LIVING MARINE RESOURCES PROJECT 12

Integrated Real-time Autonomous Passive Acoustic Monitoring System

THE NEED

The Navy is responsible for compliance with a suite of Federal environmental laws and regulations that apply to marine mammals and other marine protected species, including the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). As part of the regulatory compliance process associated with these Acts, the Navy is responsible for implementing a marine species monitoring program to assess potential impacts from Fleet and Systems Command (SYSCOM) military readiness activities involving active sonar and underwater detonations from explosives and explosive munitions. Passive Acoustic Monitoring (PAM) is a proven means of detecting and classifying vocally active marine mammals, as well as a number of fish species through underwater microphones known as hydrophones. These sensors can be moored, drifting, towed or mounted on unmanned mobile platforms. Most passive acoustic monitoring utilizes single hydrophones, often in a fixed bottom-mounted sensor configuration which limits the range of detection coverage.

THE SOLUTION

Over the past five years, under two separate Office of Naval Research (ONR) contracts, Ocean Acoustical Services and Instrumentation Systems, Inc. (OASIS) has developed autonomous passive acoustic systems for underwater surveillance purposes using multiple hydrophones and Autonomous Undersea Vehicles (AUV). This project is leveraging the technology and hardware developed for these projects to develop a system for PAM.

THE METHODOLOGY

This technology utilizes the new acoustic sensor and digital signal processing (DSP) technology developed by OASIS for ONR, as well as existing vehicle hardware developed and maintained by the Woods Hole Oceanographic Institution. The sensor and DSP technology has previously been demonstrated using Slocum 200 and G2 gliders as its AUV, and was able to provide near real-time detection of humpback whales.

For this project, the team is utilizing a self-propelled AUV known as the REMUS, which has previously been used for underwater mapping and mine detection. The REMUS AUV offers several advantages over a non-self-propelled glider such as the Slocum glider. The REMUS AUV can travel faster, covering five to ten times as much survey area, and it possesses the power and speed to properly support the sensor and DSP.

The Integrated, Real-time Autonomous PAM (IRAP) system will consist of a REMUS AUV, integrated with the OASIS low- to mid-frequency (LF/MF) towed sensor and a hull-mounted High Frequency (HF) sensor. Both systems will include onboard DSPs for the autonomous detection, classification, localization, and tracking (DCLT) of vocalizations from lower frequency baleen whales and higher frequency beaked whales. DCLT contact reports will be transmitted in near real-time from the vehicle payload when surfaced, to a shore-side command and control facility via satellite. Key to the system is the autonomous processing of raw acoustic data performed by custom software hosted on an embedded, commercial-off-the-shelf computer known as the Versalogic Ocelot.

THE SCHEDULE

The objective of this project is to integrate and demonstrate the proposed technology over the course of three years. In the first year, the focus will be on the integration of the LF/MF sensor and the humpback whale classifier (one of the marine mammal-specific classifiers previously developed and demonstrated under ONR sponsorship) into the existing REMUS AUV payload. Concurrent with

this year 1 effort, OASIS will complete data analyses for the 2013 OASIS HF sensor/G2 sea trials at the Navy's Atlantic Undersea Test and Evaluation Center (AUTEC).

In the second year, the integrated LF/MF/HF system will be demonstrated during an operational test as part of a regularly scheduled National Oceanic and Atmospheric Administration marine mammal survey along the U.S. eastern coastline. Also during year 2, the OASIS beaked whale classifier will be integrated into the HF sensor's DSP.

In year 3, the beaked whale classifier and OASIS IRAP sensors will be integrated into the REMUS AUV payload and the full IRAP system will be tested in conjunction with a full-scale U.S. Navy Fleet test.

NAVY BENEFITS

This system will enhance the Navy's ability to reliably detect the presence of vocalizing marine mammals in near real-time. The autonomous system will be able to track low-frequency baleen and high-frequency beaked whales in U.S. Navy training areas. The use of an onboard processor for autonomous DCLT of vocalizing marine mammals operates in any weather and during nighttime conditions where visual observation is not supported. Detection events may be reported via satellite or radio frequency communications from the AUV to land or to nearby marine mammal observers on ships.

This broadband frequency system and mobile platform will improve detection coverage over a much wider area, making possible to monitor a larger study area at a reduced cost. Successful demonstration of autonomous DCLT for humpback and beaked whales will provide the basis for future system enhancements such as the ability to autonomously classify other marine mammal species sounds.

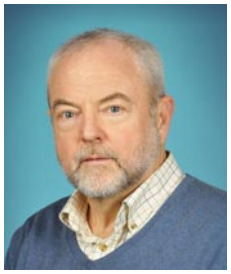
TRANSITION

Complete descriptions of the tests, along with the results of the testing and data analysis required to support the sensor performance metrics, will be included in a final report. This report will also lay the initial groundwork for the transition of the IRAP system into the Navy's marine species monitoring program where training manuals, interface control documents and configuration management systems will be necessary.

The REMUS AUV LF/MF sensor system is being used by the Naval Sea Systems Command (NAVSEA) for a User Operational Evaluation System (UOES) program and the success of the proposed effort could eventually transition to the Navy via this program.

ABOUT THE PRINCIPAL INVESTIGATORS

Principal Investigator: Philip Abbot is president of OASIS, a small business corporation providing consulting, research and design in ocean acoustics and related sciences. He holds a patent for methods and systems developed in connection with his ONR-sponsored work with AUVs. Mr. Abbot holds a master's degree in Ocean Engineering from the Massachusetts Institute of Technology.



Co-Principal Investigator: Vince Premus is a Senior Scientist at OASIS responsible for Signal Processing Development and Systems Integration for AUV-based applications. Dr. Premus holds a Ph.D. in Electrical Engineering from Duke University.

About the LMR Program

The Living Marine Resources (LMR) program seeks to develop, demonstrate, and assess data and technology solutions to protect living marine resources by minimizing the environmental risks of Navy at-sea training and testing activities while preserving core Navy readiness capabilities. For more information, contact the LMR program manager at exwc_lmr_program@navy.mil or visit www.lmr.navy.mil.