Low-Cost UUVs for Military Applications

Is the Technology Ready? A Review of Military Missions Where Lower Cost UUVs Are Being Considered

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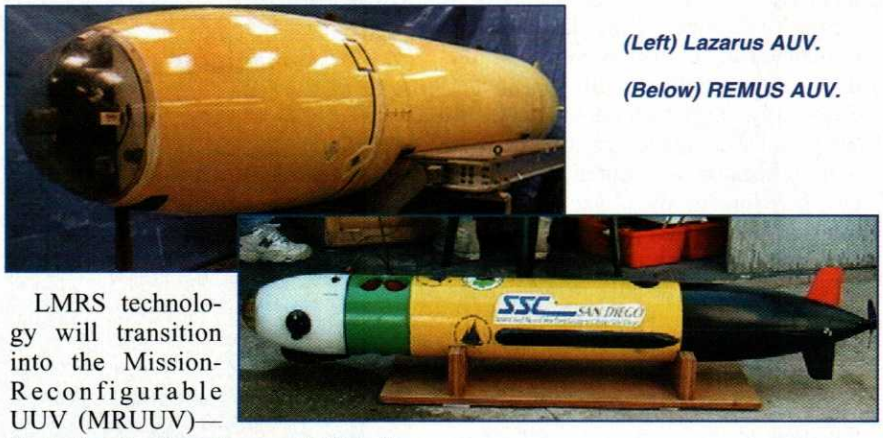
After major support in the early years of development of the unmanned undersea vehicle (UUV), military support for technology declined just as commercial interest picked up. Today, large commercial UUVs are employed in offshore oil fields and pipeline route surveys. In addition, the academic community is pushing the technology related to small, low-cost vehicles. Enhanced by the high rate of commercial implementation of UUVs, the military has renewed interest in the leverage provided by UUVs. Submarines, surface ships and small inflatable craft are approaching operational status as platforms for UUVs. Although the initial UUVs used by the Navy are large, relatively high-cost vehicles, an exciting trend is toward smaller, low-cost UUVs that can work together to complete assigned missions.

Ongoing Programs

Although early Navy UUV developments were for underwater search, the initial mission now is for mine hunting (from submarines)—fleet introduction of remotely operated vehicles (ROVs) had the same initial mission except they were operated from surface ships. The submarine-launched AN/BLQ-11 Long-Term Mine Reconnaissance System (LMRS), a torpedo-sized UUV, is scheduled for operation in 2003. Because the LMRS has a high price tag, the number of units to be built will likely be less than desired.



(Left) Lazarus AUV.

(Below) REMUS AUV.

LMRS technology will transition into the Mission-Reconfigurable UUV (MRUUV)—21-inches in diameter and 240-inches long—that will also be tube-launched using the shipboard LMRS architecture. The MRUUV, which will address the first three (of four) signature capabilities of the new UUV Master Plan, will be considered more of a "truck" on which payloads can be interchanged to suit the tactical mission.

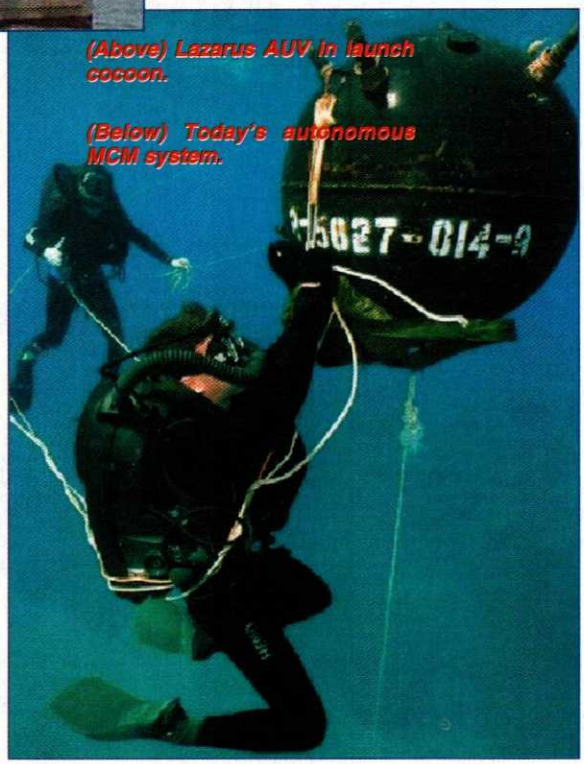
In search and survey, the Naval Oceanographic Office (NAVOCEANO) has ongoing work. NAVOCEANO entered the UUV arena in 1997 with the transfer of UUVs developed by Draper Laboratories for the U.S. Navy. The equipment was modified to create the Lazarus vehicle. In addition, two of the three *Seahorse*-class UUVs have been delivered to NAVOCEANO by Pennsylvania State University. The 28-foot long, 38-inch diameter *Seahorse* vehicles are operated from the USNS *Heezen* (T-AGS 64) for underwater survey and bottom mapping. One of the UUVs will be used for a launch demonstration from an SSGN in January 2003. In addition, Woods Hole Oceanographic Institution (WHOI) has developed a full-ocean-depth, Semi-Autonomous Mapping System (SAMS) for NAVOCEANO. The SAMS UUV, which is based on the REMUS UUV, will use acoustic communications for image transmission and position information. Another REMUS-based vehicle was developed for the U.S. Special Operations Command (USSOCOM).

