

Abstract

Conductivity is a measure of the resistance of electrical flow. Specific resistances and conductivities can be associated with specific ions. Ocean engineers can analyze the conductivity of water samples to understand which ions are present in solution, and specific concentration of said ions. By understanding ionic concentrations in a body of water, conclusions can be made about why concentrations are high or low, and ocean engineers can better approach a problem involving that body of water. Ions of interest might be salt ions found in oceans, for instance Na^+ , Cl^- , and K^+ . We calibrated using NaCl , Cl^- , and K^+ solutions. The objective was to calibrate a sensor with the use of different ionic solution concentrations to determine which ions and relative concentrations were present in an unknown, random solution.

Methods & Procedure

Calibrate AtlasScientific probe:

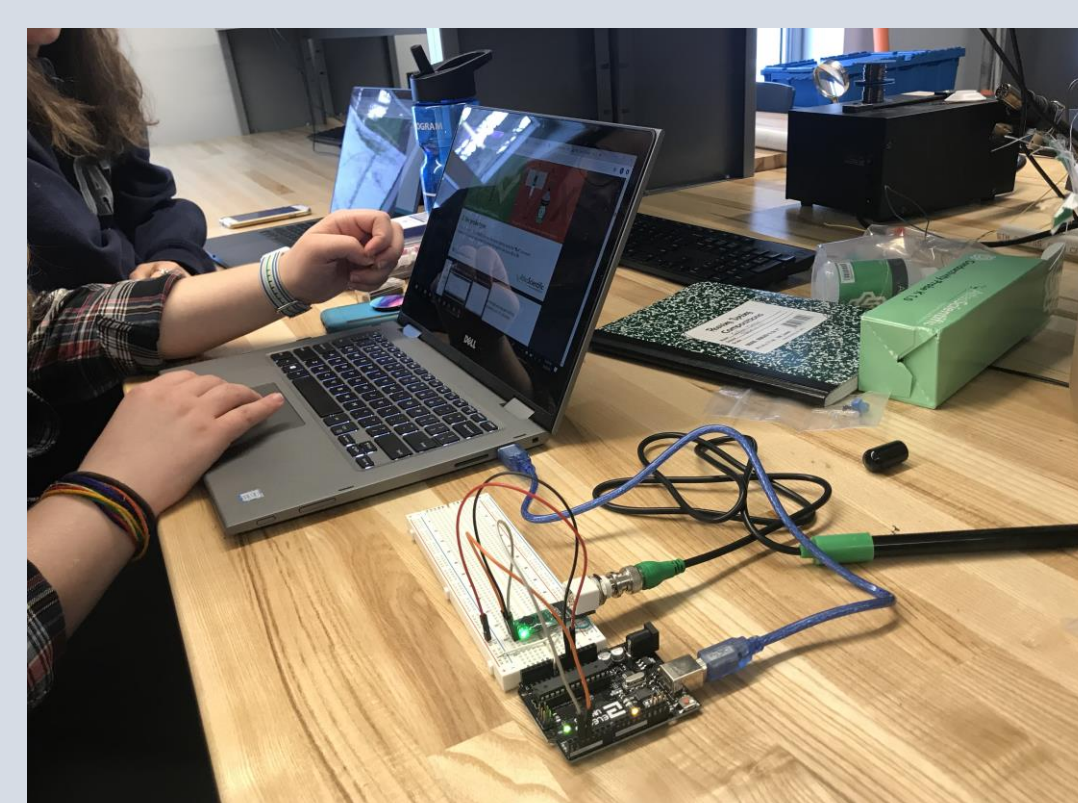
- Enter serial monitor of Arduino program
- Place the sensor in a low concentration solution, and type 'Cal,low' into the serial monitor
- Type 'Cal,high' to calibrate the high point



