fieldkit

H41S-2015

FieldKit Underwater: An Inexpensive, Open-Source Sonde Platform for Submerged Measurement Operations

Shah Selbe;
FieldKit

Author & Affiliates

Shah Selbe[1,2,3], Peter Marchetto[1,4], Bradley Gawthrop[1], Jacob Lewallen[1], Lindsay Starke[1], Sara Clements-Tiberio[1], Sarah Koons[1], Susan Allen[1], Jer Thorp[1,5], Erin Kennedy[1], Kate Kuehl[1]

[1]FieldKit, Los Angeles, CA, USA
[2]Nelson Institute for Environmental Studies, University of Wisconsin-Madison, Madison, WI, USA
[3]New England Aquarium, Boston, MA, USA
[4]Graduate School and Institute on the Environment, University of Minnesota-Duluth, Duluth, MN, USA
[5]Tisch School of the Arts, New York University, New York, NY, USA

The technology that dominates the field of underwater sensing tends to cost multiple thousands of dollars, creating a large barrier to entry for many who need data on underwater conditions over long periods of time at high frequencies. The low-cost FieldKit Underwater is an open source alternative.

Introduction

The current product landscape for underwater sensor systems consists of two extremes: either very expensive and difficult-to-use high-end hardware or semi-reliable DIY projects. This creates a situation where extended scientific deployments with high-precision data is only available to those who can afford these tools, reducing access, large unit deployments, and reproducibility for the majority of users. Several designs have been evaluated by the USGS[1,2,3,4] among others. The high cost class includes sondes and other water quality monitoring systems (e.g. those by Xylem, Hydrolab, Eureka, etc.), while the low cost class includes some of the open-source and closed-source designs put out by both academic labs and low-cost sensing system companies (e.g. Atlas Scientific, Public Lab, Seeed Studio, etc.)

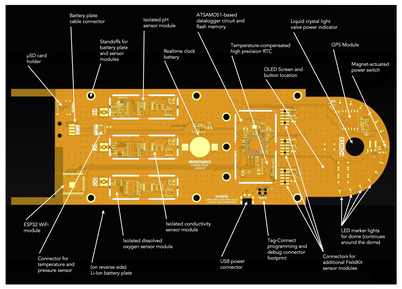
The final version of FKUW during testing.

FieldKit Underwater (FKUW) aims to fuse the best traits of both low- and high-cost instrumentation into a lower-cost, higher-precision, high-durability, and calibrated design.

Materials and Methods

The FieldKit Underwater platform is intended to be a multi-parameter datalogging sonde for fully submerged use for long deployments on the order of months.

The design of the unit enables the use of multiple rechargeable lithium ion battery packs and high-capacity µSD cards for extended deployment periods. The unit is designed to gather data from multiple sensors, and includes calibrated circuits to interface with probes for dissolved oxygen, pH, and electrical conductivity on-board. Also included is a pressure and temperature sensor. In the initial prototype embodiments, probes and sensors for pH [model S150C] (Sensorex, Garden Grove, CA), EC [model CS150] (Sensorex, Garden Grove, CA), DO [model DO1200] (Sensorex, Garden Grove, CA), and pressure and temperature [model BR-100586] (Blue Robotics, Torrance, CA, USA) are included on the bulkhead plate along with the vent port for pressure testing the enclosure.



The hardware architecture of a FKUW main board.

The circuit is built to fit within a standard cast acrylic plastic and aluminum 100 mm tubular enclosure [model BR-101052-300] (Blue Robotics, Torrance, CA, USA) with a dome port at one end. These provide a depth rating of 100 m (for the acrylic version). A custom mooring solution was also developed that is made up of a 3D printed cradle (four per FKUW), stainless steel hose clamps, and stainless steel rods. This allows for a marine-grade rope to be threaded through the rods to provide tie points on both sides of the unit.

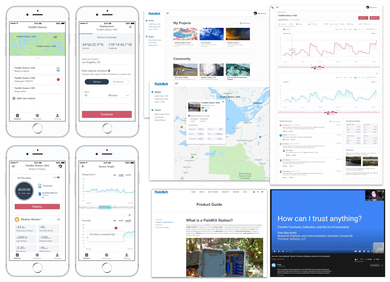
Results

The hardware has undergone five full revisions in refining the design from prototype to product, including a new design for an integrated and isolated water quality circuit (referred to as the Omni Module). The design makes use of the temperature sensor in the BR-100586, but additional temperature sensors can be added to the design using the three additional sensor module bays.

Left: An earlier prototype of the FKUW sonde.
Right: Mooring solution testing before final design.

The mooring solution went through two separate design paths, with both being independently evaluated for robustness, usability, part accessibility, and manufacturability.

Data can be collected via the µSD cards but users can also use the fully developed open source FieldKit product ecosystem, which includes a smartphone application and the online data visualization portal.



FieldKit app and data portal.

Initial test deployments of FKUW are currently being performed by the Smithsonian Tropical Research Institute in Panama.

Scan for FKUW Specs

3D model of the final FKUW configuration with protective PVC shroud around the probes.

Discussion

This design can record the same data as sondes several times its price point with the additional benefit of being completely open source in hardware, firmware, and software, allowing for additional development of other sensing modalities using the platform as needed by anyone.

Each FKUW can also accept up to three additional FieldKit sensor modules for configurations that require additional sensors during deployment. Available modules can be found at FieldKit.org or can be developed by the user through FieldKit's open source module specification.

Conclusion

FieldKit Underwater provides a research-grade submerged sonde solution at a fraction of the cost of other units on the market. Additionally, it can collect data without needing a cabled logger on shore, meaning it can be used in more remote locations for months at a time without the need for shore support. FKUW is the only alternative in this class of instrument that is completely open source, from hardware to firmware, software to the online data portal. Finally, its data retrieval uses the same FieldKit data portal as the rest of the FieldKit ecosystem, making data offloading and use as easy as connecting to the FKUW with the app and browsing the data on portal.fieldkit.org.

Acknowledgements

Gordon and Betty Moore Foundation
Smithsonian Institution

References

[1]Snazelle, T. T. (2017). Evaluation of the Hydrolab HL4 water-quality sonde and sensors (No. 2017-1153). US Geological Survey.
[2]Snazelle, T. T. (2015). Evaluation of Xylem EXO water-quality sondes and sensors. US Department of the Interior, US Geological Survey.
[3]Tillman, E. F. (2017). Evaluation of the Eureka Manta2 Water-Quality Multiprobe Sonde (No. 2017-1118). US Geological Survey.
[4]Groschen, G. E., & King, R. B. (2005). Evaluation of Measurements Collected with Multi-parameter Continuous Water-quality Monitors in Selected Illinois Streams, 2001-03(No. 2005-5060). Geological Survey (US).

GORDON AND BETTY MOORE FOUNDATION

Smithsonian

Scan for FieldKit's GitLab

www.fieldkit.org