



# Sensor Package to Promote Offshore Security

Allison Williams, Dr. Kevin Nolan, Dr. Roderick Jones, Olivia Hall  
University College Dublin College of Engineering and Architecture  
The University of Alabama



## Overview

This is a proposed sensor package that serves to promote security off of Ireland's coasts, relaying accurate, up-to-date information in real time while being compact and cost effective. This package would include three different sensors with varying abilities, all with the overall goal of detecting oil in the water. The optical sensor can detect light changes that could be detected when oil becomes present in the water, while the PH and conductivity can detect differences in the water properties when compared to external materials – in this case, oil. could be powered with the use of a lithium-ion battery. As long as these batteries are waterproofed and air-sealed, they can serve as a reliable and rechargeable power source that would not contribute to heavily to the overall weight. Sample water could enter the sensor chambers with the use of a NACA Duct. These have been used as a favorite method of intake on several car and plane designs. It is a favorite of many racecars for its contribution to drag reduction. The usage of a NACA duct on the pod that holds this sensor package could provide an intake method that does not contribute to any excess drag by fitting in smoothly with the rest of the sensor pod. While an Arduino UNO was used for this testing process, an Arduino Mega would better suit this design. With the same capabilities as the UNO, along with more room for pin connections, this computer could relay data from the sensors, contributing to overall security.

