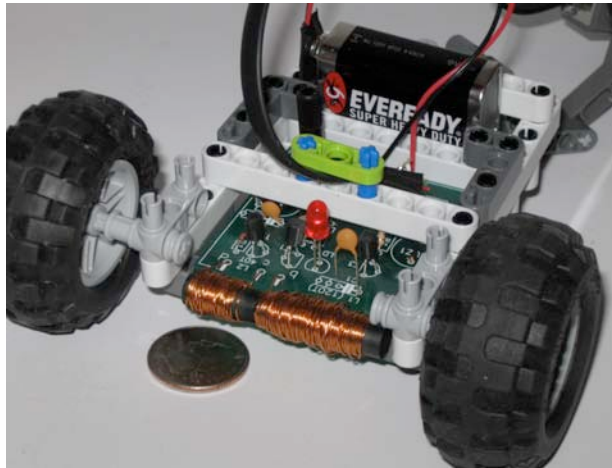


Project: NXT input device = Velleman Metal Detector Kit K7102



This project was initiated to determine the feasibility of using the inexpensive Velleman – Metal Detector Kit (K7102) as a NXT sensor. The initial thought was to use the LED indicator on the metal detector to trigger the light sensor on the NXT. After assembly of the kit and re-reading several sections of Extreme NXT – Extending the LEGO MINDSTORMS NXT to the Next Level, a direct connection to the sensor port seemed possible.

Conclusion:

The NXT was able to detect the voltage output change from the metal detector when metal was placed next to the coils. When pulled behind a robot the signal was used to stop the robot but the detection area was small and sensitivity varied over the length of the coil. The chances of finding buried treasure may be slim but not impossible.

For this preliminary report, little effort was made to optimize the sensitivity of the metal detector. The design of the voltage divider was given a large safety factor and could be redesigned. The connection to the NXT and program might be modified to increase sensitivity. Optimization can be investigated in the future by anyone so inclined.

Make no assumptions when connecting untested homemade peripherals to your NXT. The risks to do damage to yourself or your NXT should be carefully considered before attempting any project. The following information is based on my observations and experimentations. Your results may be different.

Materials

Parts	Quantity	Note
Velleman – Kit Metal Detector (K7102)	1	Many sources on the Web. Mine from Jameco <\$20
150ohm resistor	1	
180ohm resistor	1	
10Kohm resistor	1	Extreme NXT - Chapter 7

Metal Detector Kit with Light Sensor

The first order of business is to build and test the kit as per the kit's directions. The manufacturer rates the difficulty level as 3 out of 5. You will need to know how to solder. Considering my skill level, I thought there was sufficient room between solder joints and I was able to use a heat sink clip on the component side.

(The kit comes with a push button power switch. You may want to consider replacing it with a jumper wire. This will keep the circuit active whenever the 9V battery is plugged in.)

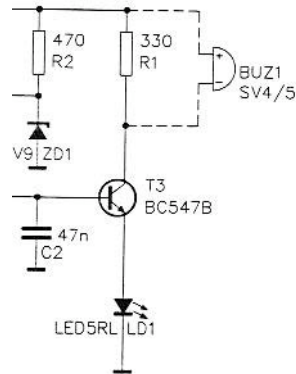
The most difficult step (for me) was winding the coils around the ferrite core. The coils are what sense the metal object. Each coil creates a magnetic field around the core. These magnetic fields interact with each other and the circuit can be adjusted to a point of equilibrium. When a piece of metal gets close enough to change how the magnetic fields interact, the circuit becomes unbalanced, and the change is amplified to power the LED.

It took a couple of tries to wind the coils. The 43 turns on the smaller coil went smoothly and I'm almost sure I was +/- 5 turns on the 120-turn coil. I'm also sure that after a couple of more tries it would have looked like the one on the front of the box.

