Long-term Acoustic Real-Time Sensor for Polar Areas (LARA)

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LONG-TERM GOALS

With ONR/DURIP funding, we are currently developing the Long-term Acoustic Real-Time Sensor for Polar Areas (LARA) which combines the advantages of both submerged and surface acoustic observing systems. LARA makes stationary passive acoustic monitoring efforts more effective, and provides maximum flexibility allowing for a wide range of applications even in ice-covered polar areas.

OBJECTIVES

Most state-of-the-art passive acoustic monitoring systems are designed to stay submerged for the entire deployment period (for a summary see Mellinger *et al.*, 2007). Deep-moored instruments feature a number of advantages. For example, they are not subject to the wear and tear caused by surface waves. However, with archival instruments it is not possible to access data, gain timely information on the presence of acoustic signals of interest (e.g., marine mammal vocalizations or seismic events), or identify system malfunctions prior to instrument recovery. Furthermore, it is not possible to update the system clock by GPS, which might drift significantly during long-term deployments and hinder accurate localization of sound sources when using multiple instruments (e.g., for tracking vocalizing animals) in an array configuration. A few passive acoustic monitoring systems use a surface buoy to overcome some of these disadvantages but cannot be reliably operated in polar areas with potential ice coverage. In addition, surface buoys are exposed to ocean surface waves, which can cause cable strumming (acoustic noise) and potentially be damaged by collisions with vessels or vandalized.

APPROACH

LARA will be deployed on a typical oceanographic mooring (Fig. 1) at a predefined depth (~300 m) to record acoustic signals and detect events of interest for up to one year. LARA's control module will run an ice sensing algorithm (ISA) based on the temperature and salinity profile in the upper 300 m of the water column. This algorithm has been proven to reliably detect sea ice in the Antarctic Ocean (Klatt *et al.*, 2007) and is currently being tested in the Arctic (Olaf Boebel, pers. comm.). LARA's acoustic module operates an on-board acoustic event detector in real-time (e.g., Klinck and Mellinger, 2011). After an event is detected (or at a pre-defined time interval), a command is sent to the winch via hydro-acoustic modem to raise the LARA sensor module to about 15 m depth. During this process the control module is monitoring depth and water temperature/salinity. Based on these measurements, the control module decides whether or not to surface the antenna module to communicate with the shore station via Iridium satellite connection. In case the "no sea ice criterion" is fulfilled, the control module sends a command to the winch to surface the antenna module. To further reduce the risk of damage by ice and other surface activities only the antenna module will be raised to the surface (see Fig. 1); the actual sensor module (containing the archived data) stays about 10 m submerged (note: Kwok and Rothrock (2009) reported a mean Arctic sea ice thickness of 1.89 m for 2008). Several of the components of this sensor (e.g., underwater winch) are already developed and proven technology, and are being used successfully in the field; it is the combination of these components and the real-time transmission of the data that make the platform unique.

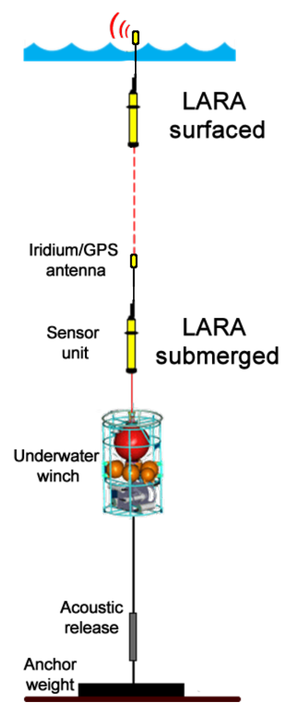

Fig. 1: Schematic of the proposed LARA.

WORK COMPLETED

The development of all major hard- and software components has been completed. Some of the components are shown in Figure 2.

