Open Acidification

A Research Tool in the Fight Against Climate Change

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ABSTRACT

From the Open Acidification webpage:

> *The goal of the Open Acidification Project is to create open-source, inexpensive tools to conduct ocean acidification research and ultimately greatly increase the amount of quality ocean acidification research that can be accomplished.*

To this end, we have spent the 2019-2020 academic year working with Dr. Kirt Onthank, Associate Professor of Biology at WWU, to design and implement many new features for the existing pH-Stat platform (responsible for monitoring and controlling pH and temperature in tanks), and to develop a brand new web application for managing and coordinating individual pH-Stat units in a way that not only allows for far better usability, but also introduces several features that were not possible before.

INTRODUCTION

At the beginning of the year, Dr. Onthank provided us with a prototype pH-Stat unit, which had a few key limitations that we were to address. First, the method of retrieving logged data was very cumbersome: Any time they needed the data, researchers would have to remove the caulk from the device's case, retrieve the SD card, insert it into a computer, replace the SD card after copying the data thereoff, and reseal the case; this process took several hours.

The devices were also limited in their primary function of setting and maintaining pH and temperature. While they could hold those values at the setpoint defined by the keypad, there was no advanced functionality like ramps, sine waves, or custom time series.

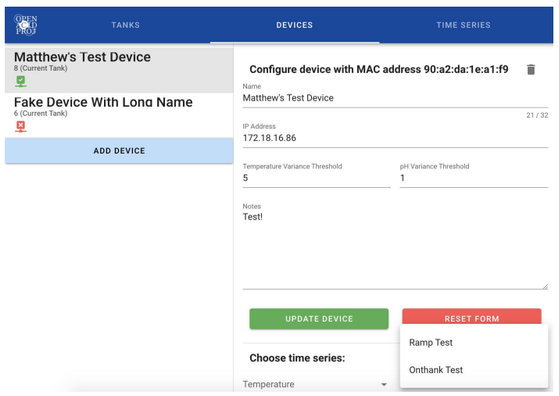
Finally, the web interface was quite bare-bones; it was a Google spreadsheet that was only updated every 15 minutes. All of these issues needed to be addressed by our overhaul.

DEVELOPMENT

The limitations of the prototype were addressed in two major ways: changes made to the codebase of the pH-Stat units themselves (Matthew), and a web application displaying tank status and providing support for custom time series, device configuration, and data download (Cameron).

On the device side, an API was developed to allow direct access to a device's data and configuration, but this was not completely straightforward. Due to issues relating to Ethernet transmission caps, the logging system was revamped to use paging by date & time, and a fixed record size was used to allow specific lines to be transmitted.

Finally, a JSON protocol was developed that specified a sequence of setpoints and times for pH and temperature, and a series endpoint was added to accept time series in this format.



The web application (shown above) was to be composed of a backend and a frontend working in tandem. The Python-based web framework Django was selected for the backend, and Vue.js was selected for the frontend. The finished product was targeted at Raspberry Pi 4. It boasts a host of time series design tools, the ability to download tank data for the specified range of time, and a convenient list of all tanks and their current status. It also features—importantly—an intuitive and visually appealing user interface.

CONCLUSION

The device upgrades will be deployed directly to existing pH-Stat units at Rosario Beach Marine Laboratory, along with a Raspberry Pi on which the web app server will be hosted. These upgrades should significantly streamline the research process, enabling researchers to spend their time more effectively, and providing them with an improved toolkit in their fight against climate change. It should be noted that all existing features of the previous pH-Stat prototype are still available in the overhauled version. Possible future upgrades include the addition of over-the-air updates to the pH-Stat units, increased server-side security, and data visualization.

SUMMARY

Through these features, we have made it far more convenient for researchers to visualize and interact with their data. The central server provides a remote single point of access that grants researchers a real-time view of tank conditions through communication with pH-Stat units, which now allow high customizability of setpoints through user-specified time series.

LINKS

- Device Codebase: https://github.com/PlasmaIntec/Open_Acidification_pH-stat_arduino
- Device API Documentation: https://app.swaggerhub.com/apis/Ocean-Acidification/device/1.0.0
- Server Codebase and Documentation: https://github.com/Open-Acidification/Open_Acidification_Server/

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