LAB 2-MEC830
Sensors
(Individual Lab)

1. Purpose

The purpose of this lab is to familiarize yourself with the use of sensors. In this lab, you will program the ELEGOO Starter Kit to read in values from the sensors.

2. Scope

The experiments in this lab are with two sensors: ultrasonic sensor and the tilt switch sensor. There are three tasks. In task 1, you will work with an ultrasonic sensor and an LCD. In task 2, you will work with a tilt switch and one LED.

3. Documents

The following documents will help you through the Lab:

- Lecture notes
- ELEGOO programing examples

4. Procedure

Familiarize with the ELEGOO Starter Kit.

- Try loading the examples from class and the kit.
- Use the serial monitor to help debug your program.
- Identify all sensors in your kit.

Quantity	Component
1	Arduino Uno R3
1	LCD 16 x 2
1	250 kΩ, Potentiometer
1	Ultrasonic Distance Sensor

Figure 1: Bill of Materials for Task 1 (10k pot is also acceptable)

Quantity	Component
1	Arduino Uno R3
1	Red LED
1	Tilt Sensor
1	220 Ω Resistor

Figure 2: Bill of Materials for Task 2

Note: For both tasks, implement your system in Tinkercad first.

Task 1: ultrasonic sensor and LCD

(a) You need to independently test the LCD display to make sure its display functionality works properly. Connect the LCD to the microcontroller. Display "hello world" on the LCD.

- Refer to the SR04 example code in module 2.9 along with the Hello World example in module 2.13, path to the file:
  (PATH: ...\Elegoo The Super Starter Kit for UNO V2.0.2020.5.6\English\Part 2 Module Learning\2.9 Ultrasonic Sensor Module\SR04_Example)
- In Task 1, the potentiometer wiper pin is connected to the VO pin on the LCD and may be used for adjusting contrast on the display.
- For the LCD, initialize the library with the number of interface pins, ie, (use the program code "LiquidCrystal lcd(7, 8, 9, 10, 11, 12);" to where the arguments are the digital pin numbers which are wired directly to the RS, Enable, D4, D5, D6, and D7 pins on the LCD.)

(b) Connect the ultrasonic sensor and follow the example to read the values of the sensor.

- For the ultrasonic sensor the "Trig" and "Echo" pins must be connected to the digital output pins that are capable of producing a PWM output signal, i.e, (Pins 3 and 5).

(c) Test the accuracy of the sensor by using a ruler and comparing the ground-truth distance with the measured values. Report the average error. Do you need to apply a calibration procedure?

(d) Under what conditions is the sensor reading the most accurate?

