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Plumbing the Depths: Unmanned Submersibles Come of Age

Unmanned underwater vehicles (UUV) have been slow to attract attention in military circles — until now, that is. Today, Jon Rosamond looks at the technological advances that are enabling the development of unmanned submersibles and which countries are leading the way.

By Jon Rosamond for ISN

Two high-profile events from the past three years have served to highlight the growing importance of the unmanned underwater vehicle (UUV) in naval operations. The first incident saw the Royal Navy minehunter HMS Brocklesby, operating off Libya in May 2011 as part of the NATO mission to enforce UN Security Council resolutions, deploy a SeaFox UUV to destroy a buoyant mine laid by pro-Gaddafi forces outside Misrata harbour. Packed with 100kg of explosives, the mine was one of three placed by Gaddafi loyalists seeking to halt the flow of humanitarian aid into the port.

Subsequently, in August 2012, the US Navy sent dozens of SeaFox UUVs to the Persian Gulf after the Iranian government threatened to use its arsenal of Soviet-era mines to blockade the Strait of Hormuz, a move that would have effectively shut down a major proportion of the world's oil supplies. Both events validated the efforts that are being made by Western navies to reshape their post-Cold War mine countermeasures (MCM) capabilities. Instead of placing bespoke timber- or GRP-hulled minesweepers and ordnance disposal divers in harm's way, navies are taking advantage of developing technology to 'keep the man out of the minefield' by allowing unmanned platforms – on the surface as well as underwater – to perform critical tasks.

Naval hydrographic and oceanographic units are using UUVs equipped with a wide array of sensors to chart the seabed and/or determine the characteristics of a given body of water, providing essential data for planning submarine and amphibious operations. Unmanned submersibles are also employed on search-and-rescue and intelligence, surveillance and reconnaissance missions. Meanwhile, trials have commenced in the US that will result in the introduction of a new class of deep-diving UUV designed to stalk hostile submarines. The development of a time-critical strike capability is a real possibility too.

ROV, AUV and...

There are two broad categories of UUV: the remotely operated vehicle (ROV) and the autonomous underwater vehicle (AUV). The first is tethered to the host vessel and controlled continuously by a human operator, while the second is programmed to swim to one or more waypoints and operate independently for a predetermined period of time. Both types are routinely equipped with payloads that include sonars, cameras, environmental sensors, manipulator arms and (in the case of MCM assets) some form of mine-destruction device.

German company Atlas Elektronik, however, describes its ubiquitous SeaFox ROV as a 'semi-autonomous' vehicle. Although it is controlled via an optical fiber cable from the host ship, SeaFox can use its sonar to automatically relocate the previously acquired positions of mines or mine-like objects. These objects are identified using the onboard CCTV camera and, if necessary, destroyed by the one-shot mine neutralization system (a large caliber shaped charge).

At the Association for Unmanned Vehicle Systems International (AUVSI) 2013 exhibition in Washington, DC, Thales UK released details of an innovative military/commercial technology demonstrator for MCM operations using a Saab Seaeye ROV fitted with a Hydra multi-shot mine neutralization system. The ROV is deployed from an optionally-manned 11m boat; demonstration trials for the Royal Navy were scheduled for October.

Containerized solutions are becoming increasingly popular with navies. In 2012, for example, the Royal Danish Navy achieved full operational capability of a modular, containerized MCM capability featuring Saab Double Eagle ROVs equipped with mine destructor charges.

Meanwhile, the Royal Canadian Navy recently acquired eight SeaBotix vLBV950 ROVs to survey ships' bottoms and conduct deep water tasks such as locating lost aircraft and retrieving their 'black box' data recorders. These ROVs may also be used to retrieve objects jettisoned by pirates or smugglers, as well as in MCM roles.