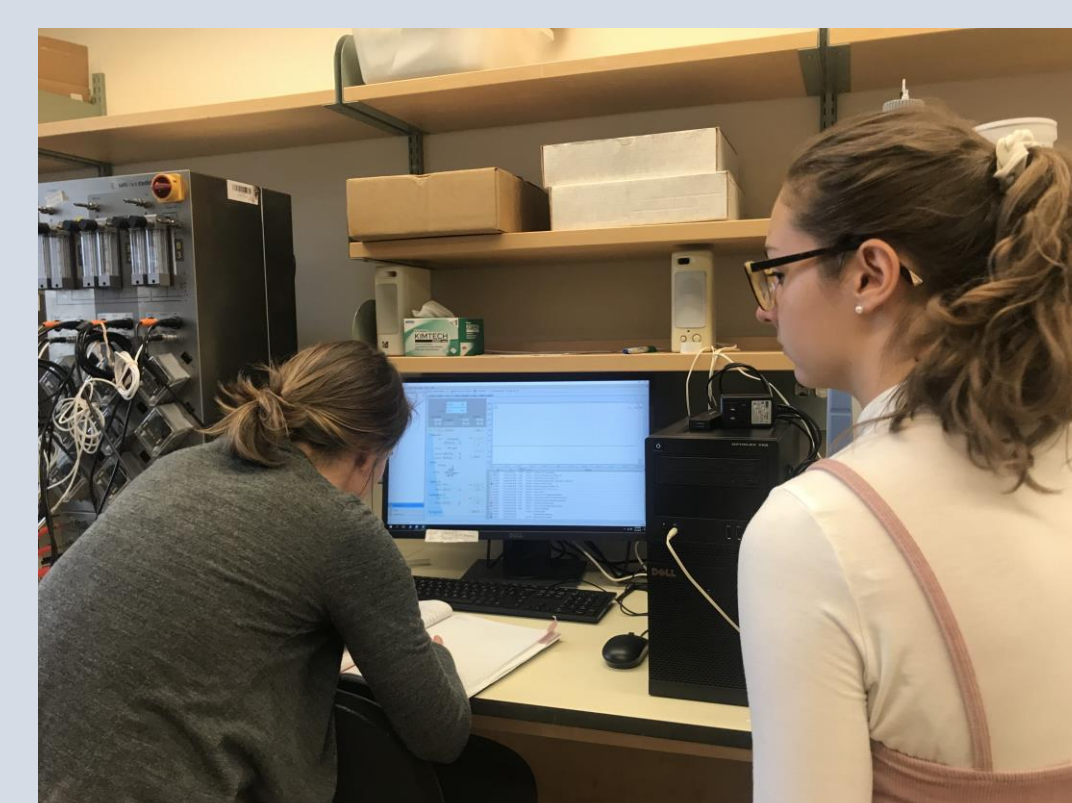
Calibrating the sensor with known concentration

Measure Concentrations/Conductivity in Lab:

- Pipette 5 mL of pure solution 4 times into a plastic tube.
- Calibrate the Arduino sensor with "Cal,dry". If serial monitor reads "*OK" then sensor is ready.
- Insert sensor into solution, wait at least 30 seconds to allow sensor to adjust.
- Write down conductivity value.
- Ensure sensor is wiped down with KimWipe each round
- To create dilution, add 10 mL of previous solution and 10 mL of deionized water to a new container. This creates a concentration gradient.

