

Lab 5

Relevant labkit components for this lab are:

- 3-d accelerometer (LSM9DS1 <https://www.sparkfun.com/products/13284>)
- temp/humidity sensor(Si7021, <https://www.adafruit.com/product/3251>)
- HC-SR04 ultrasonic distance sensor <https://www.sparkfun.com/products/15569>

Please use the contents of the lab kit to solve **one** of the following tasks: Completing a second task can take the place of the final project. Completing a third task can take the place of Lab 3 if you've thrown your hands up with regard to PWM.

To Hand in:

1. Document functionality with cellphone video and share with me.
2. Document your design with labjournal pages.
3. Share your code with me – sharing a github page is fine.

Task 1: Using the LSM9DS1 Make a “g-meter” that can be used to determine:

1. Which way is up? Possible solution: make a green LED glow when the accelerometer is sitting “right-side up” on a table.
2. What is the current acceleration? Possible Solution: Report data to the user via the LCD screen - display the current X, Y, and Z acceleration.
3. And, do something else interesting (for example, you could, based on acceleration since reset, determine a user's current speed or change in position. Ballistic missiles used to do this via $\Delta x = \int dt \int dt a_x \approx \frac{1}{2} a_x (\Delta t)^2$. For details, check out “Inventing Accuracy”. Or, you could make a “how steep is this hill I'm riding up?” meter for a bicycle.

Task 2: Use the Si7021 temp/humidity sensor to:

1. Report current temperature and weather variables. Use the LCD display and display values one after another (eg temp for 4 seconds, humidity for 4 seconds, etc)
2. Report the max and min values since power on (again in an oscillating display?).
3. Do something else cool with the data. For example, you could make spaghetti with the water pot on and then off, and measure the kitchen's temperature and humidity change graphically (send the data to serial console and make a plot). Checking a bathroom fans effect on a shower could be similar? Alternatively, can you use temp and humidity to predict rainfall?

Task 3: Use the Magnetometer in the LSM9DS1

1. Report current Magnetic field values in 3D via the 16x2 display. Reminder, in Winona, the earth's magnetic field mostly points **underneath** Wisconsin.

2. Use the Magnetometer as a simple compass to report your bearing. Eg, if you know a-priori which way the magnetic field of the earth points, use the magnetometer to tell you that you're not pointing 16 degrees East of north, 30 degrees above the horizon.
3. Determine to what extent the magnetometer can be used as a metal detector. Eg, can you use it to determine if a steel nail is hidden under an inch of cardboard or soil?

Task 4: Use the HC-SR04 distance sensor to:

1. Report the average object distance seen by the sensor for the last second via the 16x2 LCD display. Display a (statistical) uncertainty computed from the last second's measurements.
2. Report the average velocity seen by the sensor for the last second. There are many ways to measure velocity – reminder, it should be a signed measurement. You could have the sensor watch a pendulum swinging away and towards and plot the data as a check that it makes sense?
3. Do something else cool with the sensor. Acceleration vs time is certainly a possibility. Or, you could put the distance sensor on a rotating stage and make a plot of the room you're sitting in. Eg, if you rotate the sensor around the room over a known period, you'd have regular radius measurements with a (relatively) constant angular change. This would give sufficient data to make a parametric plot of the room's surface.

References:

1. Sparkfun RedBoard: <https://www.sparkfun.com/products/15123>
2. 16x2 LCD display: <https://www.sparkfun.com/products/255> and tutorial, <https://learn.sparkfun.com/tutorials/basic-character-lcd-hookup-guide>
3. LSM9DS1 3d Accelerometer: <https://www.sparkfun.com/products/13284>
4. Si7021 Temp and Humidity: <https://www.adafruit.com/product/3251>
5. HC-SR04 Ultrasonic Distance Sensor: <https://www.sparkfun.com/products/15569>