### Conductivity

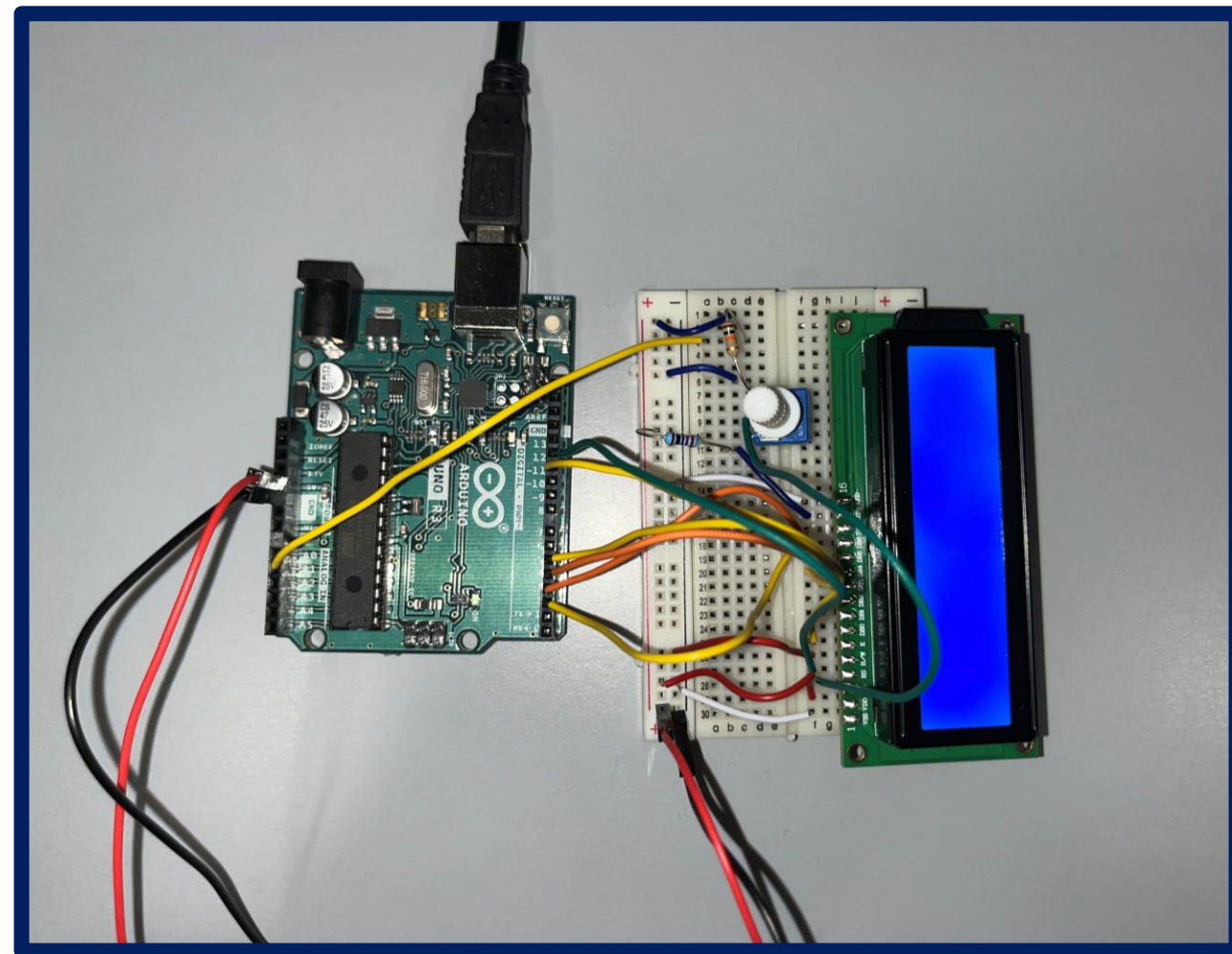
