INSTRUCTOR INFORMATION

Drinking Fountain

LEARNING OBJECTIVES

- Supplement classroom instruction of motion and its effects with hands-on engineering application.
- Control devices (pump) based on input from measured physical quantities (position and velocity).

RECOMMENDED GRADES/SUBJECTS

Grades 6–12/Physical Science, Chemistry, Biology, or Physics

TIME NEEDED

The project is designed to be completed in one 45 minute period.

RELATED EXPERIMENTS

"Graph Matching" – Experiment 1 from *Physics with Vernier*

"Graphing Your Motion" – Experiment 33 from *Middle School Science with Vernier*

"Graphing Your Motion" – Experiment 35 from *Physical Science with Vernier*

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
ETS1.A. Defining and Delimiting Engineering Problems ETS1.B. Developing Possible Solutions ETS1.C. Optimizing the Design Solution	Patterns Cause and effect Scale, proportion, and quantity Systems and system models	Asking questions and defining problems Developing and using models Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations and designing solutions Engaging in argument from evidence Obtaining, evaluating, and communicating information

INFORMATION FOR THE INSTRUCTOR

For students to be successful in this extension activity, they need to be somewhat familiar with two processes: the Engineering Process and running the Digital Control Unit (DCU). In addition to the information in this document, we have provided the following resources:

- Introduction to Engineering Design: This document includes a brief introduction to the engineering design process and an example of an Engineering Design Sheet. The Design Sheet is a great way to help your students organize their time and efforts. It also provides you with a way to assess student progress and learning.
- Drinking Fountain – Example Design Sheet (Word® document): A completed Design Sheet that will help you integrate the use of Engineering Design Sheets in your classroom
- Drinking Fountain – Example LP file: An example Logger *Pro* experiment file for this activity that will help you better understand how to program Logger *Pro* to run the DCU
- DCU Tips – Background information about using the DCU, programming it in Logger *Pro* and LabQuest 2, and general troubleshooting tips for the DCU.

In the remainder of this document you will find additional resources to help you successfully integrate this engineering extension activity into your course:

- Follow Up Questions: A few reflection questions to help your students better understand the engineering process and to help you assess their learning
- Challenge Activities: Additional activities for advanced students
- Supplemental Student Instructions: Additional instructions you can give to students if this is their first time using the DCU with Logger *Pro* or a LabQuest 2.

FOLLOW UP QUESTIONS

Engineering extension activities usually require a different assessment than a traditional lab. We suggest that you create a rubric for grading the Engineering Design Sheet. Additionally, use follow up questions, such as those below, to help students reflect on the engineering process and to help you evaluate their learning:

- Explain a design decision you made in which you had to choose from multiple ideas. How did you make your choice? Why?
- How did you decide on the conditions that would trigger the drinking fountain? What circumstances might make you change those conditions?
- What do you see as the strengths and weaknesses of your drinking fountain? What changes would you make in the next version?

CHALLENGE ACTIVITIES

If your students need more of a challenge, provide them with one or more of the following options:

- Allow the business owner/user to adjust the distance at which the drinking fountain triggers using User Parameters in Logger *Pro*.
- Program the drinking fountain so that no one could ever drink from it, even though it might tempt them.
- If you have access to multiple interfaces (e.g. LabQuest2 or LabQuest Mini interfaces), connect two Motion Detectors to one interface and the DCU to the second. Set up the

Motion Detectors and program the DCU so that the customer has to be in one exact position to trigger the fountain.

SUPPLEMENTAL STUDENT INSTRUCTIONS

We feel that the student sheets present engaging challenges. However, depending on your emphasis for this project and the level of your students, you may wish to provide them with more detailed instructions on various aspects of the software and logic setup as included below.

Equipment Setup

1. Connect the leads of the pump to the D1 and GND lines on the DCU.

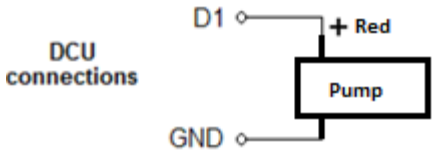

Figure 1

Tip: *The KidWind pump (Vernier order code KW-PUMP) has polarity. Connect the positive lead (red wire) to D1 and the negative lead (black wire) to GND.*

2. Connect a power supply to the DCU.

3. Connect the DCU to the first digital (DIG) port on the interface.

4. Connect the Motion Detector to the DIG2 port.

5. Connect the interface to the computer. If the interface has a power switch, turn it on.

6. Construct your fountain. The KidWind pump we are using is submersible and it has a short tube on it that is perfect for our fountain. All you need to do is put the pump in a container of water with the tubing pointed upward. It will not shoot water too far, so you should not have problems with water spraying around the room. If you want, make the setup look like a real drinking fountain as much as you can.