New Philosophy

A recent Navy study of the broader scope of UUV mission applications was completed (April 2000) by an assistant secretary of the Navy and a research, development and acquisition-charted study team. The study, which looks ahead 50 years, provides a roadmap for the Navy to use in integrating UUVs into the future battlespace. Critical missions identified include: intelligence, surveillance and reconnaissance; mine countermeasures; tactical oceanography; communications; navigation; and antisubmarine warfare.

The Navy UUV Master Plan, which incorporates near-term acquisition efforts, such as the LMRS, establishes

ed using multiple, inexpensive, small vehicles rather than fewer large and expensive UUVs. The goal is to develop a standard interface design for smaller UUVs that would eventually be in the six to 12-inch diameter range.



(Above) Lazarus AUV in launch cocoon.

(Below) Today's autonomous MCM system.

a base for long-term development and technology investment.

Previously, much of the undersea vehicle technology was developed in Navy laboratories and transitioned to industry. For example, the SPAWAR Systems Center San Diego (SSC SD)—formerly the Naval Ocean Systems Center—spearheaded the development of manned and unmanned systems with over 30 vehicles built in-house. Eventually, such technology made its way to the academic community where, because of limited funds, the cost was forced down. One interesting aspect of the Navy's new requirement for smaller vehicles is that much of the technology now resides in academia. Now, the institutions that have learned to build small, low-cost, easily handled, reliable UUVs are the ones in the driver's seat. The Navy has not ignored this area; to the contrary, the Office of Naval Research (ONR) has been funding such technology for some time. What has been missing is an acknowledgement that the technology is here, as well as a commitment to accept the technology of the smaller low-cost vehicles and begin adapting it for Navy tactical missions.

ONR Takes the Challenge

One of the most significant recommendations in the UUV Master Plan is that many missions could be completed using multiple, inexpensive, small vehicles rather than fewer large and expensive UUVs. The goal is to develop a standard interface design for smaller UUVs that would eventually be in the six to 12-inch diameter range. This is a major step away from the earlier Navy thrusts into large, deep-ocean UUVs (i.e., Lazarus and tactical submarine-launched, 21-inch diameter UUVs). However, the present thrust within the mainstream Navy remains with the larger submarine-launched UUVs, such as the LMRS and MRUUV.

ONR is one Navy office embracing the UUV Master Plan's philosophy. ONR worked with the UUV Master Plan team when the report was being completed and became proactive in incorporating its recommendations. This small-vehicle thrust, which had been resident in ONR in various forms, has now been focused into a cohesive assault on the problem. ONR dropped the gauntlet with a broad area announcement (BAA) in 2001, which dedicated many millions of dollars to the UUV effort.

ONR capabilities and related technologies have been identified through the Future Naval Capabilities (FNC) process. The autonomous operations (AO) FNC addresses critical autonomous operations gaps in the ability of naval forces to conduct successful military campaigns. AO FNC's vision is to enhance the mission capability of naval forces by developing technologies that will dramatically increase the performance and affordability of organic UUV systems. The goal of the AO FNC is to provide technologies that can eliminate manned operations in hostile environments.

This process will address the capability of submarines, surface ships and other naval forces to perform missions with UUVs that will clandestinely expand their sphere of influence while reducing potential vulnerability in the littorals. The ONR technology demonstrations are also in alignment with the four basic signature capabilities of the UUV Master Plan, which provide an outline for the development of the underlying technologies required to implement these

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signature capabilities for littoral operations. The signature capabilities include:

- Maritime reconnaissance (MR) centers on the intelligence, surveillance and reconnaissance (ISR) functions; target designation; launch and coordination of UUVs for battle damage assessment and intelligence collection.
- Undersea search and survey (USS) capability enables rapid survey of areas through the use of networks of small UUVs; performing functions such as mine hunting/neutralization, underwater object location and recovery; and hydrographic/bathymetric surveys.
- Communication/navigation aid (C/NA) capability provides a communication/navigation relay for other underwater vehicles operating within the immediate area, and is expected to serve as a gateway for an autonomous underwater communication/navigation network.
- Submarine track and trail (ST&T) provides a mobile cueing function, but could grow into a fully autonomous system offering multiple levels of engagement.