Enter Knifefish

As far as autonomous types are concerned, General Dynamics Advanced Information Systems announced in August that it had successfully completed a comprehensive risk reduction phase for what is arguably the world's most high-profile UUV program: the US Navy’s Knifefish venture. Based on Bluefin Robotics' Bluefin-21 vehicle, the Knifefish AUV is scheduled to enter service as part of the Littoral Combat Ships' MCM mission package from 2017. Knifefish is GPS-guided and can operate with full autonomy for about 16 hours in total. Each vehicle is about 20ft (6m) in length, weighs about 3,000lb (1,360 kg) and can run at 6kt, carrying a novel Low Frequency Broadband sonar designed to detect and identify mines in highly-cluttered sea floor environments.

The high-fidelity sonar was tested during the risk reduction phase along with Knifefish's ultra-high density data storage/recording system, propulsion system (with the emphasis on noise reduction) and software interfaces.

Although Knifefish is probably the world's largest UUV development program, US-based manufacturer Hydroid (now owned by Norwegian company Kongsberg) is the global market leader, having supplied more than 200 AUVs to 13 navies. In February, Hydroid announced that its contract to provide Littoral Battlespace Sensing (LBS) AUVs to the US Navy's Space and Naval Warfare Systems Command (SPAWAR) had moved into full rate production. SPAWAR ordered three LBS AUVs – a variant of Hydroid's heavyweight Remus 600 AUV – for oceanographic and meteorological data-gathering duties.

In June 2012, the company said that Japan's Ministry of Defence had purchased a single Remus 600 system for MCM missions and also to investigate and map the sea floor dispersion of contaminants following the previous year's magnitude 9.0 earthquake and tsunami. Also in 2012, Germany's Federal Office of Defence Technology & Procurement ordered six of the smaller (man portable) Remus 100 AUVs to enhance the Deutsche Marine’s MCM capabilities in very shallow waters, while the Royal

Norwegian Navy acquired four additional Remus 100 systems for MCM tasks.

Works in Progress

The technical challenges involved in developing UUVs for naval service are numerous, particularly in relation to speed and endurance, geospatial accuracy, sensor performance and data transfer. The small size of many vehicles, particularly the man-portable types, puts severe limits on the space available for batteries, propulsion and guidance systems, sonars and other sensors.

One solution to the problem of limited endurance is the underwater glider, which uses wings and small changes in buoyancy to convert vertical motion to horizontal, allowing it to travel thousands of kilometers (in a sawtooth-like pattern) over many months. Kongsberg unveiled its Seaglider model at AUVSI 2013 and will begin full production in December. Developed initially by the University of Washington with funding from the US Navy, Seaglider is designed for missions lasting up to 10 months. Heading, depth and altitude sensors allow the vehicle to navigate while submerged but it also surfaces frequently to fix its position by GPS.

The problems of data transfer are more intractable. Radio waves do not travel happily through salt water, making communication with a submerged AUV (lacking an umbilical link to the host vessel) extremely difficult. The need to come to the surface, or at least raise an antenna above the water, in order to transmit or receive data increases the risk of detection by hostile forces. With real time communication not an option, data is normally uploaded by personnel onboard the host vessel after the AUV has been retrieved from the water.

Looking to the future, one cutting edge initiative is the Deep Sea Operations (DSOP) technology and system development program run by the US Defense Advanced Research Projects Agency (DARPA), which is intended to create a deep-diving AUV able to operate at depths of 6,000m and covertly trail submarines operating overhead.

Bluefin Robotics completed six days of deep-water testing of one of its DSOP vehicles in April, including two 4,450m dives lasting 11 hours. Further tests will focus on sonar system integration while a second vehicle is produced to demonstrate networked operations. Effective power and noise management will be crucial if the required levels of endurance and silence are to be achieved.

While UUVs have been slow to gain traction in military service compared to unmanned air vehicles, the functionality and reliability of modern ROVs and AUVs mean they are now more than capable of taking on a wide variety of naval tasks that were traditionally regarded as 'dull, dirty or dangerous'. The fact that de-mining, hydrographic survey and other vital missions can now be completed in a fraction of the time that was previously required, and at a fraction of the cost, suggests that prospects for the naval UUV are bright indeed.

For additional reading on this topic please see:
Unmanned Systems in Overseas Contingency Operations Seminar
The Future of Hard Power: Tools and Techniques
Decisions Deferred: Balancing Risks for Today and Tomorrow

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