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 (Figure 1) at a predefined depth (max. 300 m) to record acoustic signals and detect events of interest for up to one year duration. 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). 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 (Figure 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.

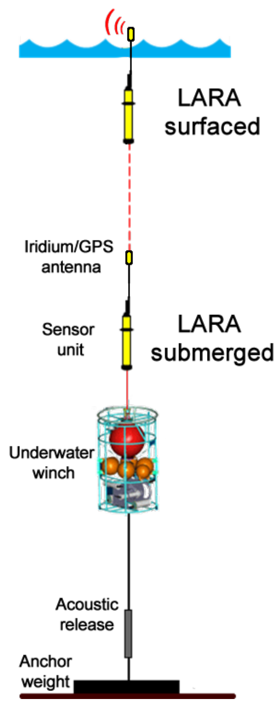

Fig. 1: Schematic of the proposed LARA.

WORK COMPLETED

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

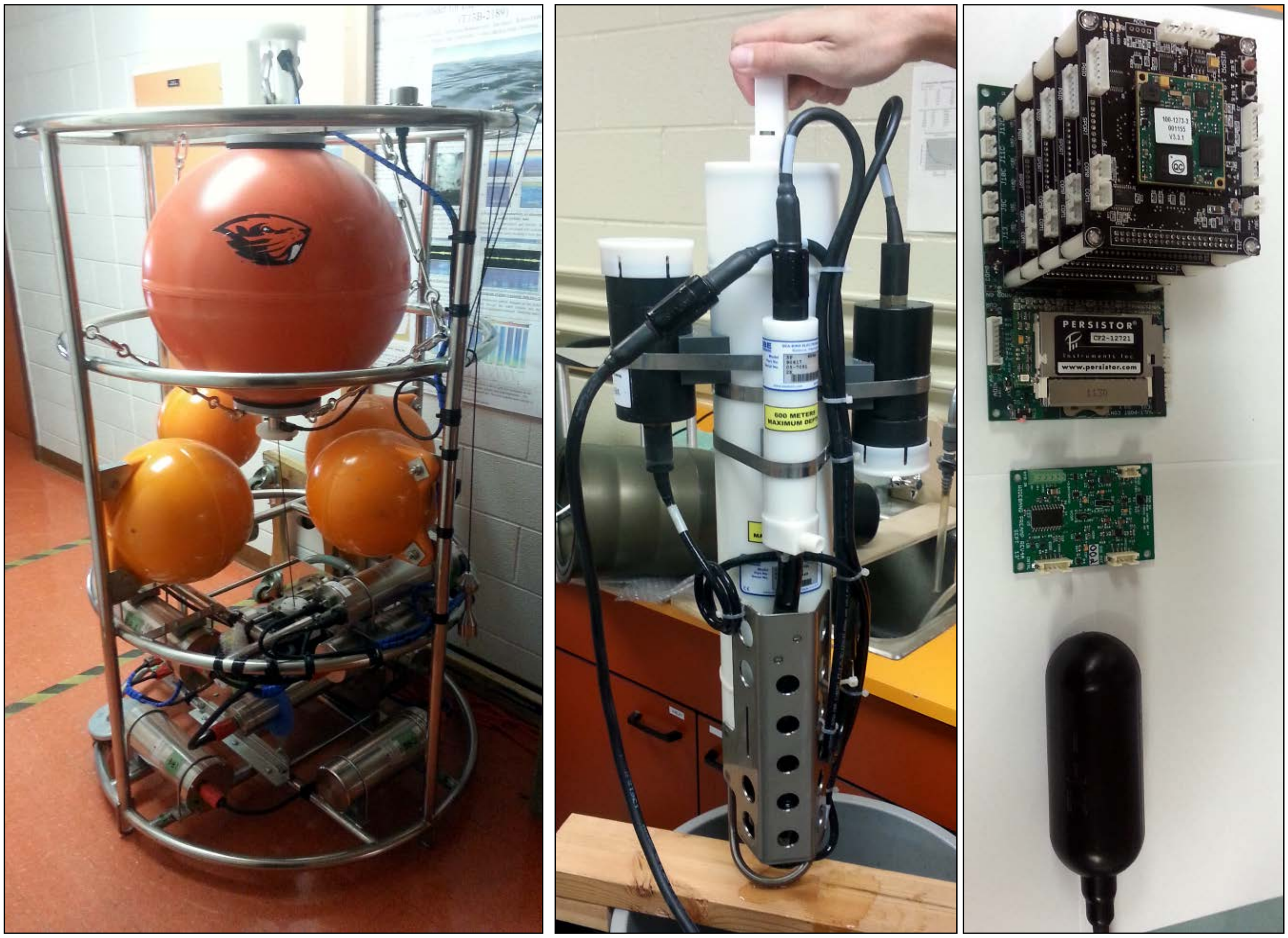

Fig. 2. a) NGK underwater winch; b) Seabird CTD with PAR and fluorometer sensor; c) multi-port controller including PAM.

Figure 2a shows the underwater winch manufactured by NGK, Japan. Figure 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 (Figure 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.

RESULTS

The underwater housing for the sensor unit has been manufactured by the Sexton Corporation (Salem, OR) and was delivered to us in early 2015 (Figures 3).

Figure 3: LARA sensor unit and antenna (spar buoy).

After implementation of all electronic components, initial testing was conducted in the lab. Several issues were identified which need to be addressed prior to actual field trials. Modelling revealed that the sensor unit is too heavy for reliable operation in heavy seas. While the winch is capable of raising/lowering the weight of the unit in calm seas, there is concern that in high seas additional forces caused by wave motions and currents could exceed the load limits of the winch or the winch cable. Therefore the decision was made to reduce the weight of the sensor unit by reducing the diameter and wall thickness of the aluminum pressure housing. To further reduce weight and complexity of the system, the DIFAR sensor will not be implemented for initial field testing. The modifications are currently ongoing and should be completed by spring 2016. Hard- and software components are functional and ready to be implemented into the new housing.

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

ONR project “Field testing and performance evaluation of the Long-term Acoustic Real-Time Sensor for Polar Areas (LARA)”, Award Number: **N00014-15-1-2240**. This award is providing funding to evaluate the performance of LARA of the Newport, OR coast (summer 2016) and in the Arctic (summer 2017 - summer 2018).

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PUBLICATIONS

None.

PATENTS

None.

HONORS/AWARDS/PRIZES

None.