

Interfacing PocketLab *Voyager* with Modular Robotics *Cubelets* Maker Space

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Introduction

The maker revolution has grown by leaps and bounds during the past four years. With dozens of robotic toys for learning and discovery now in the marketplace, it makes sense to give students opportunities for interfacing these robots with the investigative powers of PocketLab Voyager. This lesson describes an example project by which students interface Voyager with Modular Robotics *Cubelets*—robot blocks that magnetically connect to form an endless variety of robots. There are seventeen different blocks in three categories—sense, think, and act. Just like PocketLab, *Cubelets* are in use in thousands of schools throughout the United States and also internationally, with lesson plans available from pre-K through 12th grade. Also, as with PocketLab, *Cubelets* are used not only in the classroom but also in Maker spaces and innovation labs.

The student challenges are to design *Cubelets* Blockly programs that will:

1. Make a DRIVE *Cubelet* move back-and-forth with a Voyager Range Finder graph that is triangular, as shown in Figure 1. (Easy)

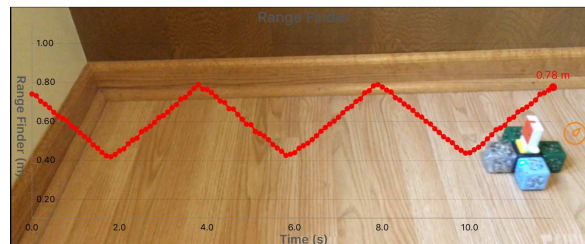


Figure 1

2. Make a DRIVE *Cubelet* move back-and-forth with a Voyager Range Finder graph that is sinusoidal, executing simple harmonic motion and shown in Figure 2. (Challenging)

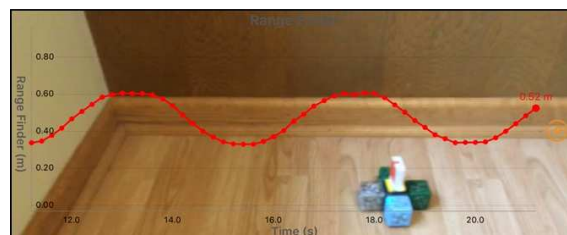


Figure 2

Action videos accompany this lesson for both challenges.

Interfacing PocketLab Voyager and Cubelets

Figures 3 and 4 show how the author interfaced Voyager and Cubelets to meet the challenges discussed in the previous section. Figure 3 is a view from above showing the five Cubelets making up the construction. The central Cubelet, to which Voyager has been mounted, is a BATTERY Cubelet that supplies power to the construction. There are two BLOCKER Cubelet whose only purpose here is to provide balance for the construction. The BLUETOOTH Cubelet interfaces with Cubelets Blockly to allow programming desired Cubelets in the construction. The DRIVE Cubelet is the Cubelet that we are interested in programming to accomplish the challenges. Figure 4 clearly shows the DRIVE Cubelet with its roller wheels for moving on a smooth horizontal surface.

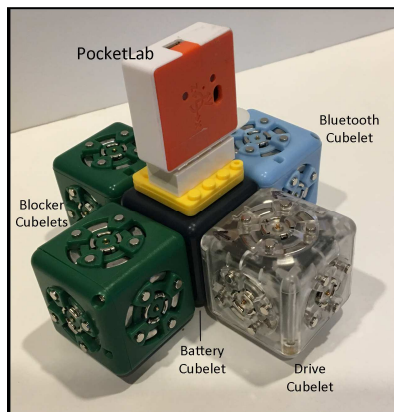


Figure 3

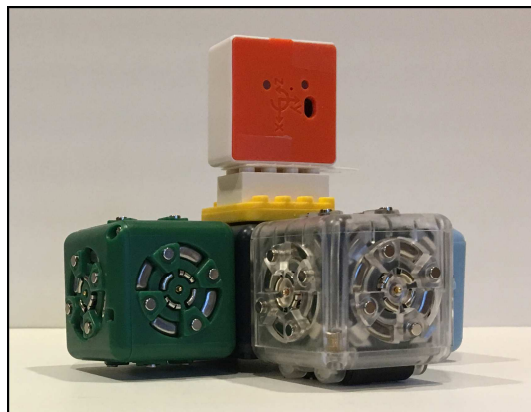


Figure 4

The Cubelet Blockly Program for the Triangular Graph

Figure 5 shows the Cubelets Blockly program for the challenge to make a DRIVE Cubelet move back-and-forth with a Voyager Range Finder graph that is triangular. The DRIVE Cubelet is of the *act* category. Numbers from 0 through 255 are used to set the speed of the roller wheels from stopped (0) to a maximum speed (255). The *setup do* block sets the speed to a constant medium value of 165. The *forever do* block waits for 2 seconds and then toggles the motor direction.