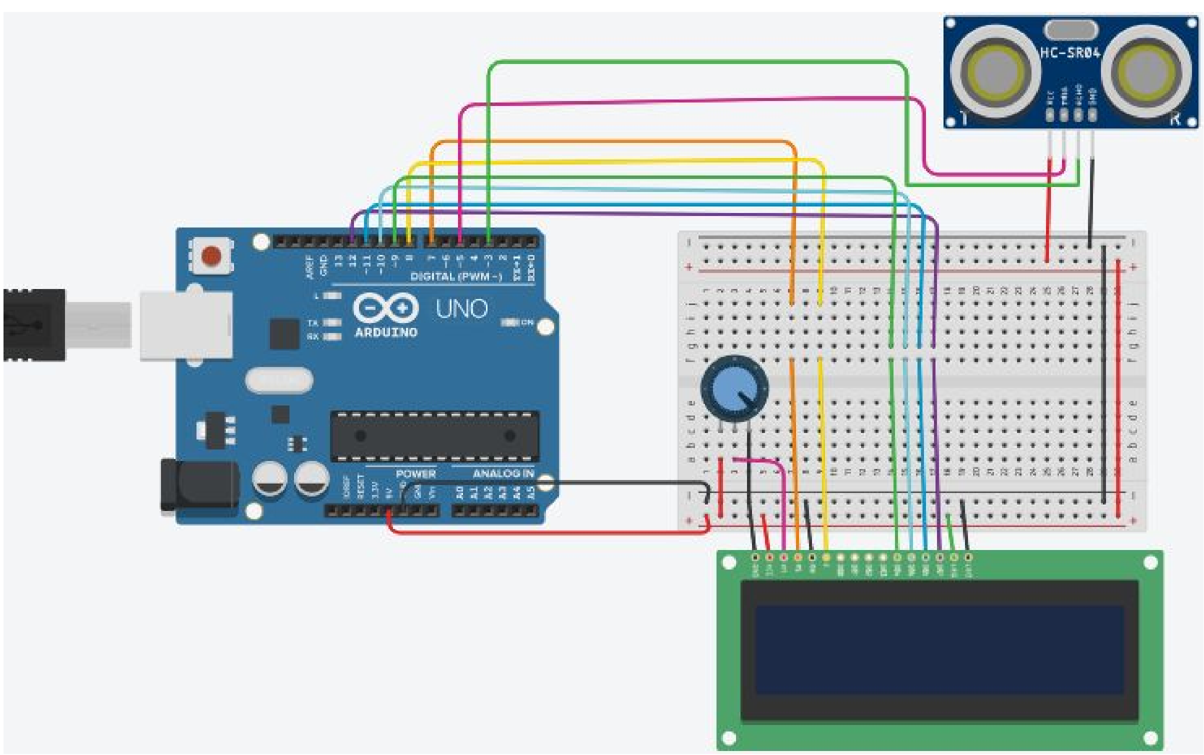

Figure 3: Schematic for Task 1

Task 2: tilt switch and LED

(a) Connect the tilt switch and a red LED to the breadboard. Read the values of the tilt switch. When the tilt switch is on, turn on the LED, otherwise, turn it off.

- In Task 2, implement the red LED as in Lab 1 to avoid burning it out.

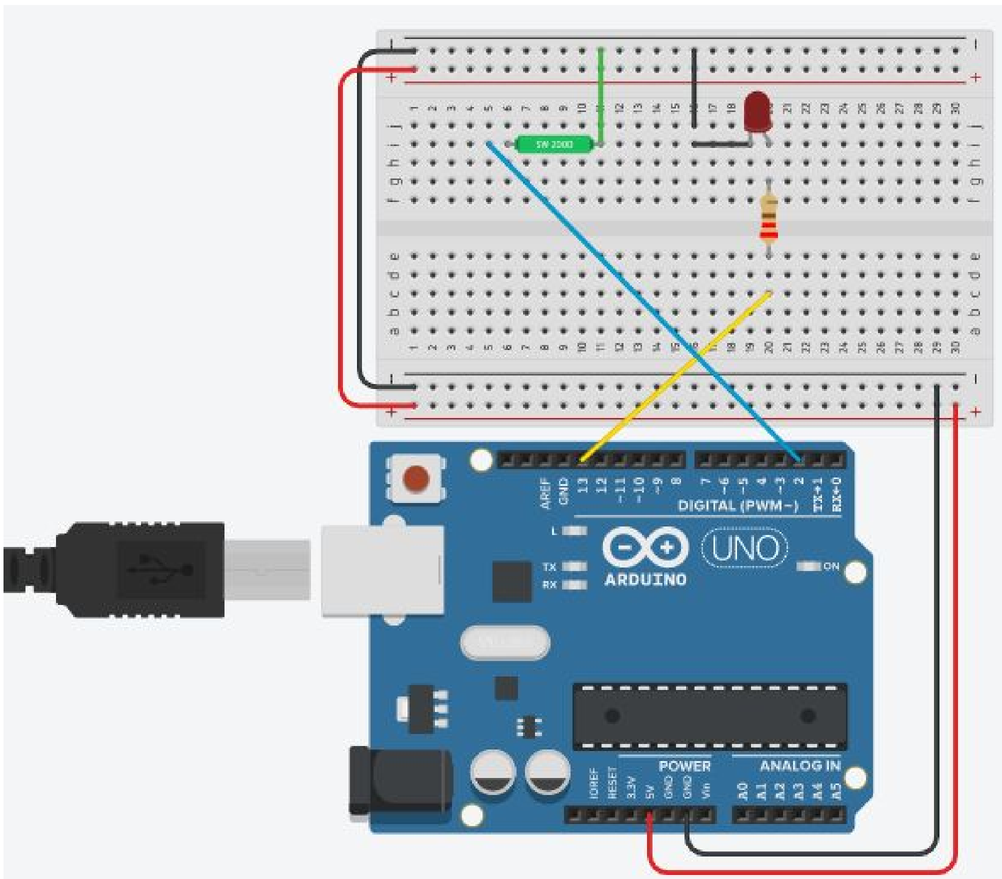

Figure 4: Schematic for Task 2

Once Tasks 1 and 2 are working properly, demonstrate to your TAs and ask them to sign off. These tasks should be finished during the lab hour.

Watch these videos to see how these should work.

Task1: https://youtu.be/a3y66D17UkE   Task2: https://youtu.be/UpgUt7IeD3g

Task 3:

(a) Identify all the sensors (with photos included) available in your kit with their functionality.

(b) Where in the real world these sensors are used?

(c) Propose example use for each sensor.

(d) Write a one-page report about (i) Inertial Measurement Units (IMU), (ii) the technologies used to make IMUs, (iii) the type of IMUs used in commercial aviation and robotics, and (iv) the main sensor in a MEMS IMU. (v) Include an example for a hobby grade MEMS IMU and an example for a commercial grade MEMS IMU in your report. Report their main difference.