Software Setup - Logger Pro

1. Start Logger Pro.

2. Choose Set Up Sensors from the Experiment menu and select your interface from the list. The DCU should be in DIG/SONIC1 and the Motion Detector in DIG/SONIC2. If they are not select them by clicking Choose Sensor.

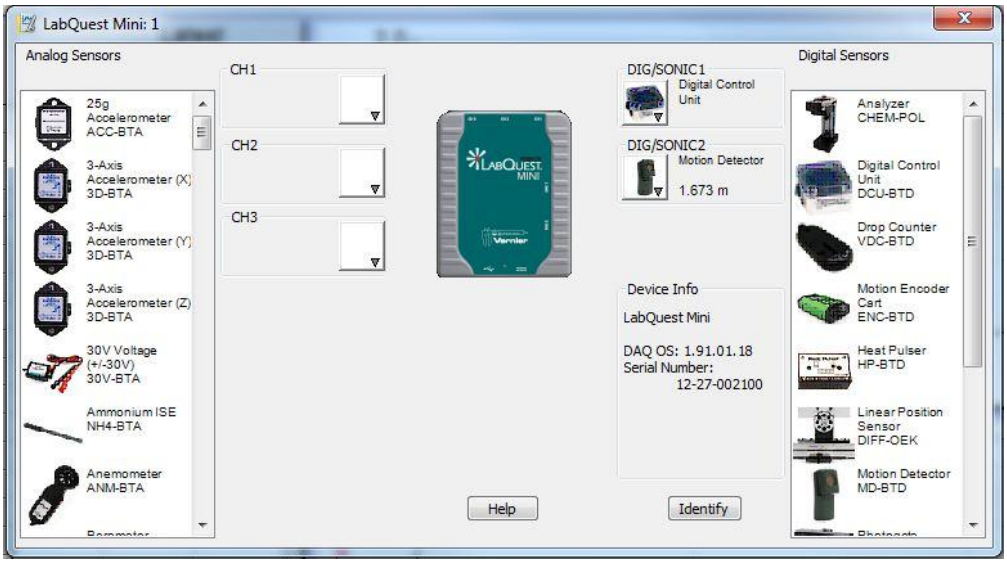

Figure 2

3. Click the DIG/SONIC1 button and select Digital Out.

4. Test your pump circuit. At the top of the Digital Out control dialog, you will see three check boxes under the words Test DCU. Each of the check boxes will turn on one of the DCU output lines. Since you have your pump connected to line 1, the pump should turn on if you click that check box. If this check box does not control the pump properly, check your circuit and refer to the Troubleshooting section.

5. Configure the DCU for the action you want.
   a. Click the box next to Activate Line 1.
   b. Select the Less Than or Equal to button and enter a threshold value for position. If you enter 0.5 m, for example, line 1 (the pump) will come on any time the Motion Detector reads 0.5 m or less.
   c. At the bottom of the dialog, select the option to Start activation when experiment run is started and select OK.
   d. Test this simple system. Close the Set Up Sensors window and start data collection. Try moving in front of the Motion Detector. Whenever the Motion Detector reads 1 meter or less, the pump should go on. You may want to increase the duration of data collection (5 seconds, by default). You can do this by choosing Data Collection from the Experiment menu.

6. Add a second condition that requires that the person must be stopped in order for the fountain to run. Open the Digital Out dialog and select "AND" from the drop down menu for Line 1. Indicate that the velocity must be Less Than or Equal to 0.1 m/s. Test the program as you did before to verify that it works as expected.