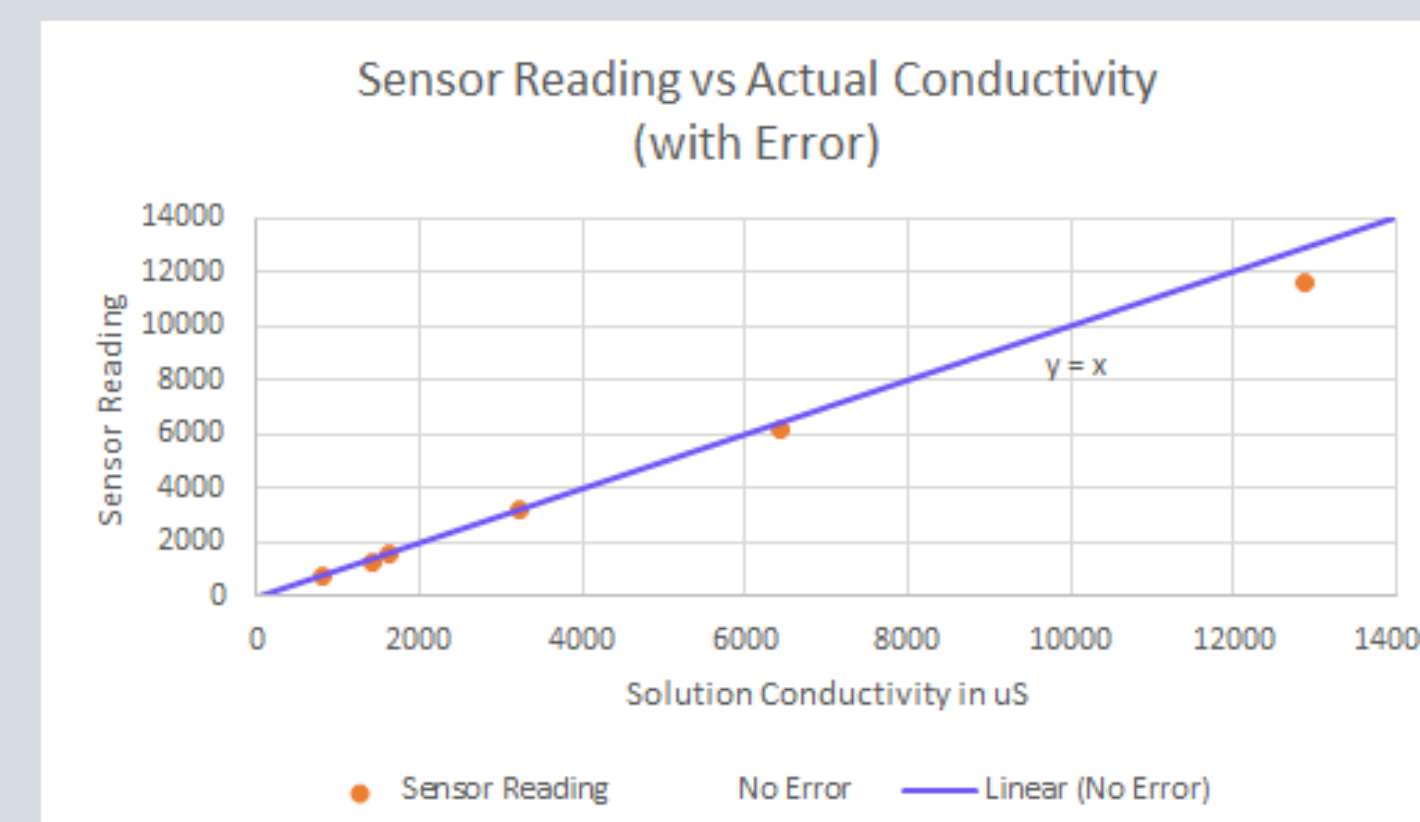


The conductivity probe connected to Arduino and computer with code



Working with Dr. Mouser in her lab to carefully determine concentration of calibration solutions