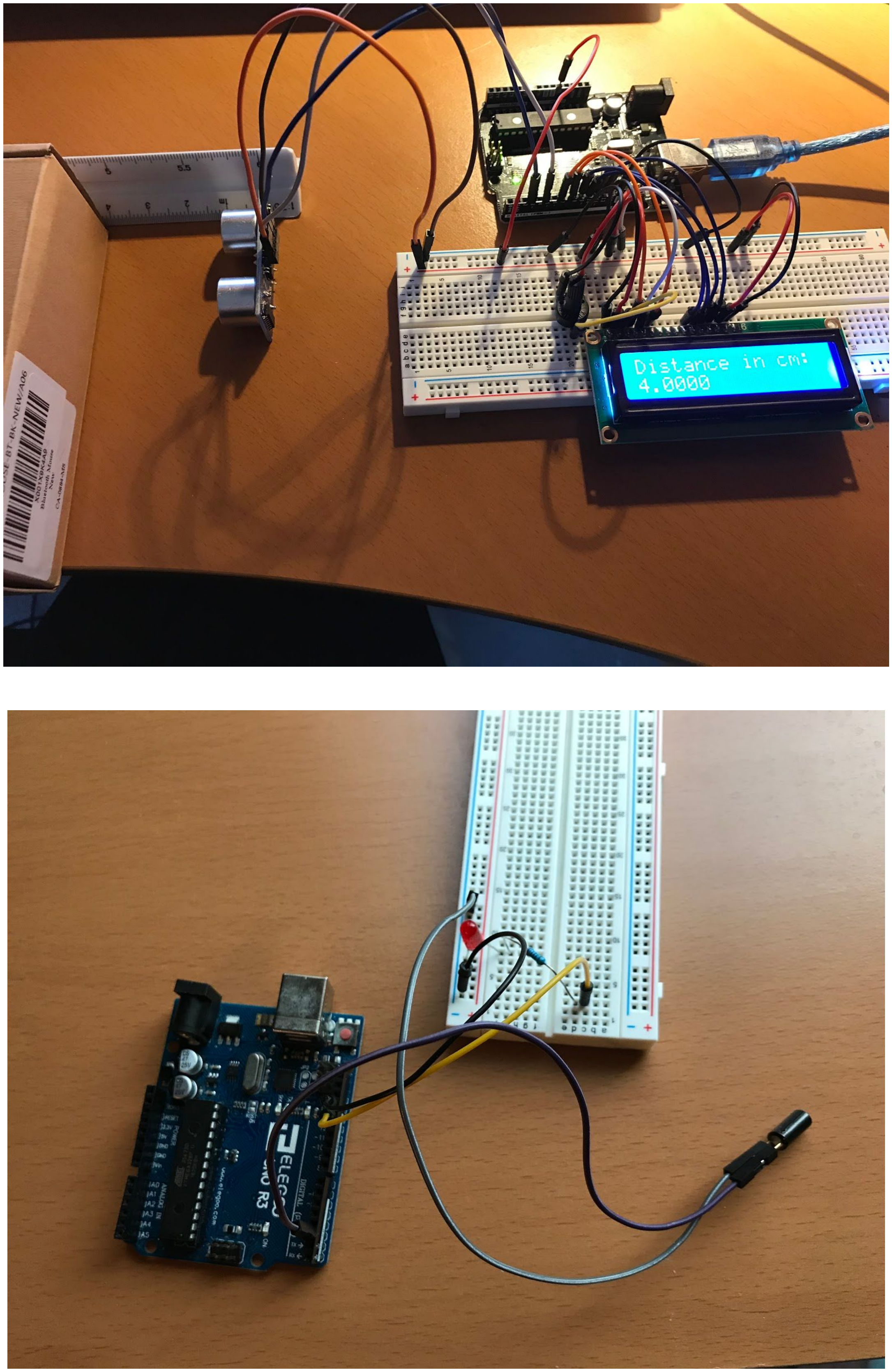

Figure 3: Reference Images for task 1 (top) and task 2 (bottom)

5. Report

Your lab report should include:

- Signed lab report cover page: http://www.ryerson.ca/mie/documents/
  (make sure you put your lab group number on the front)
- Abstract
- Introduction
- Experimental Equipment (ie. what was used)
- Description of the Program with flowchart
- Tinkercad Model of the Circuits
- Conclusions & Recommendations
- Appendix: Program Listing
- Report file name convention:
- Report_[Section#]_[Student_ID]_ [Last_Name}_[First_Name]_LAB1.pdf, e.g. Report_09_00099887766_Smith_John_LAB1.pdf
- Your code also should be submitted in a zip file, if more than one file needs to be submitted. Otherwise submit the code unzipped.
- Code file name convention:
  Code_[Section#]_[Student_ID]_[Last_Name}_[First_Name]_LAB1.pdf, e.g.
  Code_09_00099887766_Smith_John_LAB1.[c, zip]

- Lab reports are due in 1 week since your lab session starts.
- Submit to D2L→ Assessment → Assignment → Lab2
- Late submissions will be penalized at a rate of 10% per day, where weekends count as two days for online submission.
- Each student should submit his/her own individual report/work. This is not group work.
- Lab attendance is mandatory. If you submit a report without attending the lab, you will get zero marks.
- Weight:
  - 50%: TA confirms that you did the lab during the lab hour
  - 50%: Lab report and the code