ONR, working in conjunction with the AO FNC to demonstrate each of the four key signature capabilities from the Navy's Master Plan, has awarded contracts for UUV demonstrations of undersea, autonomous operation capabilities in MR, USS and C/NA. The ST&T mission will not begin until approximately 2006. The ONR contracts for UUV R&D efforts are a great start and hopefully more will be forthcoming.

Close Enough

"Close enough for government work" is an old adage being taken to heart by two Navy commands. USSOCOM, in a joint program with ONR, is evaluating the 7.5-inch diameter Semi-Autonomous Hydrographic Reconnaissance Vehicle (SAHRV). The vehicle is being used to demonstrate that the technology is sufficiently advanced for reconnaissance in littoral waters, from the seaward edge of the surf zone out to a depth of 100 meters. The goal is to achieve an initial operational capability within four years. Based on the REMUS vehicle, the system will be small, inexpensive, meet the operational requirements and be operable by a two-person crew. SAHRV will be the first system of its type employed in military operations.

Explosive Ordnance Disposal (EOD) Mine Countermeasures (MCM) Detachment divers are also evaluating small UUVs for very shallow water (VSW) operations. One of the EOD MCM team's future goals being supported by ONR is the Chemical Sensing in the Marine Environment Program (CSME).

The CSME program targets the development of novel means to detect and locate unexploded ordnance (UXO) in marine environments, and to detect, characterize and quantify

explosives and their derivatives in seawater and marine sediments.

Hydrodynamic field tests, conducted at SSC SD using a specially configured REMUS vehicle, have shown positive results, providing data for the development of detailed models capable of forward and reverse tracking of UXO plumes.

Key Technologies

Recent demonstrations of UUVs at events such as NAVOCEANO's AUV Fest and military exercises such as Kernel Blitz held at Camp Pendleton have proven that significant accomplishments can be achieved with commercial off-the-shelf (COTS) technology. But COTS technology can be taken further, especially in the reduction of size and power consumption.

With this in mind, the ONR initiative is concerned with the advancement of key UUV-related technologies. ONR technology thrusts, which are in concert with the UUV master plan, include communication, navigation, energy, sensors and autonomy.

Smaller, lighter, more efficient systems with increased capacity and capability are needed in all of these areas. The good news is that the progress made to date, often demonstrated during at-sea exercises, has caught the attention of key personnel in the U.S. Navy, and the acceptance of UUVs in the battlespace is beginning. Combine this with the philosophical change by many in the Navy that expendability is acceptable, and the real benefit of small UUVs begins to appear.


Tomorrow's autonomous MCM system.

When many inexpensive vehicles are used to solve a problem, losses are acceptable, whereas losing one of the few current expensive UUVs could end one's career.

The battle cry "It's time to lose some UUVs" is not new, but now it is being heeded by a growing number within the Navy and cheered by the academic-based companies with their line of smaller UUVs.

Conclusions

Can the technology for UUVs be advanced further to where the vehicles can do a better job? The answer is "yes." Is this advancement necessary to field operational UUVs in the near future? The unequivocal answer is "no."

The technology is at hand. UUVs can achieve more, and in the future they will. Acceptance of UUVs and incorporating them into the battle group using today's technology is the primary barrier—one that finally appears to be falling.

The Navy is moving in the direction to reduce vulnerability of military personnel, especially divers. Today, VSW MCM is conducted by EOD divers.

By the end of this decade, UUVs will be in routine use by the U.S. Navy. Hundreds of vehicles will be launched into the sea on MCM and other military missions. The loss of a UUV on such a mission is a more acceptable scenario than loss of a diver. */st/*

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Robert L. Wernli has worked in the field of underwater robotics research and development at Space and Naval Warfare Systems Center, San Diego, since 1973. His work has focused on the development of advanced undersea work systems, manipulators and tools for use to full ocean depths by both manned and unmanned vehicles. He is a recipient of the Marine Technology Society's Special Commendation and Award, the Navy Meritorious Civilian Service Award and his center's prestigious Lauritsen-Bennett award, given annually for excellence in engineering. Wernli received a B.S. in mechanical engineering from the University of California Santa Barbara in 1973 and an M.S. in engineering design from San Diego State University in 1985.