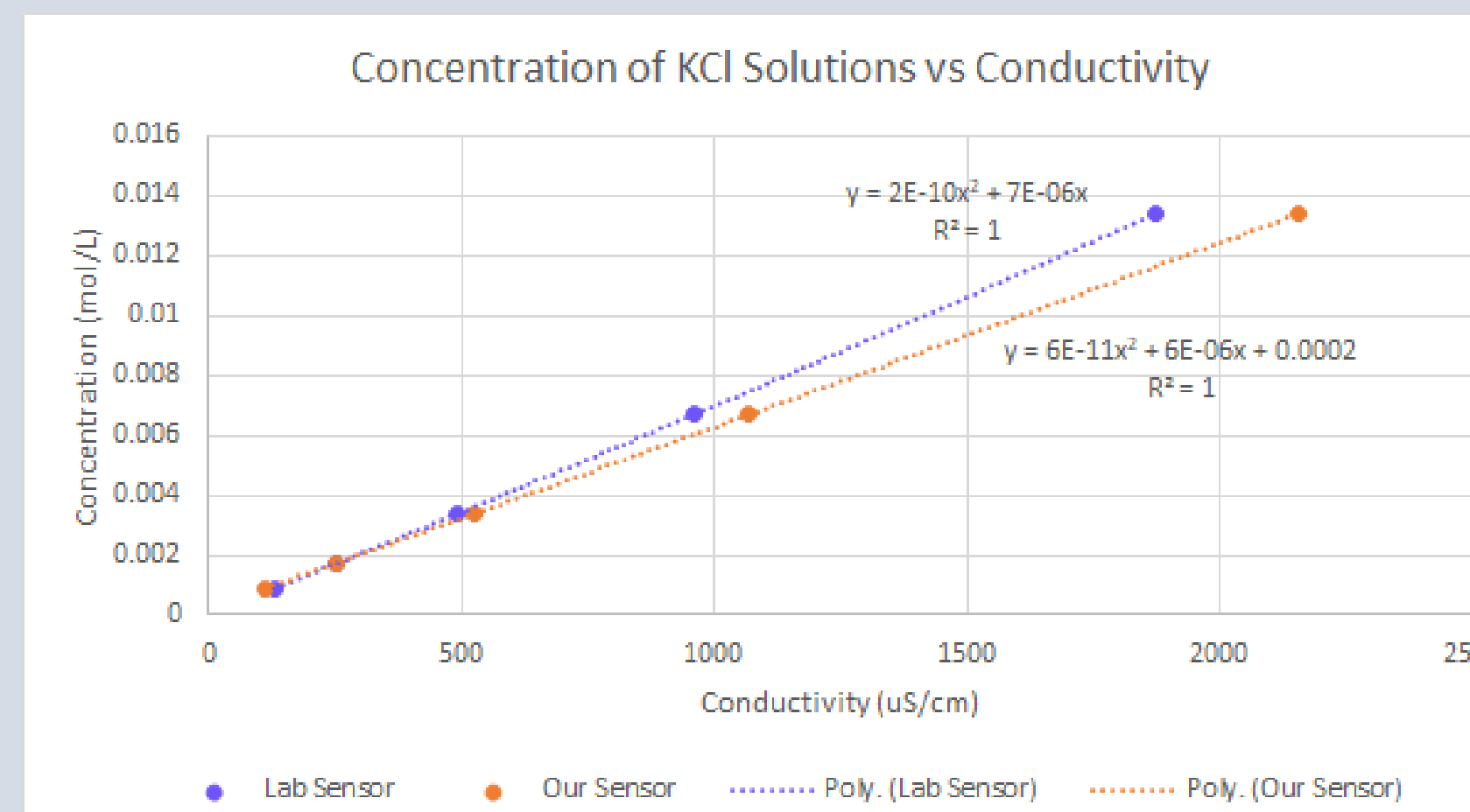
Results



A graph plotting the error of our sensor. The linear line represents a percent error of 0%.

The next set of data that was collected was the conductivity of a Cl^- solution. This data was then graphed against the known concentration to form a calibration curve. A calibration curve is a graph that is used to convert the collected conductivity value into a concentration within