Fig. 2a shows the underwater winch manufactured by NGK, Japan. Fig. 2b shows the Seabird CTD with additional environmental sensors (PAR and Fluorometer). The newly developed Multi-Port Controller (MPC) board is shown in Figure 2c. The MPC - based on a Persistor CF2 - is controlling the PAM systems, CTD and other environmental sensors, and hydro-acoustic modem and Iridium communication interfaces. It also runs the sea ice sensing algorithm. The PAM system (maximum sampling rate: 125 kHz with true 16 bit resolution) consists of 4 identical modules controlled by the MPC board (Fig. 2c). Each module features a 512 GB CF card for acoustic data storage. With file compression (FLAC) enabled, total storage capacity of the system is approximately 4 TB.

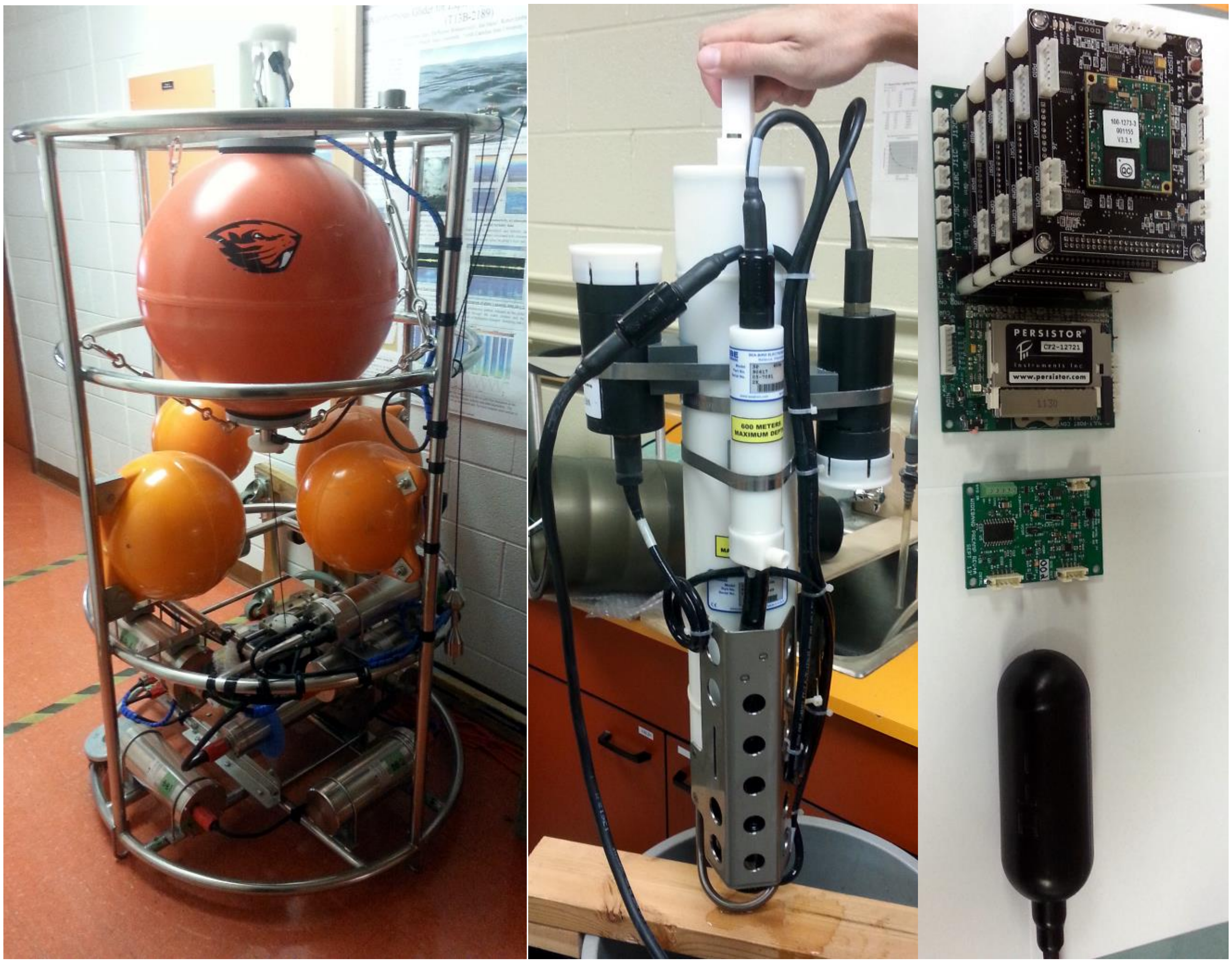

Fig. 2. Left: NGK underwater winch. Middle: Seabird CTD with PAR and Fluorometer sensor. Right: Multi-Port Controller incl. PAM.

We are now working on the system integration. The underwater housing for the sensor unit is currently being manufactured by the Sexton Corporation (Salem, OR) and will be delivered to us by the end of October 2014 (mock-ups are shown in Figure 3a/b).

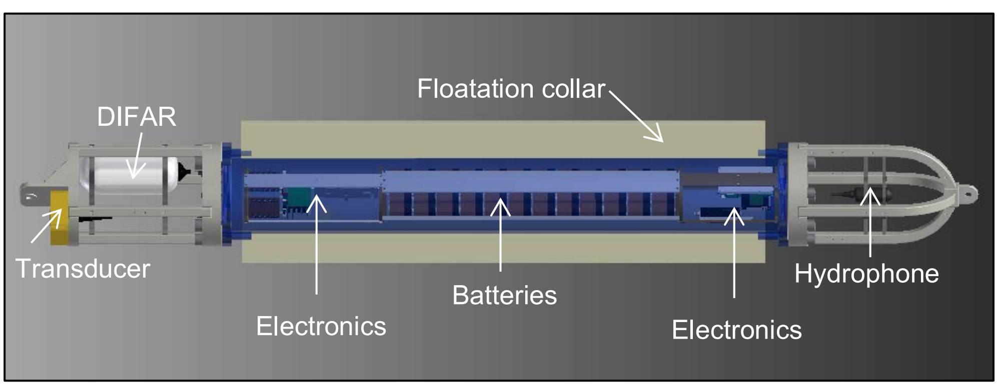

Fig. 3a: Mock-up of the sensor module.

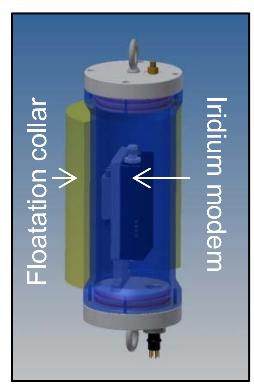

Fig. 3b: Mock-up of the antenna module.

We anticipate having the entire LARA prototype ready for testing in January 2015.

RESULTS

The main accomplishment for FY14 is the completion of the development of all major hard- and software components. The system integration is currently ongoing and expected to be completed in early 2015.

IMPACT/APPLICATIONS

LARA will expand our capability of long-term passive-acoustic real-time monitoring and more importantly allow us to conduct research in ice-covered regions such as the Arctic, a high priority area of DoD. LARA will also function as a test and development platform for new and improved detection algorithms which will potentially be implemented and used on acoustically equipped gliders and floats as well as the Marine Mammal Monitoring on Navy Ranges (M3R) systems at AUTEC and SCORE. In addition LARA technology will be useful for real-time monitoring of deep-ocean seismic and volcanic activity (e.g., Dziak *et al.*, 2012) - especially in areas where SOSUS coverage no longer exists. For example, the LARA system is intended be used to monitor continued and impending magmatic activity at Axial Volcano and the Middle Valley Ridge segment in the northeast Pacific Ocean. Both areas have seafloor volcanic eruptions forecast for the near future, and the LARA moorings will allow us to observe the accuracy of these models in real-time.

TRANSITIONS

Not applicable.

RELATED PROJECTS

None.

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PUBLICATIONS

None.

PATENTS

None.

HONORS/AWARDS/PRIZES

None.