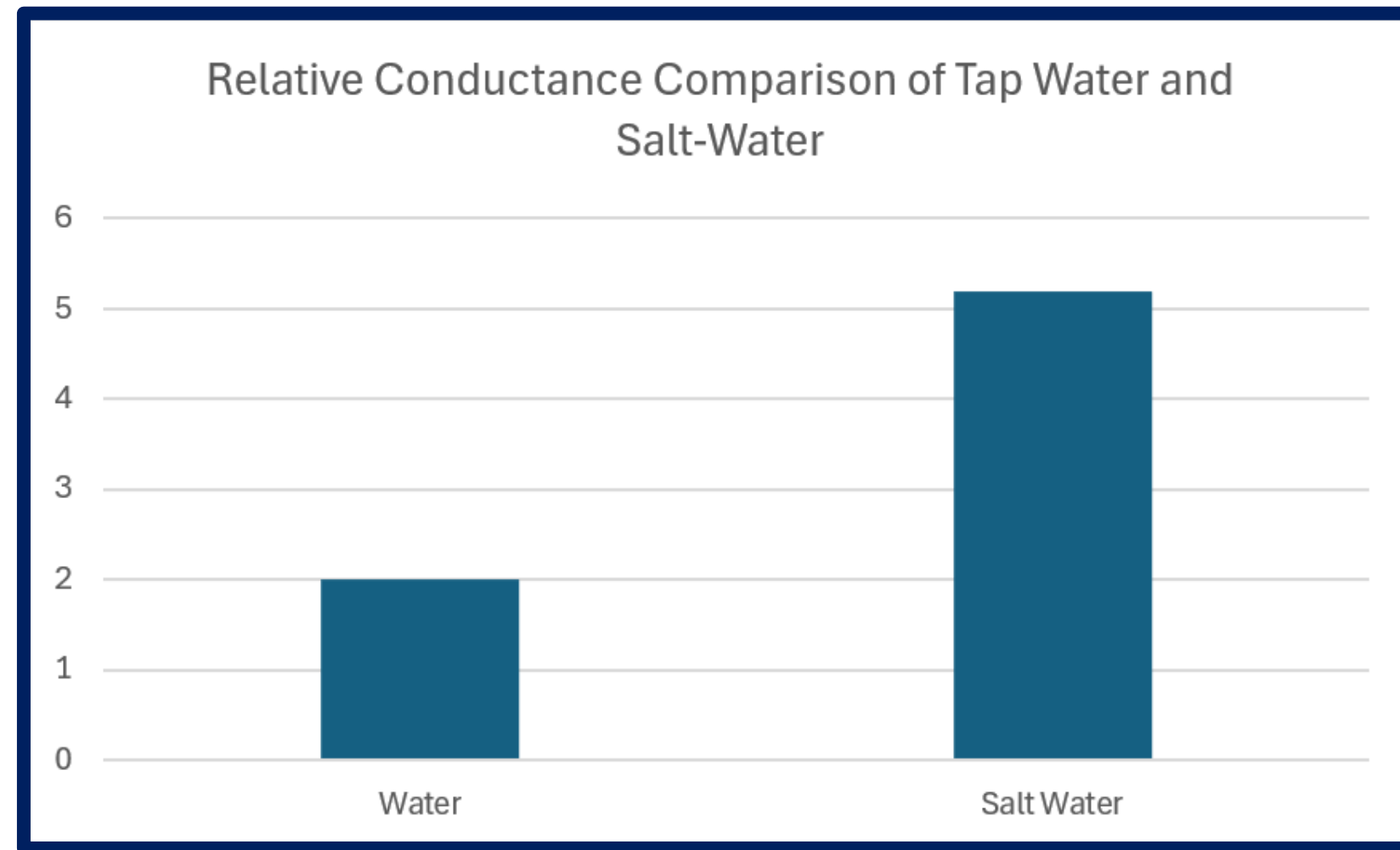


