Engineers develop low-cost, highly sensitive underwater listening device

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Ocean-going acoustic sensor array to aid in national security, ocean research efforts

Jason Holmes, a mechanical engineering graduate student at Boston University and guest researcher at Woods Hole Oceanographic Institute, has devised a low-cost, highly sensitive array of underwater ears that is perking up interest in both homeland security and ocean research circles. Holmes' device -- an underwater hydrophone array designed to be towed by a small, autonomous submarine -- can monitor for ocean-going threats to America's waterways or for sound for ocean acoustics studies.

Holmes will present research on his underwater listening device in Vancouver on May 20 at the semi-annual meeting of the Acoustical Society of America.

The array combines sophisticated engineering with off-the-shelf hardware to create a relatively inexpensive but highly sensitive underwater listening device. The prototype comprises six underwater microphones, or hydrophones, spaced inside a 30-foot plastic tube filled with mineral oil. The array tube is filled with mineral oil to create neutral buoyancy, allowing the array to float behind the underwater towing vehicle.

Signals from the hydrophones are captured and stored on mini-disc recorders aboard the unpiloted submarine, which is called Remus. Designed by Woods Hole Oceanographic Institution, Remus looks like a

small torpedo and can navigate autonomously underwater around obstacles and through harbors using GPS sensors, sonar, and electronic maps.

Listening arrays typically used by the military and ocean scientists are towed behind ships and are very long, the shortest being around 1,500 feet long, and are several inches in diameter. At 30 feet in length and 1.1 inches in diameter, the extremely compact prototype can easily be towed through the water by a small, quiet, battery-powered craft. The compact size of the towing sub and array make it easy for one or two people to launch the system, compared to the fully crewed ships required for conventional hydrophone systems.

Holmes originally developed the array to help him study how sound waves travel through shallow water, where sound is refracted by the bottom. Until recently, most acoustic ocean studies have been conducted in deep water, where the bottom has little effect on sound. Holmes constructed the hydrophone system to tackle the problem of how sound waves behave in shallow water, but the U.S. Navy saw the device as a potential security tool, one that is vastly less expensive than the multi-million dollar listening arrays currently in use. Parts for Holmes' array cost a mere $4,000 and are available as off-the-shelf technology.

Holmes is now working with the military to further develop the array for underwater intelligence gathering. Holmes says his next project will comprise four underwater hydrophone arrays towed by a fleet of unpiloted subs that could travel up to 4 kilometers per trip. Holmes and his faculty advisor William Carey, a professor of aerospace and mechanical engineering in BU's College of Engineering, say they envision a fleet of entirely autonomous listening subs will prowl the seas, returning to underwater recharging stations to upload their data and refresh their batteries.

"A lot of people were skeptical this would even work," Carey says. "But the way Jason has designed this array, this will change the way ocean measurements are made."

Source: Boston University