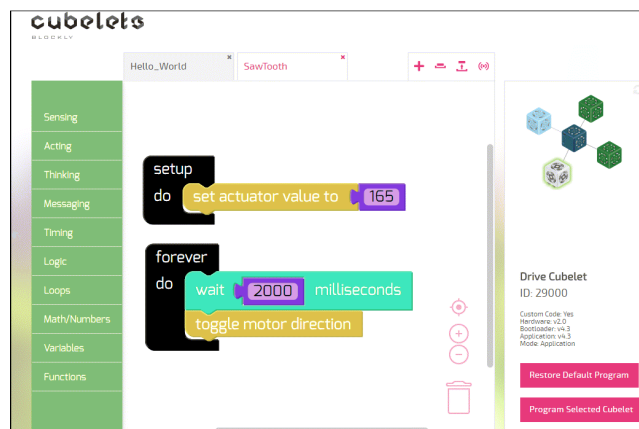


Figure 5

The Cubelet Blockly Program for the Sinusoidal Graph

Figure 6 shows the Cubelets Blockly program for the challenge to make a DRIVE Cubelet move back-and-forth with a Voyager Range Finder graph that is sinusoidal, showing simple harmonic motion. This is more challenging for a variety of reasons:

1. Students are likely to immediately think of using either a sine or cosine function to control the speed of the DRIVE Cubelet, only to discover that trigonometric functions are not included in the Cubelets Blockly *Math/Numbers* block category.
2. Students knowledgeable of the Taylor series for sin and cosine and how rapidly it converges, may then try to design a program using that series. They will discover (if they don't already know) that:
 - a. Cubelet arithmetic is confined to integer math, unless you specifically set a variable to be of type Decimal (32-bit floating point).
 - b. Cubelet floating-point arithmetic is quite demanding on the 8-bit micro-controller inside of Cubelets. Such programs may result in undesirable compilation errors, and hence be impossible to run.

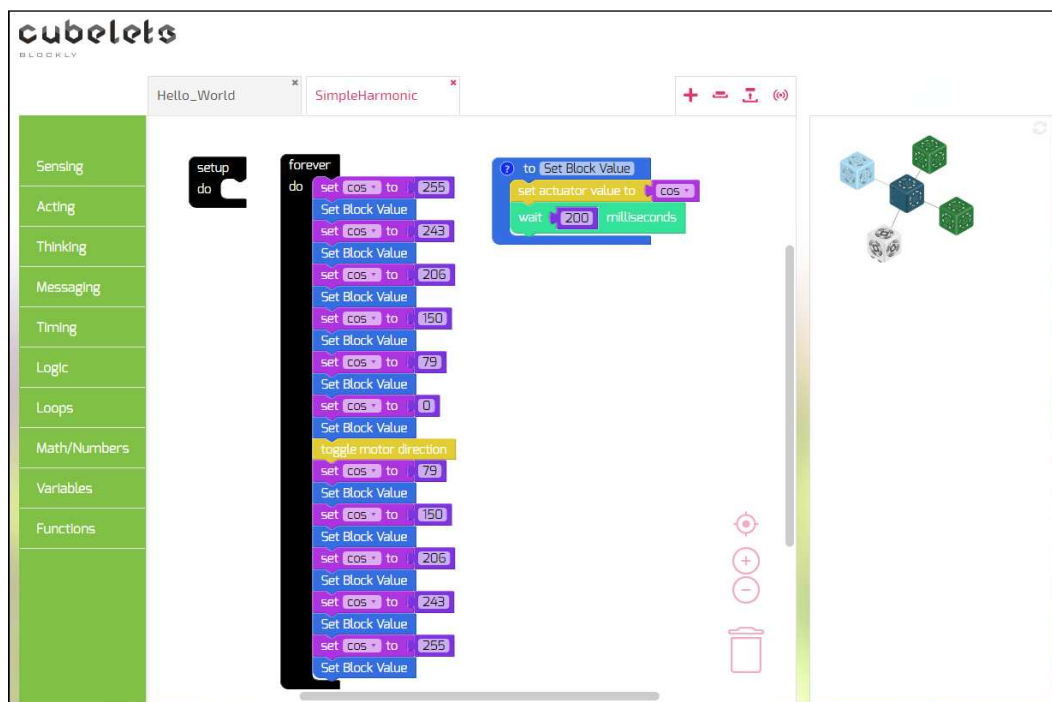


Figure 6

The above mentioned ramifications led the author to the Cubelets Blockly program shown in Figure 6. Six different actuator values between 0 and 255 were manually calculated that would provide roller wheel speeds that vary cosinusoidally with time. The user defined *Set Block Value* function set the actuator to the desired value and then waits 0.2 s, while the DRIVE Cubelet travels at the desired speed. The motor direction is toggled when the speed is 0 and the DRIVE Cubelet is at the far ends of its harmonic motion. The speed is a maximum (255) when the DRIVE Cubelet is at the center of its motion.