Figure 1: Conductivity Sensor Connections to Arduino Uno and Conductivity Differences in Water and Salt-Water

**Capabilities** Oil blocks electrical current flow, and this occurrence could be detected with the use of a conductivity sensor such as the one above.

A current is passed between two electrodes on sensors which then measure and determine the conductivity of the sample. One electrode acts as a reference providing a stable voltage while the other measures the current found in the sample.

**Limitations** Note that data displayed is related to "relative conductivity" and therefore is unitless. Easy conductivity gives way to a higher conductance. This is displayed with water and salt-water, with salt-water holding the higher conductance of the two.



### Sensors

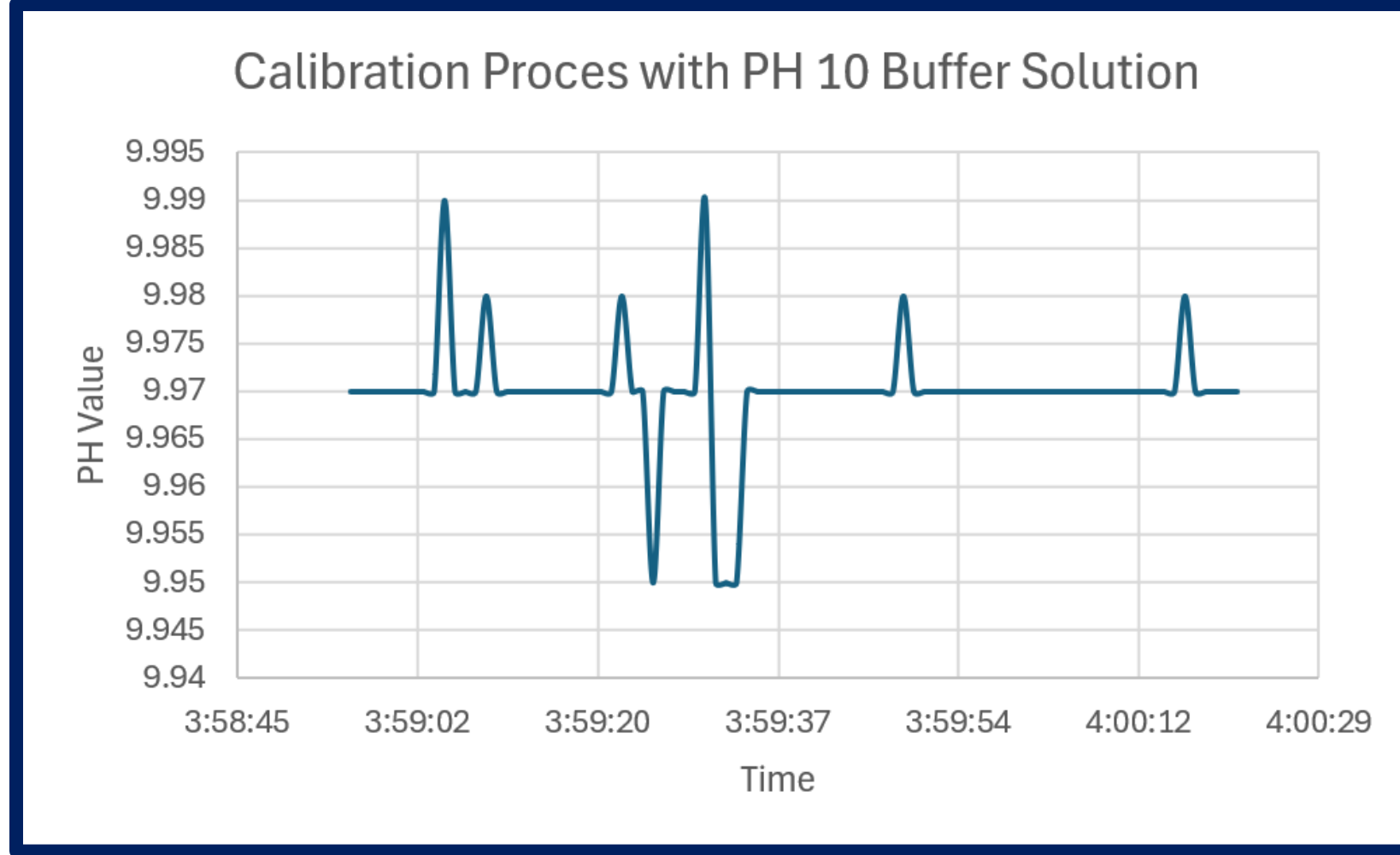
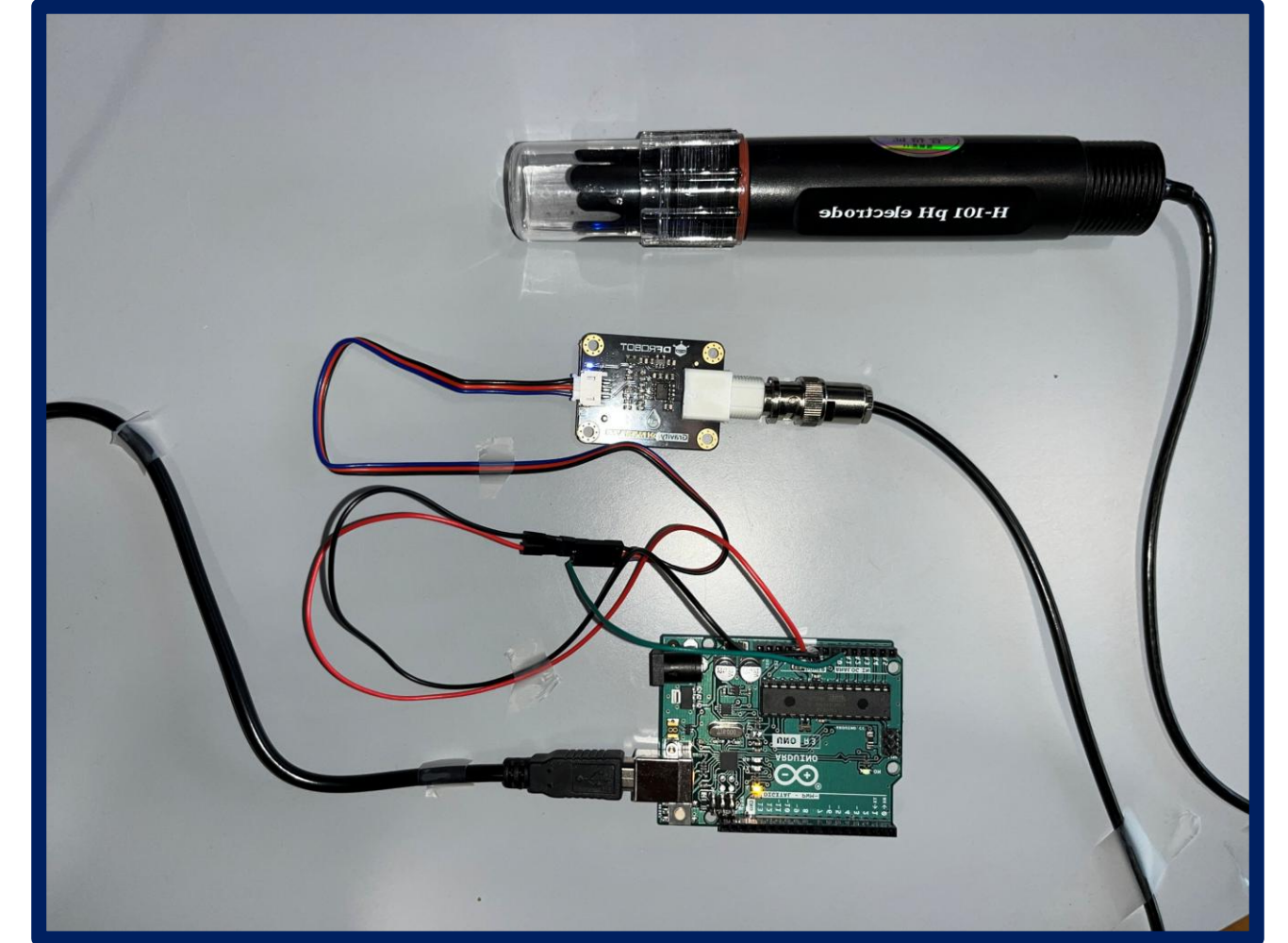


