EE241 Laboratory Exercise
Resistive Sensors

Resistive sensors are inexpensive and easy-to-use. Consequently, they can be found in a number of everyday systems. The purpose of this lab is for you to gain familiarity with these sensors, and to understand how to translate the resistance change into a voltage signal that can be the input to a system.

Equipment and Components

Assorted resistors available in lab
Variable resistor boxes
Multimeter
Power Supply
Protoboards
Thermistors: Panasonic ERT-D2FGL102S (Digikey part no. PNT113-ND)
CdS Photoconductive Photocells (aka photoresistors): Advance Photonics, Digikey part no. PDV-P9003-ND

Pre-Lab

1. Look up strain gauges, thermistors and photoresistors on the web. For each device, describe what it is and give an example of how it is commonly used (be sure to cite your source).

2. Review the datasheets for the two sensors you will be using in this lab. These are available on the web from Digikey (www.digikey.com). In particular, answer the following questions:
    - For the thermistors:
        - What nominal resistance do you expect the thermistors to display at 25 ºC?
        - What is the tolerance of the resistance? Combining this with the nominal resistance, what range do you expect on the resistance value at room temperature?
        - What nominal resistance do you expect the thermistors to display at 34 ºC?
    - For the photoresistors:
        - What resistance do you expect the photoresistors to have in completely dark conditions?
        - What light wavelength range are the photoresistors sensitive to?
        - The data sheet relates cell resistance to illuminance in units of lux. Use the web or other resources to determine how a lux relates to SI units that are more familiar to us (i.e., W, m, s…), and to determine the typical illuminance of an office or classroom. What do you expect the resistance to be under these illumination conditions?

Procedure

1. Test your resistive sensors to see if their behavior matches what you expect from the data sheets.
    a. Measure the thermistor resistance at room temperature, then pinch the thermistor so that you increase its temperature (the human skin temperature is ~34 ºC, compared to room temperature which is ~25 ºC).
    b. Measure the photoresistor resistance in ambient light and when covered. What, approximately, is the illumination level in the classroom?
2. To be useful for most systems, the resistance change must be translated into a voltage signal. Two common circuits for doing this are shown in Figures 1 and 2. For each circuit, determine the equation for v_{OUT} as a function of V_{CC}, R_1, R_2, R_3 and R_4.

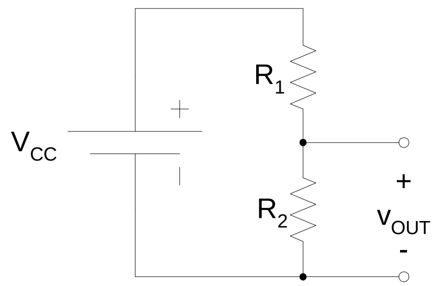

Figure 1: Voltage Divider Circuit

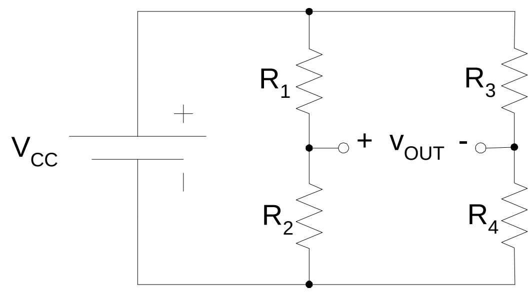

Figure 2: Wheatstone Bridge Circuit

3. Using the voltage divider configuration, design a circuit using a 5 V source that produces the largest possible voltage change in response to a reduction in illumination (caused by blocking the photoresistor). The circuit should produce a low voltage in normal room illumination conditions and a high voltage in the dark. Build your circuit and measure its output in both illumination conditions.
4. Let's say you have an application where you would like the voltage output to be as close to 0 V as possible under normal illumination but change significantly in response to darkening. Could a voltage divider work for that application? Why or why not?
5. Change your circuit so that it produces a low voltage in the dark and a high voltage in normal light. Measure the output in both illumination conditions.
6. Now using the Wheatstone Bridge, design a circuit using a 5 V source that produces as close as possible to 0 V in normal illumination and a large voltage in response to darkening. Note that you can use multiple photoresistors in your design. Build your circuit and measure its output in both illumination conditions.
7. Consider the advantages and disadvantages of the Wheatstone Bridge as compared to the Voltage Divider.
8. Prepare a formal lab report according to the guidance provided.