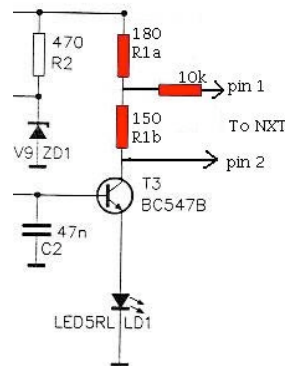
After the test and final adjustments have been preformed it should be a simple matter to put the light sensor above the LED and write a program to detect when the light is on. The light sensor and LED work like an opto-isolator. The NXT and Metal Detector circuit are electrically separated by the gap between the LED and Light sensor. (Web search optoisolator to learn more).

Modifying the Metal Detector for direct connection to the NXT

The metal detector requires 9V @ 30mAmp to operate. The use of the external 9V battery to power the metal detector will keep from draining power from the NXT battery. The push button switch needs to be replaced by a toggle switch or jumper wire. I used the jumper wire and unplug the battery to turn off the detector.



Original Circuit



Modified Circuit

Note from the detector circuit diagram that the 330ohm resistor (R1) is used to limit the current through transistor (T3) and LED (LD1). When the LED is off the voltage drop across R1 should be almost 0V and will increase as metal comes closer to the coils. The maximum voltage across R1 was measure to be 6.5 Volts.

R1 is replaced by a voltage divider consisting of 2 resistors with a total value of 330 ohms. 180ohm and 150ohm resistors were chosen. The voltage drop across 150-ohm resistors should not exceed +5V. Before connecting it to the NXT, use a voltmeter to measure the voltage drop across the 150ohm resistor. It should not exceed 5V.

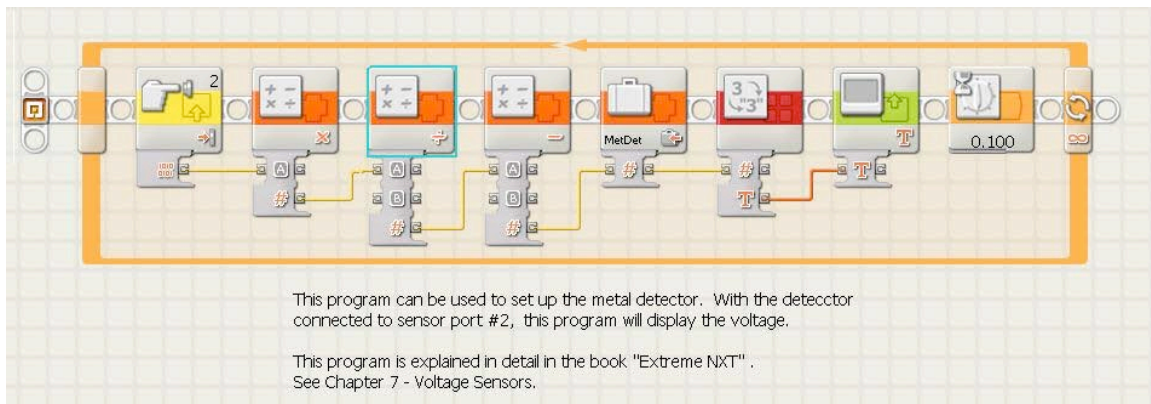
The 10K resistor on the lead to pin 1 of the NXT is required to scale the input voltage for the analog to digital conversion. This resistor will also help reduce the chance of over driving the NXT circuits.



Modified circuit

Load the Test Program into the NXT. An explanation of the program is given in Extreme NXT(Chapter 7). Start the program and then energize the metal detector. If the voltage is 5000 mV and the LED is not on, something is wrong. If you move metal close to the coil and the LED lights but the NXT is not reading a voltage change, something is wrong. Think of it as an opportunity to practice your trouble shooting skills.

Use the “Test and final adjustments” to adjust RV1 and RV2 to achieve a voltage reading to just above 0Volts. Now move a piece of metal within range of the coils and observe the voltage reading.



The LDD file contains the instructions to build a small test vehicle that will drag a trailer loaded with the metal detector around the room. When the trailer rides over metal it stops and waits for you to reactivate the drive motors. Read the comments in the NXT-G program for an explanation. Set the millivolt detection level in for your setup.

