soil by hand before you operate your device.

SENSOR NOTES

The Soil Moisture Sensor measures the volumetric water content of soil. Units are in percent. Dry soil is made up of solid material (minerals, organics, etc) and pore spaces (air pockets). A typical volumetric ratio would be 55% solid material and 45% pore space. As water is added to the soil, the pore spaces fill with water. Soil that seems damp to the touch might have 55% solid material, 35% pore space, and 10% water. This would be an example of 10% volumetric water content. When all the pore spaces are filled with water, the soil is referred to as being *saturated*. The saturation level in this example is 45% because at that value, the soil can hold no more water.

Project
3

Audio Assistant

OVERVIEW

There are times when we may need to communicate information in a non-visual format. For example, at many intersections traffic signals emit audible tones when the light is green so people with visual impairments will know it is safe to enter the crosswalk. One tone is played when the light is green in the north/south direction, and a different tone is played when the light is green in the east/west direction. As another example, there are times when it is difficult for an operator to read numbers from a dial or a meter, such as in a professional laundry where the instruments are frequently clouded with steam. The operator may not need to know the exact value of the meter reading, but he or she does need to know if the value has exceeded an acceptable working range. In this situation, a device that sounds an alert can be useful.

DESIGN REQUIREMENTS

In this project, your challenge is to design and build a device to give an audio indicator of the pulling force exerted on a Vernier Dual-Range Force Sensor. You must build some type of structure that will allow the operator to apply a pulling force to the sensor without touching the sensor directly. Your device must be able to indicate the relative strength of the applied force using sound. The frequency of your tone should be directly proportional to the measurement from the Force Sensor. In other words, a high-pitched sound for a high value and a low-pitched sound for a low value.

MATERIALS

- Vernier Dual-Range Force Sensor
- Vernier NXT Sensor Adapter

TIPS

- Set the switch on the Dual-Range Force Sensor to the ±10 N setting.
- Experiment with the Sound block to determine how you might create a good sound indicator based on the measurements of the Force Sensor.

SENSOR NOTES

The Dual-Range Force Sensor comes with a hook and a bumper for measuring tension and compression forces (pulling and pushing). You can use either attachment in your design, but you will only be interested in pulling forces. The sensor has two amplification settings that can be set by using the switch on the side of the sensor. For this project, set the switch to the ±10 N setting.