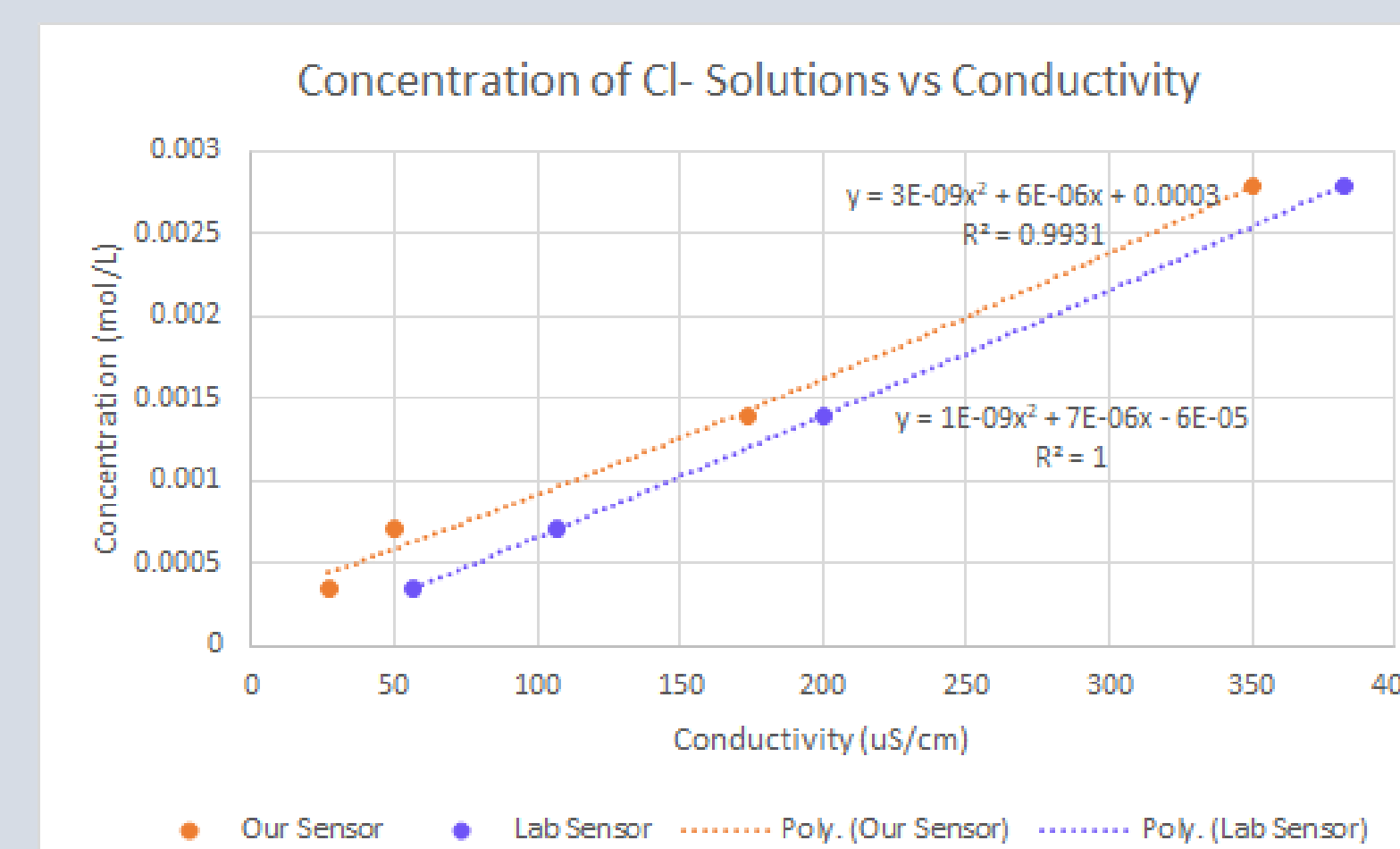
the Arduino code. The orange points are for the programmed sensor and the blue are for the laboratory sensor. A quadratic fit gave the best R^2 value for both graphs. If the lab sensor is being used as the "theoretical" or "actual" value and the programmed sensor is being used as the "experimental" value, the average percent error is 31.90%.



The calibration curves for the laboratory sensor and the programmed sensor for a KCl solution

Once again, a quadratic fit for the data gave the most accurate curve. The average percent error for these measurements is 9.56%. The second set of curves is different from the first set of points. All this means is that the equation implemented in the code will have to change based on the salt that it being tested for.

