Field test of STREAM developed thermistor string 14-03-2021

Introduction

As part of the ongoing work on the STREAM project, a thermistor string has been developed to broadcast live data. This is a cost-effective string of temperature sensors that have been daisy-chained together to measure changing water temperatures at different depths and to test for the presence of a thermocline. A thermocline is typically a transitional layer between warmer mixed water at the ocean's surface and a cooler, deeper body of water below (NOAA). Water temperatures and thermoclines have important implications for marine life, influencing the abundance and species composition of organisms in the water column. Temperature also alters the activity of marine organisms and other properties of seawater. By placing sensors in a string at one-metre intervals along a cable, we can measure the temperature differences at these discreet depths and identify the depth at which a thermocline may occur.

The thermistor string prototype that has been tested consists of the following components:

- Arduino MKR GSM 1400 board
- Arduino, Dipole Pentaband Waterproof Antenna.
- DFRobot Waterproof DS18B20 Digital Temperature Sensor Arduino.
- 12V 7Ah Battery with a transformer to 5V.
- RS PRO Grey Polycarbonate General Purpose Enclosure, IP65, 344 x 289 x 117mm.

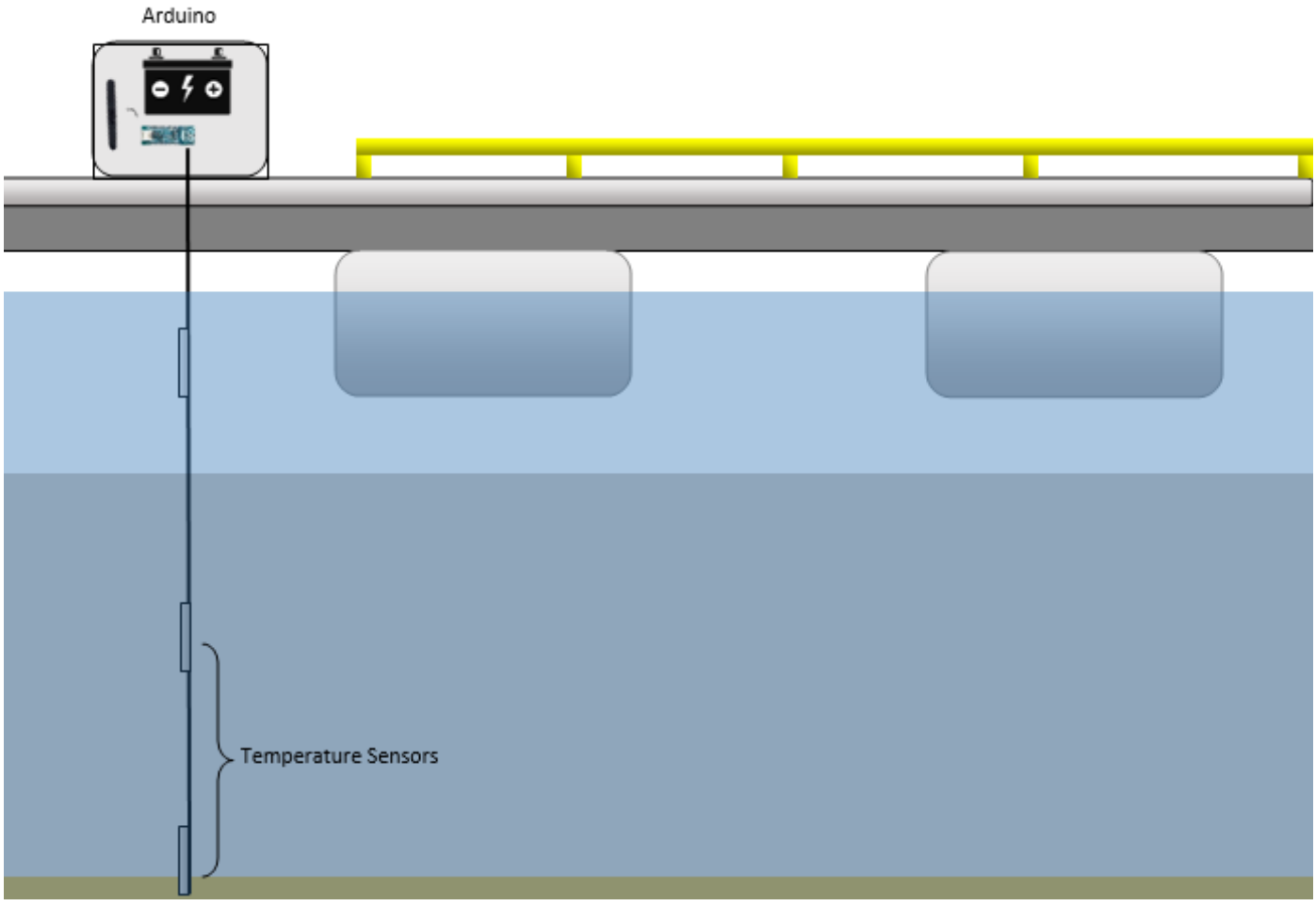

Figure 1. Schematic of the Arduino board being used to test the thermistor string from the pontoon in Waterford city.

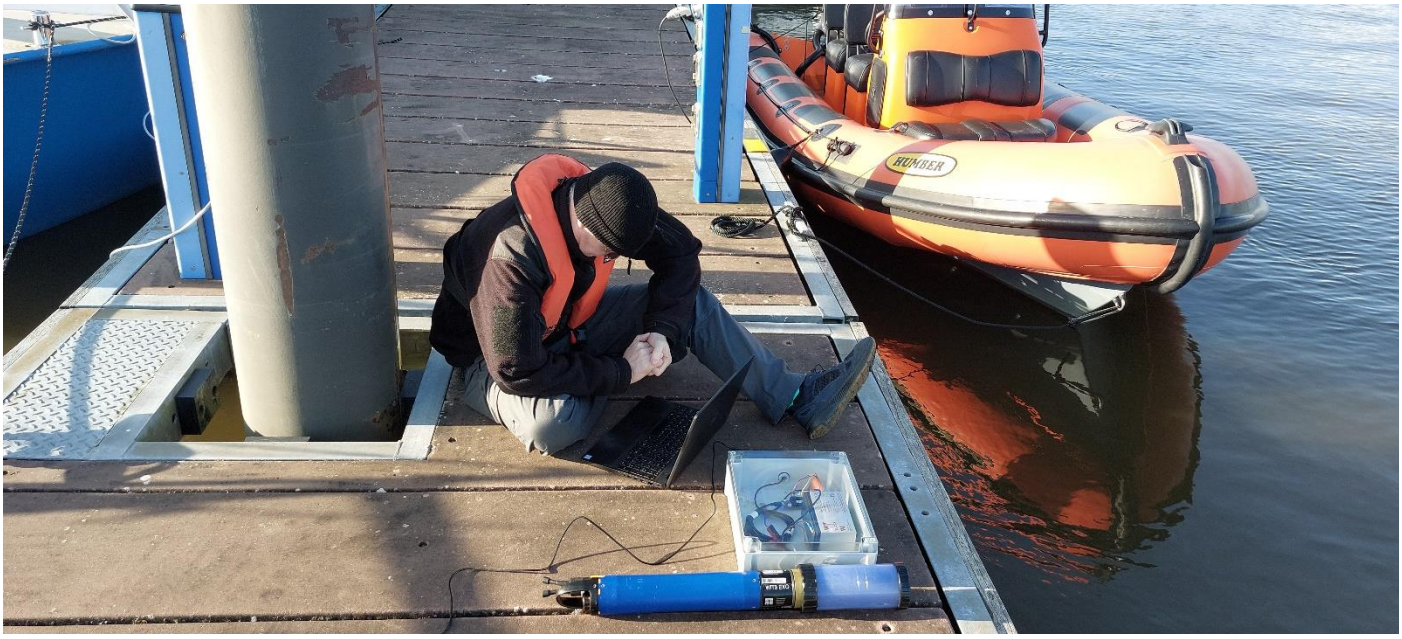

Figure 2. John Ronan (STREAM project) querying the temperature data being displayed by the thermistor string at a pontoon in Waterford City. The YSI EXO 2 Sonde is also present, this sensor was used to verify the temperature sensors being recorded by the thermistor string.