Figure 2: Calibration Process Readouts and DFRobot PH Meter Paired with Arduino Uno

**Capabilities** PH Sensors such as this model would measure the water quality PH and would convert this information into a signal which can then be analyzed. This sensor package from DFRobot can be connected to and powered by an Arduino and will provide results on the serial monitor reading out voltage and the resulting PH measurement.

**Limitations** Must first undergo sensitive calibration process with PH buffer solutions prior to every use. Failure to do so will skew results. Displayed in the graph are readouts from the sensor calibration process using a PH 10 buffer solution.



### Optical

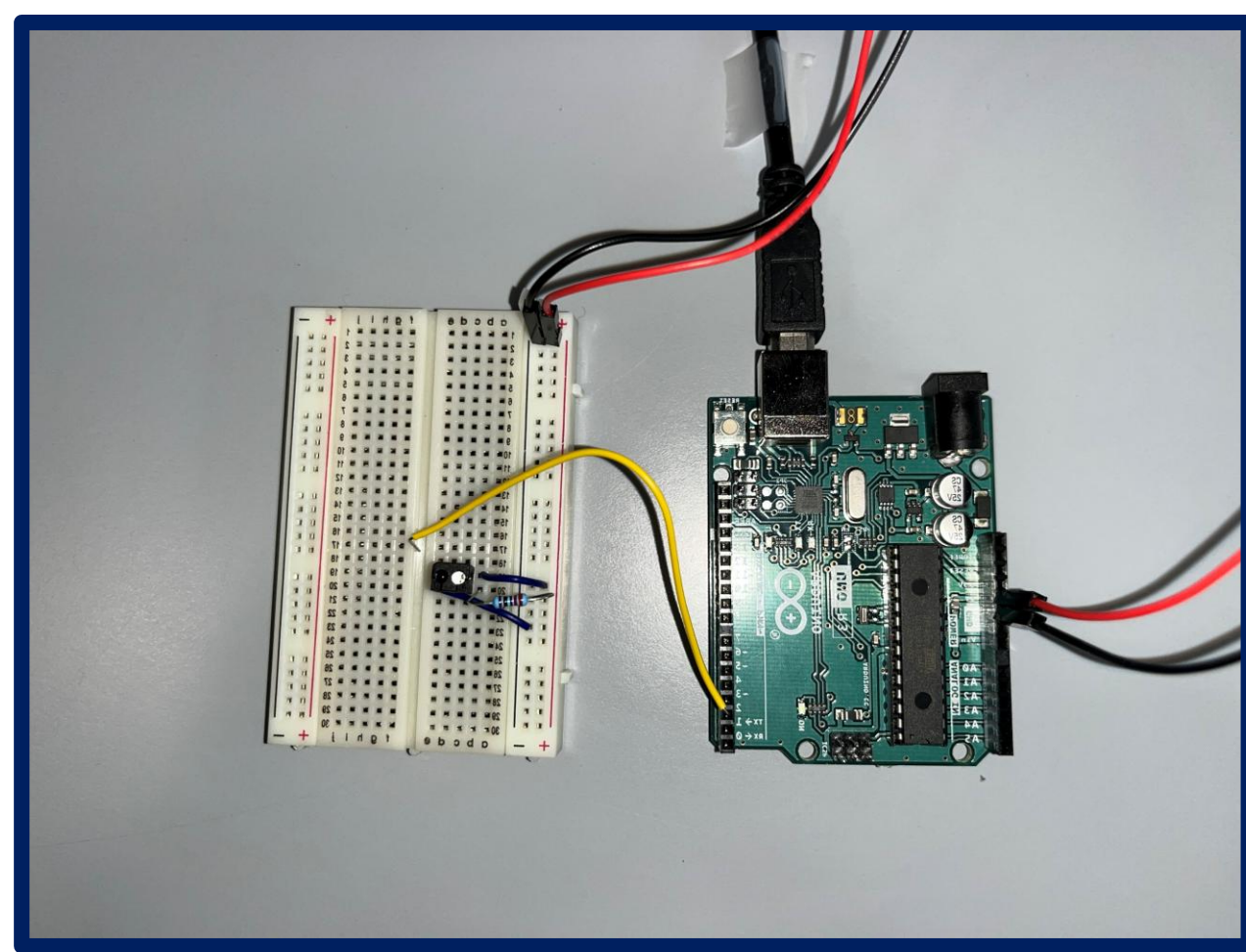


Figure 3: Adafruit Mini Reflective Optical Sensor with Arduino Uno

#### Capabilities

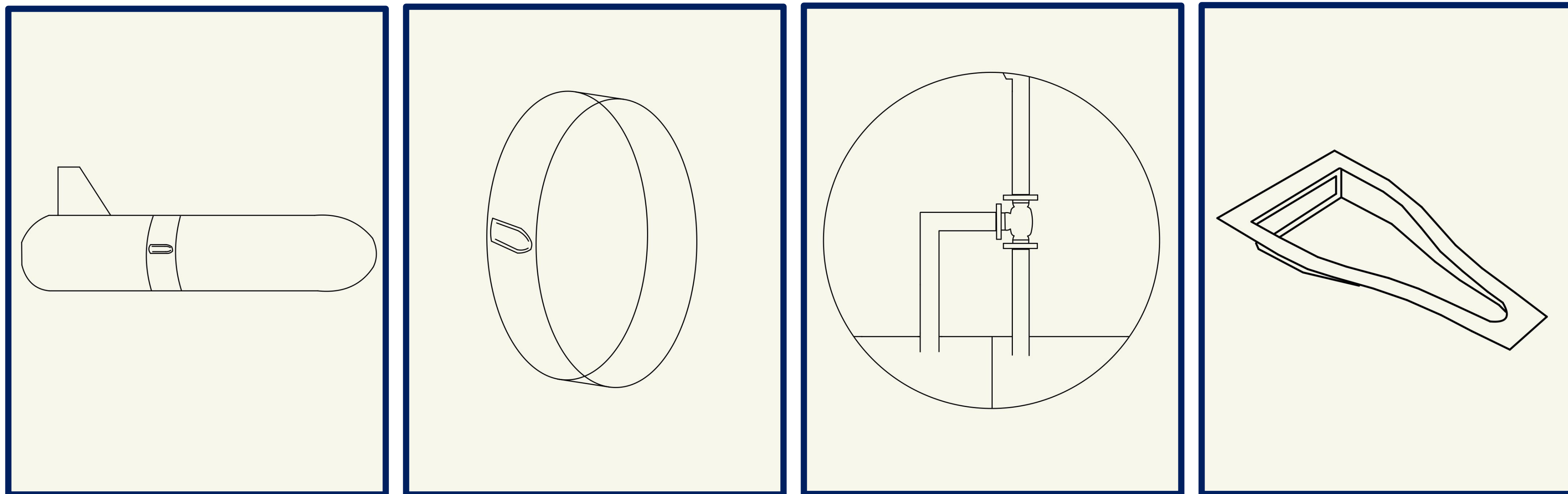
Optical sensors have been commonly used for liquid detection and have notably been used to measure the impact of oil spills, as oil absorbs certain wavelengths of light.