The data our sensor collected for the given conductivities is represented by the orange points. The average error of the sensor is 5.11%. While this is significant, it is relatively low for a sensor that is not programmed and calibrated to the extent that a factory standard one would.



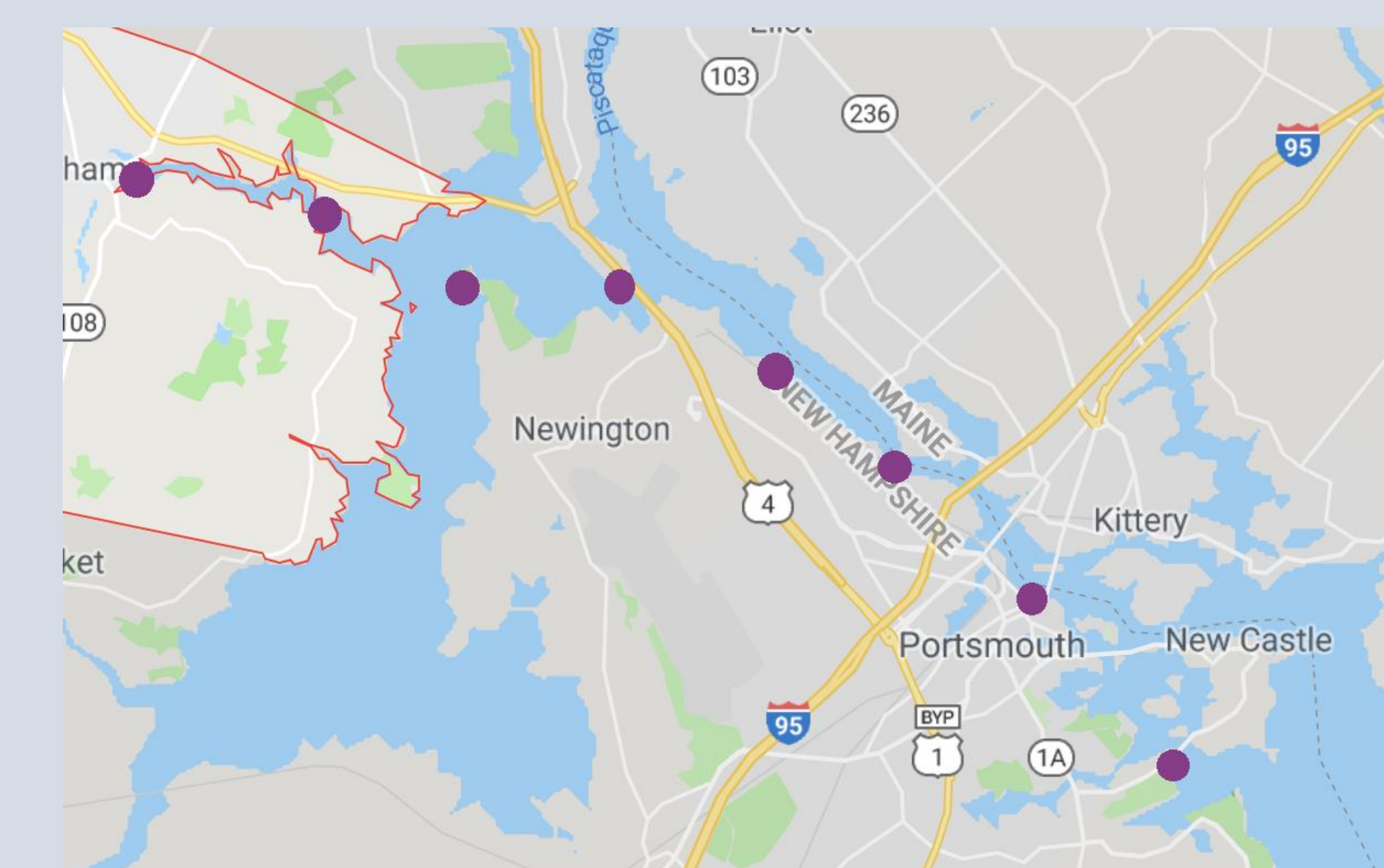
The calibrations curves for the laboratory sensor and the programmed sensor for a Cl^- solution.