Testing

The device was tested for one hour at a pontoon in Waterford City (52.257784, -7.100627) between 16:00 to 17:00 on 14/03/2022, with High water taking place at 16:00. The Thermistor string was deployed at a depth of approximately three metres, and there were three temperature sensors at one-meter intervals that were connected to the Arduino board. The sensors functioned well over the deployment period and communicated the data via telemetry (Figure 3).

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arduino/uw_temps/357520078541626/probe0/temp_c 8.31
arduino/uw_temps/357520078541626/probe1/temp_c 8.12
arduino/uw_temps/357520078541626/probe2/temp_c 8.19
arduino/uw_temps/357520078541626/status offline
arduino/uw_temps/357520078541626/status online
arduino/uw_temps/357520078541626/status/uptime 242145
arduino/uw_temps/357520078541626/status/sleeps 2
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arduino/uw_temps/357520078541626/probe1/temp_c 8.00
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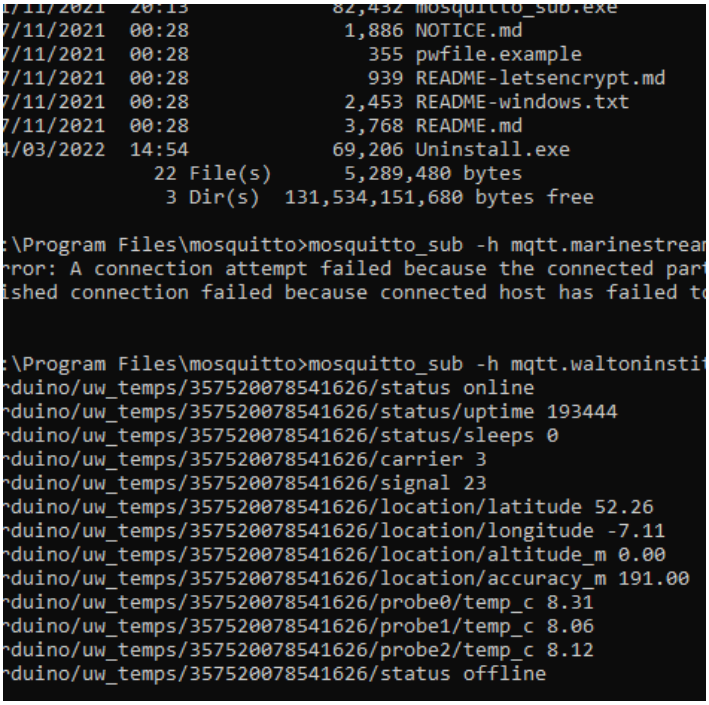
Figure 3. Screenshot of the data from the thermistor string.

To do a basic test of the accuracy of the thermistor string, it was decided to place the device in the water column at the same depth (0.5 m) as a commercially available sensor (YSI EXO 2) with a temperature sensor installed which was accurate to 0.001°C.

The provisional testing of the thermistor string was promising. All three of the sensors we purchased are reading to within 0.2°C of the commercially available sensor (Figure 4).



YSI EXO 2	
Average temperature	8.13°C

Figure 4. Data from the thermistor string and the average temperature of the EXO 2 Sonde temperature sensor.

Conclusion

The sensor performed well and tracked changes in the water temperature as the tide ebbed. These sensors are extremely cost-effective at €250 per unit and offer an alternative to more expensive thermistor strings, costing as much as €15,000 for a 20m depth.

The key to the success of this cost-effective alternative will be calibrating the sensors in the lab pre-deployment. The next step will be to develop a longer string with an increased number of sensors that can be used to monitor thermoclines in the water column.

References

- https://oceanservice.noaa.gov/facts/thermocline.html