Light is projected forward then bounced back to the transistor, which controls the light output. The intensity of the bounced back light is measured. This 'off-the-shelf' optical sensor will be connected to an Arduino board and provided a simple code. When using the serial monitor on the Arduino Cloud, user will see "Detected" or "Not Detected" when exposed to light versus being blocked by a dark object.

#### Limitations

Extreme sensitivity to changes in light, must test solution in completely controlled environment for accurate results.

### Pod Design



This cylindrical pod would serve as the case for these three sensors, each separated into its own chamber to prevent any potential interaction between the sensors that would skew the results. It would involve the use of a NACA duct that takes in water and a control valve that would send portions of the same water sample to each sensor chamber. It could fit within a larger underwater drone system without providing additional drag. Silicone is a waterproof and relatively low-cost material that could be used to construct this pod. This same material could be used to construct the fin due to its flexibility that could contribute to overall level motion. Size is an adaptable element; goal size would be just large enough to accommodate all three sensor components as well as the valve and an Arduino mega.

### Conclusion

In conclusion, this sensor package has the potential to provide an effective solution at a reasonable price using simple sensors working together to create a functional detection system. Each sensor has been selected upon literature review due to their abilities to detect the presence of oil in the water from various causes, be it from the presence of ships or oil spills and lab tested to ensure functionality. Precautions, such as sensor separation, will ensure there is no interruptive sensor to sensor interaction.

### References

- Farnell. Available at: <https://www.farnell.com/datasheets/1503896.pdf> (Accessed: 15 April 2025).
- Electrochemical Sensor - an overview | ScienceDirect Topics. Available at: <https://www.sciencedirect.com/topics/engineering/electrochemical-sensor> (Accessed: 15 April 2025).
- Dadams (2024) How do optical level sensors work?, SMD Fluid Controls. Available at: <https://www.fluidswitch.com/2022/02/16/how-do-optical-level-sensors-work/> (Accessed: 15 April 2025).
- Admin (2023) Understanding how conductivity sensors work, ICON Process Controls. Available at: <https://iconprocon.com/blog-post/understanding-how-conductivity-sensors-work/> (Accessed: 15 April 2025).
- Build and test a conductivity probe with Arduino - activity (2023) TeachEngineering.org. Available at: [https://www.teachengineering.org/activities/view/nyu\\_probe\\_activity1](https://www.teachengineering.org/activities/view/nyu_probe_activity1) (Accessed: 16 April 2025).

Thank you to Dr. Kevin Nolan and Dr. Roderick Jones for their help and guidance throughout this research project, as well as Debarati Chakraborty for her assistance in the lab and my research partner, Olivia Hall.