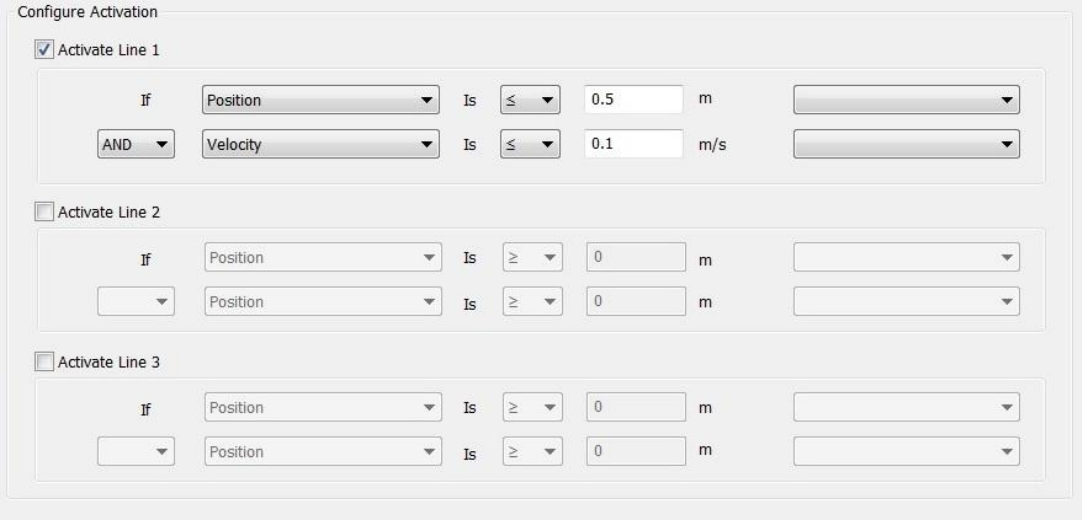

Figure 3

Software Setup - LabQuest 2

1. Start your LabQuest 2, connect the DCU to one of the DIG ports and your motion detector to the other DIG port.

2. Choose Sensors tab from the app, select DCU Setup, and then select the DCU from the list.

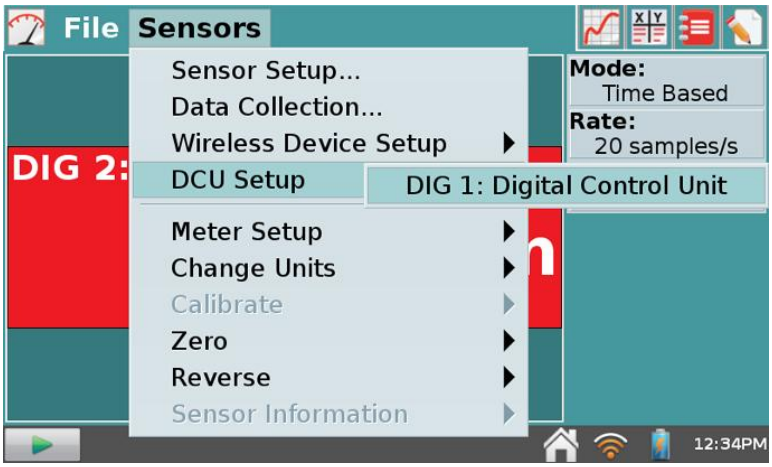

Figure 4

3. Test your pump circuit. At the top of the Digital Out control dialog, you will see three check boxes under the words Test DCU. Each of the check boxes will turn on one of the DCU output lines. Since you have your pump connected to line 1, the pump should turn on if you click that check box. If this check box does not control the pump properly, check your circuit and refer to the Troubleshooting section.

Figure 5

4. Configure the DCU for the action you want.
   a. Click the box next to Activate Line 1.
   b. Select the Less Than or Equal to button and enter a threshold value for position. If you enter 0.5 m, for example, line 1 (the pump) will come on any time the Motion Detector reads 0.5 m or less.
   c. At the bottom of the dialog, select the option to Start activation when experiment run is started and select OK.
   d. Test this simple system. Close the Set Up Sensors window and start data collection. Try moving in front of the Motion Detector. Whenever the Motion Detector reads 1 meter or less, the pump should go on. You may want to increase the duration of data collection (5 seconds, by default). You can do this by choosing the Sensors tab and clicking on Data Collection from the Meter screen on the LabQuest.

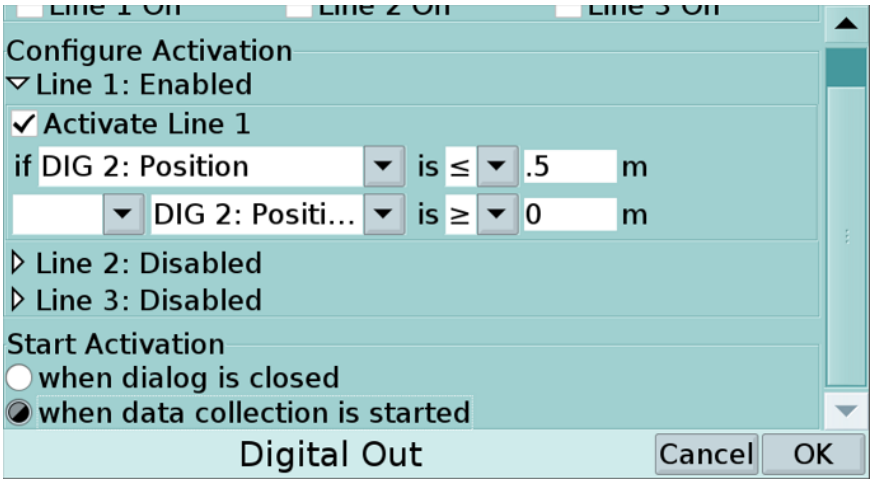

Figure 6

6. Add a second condition that requires that the person must be stopped in order for the fountain to run. Open the Digital Out dialog and select "AND" from the drop down menu for Line 1. Indicate that the velocity must be Less Than or Equal to 0.1 m/s. Test the program as you did before to verify that it works as expected.

TROUBLESHOOTING

If the pump does not turn on

- Make sure the DCU is connected to a power supply.
- Make sure the circuit is wired correctly.

If the pump goes off when it should be on, check to see if you have one of the pump connectors connected to the GND connector.