Low Cost Whale Detection and Monitoring with Optics

Advanced Coherent Technologies, LLC
4022 Liggett Dr.
San Diego, CA, 92106

Mr. Jon Schoonmaker
Phone: (619) 838-1218
Fax: (858) 551-0257
Email: jon.schoonmaker@advanced-coherent.com
Website: www.advanced-coherent.com

Command: NAVAIR
Topic: N07-019

PROBLEM STATEMENT

Current Anti-submarine warfare (ASW) training exercises are often limited by the presence of marine mammals on the ASW training ranges. The Small Business Innovation Research (SBIR) solicitation suggests the development of a radar system and associated algorithms to detect breaching whales in various sea states and generally assist in the Marine Species Mitigation (MSM) problem as required by the Marine Mammal Protection Act. The detection would then be handed off to an electro-optical (EO) system for verification, classification, and possible identification. The EO system, once queued, must be able to reacquire the animal for verification and classification. This suggests the employment of an EO system that would not only be used as a verification/classification system but would also be used to detect non breaching submerged marine mammals in low sea states as well as breaching animals in high sea states.

Current Naval EO imaging systems are designed for very general applications utilizing three-color video technology. While producing real-time images with subsequent situational awareness, the systems are not designed for automated target recognition. The inability of current EO imaging systems to exploit narrowband spectral or polarization information present in the light reflected from the target limits the ability to visualize the target when submerged or in high-sea conditions.

The narrowband spectral and polarization information also needs to be interpreted by a system specifically designed for this application capable of producing mission-relevant data products in a timely manner. This exploitation will result in significant reduction of false alarms and an increase in probability of marine mammal detection in maritime

operations. The EO system can operate on a ship, airplane, or unmanned aerial vehicle (UAV).

WHO CAN BENEFIT?

This project is specifically oriented toward the Program Management Activity (PMA)-264 Whale Search Radar. By reducing the number of false positive and false negative whale sightings, more efficient use of ASW training time can occur. The capability of collecting and analyzing multispectral and polarized light images will have value for larger integrated EO systems as well as for low cost and low volume alternatives for small platforms. Our system's flexibility and cost would make it useful in any military operation requiring a small UAV-capable imaging system. With a size comparable to a standard video system, but with a much greater detection capability, it can be used in a variety of applications such as counter terrorism (camp as well as Improvised Explosive Device (IED) detection), local search and rescue, and law enforcement. The targeted platform in this general application is the new Navy Small Tactical Unmanned Aircraft System (STUAS).

Relevant prime contractors would include those developing imaging systems as well as those developing UAV EO payloads.

BASELINE TECHNOLOGY

Navy ships are required to have at least one (1) dedicated "lookout" person with binoculars solely for the purpose of looking for marine mammals in ASW training areas. They refer to this as their 'gold standard'.

The current method of marine mammal detection relies on the ability of a person to 'catch' a view of an animal as they survey the area. This requires the person to be alert and diligent for an extended period of time surveying a vast amount of ocean surface. Also, as the lookout is relying on views illuminated by visible light, they may miss non-breaching animals in shallow water or breaching animals in high seas.

TECHNOLOGY DESCRIPTION

The key advantage to what Advanced Coherent Technologies (ACT) is offering is the ability to collect multispectral and polarization filtered images at a relatively modest cost within a small-sized EO system. Our development focus is to ensure that the system's end cost is within reach of non-Department of Defense (DoD) end users. We recognize that the current utility of this type of technology resides not in especially high quality imagery, but rather in the ability to produce real-time usable data products from the imagery collected. If the cost is low enough to allow university and community access, the sheer number of end users provides an immediate market for data products. We

believe that our system will allow enhanced surveillance at affordable costs. The sensor head itself will weigh less than 7.5 pounds, be compatible in volume with all STUAS candidates, and consume less than 40 watts.

The following table shows advantages of ACT's Multi-Channel Imager (MCI) EO over standard video.

Items are ranked from 1 to 10 with 10 being the most capable

Item/Mission	ACT's MCI	Standard Video	Other Spectral Systems under development
Marine Mammal Monitoring	9	6	9
Non-Acoustic ASW	5	1	6
Mine Countermeasures	5	1	6
Situational (battlefield) Awareness	9	8	9
Special Operations	9	5	0
Cost	6	9	1
Size	8	8	1

The following table displays the Technology Development Milestones along with Technical Readiness Level (TRL), Risk, Measure of Success and TRL Date.

Technology Development Milestones (SBIR/STTR)

Milestone	TRL	Risk	Measure of Success	TRL Date
Prototype Sensor Head Complete	6	Low	Successful flight test	October 2009
Prototype Field-programmable Gate Array (FPGA) Processor Complete	4	Moderate	Integration with sensor head	February 2010
Complete System flight demo	4	Moderate	Real-time detection and tracking of marine mammals	March 2010
Ruggedized system flight demo	6	Moderate	Airborne real-time detection and tracking of marine mammals	August 2010
Delivered system integrated onto NAVAIR aircraft	6	Moderate	Functional Marine Mammal detection and tracking system	October 2010

CURRENT STATE OF DEVELOPMENT

This project seeks to develop a low cost, low volume, multi-channel imaging system while answering fundamental questions about the channel content needed for Naval EO systems. Channel content is driven by the specific mission and will include choice of field of views, narrowband filter band and bandwidths, multispectral sensitivity, and even camera selection (for number of pixels and bit depths). The system control should have the ability to cope with a wide variety of content choices as well as produce useful data products in real time.

At the culmination of this project we expect to have answered these types of fundamental questions and to have developed a system that is marketable both directly as a multi-channel EO system for military applications and as a research tool to determine specifications for higher-end EO systems.

The system used in the channel content investigation and expected as a final product is a four aperture, four-camera system with each camera/aperture containing a spectral filter and or a polarization analyzer. The channel content is a function of the type of target and the expected background in which the target may be residing. Whether this is a submarine in coastal waters or a camouflaged terrorist camp in jungle canopy, channel content will be chosen to maximize detection capability. In addition to the sensor itself a real-time data product must be available to the user to make the system useful.

This system should have a reasonable capability to detect marine mammals directly from small airborne or shipborne platforms. It will have additional military utility in battlefield awareness, mine countermeasures, and possibly IED detection or other counter insurgency missions.

REFERENCES

ACT's MCI sensor system has been exercised by various organizations in a number of applications. Points of Contact are listed in the following table.

Organization	Program	POC Phone
ONR	ROR program	850 234-4998
NAVAIR 4.5x	R2D2	301 342-0093
Radiance Technologies	JWATH	251 445-0045
Canadian DRDC	Marine Mammal Detection	418 844-4000 x4313
PMA 264 Air ASW	Polarization in ASW	301 342-2022

ABOUT THE COMPANY

Advanced Coherent Technologies, LLC (ACT) was formed in 2006 to focus on the development and utilization of low cost multichannel imaging systems. Its founders have decades of experience in non-acoustic ASW, hydrologic optics, electrical engineering, and physical oceanography both within the government at SPAWAR and ONR and in private industry. This unique experience has given ACT the capability to produce a reasonably low cost ASW tool. It has also allowed ACT to realize the need for such a system that would be affordable to local communities for other applications such as disaster relief and search and rescue and to universities to conduct research necessary to fully exploit the capabilities of multi channel imaging technology.