Stage Magic (Preliminary Draft)   Electricity & Inequalities

Creating Illusions

Magicians the world over have become very skillful at showing their audiences events which seem impossible. Very few people actually believe that a rabbit has "magically" appeared from nothing, that an audience volunteer has really been transformed into a tiger, or that David Copperfield actually levitated by turning off gravity. Much of the fun in watching these performances lies in trying to figure out just how the magician created the illusion. In almost all cases, the magician's illusion requires a combination of psychology and physical science, often with some serious mathematics as well.

Task: In this activity you will design and test ways to make things happen as if by magic.

Bunny in the Hat
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Additional Materials:

RGB Color Mixer

Vernier or TI Light sensor (Other analog sensors are optional)[1].

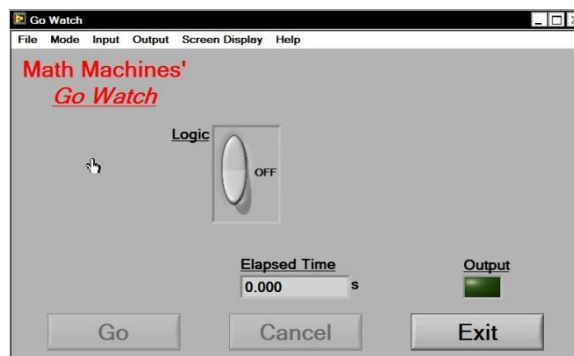A DC electrical device or circuit which includes a small battery (no more than 9 V).

Math Machines Program:

GoWatch

Activity Files: None

Place a sensor in "CH1" of the SensorDAQ and insert the RGB Color Mixer as shown at right, then run the program GoWatch and answer "yes" in the "Analog Probe in Ch.1" window.


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[1] See http://www.vernier.com/products/sensors/ for examples of possible sensors. Version 4.0 of *Go Watch* should work with any single-input analog sensor shown, but it will not currently work with digital sensors such as the Motion Detector.

Like most electronic systems, the GoWatch program operates using simple True/False, On/Off, Zero/One logic. (All these terms mean the same thing.) Also following the most common convention, the SensorDAQ uses electrical signals of 0 volts to represent "False," "On" or "Zero" and uses +5 volts to represent "True," "On" or "One." The signals produced by the SensorDAQ are very weak, with very little current or power. The direct signals are intended to carry only information and are far too weak to operate a toy car or other substantial device[2]. The RGB Color Mixer amplifies the weak output signals and uses them to operate not only 2 LEDS, but also a "relay."

The Color Mixer's relay is a black, cylindrical object containing an electromechanical switch. The switch is normally "open" (not able to conduct electricity). A small current from the SensorDAQ activates a small electromagnet, which "closes" the switch and enables it to conduct electricity. If you connect an appropriate battery and a motor or other device in series with the Color Mixer's switch, your device will turn on or off depending on the True/False logic set by the GoWatch program.

1. Experiment with the Logic Controls. Before you connect an actual device for your magic tricks, experiment with the different modes in which GoWatch can turn things on and off.

    a. When you click on the basic logic switch, you should see green indicators light on both the screen and the Color Mixer. When you click the switch off, you should also be able to hear the relay turning off. (It is usually too quiet to hear it turning on.)

    b. Use the GoWatch menu to switch to Mode/Button/Momentary and experiment with this alternative button. Explain below how the "Momentary" mode is different from the "Toggle" mode.

    c. Try the "Timed" mode, and use it to activate the switch for 7.259 seconds (or any other time you like). Could you use this mode to create an illusion that you have "magical" powers to turn something off?

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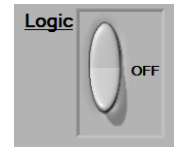
[2] The maximum current output for each of the SensorDAQ's 4 data lines is 8 mA. Using $P=VI$, the maximum power output from each line is 0.04 watts.

d. Now try the more mathematical "Logic /1 Condition" mode as shown. To begin, just click "Run" and experiment with the values produced by the sensor under different conditions. What values do you see, for example, if you cover and uncover a light sensor with your hand?
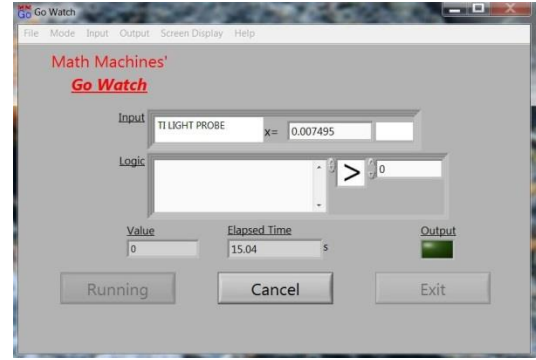
e. "Cancel" the run, then enter "x" in the large block to include the sensor reading as the independent variable of your inequality. Change the inequality sign to "≤" and replace "0" in the right box with a number midway between the values you found above. Run the program again and describe below what happens when you cover and uncover the sensor.

Do not proceed with step 2 unless you have mastered both the theory and the hands-on practice of wiring safe DC electric circuits. You can instead develop your magic trick (steps 3 and 4) using just the LEDs on the RGB Color Mixer.

2. Add an Electrical Circuit. *See caution above.* Wire a series electrical circuit, including a battery (no larger than 12 volts), a motor or other device (be certain the device matches the voltage, current and power capabilities of your battery) and the Color Mixer's relay. Draw a diagram of your circuit below. Can you "magically" activate and deactivate the device without touching anything?

3. Modify your Logic Statement to reverse the "True/False" actions. For example, if the motor came on when you covered the probe, make it come on instead when the probe is uncovered. Write your new logic statement below.

4. Develop a Magic Trick. Experiment with other sensors, other devices and different logic statements. Add enough drama and psychological misdirection to convince an audience (at least an audience of young children) that you are a true magician!