The final collection that was done was for solutions of KCl. The colors of the lines and points correspond to the same source as the previous graph. These curves are different from the curves for the previous salt.

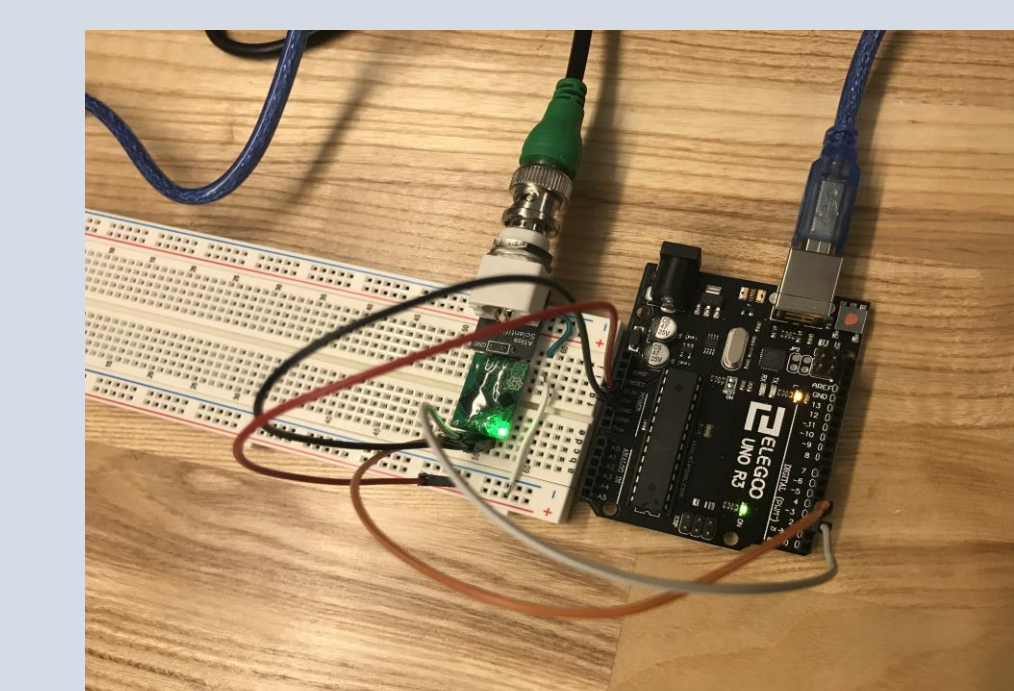
Analysis & Conclusions

A noteworthy observation is that our sensor had low error in accuracy between a cheaper sensor and a professional grade sensor. The error was 5.1%, and while significant, would be lowered with more calibration repetition and specialization. The intercepts of the curves for the developed sensor are not at the origin, as would be expected. This is because the zero point was calibrated when the sensor was dry, therefore even a solution with a concentration of 0 mol/L (deionized water) will have a conductivity of above 0 μS . The sensor from the lab was calibrated in a 0 mol/L solution, so the intercept of the curve is at the origin. This is the main source of error for the developed sensor when compared to the lab sensor. If more data was to be collected, the calibration should be done with a 0 mol/L solution to avoid this source of error.

Looking Forward



In the future, we hope to take the probe into the field to test conductivity and ion concentrations in the oyster river, moving towards the ocean as salt concentration increases. Points on the map indicate places to use the probe for gathering data. This probe can also be used in fresh water streams and rivers to test for pollution such as from road salt, as well as in a simple lab setting.



A closer look at the wiring set-up

Acknowledgements
Dr. Paula Mouser, Dr. Diane Foster,
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